Lecture Notes in Networks and Systems 119

Raghavendra Rao Chillarige
Salvatore Distefano
Sandeep Singh Rawat *Editors*

Advances in Computational Intelligence and Informatics

Proceedings of ICACII 2019

Springer

Lecture Notes in Networks and Systems

Volume 119

The series "Lecture Notes in Networks and Systems" publishes the latest developments in Networks and Systems—quickly, informally and with high quality. Original research reported in proceedings and post-proceedings represents the core of LNNS.

Volumes published in LNNS embrace all aspects and subfields of, as well as new challenges in, Networks and Systems.

The series contains proceedings and edited volumes in systems and networks, spanning the areas of Cyber-Physical Systems, Autonomous Systems, Sensor Networks, Control Systems, Energy Systems, Automotive Systems, Biological Systems, Vehicular Networking and Connected Vehicles, Aerospace Systems, Automation, Manufacturing, Smart Grids, Nonlinear Systems, Power Systems, Robotics, Social Systems, Economic Systems and other. Of particular value to both the contributors and the readership are the short publication timeframe and the world-wide distribution and exposure which enable both a wide and rapid dissemination of research output.

The series covers the theory, applications, and perspectives on the state of the art and future developments relevant to systems and networks, decision making, control, complex processes and related areas, as embedded in the fields of interdisciplinary and applied sciences, engineering, computer science, physics, economics, social, and life sciences, as well as the paradigms and methodologies behind them.

**** Indexing: The books of this series are submitted to ISI Proceedings, SCOPUS, Google Scholar and Springerlink ****

More information about this series at http://www.springer.com/series/15179

Raghavendra Rao Chillarige ·
Salvatore Distefano · Sandeep Singh Rawat
Editors

Advances in Computational Intelligence and Informatics

Proceedings of ICACII 2019

Springer

Editors
Raghavendra Rao Chillarige
School of Computer
and Information Sciences
University of Hyderabad
Hyderabad, Telangana, India

Sandeep Singh Rawat
Department of Computer Science
and Engineering
Anurag Group of Institutions
Hyderabad, Telangana, India

Salvatore Distefano
Dipartimento di Scienze Matematiche e
Informatiche, Scienze Fisiche e Scienze della
Terra—MIFT
University of Messina
Messina, Italy

ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-981-15-3337-2 ISBN 978-981-15-3338-9 (eBook)
https://doi.org/10.1007/978-981-15-3338-9

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Committee of ICACII 2019

Chief Patrons

Dr. Palla Rajeshwar Reddy, Chairman, Anurag Group of Institutions
Ms. S. Neelima, Secretary, Anurag Group of Institutions

Patrons

Dr. K. S. Rao, Director, Anurag Group of Institutions
Prof. M. Mutha Reddy, Dean of Examinations, Anurag Group of Institutions

General Chair

Dr. V. Vijaya Kumar, Dean, CSE and IT, Anurag Group of Institutions

Program Chair

Dr. G. Vishnu Murthy, Deputy Director, Anurag Group of Institutions

Convenor

Dr. Sandeep Singh Rawat, Professor, CSE, Anurag Group of Institutions

Steering Committee

Dr. Anuj Sharma, Iowa State University, USA
Dr. San Murugesan, Fellow IEEE, Adjunct Professor, Western Sydney University, Australia
Dr. X. Z. Gao, University of Eastern Finland, Finland
Dr. Amjad Gawanmeh, Khalifa University of Science and Technology, Abu Dhabi, UAE
Mr. Bala Prasad Peddigari, Technology Head, TCS, Hyderabad
Mr. M. Harikrishna, Lead Data Scientist, SpOvum Technologies Pvt. Ltd.
Mr. Neeraj Kapre, Capgemini, Hyderabad

Advisory Board—International

Prof. Dharma P. Agrawal, OBR Distinguished Professor, Fellow IEEE, University of Cincinnati, Cincinnati, USA
Dr. Chilukuri Mohan, Professor, Electrical Engineering and Computer Science, Syracuse University, USA
Dr. Ljiljana Trajkovic, Professor, Fellow IEEE, Simon Fraser University, Canada
Dr. Radim Burget, Sildenafil sales Brno University of Technology, Brno, seek sales Czech Republic, European Union
Dr. Thinagaran Perumal, University Putra Malaysia, Malaysia
Dr. Mohammad S. Obaidat, Professor, Fellow IEEE and Fellow IEEE SCS, The University of Jordan, Amman, Jordan
Dr. Salvatore Distefano, University of Messina, Italy
Dr. Alex James, Head, Electrical and Computer Engineering, Nazarbayev University, Republic of Kazakhstan
Dr. Joel J. P. C. Rodrigues, National Institute of Telecommunications (Inatel), Portugal
Dr. Xavier Fernando, Professor, Department of Electrical, Computer and Biomedical Engineering, Ryerson University, Canada
Dr. Kithsiri Liyanage, Professor, Department of Electrical and Electronic Engineering, University of Peradeniya, Sri Lanka
Dr. Shivakumara P., Senior Lecturer, Faculty of Computer Science and Information Technology, University of Malaysia, Malaysia
Dr. Michael Sheng, Head, Macquarie University, Sydney, Australia
Dr. P. N. Suganthan, Nanyang Technological University, Singapore
Dr. Vincenzo Piuri, Università degli Studi di Milano, Dipartimento di Informatica, Via Celoria, Italy
Dr. Khan M. Iftekharuddin, Old Dominion University (ODU), USA
Dr. Dhananjay Singh, School of Engineering, Hankuk (Korea) University of Foreign Studies (HUFS), South Korea

Advisory Board—National

Dr. A. Govardhan, Rector, JNTUH
Dr. S. V. L. Narasimham, Director—SIT, JNTUH
Dr. D. C. Jindwala, Professor, IIT Jammu
Dr. Naveen Kumar, Professor, IGNOU, New Delhi
Prof. V. Kamakshi Prasad, Director of Evaluation, JNTUH
Dr. B. Vishnu Vardhan, Professor, JNTUH
Dr. D. V. L. N. Somayajulu, Director, IIIT DM, Kurnool
Dr. P. Radha Krishna, Professor, NIT Warangal
Mr. Richard King Chatragadda, Tata Consultancy Services, Hyderabad
Prof. Atul Negi, School of CIS, University of Hyderabad, Hyderabad
Dr. Chandra Mouli PVSSR, NIT Jamshedpur
Dr. Satya Bagchi, NIT Durgapur
Mr. C. Yuktesh, IBM, Hyderabad
Dr. Kandarpa Kumar Sarma, Gauhati University, Assam
Dr. Suryakanth Gangashetty, IIIT Hyderabad
Dr. Rajesh R., Central University, Kerala
Dr. K. Chandra Sekharan, Professor, NITK
Dr. S. V. Rao, Professor, IIT Guwahati
Dr. M. Krishna Mohan, Professor, IIT Hyderabad
Dr. Salman Abdul Moiz, Associate Professor, University of Hyderabad, Hyderabad

Organizing Committee

Dr. M. Mutha Reddy, Dean—Examinations, AGI
Dr. Vasudha Bakshi, Dean, School of Pharmacy, AGI
Mr. Vidyasagar Tejomurtula, Chair, IEEE CS Chapter, Hyderabad Section
Dr. Manjanna, IIIT Dharwad
Dr. K. S. Reddy, Head—IT, AGI
Dr. A. V. Krishna Prasad, Professor, MVSR College of Engineering, Hyderabad
Dr. S. Satheeskumaran, Head—ECE, AGI
Dr. Selvakumar R., Senior Professor, VIT Vellore
Dr. Sunil B., Professor, SNIST, Hyderabad
Mr. Mohan Raidu, Director, Informatics India, Hyderabad
Dr. T. Anil Kumar, Head—EEE, AGI
Dr. Manjaiah, Mangalore University, Mangalore
Dr. R. Venkat Reddy, Mechanical Engineering, AGI
Dr. Savitha Belwal, Head—Chemistry, AGI
Dr. G. V. S. Anantha Lakshmi, Head—English, AGI
Dr. K. Shiva Reddy, Head—Mathematics, AGI
Dr. M. Srinivasa Reddy, Head—Physics, AGI

Dr. Soanpet Rajender, Professor, SCETW, Hyderabad
Dr. M. MukundaVani, Head—Chemical Engineering, AGI
Dr. G. Sabitha, Head—School of Management, AGI
Dr. A. Vimala, Head—Civil Engineering, AGI
Dr. Ahmed Abdul Moiz Qyser, Professor, MJCET, Hyderabad

Program Committee

Dr. G. Vishnu Murthy, Professor (Program Committee Chair)
Ms. M. Sridevi, Associate Professor
Ms. K Shailaja, Associate Professor
Ms. A. Jyothi, Associate Professor
Mr. P. Raja Shekar Reddy, Assistant Professor
Mr. K. Raghavendar Rao, Assistant Professor

Publication Committee

Dr. Sandeep Singh Rawat, Professor (Publication Committee Chair)
Mr. V. Rama Krishna, Associate Professor
Ms. M. Madhavi, Associate Professor
Mr. Dasu Vaman Ravi Prasad, Associate Professor
Ms. B. Jyothi, Assistant Professor
Ms. Veda Reddy, Assistant Professor

Publicity Committee—International

Dr. Tilottama Goswami, Professor, and Dr. C. Pavan Kumar, Associate Professor (Publicity Committee Chairs—International)
Ms. D. Lakshmi Padmaja, Associate Professor
Ms. P. Srilatha, Associate Professor
Ms. V. Jyothi, Associate Professor
Mr. P. Ravi, Assistant Professor
Mr. G. Bala Krishna, Assistant Professor

Publicity Committee—National

Dr. Prashanth Rao, Professor
Dr. A. Mallikarjuna Reddy, Associate Professor
Ms. G. Bindu Madhavi, Associate Professor
Ms. N. Swapna Goud, Associate Professor
Mr. B. Ravinder Reddy, Assistant Professor
Ms. A. Durga Bhavani, Assistant Professor
Mr. G. Balram, Assistant Professor

Sponsorship Committee

Mr. P. Ravinder Rao, Associate Professor (Sponsorship Committee Chair)
Mr. J. Siva Prashanth, Associate Professor
Ms. S. Deepika, Assistant Professor
Mr. M. Ravi Kishore, Assistant Professor

Accommodation Committee

Dr. A. Obulesh, Associate Professor (Accommodation Committee Chair)
Mr. V. Amarnadh, Assistant Professor
Mr. Jayendra Kumar, Assistant Professor
Mr. Madar Bandu, Assistant Professor
Mr. Hari Prasad, Assistant Professor

Organizing Committee—Local

Mrs. B. Ujwala, Assistant Professor
Mr. G. Kiran Kumar, Assistant Professor
Ms. P. Vinay Sree, Assistant Professor
Ms. G. Lavanya, Assistant Professor
Mr. V. Rama Krishna, Assistant Professor
Ms. P. Rajeshwari, Assistant Professor
Mr. Ravinder Naik R., Assistant Professor
Ms. M. Sandhya Rani, Assistant Professor
Ms. J. Hima Bindu Priyanka, Assistant Professor
Mr. K. Naresh, Assistant Professor
Ms. K. Shanthi Latha, Assistant Professor

Ms. Ch. Hyma, Assistant Professor
Mr. K. Shravan Kumar, Assistant Professor
Mr. N. Ravi, Assistant Professor

Technical Program Committee

Prof. P. V. Sudha, Osmania University, Hyderabad, India
Prof. S. Sameen Fathima, Osmania University, Hyderabad, India
Dr. Sabrina Senatore, University of Salerno, Italy
Dr. P. S. V. S. Sai Prasad, University of Hyderabad, Hyderabad, India
Dr. A. Nagaraju, Central University of Rajasthan, India
Dr. Khaleel Ahmad, Maulana Azad National Urdu University, Hyderabad, India
Dr. Pardeep Kumar, Presidency University, Bangalore, India
Dr. Imran Qureshi, Sultanate of Oman, Oman
Dr. Samiksha Shukla, Christ University, Bangalore, India
Dr. Raju G., Christ University, Bangalore, India
Dr. Amit Kanchi, Whirlpool Corporation, Michigan, USA
Dr. Prabhjot Singh, Michigan Technological University, USA
Dr. Mahardhika Pratama, Nanyang Technological University (NTU), Singapore
Dr. G. R. Sinha Professor, Myanmar Institute of Information Technology (MIIT), Myanmar
Prof. T. Adi Lakshmi, Vasavi College of Engineering, Hyderabad, India
Dr. M. Nageswar Rao, K L University, Vijayawada, India
Dr. Sandhya Banda, MVSREC, Hyderabad, India
Dr. P. Subhashini, MLRIT, Hyderabad, India
Dr. S. Ramakrishna, Bapatla Engineering College, Bapatla, India
Dr. N. Swapna, CMRTC, Hyderabad, India
Dr. M. Venu Gopalachari, CBIT, Hyderabad, India
Dr. P. M. Mallikarjuna Shastry, REVA University, India
Dr. K. Ravindranath, K L University, Vijayawada, India

Preface

This LNNS series contains 45 papers presented at the 1st International Conference on *Advances in Computational Intelligence and Informatics* (ICACII 2019) held during December 20–21, 2019, at Anurag Group of Institutions, Hyderabad.

The focus of 1st ICACII 2019 is to provide an opportunity for all the professional and aspiring researchers, scientists, academicians and engineers to exchange their innovative ideas and new research findings in the field of computational intelligence and informatics. This conference provides a platform for these personnel, participants, researchers, students and other distinguished delegates to share their research expertise, experiment breakthroughs or vision in a broad criterion of several emerging aspects of computing industry. It received a total of 160 submissions from the different areas related to computational intelligence and informatics in main tracks, and after a rigorous peer review process with the help of our technical program committee members and external reviewers finally we accepted 45 submissions with an acceptance rate of 28.12%.

ICACII 2019 was inaugurated by Hon'ble Professor and Rector—JNTUH, Dr. A. Govardhan. We take this opportunity to thank all keynote and plenary speakers and session chairs for their excellent support to make ICACII 2019 a grand success. We would like to thank all reviewers for their time and effort in reviewing the papers. Without this commitment, it would not be possible to have the important 'referee' status assigned to papers in the proceedings. The quality of these papers is a tribute to the authors and also to the reviewers who have guided any necessary improvement. We are indebted to the technical program committee members and external reviewers who not only produced excellent reviews but also did in short time frames.

We would also like to thank the authors and participants of this conference. A special thank to all the volunteers; without their tireless effort, we could not arrange every detail to make the conference run smoothly. All the efforts are worth and would please us all if the readers of this proceedings and participants of this conference found the papers and event inspiring and enjoyable.

Finally, we place our special sincere thanks to the press, print and electronic media for their excellent coverage of this conference.

Hyderabad, India	Dr. Raghavendra Rao Chillarige
Messina, Italy	Dr. Salvatore Distefano
Hyderabad, India	Dr. Sandeep Singh Rawat

Contents

Editors and Contributors

About the Editors

Dr. Raghavendra Rao Chillarige is a Professor at the School of Computer & Information Sciences (SCIS), University of Hyderabad. He received his bachelor's degree from Andhra University, and his master's and Ph.D. from Osmania University, Hyderabad. A Fellow of the IETE, APAS and senior member of the IRSS, his interests include operations research, stochastic processes, computer graphics, artificial intelligence and rough computing. He is a Professional Member of the ACM, Society for the Development of Statistics, Indian Society for Probability and Statistics, Indian Mathematical Society, and many more.

Dr. Salvatore Distefano is an Associate Professor at the University of Messina, Italy, and Fellow Professor at Kazan Federal University, Russia, as well as Head of the Social and Urban Computing Group and of the Cisco Innovation Center in Kazan. He received his master's degree in Computer Engineering from the University of Catania, and his Ph.D. in Computer Science and Engineering from the University of Messina, in 2001 and 2006. Dr. Salvatore has authored or co-authored more than 200 scientific papers and contributions to international journals, conferences and books. He has 16 years of experience in teaching, research, consultancy and curriculum development.

Dr. Sandeep Singh Rawat is a Professor at the Computer Science & Engineering Department, Anurag Group of Institutions, Hyderabad. He received his bachelor's degree in Computer Science & Engineering from the National Institute of Technology, Surat (formerly REC, Surat), his master's from the Indian Institute of Technology, Roorkee, and his Ph.D. from the University College of Engineering, Osmania University, Hyderabad. Dr. Sandeep was a Research Scholar and Visiting Professor at Iowa State University, USA, from 2016 to 2018. His areas of expertise include knowledge extraction, information systems & machine learning, databases, information retrieval, data warehousing, cloud computing and group decision support systems. He has published numerous papers in national and international journals and conference proceedings.

Contributors

K. Adi Narayana Reddy BVRITH College of Engineering for Women, Telangana, India

Adedeji Afolabi Department of Building Technology, Covenant University, Ota, Nigeria

Ibukun Afolabi Department of Computer and Information Sciences, Covenant University, Ota, Nigeria

Pranshu Agarwal Department of Computer Science Engineering, Graphic Era University, Dehradun, India

Ravin Ahuja Shri Vishwakarma Skill University, Gurgaon, India

V. Akila Pondicherry Engineering College, Puducherry, India

Faith Akinbo Department of Building Technology, Covenant University, Ota, Nigeria

Aditya Allamraju CSSTEAP, Indian Institute of Remote Sensing (IIRS/ISRO), Dehradun, India

A. Anil Kumar Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, India

Abraham Ayegba Alfa Kogi State College of Education, Ankpa, Nigeria

Srinivasu Badugu Department of Computer Science and Engineering, Stanley College of Engineering and Technology for Women, Hyderabad, India

G. Balakrishna Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

G. N. Beena Bethel CSE Department, GRIET, Hyderabad, India

Kharimah Bimbola Ahmed Kogi State College of Education, Ankpa, Nigeria

Achem Bumojo University of Nigeria, Nsukka, Nigeria

K. V. Chalapati Rao CVR College of Engineering, Ibrahimpatnam, Hyderabad, India

Muskan Chaudhary Department of Computer Science Engineering, Graphic Era University, Dehradun, India

Ameet Chavan Department of ECE, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana, India

V. Dattatreya CVR College of Engineering, Ibrahimpatnam, Hyderabad, India

Sirmoria Deepika Anurag Group of Institution, Hyderabad, India

Priyaranjan Gangula Srinivasa Ramanujan Institute of Technology, Anantapur, Andhra Pradesh, India

Siddhartha Ghosh Department of CSE, Vidya Jyothi Institute of Technology, Hyderabad, India

A. Govardhan JNTUH, Kukatpally, Telangana, India

V. Govindasamy Pondicherry Engineering College, Puducherry, India

Zameer Gulzar BSAR Crescent Institute of Science and Technology, Chennai, India

Mohammed Abdul Habeeb Department of Information Technology Sultanate of Oman, AlMusanna College of Technology, Al Muladdah, Oman

Yashodhara Haribhakta College of Engineering Pune, Pune, India

Adeed Ishaq The University of Lahore, Lahore, Pakistan

Muralikrishna Iyyanki Defence Research and Development Organisation, Hyderabad, India

M. Jayanthi Mahatma Gandhi University Nalgonda, Nalgonda, India

Prisilla Jayanthi Department of Computer Science and Engineering, K G Reddy College of Engineering and Technology, Moinabad, Hyderabad, India

V. Jeevika Tharini Department of Computer Science, Bharathiar University, Coimbatore, India

P. Joshua Ernest Department of ECE, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana, India

Syam Kakarla Srinivasa Ramanujan Institute of Technology, Anantapur, Andhra Pradesh, India

M. Kameswara Rao Department of Computer Science and Engineering, Annamalai University, Chidambaram, India

G. S. Karthick Department of Computer Science, Bharathiar University, Coimbatore, Tamil Nadu, India

J. Kavya Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

Shahebaz Ahmed Khan Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India

Thayyaba Khatoon Mohammed MRCET, Medchal, Telangana, India

Hi-Seok Kim Department of Electronic Engineering, Cheongju University, Cheongju, South Korea

B. Kishore PhD Scholar, Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya University, Kanchipuram, India;
Professor of Practice, EECS, Oregon State University, Corvallis, USA

Ramakrishna Kolikipogu Department of Research and Development, Stanley College of Engineering and Technology for Women, Hyderabad, India;
Department of IT, Stanley College of Engineering and Technology for Women, Hyderabad, India

Nilesh Kulkarni Department of EXTC Engineering, Sinhgad Institutes, Pune, India

Raghavendra Kulkarni Department of Computer Science, Bhagwant University, Ajmer, Rajasthan, India

Naveen Kumar IGNOU, New Delhi, India

B. Lakshmi Sucharitha JNTUH, Hyderabad, Telangana, India

V. Maheshwar Reddy ACE Engineering College, Telangana, India

Manikanta Prahlad Manda Department of Electronic Engineering, Cheongju University, Cheongju, South Korea

Prathamesh Mane College of Engineering Pune, Pune, India

Kaushik Mazumdar Department of Electronics and Communication Engineering, Gauhati University, Jalukbari, Assam, India

Sanjay Misra Department of Computer Engineering, Covenant University, Ota, Nigeria

Burhanuddin Mohammad Department of Information Technology Sultanate of Oman, AlMusanna College of Technology, Al Muladdah, Oman

Ch. Mounica Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

Roshan Nalawade College of Engineering Pune, Pune, India

Kandula Neha Department of CSE, Vidya Jyothi Institute of Technology, Hyderabad, India

Rahul Nijhawan Department of Computer Science Engineering, Graphic Era University, Dehradun, India

Avuku Obulesu Anurag Group of Institution, Hyderabad, India

ByeongCheol Oh Department of Electronic Engineering, Cheongju University, Cheongju, South Korea

Modebola Olowu University of Lagos, Akoka, Lagos, Nigeria

Jonathan Oluranti Covenant University, Ota, Nigeria

P. Padmavathy BSAR Crescent Institute of Science and Technology, Chennai, India

S. Pakkir Mohideen BSAR Crescent Institute of Science and Technology, Chennai, India

P. B. Pankajavalli Department of Computer Science, Bharathiar University, Coimbatore, Tamil Nadu, India

Saurabh Parhad Department of EXTC Engineering, Sinhgad Institutes, Pune, India

ChanSu Park Department of Electronic Engineering, Cheongju University, Cheongju, South Korea

K. Pattabiraman Department of Mathematics, Government Arts College (A), Kumbakonam, India;
Department of Mathematics, Annamalai University, Annamalai Nagar, India

C. V. Pavan Kumar Department of Mathematics, Apex Math Excel Center, Carolina, USA

B. Pavitra Jaipur National university, Jaipur, India

J. Prasanna Kumar MVSR Engineering College, Hyderabad, India

Ch. Pravallika Reddy Mahatma Gandhi University Nalgonda, Nalgonda, India

Imran Qureshi Department of Information Technology Sultanate of Oman, AlMusanna College of Technology, Al Muladdah, Oman

Naila Rafique The University of Lahore, Lahore, Pakistan

M. Raghava CVR College of Engineering, Ibrahimpatnam, Hyderabad, India

Ch. V. Raghavendran Department of IT, Aditya College of Engineering & Technology, Surampalem, EGDt, Andhra Pradesh, India

Abdul Rahiman Research Scholar, Department of Computer Science, Rayalaseema University, Kurnool, Andhra Pradesh, India

T. V. Rajinikanth CSE Department, SNIST, Hyderabad, India

K. Ramesh Anurag Group of Institutions, Hyderabad, Telangana, India

Rajasekhar Rangasamy St. Peters Engineering College, Medchal, Telangana, India

G. Ranjith Kumar Anurag Group of Institutions, Hyderabad, Telangana, India

I. Ravi Prakash Reddy G. Narayanamma Institute of Technology and Science, Telangana, India

B. Ravinder Reddy Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, India

Sandeep Rawat Department of Computer Science & Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

V. S. K. Reddy MRCET, Medchal, Telangana, India

Thimmaraju Rishwi Anurag Group of Institution, Hyderabad, India

Anuradha Salvi Department of EXTC Engineering, Sinhgad Institutes, Pune, India

B. Sandhya MVSR Engineering College, Hyderabad, India

S. G. Santhi Department of Computer Science and Engineering, Annamalai University, Chidambaram, India

Alakesh Sarkar Department of Electronics and Communication Engineering, Gauhati University, Jalukbari, Assam, India

Kandarpa Kumar Sarma Department of Electronics and Communication Engineering, Gauhati University, Jalukbari, Assam, India

T. Hitendra Sarma Srinivasa Ramanujan Institute of Technology, Anantapur, Andhra Pradesh, India

J. Sasi Kiran Farah Institute of Technology, Chevella, India

Syed Abdul Sattar Department of Computer Science, Nawab Shah Alam Khan College of Engineering & Technology, Hyderabad, India

V. Seethalakshmi Pondicherry Engineering College, Puducherry, India

S. G. M. Shadab Department of Information Technology Sultanate of Oman, AlMusanna College of Technology, Al Muladdah, Oman

K. Shailaja Department of Computer Science & Engineering, Anurag Group of Institutions, Ranga Reddy (Dist.), Venkatapur, Hyderabad, Telangana, India

Kalpana Sharma Department of Computer Science, Bhagwant University, Ajmer, Rajasthan, India

Vishnu Dutt Sharma Department of Computer Science, Shri Jagdish Prasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India

Sudhir Kumar Sharma Jaipur National university, Jaipur, India

K. Shiva Reddy Anurag Group of Institutions, Hyderabad, Telangana, India

Muhammad Shoaib The University of Lahore, Lahore, Pakistan

Samikshal Shukla CHRIST (Deemed to be University), Lavasa, Pune, India

C. Sai Charan Singh Srinivasa Ramanujan Institute of Technology, Anantapur, Andhra Pradesh, India

Kamakhya Narain Singh School of Computer Applications, KIIT Deemed University, Bhubaneswar, India

D. Narendar Singh Anurag Group of Institutions, Hyderabad, India

P. Sita Sowjanya MVSR Engineering College, Hyderabad, India

P. Srilatha Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

M. N. Srinivas Department of Mathematics, Vellore Institute of Technology, Vellore, India

Hari Shanker Srivastava Indian Institute of Remote Sensing (IIRS/ISRO), Dehradun, India

A. Subhananda Rao Department of ME, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana, India

Rubeena Sultana Department of Computer Science & Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

Aerpula Swetha Department of Computer Science & Engineering, Anurag Group of Institutions, Ranga Reddy (Dist.), Venkatapur, Hyderabad, Telangana, India

Anjan Kumar Talukdar Department of Electronics and Communication Engineering, Gauhati University, Jalukbari, Assam, India

Kavita Tewani Computer Science and Engineering Department, Institute of Technology, Nirma University, Ahmedabad, Gujarat, India

Vaishali S. Vairale CHRIST (Deemed to be University), Kengeri Campus, Bangalore, Karnataka, India

B. Venkataramana Department of CSE, HITS, Hyderabad, Telangana, India

V. Vijaya Kumar Professor & Dean, Department of CSE & IT, Aurag Group of Institutions, Hyderabad, Telangana, India

S. Vijayarani Department of Computer Science, Bharathiar University, Coimbatore, India

G. Vishnu Murthy Department of Computer Science & Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India

S. Viswanadha Raju CSE Department, JNTUHCEJ, Jagityal, Telangana, India

Santosh Kumar Yadav Department of Computer Science, Shri Jagdish Prasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India

Sumit Kumar Yadav Department of Computer Science, IGDTUW Delhi, New Delhi, India

Rutuja Yedke College of Engineering Pune, Pune, India

Chika Yinka-Banjo University of Lagos, Akoka, Lagos, Nigeria

Extraction of Tumor Chunk Using Image Segmentation: Thresholding and HSV Color Space

Prisilla Jayanthi and Muralikrishna Iyyanki

Abstract Hue–saturation–value (HSV) color space has proved efficiently by extracting a colored object using image segmentation. The study involves extracting the image, tumor chunk from brain tumor X-ray, or MRI for further analysis—brain tumor type, size, and duration of the tumor. Applying image blur and erosion segments the tumor in the image. The segmentation deals with the intensive study of the image dataset where convolution and thresholding take place. The more number of epochs is applied for training the brain tumor image; the better, accurate, and efficient results are obtained. In this study, the results showed the difference for the epochs applied as 20 and 50 with steps per epochs as 2000 and 8000. Hence, HSV color space thresholding produced 99% accuracy in extracting the image. The least loss: 0.0032 and best accuracy: 0.9993 were obtained on training the image dataset for 50 epochs.

Keywords Accuracy · Color space · Image · Pixels · Segmentation · Thresholding

1 Introduction

Image segmentation (IS) is the technique of segmenting the image for further deeper analyzing. Retrieval of the content-based image, object recognition, compression, editing and recognition of images, and medical imaging are few practical application of segmentation. The image analysis depends totally on the consistency of segmentation, but image partitioning happens to be a challenge.

The segmentation techniques are of two types, namely contextual and non-contextual. Firstly, contextual groups pixels of nigh likeness gray levels and near

P. Jayanthi (✉)
Department of Computer Science and Engineering, K G Reddy College of Engineering and Technology, Moinabad, Hyderabad, India
e-mail: prisillaj28@gmail.com

M. Iyyanki
Defence Research and Development Organisation, Hyderabad, India
e-mail: iyyanki@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_1

spatial locations relationship. Next, non-contextual considers no information about the spatial relationships between image features and groups pixels based on a definite global attribute. Thresholding is a technique of non-contextual segmentation with a nonlinear operation that converts an image from gray scale into a binary. The procured binary image reduces the data complexity and throws light on image recognition and classification.

1.1 Contextual Segmentation

This involves separating individual objects as it is intended for pixels closeness that belongs to an individual object. The segmentation emphasizes discontinuity of signal and similarity. Identifying the boundaries by encircling within the uniform regions and visualizing the abrupt signal changes through each boundary are discontinuity-based technique. Similarity-based is the region created uniformly by grouping together all similar pixels that satisfies definite criteria. Two methods reflect each other and hold responsible for a complete one region boundary splits into two parts.

1.2 Non-contextual Segmentation

Non-contextual groups pixels with no regard to the relative locations of the image plane, and grouping pixels is carried out based on the definite attribute.

1.2.1 Thresholding

The simpler technique of non-contextual segmentation is where the transformation of grayscale image to binary is known as binary region map (BRM). The two disjoint regions of BRM are one that has input data pixel values lesser than threshold and other the pixels values with the same value of threshold or greater. The two levels assigned to pixels are below or above the specified threshold value, i.e., if a pixel value is above the threshold value, it is assigned one value for white, and other is assigned black. The gray-level pixel thresholding is given as follows: $p(a, b) = 0$ if $q(a, b) < \mathrm{Th}$ and $p(a, b) = 1$ if $q(a, b) \geq \mathrm{Th}$, where Th represents the threshold. Two thresholds, $\mathrm{Th}_1 < \mathrm{Th}_2$, gray-level region1 range is given as $p(a, b) = 0$ if $q(a, b) < \mathrm{Th}_1$ or $q(a, b) > \mathrm{Th}_2$ and $p(a, b) = 1$ if $\mathrm{Th}_1 \leq q(a, b) \leq \mathrm{Th}_2$.

The use of gray level is carried out at higher gradient regions and is known for data to interpolate the threshold surface of image document texture features [1].

1.2.2 Color Thresholding

Color segmentation gives more accurate information at the pixel level when analyzing with gray images. Hue–saturation–lightness (HSL), hue–saturation–intensity (HSI), HSV, or other models are used for feature detection or IS. The robust interrelated color components are present in red–green–blue (RGB) standard color, while other colors (HSI) reduce redundancy, decide the actual object/background colors regardless of illumination, and achieve better stable segmentation. The color space partitioning in RGB or HSI is performed out by division of color images. The method is established on a leading color (R_0, G_0, B_0) and Cartesian distances threshold from each pixel color $f(a,b) = (R(a,b), G(a,b), B(a,b))$:

$$g(a,b) = \begin{cases} 1 \text{ if } d(a,b) \le d_{\max} \\ 0 \text{ if } d(a,b) > d_{\max} \end{cases} \quad d(a,b) = \sqrt{(R(a,b) - R_0)^2 + (G(a,b) - G_0)^2 - (B(a,b) - B_0)^2}$$

where $g(a, b)$ represents the BRM after the process of thresholding.

The principles of thresholding define a sphere in RGB space as focused on the reference color. If the pixels are placed inner of the sphere, then those are referred to region 1 and region 0 has other pixels [2].

HSV Color Space

For applying multiple masks, isolation of colors is needed. The three components of HSV color space are—hue/dominant wavelength, saturation, and value. A lower threshold and higher threshold mask for these modules are considered. Any pixel within these thresholds will be set to 1, and the remaining pixels will be zero.

Both the transformations, HSL and HSV of RGB maintain symmetries, and the curves of R, G, and B are equally set from the midway of neutral axis. On plotting the RGB scale, a uniform space is obtained, and it is lucid that the primaries of red, green, and blue do not have any same lightness or evenly spaced hues [3].

2 Previous Work

Maiti and Chakraborty (2012) initiated an approach for brain tumor segmentation. The combination of the watershed method with edge detection operation was used. The algorithm used brain MRI images in HSV color space. Later, for the output image, a canny edge detector was applied [4]. Sural (2002) analyzed HSV characteristics with variation values in HSI color space of an image pixel. The implementation of feature extraction was carried out on content-based image retrieval method named Image Segmentation and histogram generation [5]. Prisilla and Iyyanki (2018) have proposed an algorithm that detects tumors in brain tumors MRI digital images. The algorithm is based on convolutional neural network and object recognition and that does automatic detection [6].

Panchhi (2013) in their study implemented the Grab cut approach based on graph cut optimization that was implemented by Rother (2004) [7]. Grab cut is a technique and variation of Grab cut was applied on other color models [8]. Taneja (2015) implemented image-based applications that require an efficient segmentation process in their work. The two methods are intensity and texture-based segmentation that produced better results [9].

3 Experimental Findings

This study is an extension of object detection which was proposed by the authors using CNN model and is carried out in python. For this study, the brain tumor images were obtained from Omega Hospital, Hyderabad. For extracting an object from the image, i.e., tumor chunk from the brain tumor image, the following steps are involved:

1. Read the gray color image as input image.
2. Conversion of gray image to RGB or BGR.
3. Next, conversion of RGB/BGR image to HSV.
4. By image blurring, i.e., convolving image with a low-pass filter kernel on the HSV.
5. Apply erosion for eroding away the boundaries of foreground object.
6. Compare the extracted results with RGB or BGR or gray model.

4 Analysis and Results

The extracted segmented results using thresholding and HSV color space are shown in Fig. 1. The extracted image in green color can be seen in the left bottom most of each brain tumor image with the black background.

Outcome
This is obtained by applying a low-pass filter kernel and convolving image blurring to each tumor image. Image blurring eliminates noise and high-frequency content from the image. Moreover, applying Gaussian blurring is highly potent in removing Gaussian noise from the image. During the tumor extraction, the loss and accuracy were computed on training the tumor image for epochs of 20 and 50 for the steps of 2000 and 5000 as shown in Tables 1 and 2, respectively. On observation, the accuracy and loss are found to be better when the datasets were trained for 50 epochs.

The pictorial representation of the image training can be seen in Fig. 2. The sum of all the errors obtained from each image in training or/and validation sets is known as loss. The loss is computed on image training and infers that the CNN model is

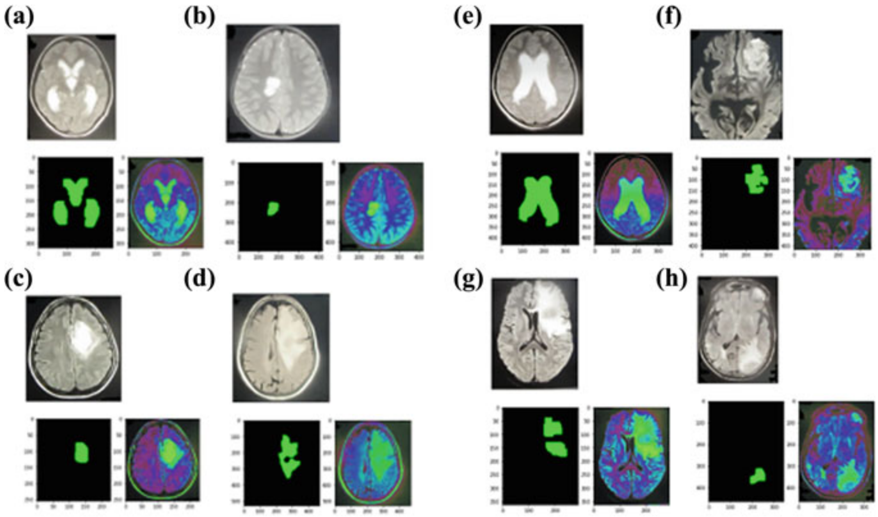


Fig. 1 Results of extracted image

Table 1 Image training for 20 epochs

E→2000	Time (s)	Speed (ms/step)	*L*	Acc.
1/20	629	315	0.4127	0.8289
2/20	699	350	0.2865	0.8820
19/20	559	280	0.0129	0.9959
20/20	547	287	0.0136	0.9958

E: epoch, *L:* loss

Table 2 Image training for 50 epochs

E→8000	Time (s)	Speed (ms/step)	*L*	Acc.
1/50	2410	301	0.2438	0.8997
2/50	2335	292	0.0470	0.9833
49/50	2369	296	0.0035	0.9992
50/50	2335	292	0.0032	0.9993

E: epoch, *L:* loss

performing well, lesser the loss, a better result with minimum error is obtained [10]. On the other end, if the accuracy increases, then the model is learning well. If the loss decreases, the training process is functioning well. Figure 3 shows the enhanced result of an extract image with the grid lines to locate exactly the position of the tumor.

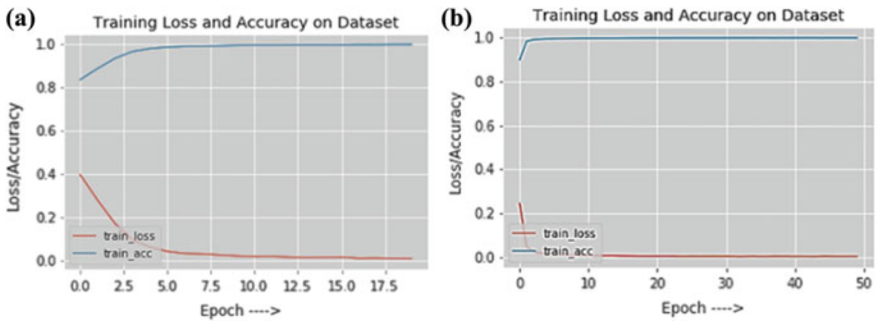


Fig. 2 Graphical representation for 20 (**a**) and 50 (**b**) epochs

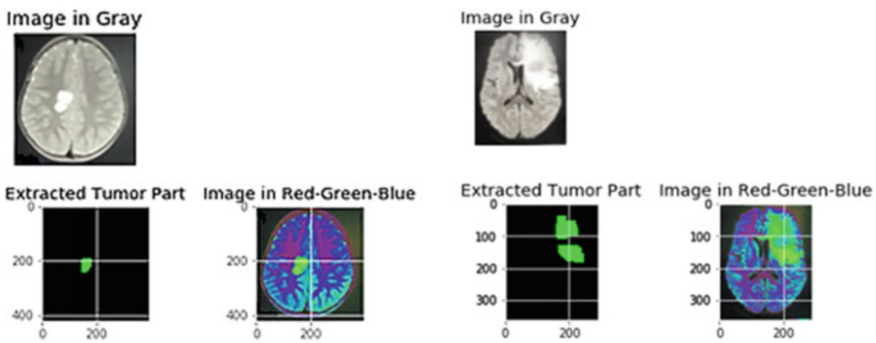


Fig. 3 Position of extracted tumor chunk

5 Conclusion

In this study, the experiment was carried out by an application of HSV color space, and the frame was developed using image segmentation and graphical representation. To decide if the pixel intensity is very closer to person observation color or not, the approach uses HSV pixel. When $v = 0$, or $v = 1$, all the colors approach to black, be it the hue or the saturation. On training the brain tumor image datasets, the best accuracy: 0.9993 and loss: 0.0032 were achieved, and hence, the model is assumed to be a good overfitting model. And using HSV, extracting the tumor part was 99% accurate.

References

1. Leedham G, Yan C, Takru K, Tan JHN, Mian L (2010) Thresholding algorithms for text/background segmentation in difficult document images (ICDAR 2010)

2. https://www.cs.auckland.ac.nz/courses/compsci773s1c/lectures/ImageProcessing-html/topic3.htm
3. Efford N (2000) Digital image processing: a practical introduction using Java^{TM}. Pearson Edn., United kingdom
4. Maiti I, Chakraborty M (2012) A new method for brain tumor segmentation based on watershed and edge detection algorithms in HSV colour model. In: NCCCS, IEEE. https://doi.org/10.1109/ncccs.2012.6413020
5. Sural S, Qian G, Pramanik S (2002) Segmentation and histogram generation using the HSV color space for image retrieval. In: Proceedings of international conference on image processing, IEEE. https://doi.org/10.1109/icip.2002.1040019
6. Prisilla J, Iyyanki MK (2018) Convolution neural networks: a case study on brain tumor segmentation in medical care. In: Proceedings of International Conference on ISMAC-CVB. Springer Nature Switzerland AG
7. Rother C, Kolmogorov V, Blake A (2004) GrabCut: interactive foreground extraction using iterated graph cuts. ACM Trans SigGraph 23:309–314
8. Panchhi P, Jain A, Kaushik S (2013) Extraction of foreground in Images with similar background using Grab Cut in HSV color space. In: Proceedings of International Conference on Emerging Trends in Engineering and Technology. 03.AETS.2013.3.121 (Association of Computer Electronics and Electrical Engineers)
9. Taneja A, Ranjan P, Ujjlayan A (2015) A performance study of image segmentation techniques, IEEE. 978-1-4673-7231-2/15/$31.00
10. Jason B (2019) Deep learning performance. https://machinelearningmastery.com/loss-and-loss-functions-for-training-deep-learning-neural-networks/

Predictive and Interactive IOT Diagnosis System with AI and ML Tools: Review

B. Pavitra, D. Narendar Singh and Sudhir Kumar Sharma

Abstract Alzheimer's disease is a common and tremendous growing neuron-based disease over the globe. Several biomedical devices for the detection and prediction of Alzheimer's disease with IOT-based remote monitoring system were developed. For optimization and accurate Alzheimer's disease prediction, a new wearable IOT framework is designed and developed by integrating electroencephalogram (EEG) and electromyography (EMG) sensors by interfacing machine learning and neural network algorithms. Data collected from EEG and EMG wearable sensors devices is stored on the cloud database. Machine learning and AI algorithm are applied to analyze on stored data to diagnosis Alzheimer's disease and neural network algorithm applied for optimization of diagnosis of Alzheimer's disease. Obtained result is shared with patients' caretaker and doctor through designed IOT system to avoid and rescue the patient to escalate the next stage of disease. System is also designed to interact and monitor the patient.

Keywords EEG · EMG · AD · IOT · AI and sensors

1 Introduction

Alzheimer's disease (AD) is one of the most affected brain diseases that is characterized by impairment of memory and disturbances in reasoning, planning, language, and perception. AD leads for a gradual decline of alternative intellectual and thinking talents, known as psychological feature functions, and changes in temperament or behavior although cancer and vascular diseases are one among the foremost dearly won diseases. Alzheimeir's disease is most frequently attacking to cause the death. It is a neurodegenerative did order causing for loss of memory with psychological impairment [1, 2]. It is predicted that the disease may be doubled in next twenty

B. Pavitra · S. K. Sharma (✉)
Jaipur National university, Jaipur, India
e-mail: sudhir.732000@gmail.com

D. N. Singh
Anurag Group of Institutions, Hyderabad, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_2

years [3]. AD is commonly seen in elder persons. Early symptoms may be reliable and valid to diagnosis the prediction of disease at early stage to identify the severity of the disease. As mentioned in reference paper [4], physcological defects are determined for identifying the severity of the patient. As per World Health Organization (WHO), it is expected that by the year 2030 six million population will be victimed, and by 2050 it is expected that 135.5 million population are affected by AD. Report also mentions that most AD patient countries will be India, China, South Asia, and Western Pacific Countries [5]. EEG and EMG signals are used for predicticing early diagnosis of the AD; to improve the diagnosis accuracy process, both EEG and EMG signal are used. The myogram signals and alternative factors are determined through a Python program designed to run in Console mode through a SSH affiliation. Some solutions rely upon an affiliation to a private PC [6, 7] or a smartphone [8] for the observance and the results of the myoelectric activity. There are systems that permit associate degree autonomous practicality, with associate degree embedded screen for observance [8, 9]. These devices have allowed for substantial advances in assisted rehabilitation reception, wherever the patient will follow a collection of controlled exercises while not the requirement of a caretaker.

2 Literature Survey

2.1 Title: Alzheimer's Patients Tracking Gadget Device [7]

Objective: To track Alzheimer's patients
Technology: Wearable technology
Methodology: Embedded systems
Process/Algorithm: UWD
Components/Inventory: MEMS, GPS, GSM
Implementation: As shown in Fig. 1, a real-time patient monitoring system was designed and developed. An analysis of the tracking systems has been performed, describing the technical shortcomings of the present methodology.

2.2 Title: Detection of Alzheimer's Disease Using DTW Algorithm [8]

Objective: The leg movement is monitored to diagnosis the early stage of Alzheimer's disease
Technology: IOT and machine learning algorithm
Methodology: Machine learning with IOT technology
Process/Algorithm: Dynamic time warping (DTW) algorithm

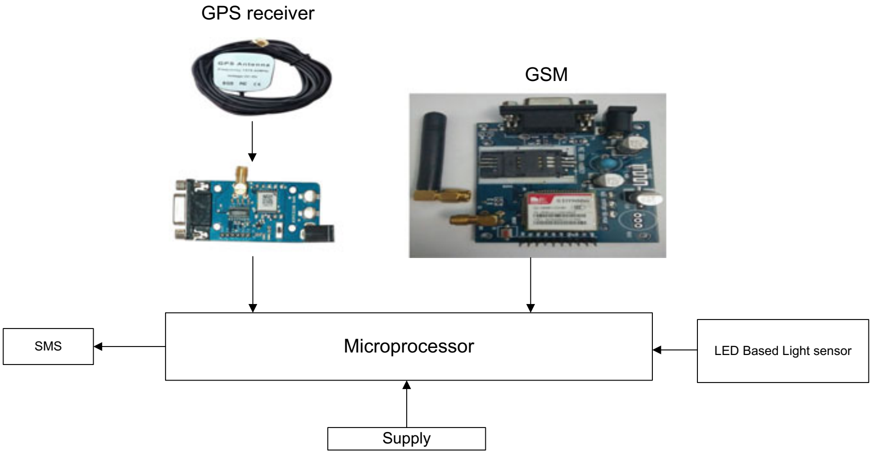


Fig. 1 Block diagram of Alzheimer's patients tracking gadget device

Components/Inventory: Camera, sensors, and motion detector sensor
Implementation: As shown in Fig. 2, the DTW algorithm compares the different shapes of gait signals collected from patients of AD and warped them on time. The changes in the leg movement are identified with the help of cross function.

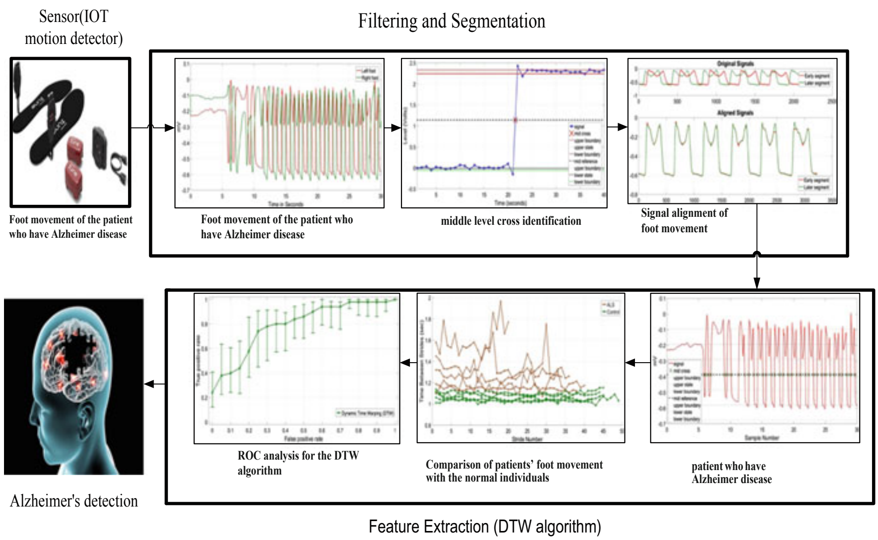


Fig. 2 Block diagram of early detection of Alzheimer's disease DWT

Fig. 3 Block diagram of health monitoring of elderly through wearable sensors

2.3 Title: Remote Health Monitoring System for Elderly Persons [9]

Objective: Developed an intelligent remote health monitoring device, which is used to observe old people remotely
Methodology: IOT-based remote monitoring system
Process/Algorithm: Ambient assistive living
Components/Inventory: Mobile unit, Internet, and wearable sensors
Implementation: As shown in Fig. 3, collected data from wearable sensors is transferred to cloud database through gateway server to check abnormalities of the collected data. Reports are generated after diagnosis; if any abnormality is found, the same report is shared with patient's doctor and caretakers to monitor the health (e.g., hospital) with respect to the privacy and authentication of the data.

If any abnormal report, it will be reported to patient's doctors via hospital mobile application. SW-SHMS architecture is flexible and scalable so that it can be expanded easily, by providing reliable and cost-effective systems to monitor patients remotely.

2.4 Title: EEG-Based Diagnosis of Alzheimer's Disease [10]

Objective: Diagnosis of AD with EEG signals
Technology: IOT and amplitude modulation
Methodology: AI with MATLAB technology
Process/Algorithm: Spectral power-based features (SPBF) were used
Components/Inventory: EEG sensors, MATLAB toolbox, and interactive graphics user interface (GUI)

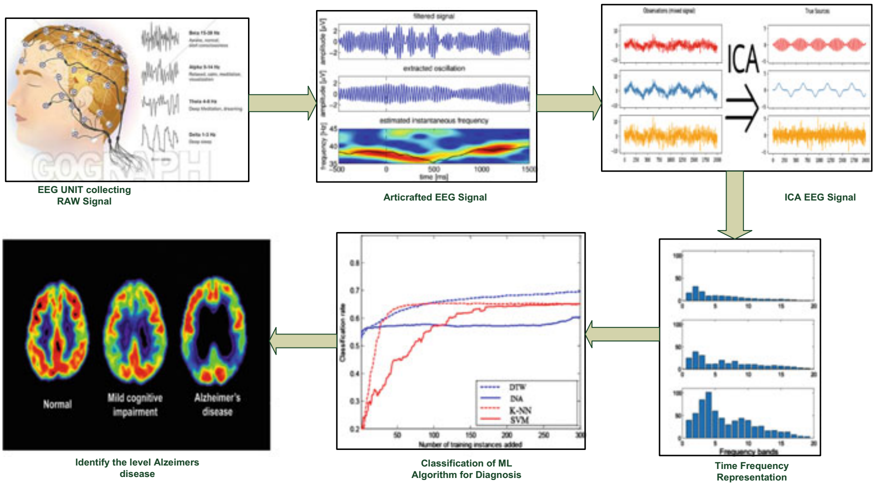


Fig. 4 Block diagram of EEG-based diagnosis of Alzheimer's disease

Implementation: As shown in Fig. 4, EEG signals are recorded by EEG electrode cap, by placing electrode on the patient's scalp. (a) Linear Discriminant Analysis (LDA), (b) Support Vector machine (SVM), (c) K-means Clustering and (d) Artificial Neural Networks (ANN) algorithms are applied and tested, etc., to compare the diagnostic accuracy of the signal. By the use of appropriate features extraction tool, several features were extracted such as spectral power, frequency, and spectral–temporal modulation energy, depending on the different frequency band of EEG signals.

3 Proposed Method

With reference to the above papers, a new wearable IOT frame is designed in this proposed work as shown in Fig. 5. Data acquisition can be done by placing electroencephalogram (EEG) and electromyograph (EMG) sensor electrodes to the patient. The data will be processed through the Aurdino by serially connecting Raspberry Pi and interfacing the two sensors. Data will be uploaded to the cloud server, and the model is designed using machine learning algorithms by training the data set of Alzheimer's disease patients which will be collecting from the hospitals. For better accuracy of predicting the disease, two sensors data can be taken: machine learning and neural network algorithms. Data collected from sensors and applied different algorithms to analyze the data to diagnosis the Alzheimer's disease, Collected EEG and EMG sensor from wearable devices is processed through Arduino and pushed the same data to cloud server with Raspberri Pi node. Different algorithms were applied for diagnosis of Alzheimer's disease, and the obtained result is shared with

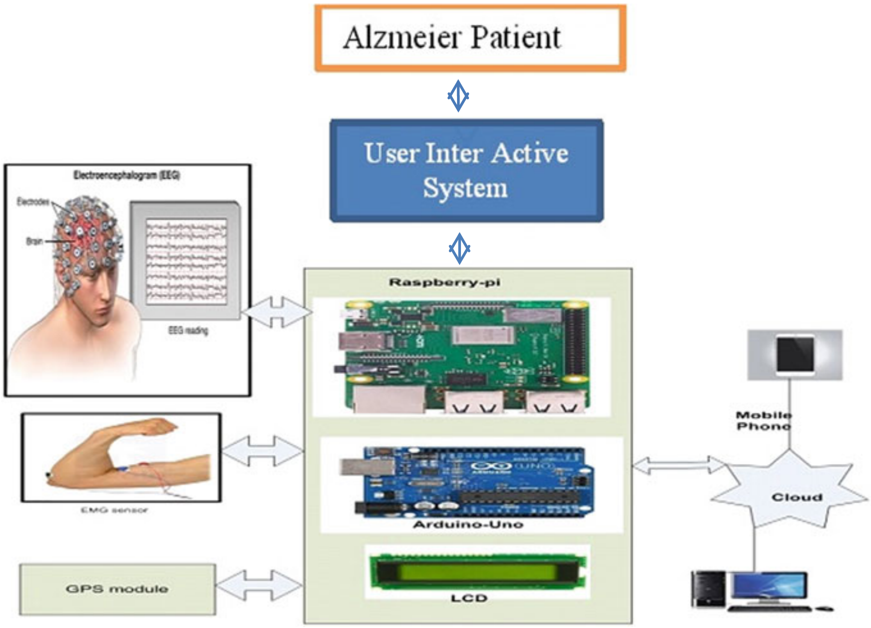


Fig. 5 Optimized and accurate IOT framework of Alzheimer's disease prediction

patients' caretaker and doctor through designed IOT system to avoid and rescue the patient to escalate next stage of disease.

EEG and EMG sensor inputs are connected to the Arduino, and the frequncy values as shown in Table 1 are converted to digital data and are sent to the cloud storage via Raspberry Pi. Raspberry Pi is connected to Arduino serially. Once the data is sent to the cloud, the patient can retrieve the data from anywhere and check

Table 1 Muscular point with standard frequency and sampling parameters for EMG signals

S. No.	EEG		EMG			
	Brain waves type	EEG frequency ranges (Hz)	Muscle	Flow (Hz)	Fhigh (Hz)	SR
1	Alpha	1–3.5	ta, pl, mg, so, tp	40	400, ~80	250
2	Beta	4–7.5	ta, mg	6	400	1000
3	Theta	8–13	Bb	5	1000 (2p Cheb)	2000
4	Delta	14–30	Bb	10	450 (2p)	1024

Parameters specification of the above in Table 1
bb biceps brachii, *d* deltoid, *mg* medial gastrocnemius tibialis anterior

his details. To retrieve the data, the patient can login to patient mobile app and see his details. If the patient gets the abnormal readings, then an alert is sent to the doctor.

3.1 Neural Network Back Propogation Algorithm Pseudo Code

Step1: Random initialization of ‘X’ is training data set of size, ‘Y’ is labels to records in X, ‘w’ weights for respective layers, and ‘l’ number of neural network.
Step2: Feed forward and calculate loss function from desired outputs.
Step3: Calculate the derivative error of gradient for the last layer.
Step4: Backpropagation by updating the weights to iterate until convergence.

4 Conclusion

Predicting the disease at the first stage by collecting information regarding accuracy of finding earlier symptoms of disease in patient using EEG and EMG from doctors. With the availability of data, the next stage of disease will be predicted and necessary action will be taken by the caretaker and the consult doctor. For severe stage patients, an alert system is designed for taking care of themselves in taking their medications, food, etc., due to their memory loss by designing smart interactive model like GPS, Alexa, etc. Collecting of disease data from neuro physicians using EEG and EMG sensors. Considering two sensors data and training the model by using different machine learning algorithms. Choosing best suitable algorithm which will give more accuracy to predict the disease in earlier stage. Once the data is sent to the cloud, the patient can retrieve the data from anywhere and check his details. To retrieve the data, the patient can login to patient mobile app and see his details. If the patient gets the abnormal readings, then an alert is send to the doctor.

References

1. Mattson MP (2004) Pathways towards and away from Alzheimer’s disease. Nature. https://doi.org/10.1038/nature02621 Review Article (2004/08/05/online 430-631 Macmillan Magazines Ltd.)
2. Meek PD, McKeithan EK, Schumock GT (1998) Economic considerations in Alzheimer’s disease. Pharmacotherapy J Human Pharmacol Drug Ther 18:68–73. https://doi.org/10.1002/j.1875-9114.1998.tb03880.x
3. Wortmann M (2012) Dementia: a global health priority—highlights from an ADI and World Health Organization report Alzheimer’s Research & Therapy 4 1758–9193. https://doi.org/10.1186/alzrt143: Förstl H, Kurz A (1999) Clinical features of Alzheimer’s disease. Eur Arch Psychiatry Clin Neurosci 249:288–290

4. Thakare P, Pawar VR (2016) Alzheimer disease detection and tracking of Alzheimer patient. In: 2016 International Conference on Inventive Computation Technologies (ICICT), Coimbatore, pp 1–4. https://doi.org/10.1109/inventive.2016.7823286
5. Kulkarni N, Bairagi VK (2014) Diagnosis of Alzheimer disease using EEG signals. Int J Eng Res Tech 3(4):1835–1838
6. Traimboli LR, Falk TH, Fraga FJ, AnghinahR, Lorena AC (2011) EEG sepectro-temporal modulation energy: a new feature for automated diagnosis of Alzheimer disease. In: Proceedings of international conference of the IEEE-EMBC, vol 1, Boston, USA, pp 3828-3831 (2011)
7. Shenvi P, Baheria P, Jose S, Kumar S, Nayak JS (2016) Wearable tracking device for Alzheimer's patients: a survey. 3(4):147–151. ISSN-2349-5162
8. Varatharajan R, Manogaran G, Priyan MK, Sundarasekar R (2018) Wearable sensor devices for early detection of Alzheimer disease using dynamic time warping algorithm. Cluster Comput 21(1):681–690
9. Al-khafajiy M, Baker T, Chalmers C, Asim M, Kolivand H, Fahim M, Waraich A (2019) Remote health monitoring of elderly through wearable sensors. Multimedia Tools Appl 1–26
10. Kulkarni NN, Bairagi VK (2015) Electroencephalogram based diagnosis of Alzheimer disease. In: 2015 IEEE 9th International Conference on Intelligent Systems and Control (ISCO), pp 1–5. https://doi.org/10.1109/isco.2015.7282275

Multi-agent Data Mining Using Asymmetric AES Algorithm in Cloud Computing

Imran Qureshi, Burhanuddin Mohammad, Mohammed Abdul Habeeb and S. G. M. Shadab

Abstract In the present-day scenario, huge amount of data is available on Web due to which the current-day major challenge in the cloud computing is converting the data to knowledge which can be used in the industry for different reasons and on the other hand to attain the confidence of consumers by imposing privacy and security for generating constructive suggestions by agents in a multi-agent architecture using OLAP for eliminating regulatory constraints over sensitive data. In this paper, we are proposing a novel algorithm that uses basic AES while performing communication between distinct agents in a cloud computing environment.

Keywords Agent · Multi-agent · Advanced encryption standard · API · CSP · Server

1 Introduction

In cloud computing environment, performing data mining is the famous research area evolving in the current application development process and in the field of information technology era. The promising changing trends generate a novel concept which will discover significant importance where the process defined for performing extracting data or information from a database is not explicitly specified by database [1].

Multi-agents in a data mining environment may be defined as distinct types of agents which will communicate with the environment to obtain the specific objective where multi-agents will perform operations on behalf of the end-users who will communicate or notify or exchange the data with one other.

An agent represents a software agent or program or a robot or a human being for discovering knowledge defined by the process that performs a search operation

I. Qureshi (✉) · B. Mohammad · M. A. Habeeb · S. G. M. Shadab
Department of Information Technology Sultanate of Oman, AlMusanna College of Technology, Al Muladdah, Oman
e-mail: imran@act.edu.om

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_3

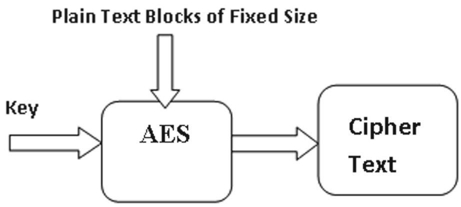


Fig. 1 Plain text blocks of fixed size cipher

over large collection of data with the aim of identifying patterns that can generalize generated conclusions.

These patterns are sometimes referred as knowledge about the data where cloud computing will be defined as the delivery process of computing various services. To share various resources, the software provides those services over the network. Cloud computing is performed as a Web-based service that hosts and analyzes the probable critical analysis in a multi-agent-driven data mining architecture for performing knowledge discovery in cloud computing environment [2].

The AES is a technique that performs data encryption to implement or handle various operations mathematically in an efficient and elegant cryptographic algorithms that are considered to be a major strength due to the availability of various key length options. The major advantage of AES algorithm is that it allows us an option to choose the key lengths for making it exponentially stronger. *On the other hand,* AES uses permutation–substitution technique that involves a series of substitution and permutation steps for generating the encrypted block [3].

AES is a "Block Cipher Algorithm" which takes plain text in blocks and generates cipher text which is probably a secured one where the process of file transfer is secured using AES as the data in a file is partitioned into fixed blocks that are further converted to cipher text and then are transmitted for receiving the data through a secured channel as the key that is used in the process of implementing AES algorithm is "symmetric key" where the same key is utilized at both sender and receiver ends as depicted in Fig. 1, where it explains the probable skeleton of AES algorithm [4].

AES algorithm steps

```
The logical idea behind AES as follows content = message(M)
  Add_Round_Key (content, k[0])
    for i=1 to 9
SubBytes(content)
shiftRows(content)
MixColumns(content)
Add_Round_Key (content, k[9])
End for
SubBytes(content)
ShiftRows(content)
Add_Round_Key (content, k[10])
Cipher = content
```

Data Mining

The process of data mining and knowledge discovery is considered to be a very useful concept that is determined to be unknown phenomena where a particular store sells distinct products along with data mining skills to perform some decisions that observe the beginning of market state and behavior.

In almost all cases, patterns are being identified where a pattern comprises of information such as the name of the product and time of purchase of product; based on these two attributes, most of the pattern-oriented data mining is performed [5].

We need an agent to perform or observe the sales pattern or a store where the agent learns or acquires knowledge so that the predictions can be made about the need and sale of a product in which season, and this data is transmitted or notified from one agent to another agent where the AES algorithm is implemented to secure the data being transmitted.

Cloud Computing

Agent-based cloud computing along with data mining will be considerably useful to the cloud vendors where every cloud vendor can acquire useful information about the probable type of agents and the probable decisions they make for obtaining information by performing cloud computing in data mining. On the other hand, we must ensure that the cloud owner must not be in a state to acquire or steal data which can be resold to the competitors in the market [6].

Distributed Computing

The distributed storage model is used for acquiring basic computer information that performs data piling where the advanced information is kept away in the form of legitimate pools of data stores. Once in a while, an agent travel in distinct servers and it performs the physical stockpiling and claims by possible facilitation organization. These distributed storage suppliers are responsible for keeping the information accessible and secure open for the physical condition by ensuring and running where individual- and association-based purchase or rent stockpiling limits from the suppliers to store client along with association or application information.

Agent-based distributed storage administration is the major aspect that might be considered through allocated distributed computing administration for an agent as the Web administration "Application Programming Interface (API)" [7] or by the applications that utilize the API document. For an example, every cloud work area or the stock pilings considered to be a distributed storage portal or the Web-based substance the board various frameworks.

The process of distributed storage completely depends on virtualized framework that resembles more extensive distributed computing aspect in regard of open interfaces as well as close moment flexibility and adaptability for obtaining multi-tenure and metered assets.

Distributed storage administrations are utilized by “off-premises administration (Amazon S3)” or conveyed “on-premises (ViON Capacity Services)” [8]. Cloud stockpiling normally comprises of article stockpiling administration where the term has expanded to incorporate various kinds of information that is stockpiled and is more often accessed by administrations (Fig. 2).

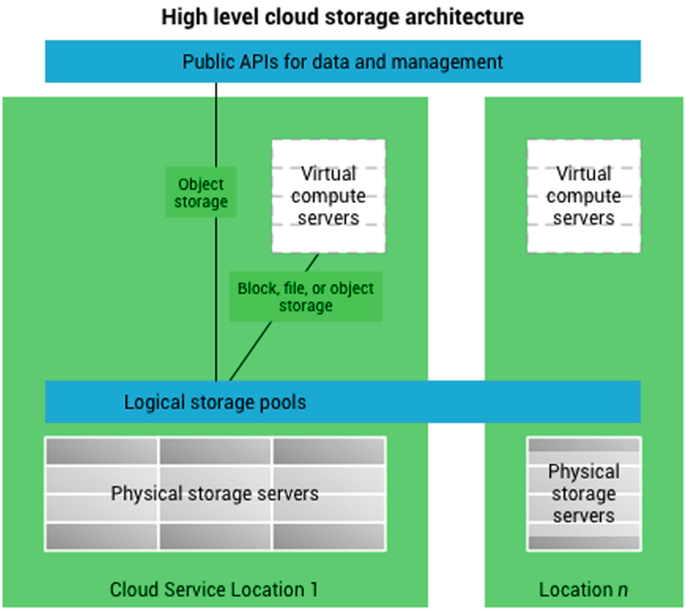


Fig. 2 Public APIs for data and management

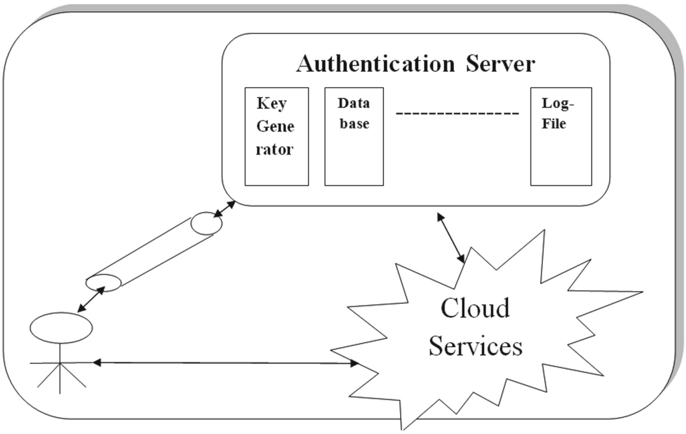


Fig. 3 Authentication server process for cloud services

Article "stockpiling administrations like Amazon S3," "Oracle Cloud Storage and Microsoft Azure Storage," "object stockpiling programming like Openstack Swift," "object stockpiling frameworks like EMC Atmos," "EMC ECS and Hitachi Content Platform" and disseminated stockpiling research ventures like OceanStore and VISION Cloud are largely considered to be the instances of capacity that can be facilitated and conveyed with distributed storage attributes.

Distributed storage is:

- Made up of many conveyed assets and at the same time goes about as one or either in a united or a helpful stockpiling cloud design environment.
- Higher deficiency tolerant through repetition and conveyance of provided information.
- Highly sturdy through the production of formed duplicates or duplicate values.
- Typically at the end, predictable concerning information reproductions are attained.

2 Agent-Oriented Data Security

Re-appropriating information stockpiling builds the assault surface region for every possible agent in the system.

(a) As and when information has been dispersed, it is put away at more areas by performing expansion as the only danger of unapproved physical access to the information when a agent retrieves or receives the information. As the cloud-based engineering is performed for acquiring the information the danger of unapproved information recovery increments significantly by a data agent. For example, on account of transfer of old data center, we can reuse all the existing disk drives or reallocate them in an extra room. The way that information is repeated relies purely upon the administration level by an agent who seeks the information at a gave point. When encryption is set up it can guarantee the aspect of classification in a circular form to a requesting agent.

(b) In order to access data or information by an agent on individual basis, the data is undermined or constrained with possible data increments that are significantly performed in a stochastic agent architecture that comprises of a set of agents that serve the requirements generated by end-users or another agent in the system. This framework requires multi-agents to work on servers where every agent comprises of specialized process to extract knowledge by performing physical and electronic access, as the majority of the information will tend to unscrambling keys. Separate keys are made available for administration users, and a separate set of keys are for generator agent and for intermediate agents. One of the major concerns in this framework is when an agent tries to become a grabber over a cloud. In addition to this, every agent is to be provided by a unique key so that the system cangenerate many or most of the keys that are to be disseminated to probable agents.

(c) Quantity of systems can be constructed with possible set of information where the agents venture with possible "neighborhood (LAN)"or "capacity region arrange (SAN)" as the information is kept away over possible clouds required by "wide region organize (WAN)" that is associated to both of them in the system.

(d) By offering stockpiling systems to numerous agents information access has become easy. There is a possibility of inconsistent activities that are obtained due to flawed hardware or due to possible attainment of bug or due to any possible criminal aim, the possible hazard applies to a wide range of distributed storage. The risk involved in having information perused or transmitted can be alleviated through encryption innovation scheme where the encryption secures information before transmitting to and from the cloud administration process. The process of encryption ensures information by specialist organization for encoding information in an on-premises cloud administration for obtaining entrance ramp framework which is provided in two sorts of encryption assurance.

A. ***Problem Statement***:

Basically, AES is a symmetric encryption algorithm where the same key is used by sending and receiving agents to store a file over a cloud for maintaining and providing security to the file which does not need to search or indexing a file; we take the advantage of AES algorithm to convert the file data into cipher text and store it on to the cloud. But, the problem is unauthorized agents or intruders who are closely watching the network can enter into the cloud and download the cipher text, and cryptanalysis can be done, and key can be expected by brute force, and the same key is used to decrypt the data into actual file which can make money for the intruders.

B. ***Solution***:

Once the data owner is authenticated by the server (a data owner is a agent who wants to store the data on the cloud), the data owner performs the operations (Fig. 3)

(a) Data owner request AS for a key which will be supplied to the authenticated owner; AS creates two keys, private key (pk) and public key(pu).

(b) The public key generated by the server is sent to the owner, and the private key for this particular owner is stored/appended to a file.

(c) Data owner takes the public key.
(d) The file which is to be stored into the cloud is divided into divisions or parts we intend to have blocks in it; we use the public key to convert these divisions into cipher text.
(e) This cipher text is stored over the cloud.
(f) These steps are repeated till the data in file is exhausted.

Role of authentication server(AS)—It authenticates the data owner to store the data over the cloud, and a special component which exists in the AS is key generator which generates the key in the manner of producer and consumer where new key is not generated till the old one is been used for the data encryption for every request.

3 Algorithm (Java Code) for Splitting a File

```
public static List splitFile(String fileName, int mBperSplit) throws IOException {
    if (mBperSplit <= 0) {
        throw new IllegalArgumentException("mBperSplit must be more than zero");
    }
    List partFiles = new ArrayList();
    final long sourceSize = new File(fileName).length();
    int bytesPerSplit = 1024 * 1024 * mBperSplit;
    long numSplits = sourceSize / bytesPerSplit;
    int remainingBytes = (int) sourceSize % bytesPerSplit;
        byte[] originalBytes = convertFileToBytes(fileName);
    int partNum = 0;
    while (partNum < numSplits) {
        copyBytesToPartFile(originalBytes,
      partFiles, partNum, bytesPerSplit, bytesPerSplit);
        ++partNum;
    }
    if (remainingBytes > 0) {
        copyBytesToPartFile(originalBytes,
      partFiles, partNum, bytesPerSplit, remainingBytes);
    }   return partFiles;
}

private static void copyBytesToPartFile(byte[] originalBytes,
List partFiles, int partNum, int bytesPerSplit, int bufferSize) throws IOException {
    String partFileName = dir + "part" + partNum + suffix;
    byte[] b = new byte[bufferSize];
      System.arraycopy(originalBytes,
      (partNum * bytesPerSplit), b, 0, bufferSize);
    writeBufferToFiles(b, partFileName);
    partFiles.add(partFileName);
}
```

4 Algorithm for Waiting and Sending Request for a Public Key From as

```
int itemCount=0;
 void authenticatingServer()
{
    int pu,pk;
   while (true)
   {
        pu= producePublicKey();
        pk=producePrivateKey();
       if (itemCount == BUFFER_SIZE)
       {  sleep();   }
        itemCount = itemCount + 1;
       if (itemCount == 1)
       {
          wakeup(dataOwner(pu));
       }}}

       void   dataOwner(int pu)
{
   while (true)
   {
       if (itemCount == 0)
       {   sleep(); }
       itemCount = itemCount - 1;
       if (itemCount == BUFFER_SIZE - 1)
       {
          wakeup(authenticatingServer);
       }
       addPUtoDivision(pu);
   }}
```

5 Result and Analysis

In the above line chart, *y*-axis is the time taken to transmit the data and *x*-axis is the file size; red line shows the time taken by the AES algorithm, and the blue line defines the asymmetric AES algorithm which was simulated on Java platform. When security is concerned, we can compromise with time after all we are dealing with sensitive data in a multi-agent architecture (Fig. 4).

6 Conclusions

In a multi-agent architecture, the data is transmitted from one agent to another; we need AES algorithm where only one key can be generated by the intruder or intruder agent for making a bit analysis, but whereas in our proposed algorithm, the files have different divisions and every divisions are encrypted with a different public

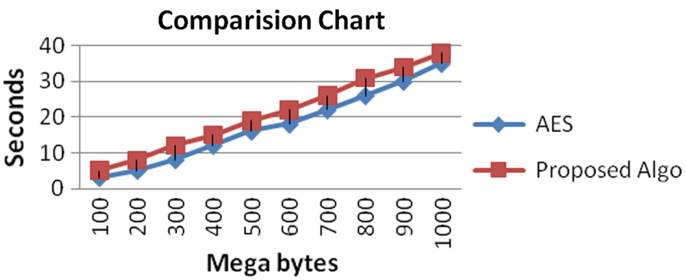


Fig. 4 Comparison chart of AES and proposed AES for memory utilization in megabytes for a span of seconds for performing file transmission between agents

key. When an agent wants to download the file, he should be authenticated by the AS and AS should supply the log file to the agent so that he can decrypt the file. The above scenario was applied only for the text sought of data; in future, we apply it to different files like pdf, docx, videos.

References

1. Agogino A, Tumer K (2006) Efficient agent-based cluster ensembles. In: Proceedings of the 5th international conference on Autonomous Agents and Multiagent Systems (AAMAS'06), ACM, New York, NY, USA, pp 1079–1086
2. Shaik MA, Sampath Kumar T, Praveen P, Vijayaprakash R (2019) Research on multi-agent experiment in clustering. Int J Rec Technol Eng 8(14):1126–1129
3. Bailey S, Grossman R, Sivakumar H, Turinsky A (1999) Papyrus: a system for data mining over local and wide area clusters and super-clusters. IEEE Supercomput
4. Bellifemine F, Bergenti F, Caire G, Poggi A (2005) JADE: a java agent development framework. In: Bordini RH (ed) Multi-agent programming: languages, platforms, and applications, Springer, New York, p 295
5. Cao L, Gorodetsky V, Mitkas PA (2009) Guest editors' introduction: agents and data mining. IEEE Intell Syst 24(3):14–15
6. Chaimontree S, Atkinson K, Coenen F (2010) Best clustering con guration metrics: towards multiagent based clustering. In: Proceedings of 6th international conference on Advanced Data Mining and Applications (ADMA'10). Springer LNAI 6440, pp 48–59
7. Juels A, Kaliski BS (2007) PORs: proofs of retrievability for large files. In: Proceedings of the 14th ACM conference on computer and communications security, pp 584–597
8. He J, Zhang Y, Huang G, Shi Y, Cao J (2012) Distributed data possession checking for securing multiple replicas in geographically-dispersed clouds. J Comput Syst Sci 78(5):1345–1358

A Novel Architecture for a Two-Pass Opinion Mining Classifier

P. Padmavathy, S. Pakkir Mohideen and Zameer Gulzar

Abstract Opinions given by others usually have a vast influence on the actions of human beings and opinions are vital to almost all decision-making activities. The rapid growth of social media has extensively came up with user data which includes opinions, comments, reviews, events, and other services. The data generated will be helpful for both manufacturer as well as the customer. The manufacturers can get an online reality check about the weaknesses and strengths of the product which totally depends on the sentiments of the customer. Opinion mining is a well-known problem in Natural Language Processing (NLP) that has been increasing attention in recent years. In opinion mining, the greater part of the researchers have dealt with general domains, like electronic items, movies, restaurants, etc., but the domain of health care has been neglected or paid less attention. Therefore, in this study, we proposed a novel two-pass classifier architecture which focuses on classifying the drug-satisfaction level among the patients who have already experienced a particular drug. The two-pass classifier is an intelligent classification system designed with the combination of support vector machine and artificial neural network. The results suggest that the proposed classifier provides better results in terms of precision and recall as compared to traditional individual approaches.

Keywords Opinion · Mining · Classification · Neural network · Drug · Patient

P. Padmavathy · S. Pakkir Mohideen · Z. Gulzar (✉)
BSAR Crescent Institute of Science and Technology, Chennai, India
e-mail: zamir045@gmail.com

P. Padmavathy
e-mail: padmavathy28@crescent.education

S. Pakkir Mohideen
e-mail: pakirmoitheen@crescent.education

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_4

1 Introduction

Opinion mining is a kind of NLP that deals with tracking the mindset of the clients about a specific topic. This system gives automatic extraction of opinions, perceptions, sentiments, and emotions in text and also observes feelings and attitudes on the Web [1]. People let others know about their opinions through comments, reviews, blog posts, and tweets on various topics. Tracking a product or brand and determining whether it is perceived positively or negatively can be performed utilizing Web [2]. The vast quantity of reviews for a single product may likewise make it harder for people to track the gist of clients' consultations and assess the product's genuine basic nature. Hence, opinion mining is a task under NLP to detect the mood of the clients about a specific topic which incorporates a system to gather and analyze opinions about the product or topic. After NLP, the text element or opinion is converted into machine format to find whether something is positive or negative using an artificial intelligence technique. Various methods have been presented to successfully achieve opinion mining but none of them could achieve an absolute solution for all the issues.

Opinion mining in medicine administration has been a crucial area because, as soon as the drug is released for public usage, the surveillance of that drug is a crucial factor for safety and satisfaction of the drug [3]. In most of the occurrences, drug try-outs are done with limited test subjects, where the possibility of detecting unusual and undesirable effects is low. It is very crucial to learn how the common people utilize a specific drug, view on its safety, responses, and efficiency [4]. So as to deal with these issues, a new approach is presented in the form of a two-pass hybrid classifier which will be utilized for extracting specific features from the dataset for classifying the reviews with more accuracy. The main aim of this study is to propose the opinion mining classification architecture which will analyze the user's drug-satisfaction level by focusing on the medical domain for a single drug dataset and process the patient opinions to improve the classification performance. The ANN and SVM are integrated together to classify the review by mitigating the difficulties faced by individual techniques. The experimental results in this study show that using proposed opinion mining architecture for drug prediction performs well than other traditional methods. The rest of the paper is organized as follows: Sect. 2 presents a literature survey, while as in Sect. 3, proposed architecture will be discussed. Section 4 will discuss the results and finally, Sect. 5 will conclude the paper.

2 Literature Survey

The foremost element for gathering information is to search out what other researchers have done in the healthcare domain. The customer more often checks the reviews and remarks posted by the other customers during an online transaction. In recent times, machine learning techniques have been extensively considered for these tasks, generally with the application of supervised learning methods such as maximum entropy, SVM, and Naive Bayes. Comparatively diminutive workings have considered content from social media into the medical and healthcare domains. For example, a system was developed by [5] for classifying latest posts from a forum according to the polarity of the topic. The forum is known by the name "Patient Opinion" which is a service provided to the users of the British National Health Service for online reviews and later users can add reviews related to staff, treatments, and so on. Both polarity and topic identifications were attained through effortless machine learning methodology known as Bag of Words. In addition, [6] have clarified the probabilistic aspect of mining approach for elucidation and assessment of medication reviews. This exploration topic modeling is based on a probabilistic approach, a finely grained aspect level opinion mining is utilized. It is fascinating to apply the model to discover aspects identifying with the various division of information, like age groups, sex, or traits. Similarly, a method of classification was proposed by [7] to distinguish effective medical blogs using both the sentiment lexicon WordNet and semantic types of the UMLS. Huang [8] believed that even though NN may have an intricate configuration, lengthy training time, NN has high receiving ability for data containing noise with high accuracy and is also preferred in data mining. Niu et al. [9] used SVM for detecting four potential clinical result sentences in medicinal publications. They argued that merging domain knowledge and linguistic features led to the highest accuracy. Gopalakrishnan [10] used patient opinion mining to examine medication fulfillment utilizing directed learning. The opinion mining technique utilized in this work centers around predicting the medication fulfillment level among alternate patients who have previously encountered the impact of medication. The outcomes show that the neural-system-based opinion mining approach outflanks the support vector machine. For opinion mining, various researchers have proposed numerous methodologies and among them, a modest bunch of noteworthy examines are displayed in this section. To affect classification accuracy, the hybrid approach is being applied in this study for getting better results as compared to other methodology discussed above.

3 Proposed Architecture and Methodology

Methodology: The proposed methodology for opinion mining to study the patient opinion review about a drug consists of following steps.

1. Collect the dataset of drug reviews.
2. Qualify the collected dataset using natural language processing.
3. Feature selection is done to generate the feature vector to be given as input.
4. Opinion mining is applied for the qualified dataset.
5. Opinion mining results are presented as output.

The proposed architecture as shown in Fig. 1 consists of four different stages which are mentioned below:

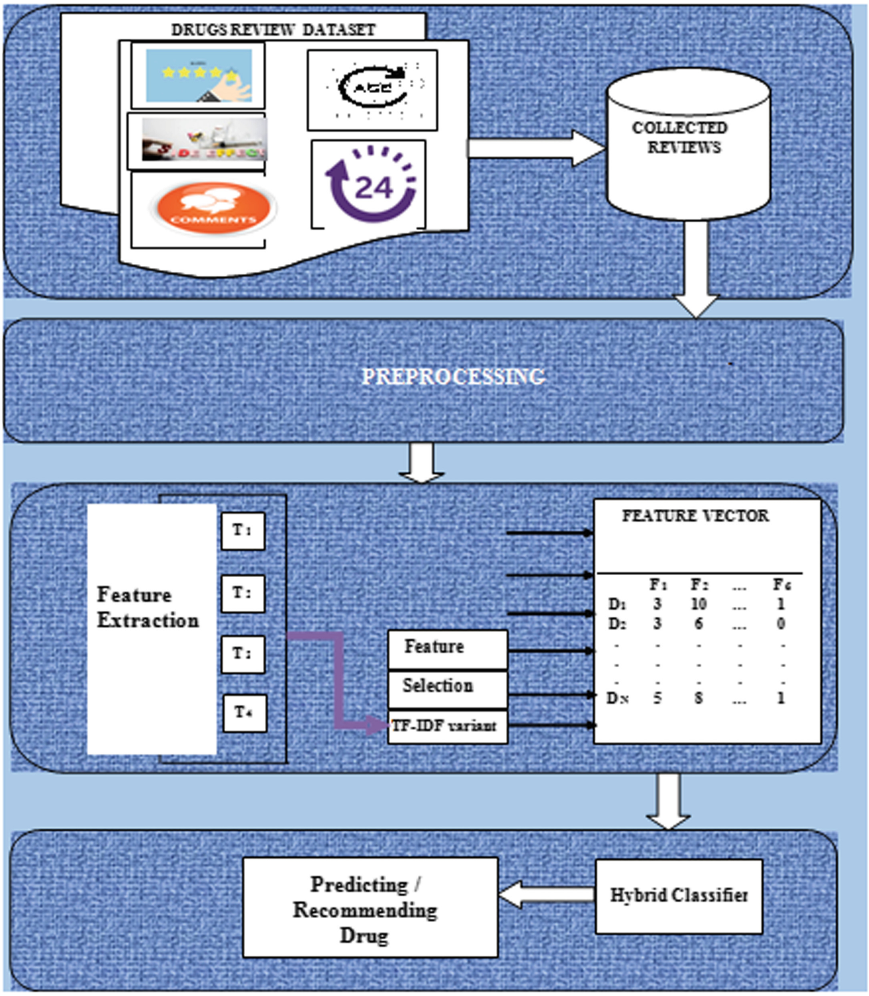


Fig. 1 Architecture of proposed hybrid classifier

The dataset is given as input to train the feature vector model using support vector machine and using artificial neural network. After completing one iteration in SVM and ANN, both results are combined to choose the best weight. In this way, we finally obtain the classified review as output.

Table 1 Sample review for dataset I

Rating	Reason	Side effects	Comments
3	Muscular rheumatism	Weight gain foggy brain	It did help with pain somewhat

3.1 Data Collection

The first phase begins with collecting the dataset consists of patient reviews with respect to a particular drug used for depression patients. Adult diabetics are treated with drug Cymbalta also to relieve pain caused due to nerve damage and the dataset I consist of 1000 customer reviews which are collected during 2005–2018. The dataset consist of three features such as rating, side effects, comments, and the sample dataset is given in Table 1.

3.2 Preprocessing

Preprocessing is a time consuming but an important process for opinion mining as the reviews given by the patients will not be in a common format. To calculate the decision with respect to each opinion, the reviews are needed to be preprocessed. The reviews are undergone some stop word removal process, stemming the words, clearing superfluous punctuations, tagging, etc. The features extracted from the dataset are ratings, comment, and side effects and saved in a separate document for future use.

3.3 Feature Extraction

This phase is of great importance and in this phase, the four important features related to a drug are extracted from the reviews using TF-IDF as given in Eq. 1.

$$\mathrm{TF}-\mathrm{IDF}=\frac{\mathrm{FR}_{\mathrm{td}}}{\mathrm{length}_d}*\log\left(\frac{N}{n_j}\right) \tag{1}$$

TF represents the frequency of a particular document term (in this study, three terms), IDF gives lesser weight-age for high-frequency review terms. The N represents the total number of reviews present in the dataset and n_j represent the frequency of the jth word in the training dataset. The feature vector model formation is given in Table 2 and the feature vector matrix is given in Eq. 2.

Table 2 Feature vector formation

Reviewers	M_1 (rating)	M_2 (side effects)	M_3 (comments)
R_1	3	10	12
R_2	2	6	15
R_3	5	8	9
R_n	1	9	6

$$F_{\text{Vector}} = \begin{pmatrix} 3 & 10 & 12 \\ 2 & 6 & 15 \\ \cdots & \cdots & \cdots \\ 1 & 9 & 6 \end{pmatrix} \tag{2}$$

3.4 Classification

Finally, the classification phase will help to attain opinion of corresponding drugs using the reviews given in terms of feature vector which is later used to categorize the positive and negative reviews given by the patient after using the particular drug. The hybrid classifier proposed in this study is developed by integrating the ANN and SVM to form hybrid SVM-NN. To enhance the performance of hybrid classifier, the weight value of is optimally selected with the help of improved gray wolf optimization algorithm. Initially, the ANN is trained with the dataset given in Eq. 3. The output of hidden layer of the ANN is given to SVM to train same target.

$$D = \{F_i, Y_i\}_{i=1}^{N} \tag{3}$$

Whereas F_i is an input feature vector and is its corresponding target value, the number of iteration is represented by N. Finally, during testing process, the reviews classification into positive or negative groups is done, and later evaluation is done by utilizing the accuracy metrics using precision and recall given in equations.

Precision: Precision is the ratio of the number of positive comment detected to the total number of positive and negative comments which is given in Eq. 4.

$$P = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{4}$$

Recall: Recall is the ratio of the number of positive comments detected to the total number of comments present in the dataset which is given in Eq. 5.

$$R = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}} \tag{5}$$

4 Result and Discussions

This section will elucidate the experimental result evaluations for estimating the performance of the proposed opinion mining system architecture and subsections will discuss the experimental results and the methodology for evaluation.

Table 3 shows the precision acquired for various iterations is compared between the proposed method, neural network (BP), neural network (LM), and SVM (linear) as shown in Fig. 2. When the iteration is set to value ten, the precision acquired by utilizing the neural network (BP) is 79.43991 utilizing neural network (LM) and 77.85844 when utilizing SVM (linear proposed method is 80.65165, and it is 79.46193 when). Moreover, when the iteration is set as twenty, the precision acquired by utilizing the proposed method is 81.14542 and it is 79.18861 when utilizing the neural network (BP), 79.3219637 utilizing neural network (LM) and 78.27199948 when utilizing SVM (linear). At the point when the iteration is set to thirty, the precision acquired by utilizing the proposed method is 82.17987421 and it is 80.77296898 when utilizing the neural network (BP), 80.86104287 utilizing neural network (LM) and 79.20582622 when utilizing SVM (linear). In general, in

Table 3 Performance analysis based on precision by varying iteration

Method	Iterations		
	10	20	30
Proposed (SVM + NN)	80.65165	81.14542	82.17987
Neural network (BP)	79.46193	79.18861	80.77297
Neural network (LM)	79.43991	79.32196	80.86104
SVM (linear)	77.85844	78.272	79.20583

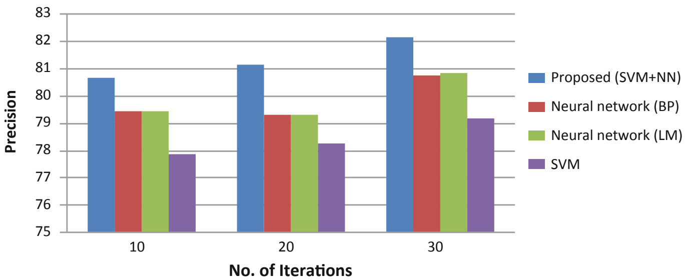


Fig. 2 Performance analysis based on precision

all the iterations, the proposed method performed better contrasted with the neural network (BP), neural network (LM), and SVM (linear) taken for examination.

The hybrid classifier has been built by combining two methods such that the advantages of both the methods are preserved while fixing their drawbacks led to the plan for the proposed two-pass classification approach. At times when conventional learning systems like NN undergo hypothetical weakness, then back-propagation usually intersects to local optimal solutions only. SVMs could be helpful in providing the considerable improvement by finding a global minimum. In problems, when linear decision hyper planes of SVM became infeasible then an input space is mapped into a feature space through hidden layer of neural network.

5 Conclusion

The need is to build a versatile opinion mining system to deal with the issue of checking drug-level satisfaction of the patients from their online reviews. Therefore, this study proposed hybrid two-pass classification systems that will solve the problem related to the patient's opinion, by selecting certain features of the drug to analyze their drug-satisfaction level. The system will provide a recommendation to the patients which are more suitable in terms of the health condition faced by them. The integration of the support vector machine and the artificial neural network achieves the maximum precision and recall in comparison to other individual approaches. The future work will be to include a number of datasets and to increase the optimization certain other drug features and algorithms need to be included for enhancing the throughput (precision and recall) of the proposed system.

Acknowledgements The authors are grateful to acknowledge the support of faculty and research scholars of BSARCIST to provide their intellectual feedback related to this study.

Competing Interest The authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. O'Connor B, Balasubramanyan R, Routledge BR, Smith N (2010) From tweets to polls: linking text sentiment to public opinion time series. In: Proceedings of the 4th international AAAI conference on web and social media, pp 122–129
2. Chambers N, Bowen V, Genco E, Tian E, Young E, Harihara G, Yang E (2015) Identifying political sentiment between nation states with social media. In: Proceedings of the conference on empirical methods in natural language processing, pp 65–75
3. Cho H, Kim S, Lee J, Lee JS (2014) Data-driven integration of multiple sentiment dictionaries for lexicon-based sentiment classification of product reviews. Knowl-Based Syst 71:61–71

4. Choi Y, Cardie C (2008) Learning with compositional semantics as structural inference for sub sentential sentiment analysis. In: Proceedings of the conference on empirical methods in natural language processing, pp 793–801
5. Xia L, Gentile AL, Munro J, Iria J (2009) Improving patient opinion mining through multistep classification. Lecture notes on artificial intelligence, vol 5729. Springer, Berlin, pp 70–76
6. Tushar T, Emmanue M (2016) Probabilistic aspect mining approach for interpretation and evaluation of drug reviews. In: Proceedings international conference on Signal Processing, Communication, Power and Embedded System (SCOPES). https://doi.org/10.1109/scopes.2016.7955684
7. Denecke K (2014) Ethical aspects of using medical social media in healthcare applications. Stud Health Technol Inf 198:55–62
8. Huang Z, Chen H, Hsu C, Chen W, Wu S (2004) Credit rating analysis with support vector machines and neural networks: a market comparative study. Decis Support Syst 37(4):543–558
9. Niu Y, Zhu X, Li J, Hirst G (2005) Analysis of polarity information in medical text. In: Proceedings of the American Medical Informatics Association Symposium (AMIAl), pp 570–574
10. Gopalakrishnan V, Chandrasekaran R (2017) Patient opinion mining to analyze drugs satisfaction using supervised learning. J Appl Res Technol 15(4):311–319

QoS-Based Routing Algorithm for Software-Defined Network Using Ant Colony Optimization

Raghavendra Kulkarni and Kalpana Sharma

Abstract Recently, software-defined networking (SDN) is the most promising solutions for future network. In SDN, networking architecture combines central management along with network programmability. It separates network management from the underlying network infrastructure, allowing administrators to dynamically adjust network-wide traffic flow to meet the changing needs. Due to these unique features, SDN easily manages network, gives better performance than traditional network, and provides higher flexibility. In this paper, we have proposed an ant colony optimization-based routing protocol targeting to achieve significant value of various QoS parameters. The proposed methodology is based on the classification of various types of traffic. To classify the traffic, we introduce to the bandwidth requirement for multimedia traffic like audio, video, and text. Here, our method is compared with particle swarm optimization-software-defined network (PSO-SDN), The results obtained in terms of various QoS parameters show that ant colony optimization outperforms to PSO-SDN. Finally, we concluded the paper with few suggested open research challenges.

Keywords Software-defined network · PSO · ACO · QoS · Controller · Routing

1 Introduction

Software-defined networks (SDN) [1–3] are a novel type of networking technology used for smart grid. The network traffic is controlled in a flexible manner. Traditional network is having lots of limitation, and SDN is expected to mitigate the limitations of the traditional network system.

R. Kulkarni (✉) · K. Sharma
Department of Computer Science, Bhagwant University, Ajmer, Rajasthan, India
e-mail: raghavendra.kulkarni82@gmail.com

K. Sharma
e-mail: kalpanasharma56@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_5

In SDN networking [4], architecture combines central management along with network programmability. Here, the control plane is separated from data plane [2]. A central point controls overall network management known as controller. This can be programed and acts as the brain of the whole network. Due to these unique features, SDN easily manages network, gives better performance than traditional network, and provides higher flexibility. Recently, many researches show advancements in the artificial intelligence domain and optimization domains, which provide learning abilities and enhance the better decision-making in SDN.

The quality of service (QoS) focuses on [5] adjusting the allocation of various network resources as per the requirements of services and administer the network, and increase the performance of the network [3, 4, 6]. The QoS is an essential criterion for many communication network applications. The multimedia network applications need high level of QoS to maintain various network services [7], the smart grid [8], and networked control systems [9]. In transmitting multimedia data in real time requirement on time delivery of data, QoS parameter like delay should be always nil.

The paper is organized as follows: In Sect. 1, the Introduction section describes the different issues related to software-defined network ; in Sect. 2, various literatures related to the proposed scheme are reviewed; in Sect. 3, the proposed algorithm and methodology is discussed; in Sect. 4, the experimental setup and results are discussed. The paper is concluded in Sect. 5.

2 Literature Review

There are so many works, which have been done by various researchers for load balancing, resource utilization, network performance for SDN environment. Still this area of research attracts attentions of researchers to explore the area for improving the network performances of SDN. Till date, there are so many algorithms, routing protocols, and techniques which are proposed on for better load balancing to improve the robustness of the SDN. So, the better the load balancing in this environment the better the utilization of network resources achieved. In literature review section, we have summarized many researchers work based on ant colony algorithm.

In this paper [1–3], the authors proposed multicast-based ant colony cleaning behavior algorithm-based cluster approach for the SDN to perform the smart multicast cluster. The multicasting is an important issue for SDN, because of distinctive features like flexibility, programmable, and dynamic features. The implementation system of the multicast scheme is designed in SDN controller. The proposed technique is tested with random walk method, and as result, it achieves higher throughput and lower transmission delay. Finally, reliability and communication performance of SDN are also improved.

In this paper [5, 9], the authors proposed an ant colony optimization (ACO)-based routing protocol for SDNs. The SDN uses flow-based routing strategy, and this is the reason why ACO is most effective, as it also uses the same technique. The packet delivery ratio, delay, and the first packet arrival time are used for performance analysis. The results show that ACO outperforms others in term of higher packet delivery ratio and first packet arrival time is less in low-density traffic.

In this paper [7, 10], authors proposed a link load balancing framework for SDN. The proposed ACO used link load, delay, and packet loss to minimize search scope of path. This also simplifies multi-objective optimization problem by setting dynamic load threshold. The simulation works proven better balancing of load and significant improvement in QoS, increase stability, and rapidity of network traffic forwarding.

In [3, 4, 11], authors show that well utilization of resources can improve system and network performance. This is achieved through load balancing. The traditional load balancing techniques are not suitable for SDN. In this paper, a dynamic load balancing technique for SDN is proposed, which aims to load balancing both the servers and the paths leading to the servers. The best server is chosen and uses the least loaded server LB policy. The ant colony system (ACS) algorithm is used to find the best path toward the server. This algorithm considered the server-load and network statistics by the controller to find both the best server and the best path for network flows.

In paper [12], authors thoroughly studied various routing mechanism exist for SDN. A fusion genetic ant colony (GAC) routing algorithm is proposed for SDN [6]. The advantages of genetic algorithm and ant colony algorithm are combined together in this method. This GAC algorithm uses positive feedback technique to minimize the search times and to obtain an optimal path [6]. The result comparison with other well-known algorithm shows that speed of the algorithm is improved as well as the efficiency and high accuracy of selecting best path.

In paper [13], authors proposed an ant colony optimization (ACO) approach to flow routing in softwaredefined networking based on quality of experience (QoE)-centric approach. In case of packet loss directly influence the QoE services. The purpose of ACO algorithm calculate QoE-aware shortest paths routing and as well as low running time. The scalability issues handled by different SDN controllers, configuring paths for respective categories of multimedia services.

3 Methodology

The major aim of this research is to develop a routing protocol for SDN environment using ant colony optimization by maintaining reasonable level of various quality of service (QoS) parameter. The proposed methodology is discussed below.

The methodology is based on the classification of the traffic. To classify the traffic, we introduce the bandwidth requirement of multimedia traffic like audio, video, and text. The same network for the need for a class, labeled as N class where $N = 1, N = 2, N = 3, N = 4\ldots..$ C.

Under normal circumstances, the network traffic may be of different size of packets which may involve multimedia traffic like audio, video, image, and text items.

Aspects of classification:

Ports and sockets:

All the packets, audio, video, image, and text, involve different ports and protocols. Let Pt be the port used for text and in Pa, and Pv be the ports for audio and video, respectively.

Factor to improve QOS:

Bandwidth utilization:

For different types of multimedia data, different types of bandwidths are used with multiple connections to increase the QOS in the simulation setup. Further, to improve the QOS, different multimedia data would be passed through the appropriate bandwidths.

Ant colony optimization:

Adaption ACO in SDN:

The ant colony algorithm is defined as the link in the SDN network, which is defined as the link load. When the link usage rate is higher, the pheromone concentration is lower.

In SDN, we classify the network based on the type of packet. Each type of packets needs a different QOS. As defined in the architecture, SDN is connected with different types of connection like wireless, wired, Internet. SDN checks the ports and protocols for each packets and allots suitable network segment using previous learning.

Minimal bandwidth needed: Br = Minimal bandwidth needed

$$\mathrm{Br} = \min\{\mathrm{Ba}(1), \ldots\ldots \mathrm{Ba}(\mathrm{j}), \ldots.\mathrm{Ba}(\mathrm{C})\} \tag{1}$$

The minimal critical value is related to high bandwidth demand. $W(j)$ weight of bandwidth needed

$$W(j) = \mathrm{Bc}(J)/\mathrm{Bm},\ J \in \{1,\ \ldots,\ C\} \tag{2}$$

The relationship between the pheromone concentration and the link utilization is given.

$$\tau_{ij}(t) = k\big(1/\mathrm{load}_{ij}(t)\big) \tag{3}$$

which represents the t time node i and node j the link between the pheromone, which represents the link between the node i and node j, K for the link between the pheromone and the conversion constant.

The probability formula of ant m from node i to node j in ant colony algorithm is as follows.

$$P_{ij} = \{[\tau_{ij}(t)]\alpha * [\eta_{ij}(t)]\beta\} / \sum \{[\tau_{ij}(t)]\alpha * [\eta_{ij}(t)]\beta\} \tag{4}$$

Said that the ants to explore new path of the opening rounds, the greater the value that the ants are increasingly interested in the new path, the value smaller said that the ants on a new path to less interested i which the ant to explore the new path of the heuristic function, the formula is as follows.

$$\eta_{ij}(t) = 1/(\text{load}_{ij}) \tag{5}$$

Algorithm

```
step1: Input: Traffic Data
step2: Output: Suitable Segment of network begin
step3: For all collected data
step4: Compute the similarity between data;
step5: Check port and protocol of respective packet; send to
the lower bandwidth segment; collect information and time to
delivery; compare with previous delivery time
step6: If previous delivery time > current delivery time
       Then update previous delivery time = current delivery;
Else
        No change
step7: End if
step 8: Go to Begin.
```

4 Experimental Results and Discussions

The simulation work is carried in NS-3 simulator. For the analysis of performance of both the protocols, we used a topology of a campus network. It consists of a partial mesh topology comprising 100 hosts and 11 switches, illustrated in following Fig. 1. The simulation parameter considered is shown in Table 1.

Above setup consists of multiple sources of multimedia data. Like Web servers generating regular text traffic, video streaming, and audio streaming servers. The end-to-end delay, packet delivery ratio, control overhead, and throughput QoS parameters are considered for performance evaluation of both the protocols.

(i) End-to-End Delay

In Fig. 2, we have shown the end-to-end delay analysis of PSO-SDN and proposed scheme. The delay throughout the different node density is measured and the performance of the proposed protocol is much better. The value of delay lowest for the number of node is 20. The performance of the proposed protocol based on average delay is 20% lower than the PSO-SDN.

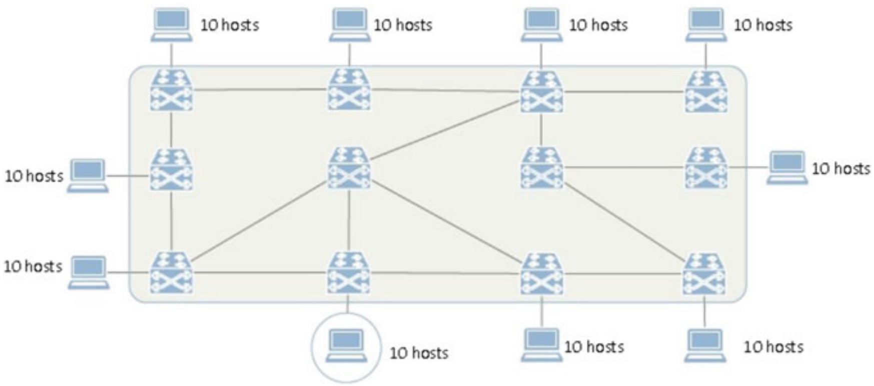


Fig. 1 Topology of a campus network used in simulation

Table 1 Simulation parameters

Parameter	Value
Hosts	100
Switches	11
Traffic profile	40% Web, 30% video, 30% audio
Model	Open switch

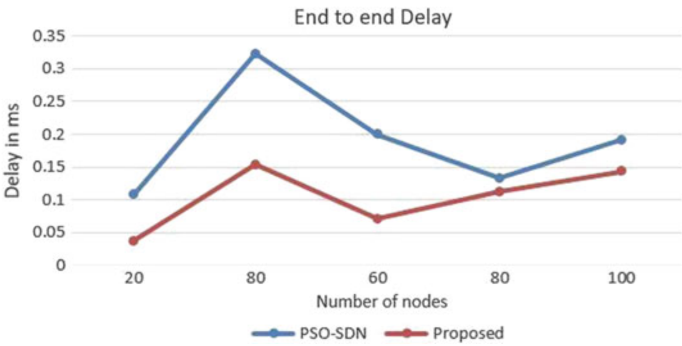


Fig. 2 End-to-end delay analysis of PSO-SDN and proposed scheme

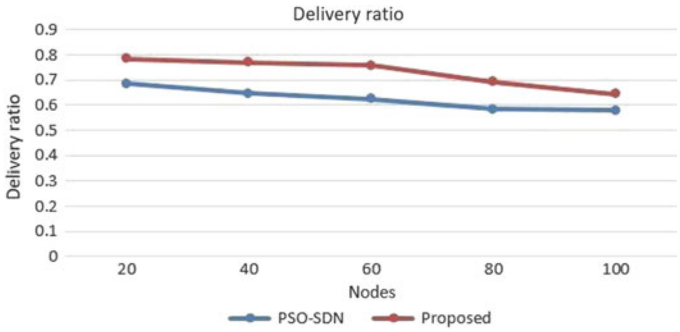


Fig. 3 Delivery ratio analysis of PSO-SDN and proposed scheme

(ii) Delivery Ratio

In Fig. 3, we have shown the packet delivery ratio analysis between PSO-SDN and proposed scheme. The delivery ratio throughout different node densities is decreasing for both the protocol as the number of node increases. As the number of node increases, the network congestion also increases. The highest packet delivery achieved is about 79% by our proposed protocol. The performance of the proposed protocol based on PDR is average 10% higher than the PSO-SDN.

(iii) Control Packet Overhead

In Fig. 4, we have shown the overhead analysis between PSO-SDN and proposed scheme. The overhead for different node densities is gradually increasing for both the protocol with the increase in the number of nodes. The highest overhead encounter is achieved when the number of nodes is 100. Throughout different node densities, overhead occurred is lesser than the PSO-SDN protocol.

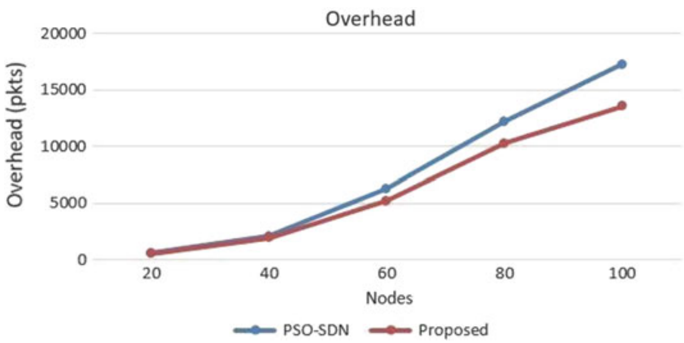


Fig. 4 Overhead analysis of PSO-SDN and proposed scheme

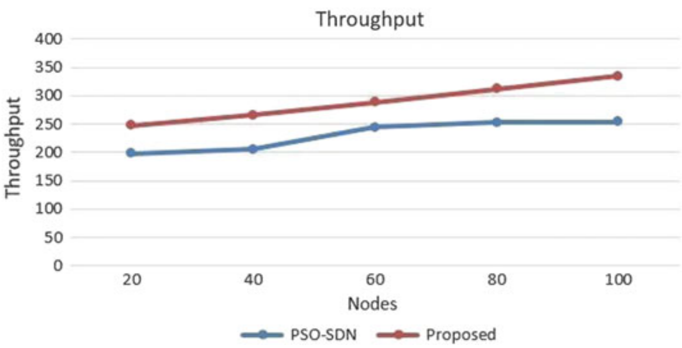


Fig. 5 Throughput analysis of PSO-SDN and proposed scheme

(iv) Throughput

In Fig. 5, we have shown the throughput analysis between PSO-SDN and proposed scheme. To maintain good QoSs of the network, many parameters are evaluated. The throughput analysis is also a QoS parameter. The value of throughput throughout different node densities is increasing for both the protocol. The highest value of throughput is achieved when number of node is 100. The performance of the proposed protocol based on throughput is average 20% higher than the PSO-SDN.

Here, our method is compared with particle swarm optimization-software-defined network (PSO-SDN). The results obtained in terms of various QoS parameters show that ant colony optimization outperforms to PSO-SDN. Overall, the performance of our proposed protocol is better than PSO-SDN. Our protocol achieves average delay which is 20% lower, average PDR is 10% higher, and average throughput is average 20% higher than the PSO-SDN. The various QoS parameters are considered for performance evaluation of both the protocol.

5 Conclusion

The paper mainly focuses on various types of multimedia traffics flow in the network. The multimedia traffics may be an image, a video, etc., and their bandwidth requirements are also different. We here considered different types of traffics like 40% Web, 30% video, 30% audio which are considered in the analysis. Our protocol achieves average delay which is 20% lower, average PDR is 10% higher, and average throughput is average 20% higher than the PSO-SDN. Overall, the performance of our proposed protocol is better than PSO-SDN with respect to all the QoS parameters considered in this work. Further, in future, more efficient routing protocol can be designed with other nature-inspired optimization algorithms.

References

1. Wu J, Zhang P, Li J, Liu Z (2018) Ant colony cleaning behavior algorithm based multicast for SDN in smart grid. In: 2018 the 6th IEEE international conference on smart energy grid engineering, pp 1–5
2. Latah M, Toker L (2018) Artificial intelligence enabled software defined networking: a comprehensive overview. IET Netw 1–25
3. Tassi A, Khirallah C, Vukobratović D, Chiti F, Thompson JS, Fantacci R (2015) Resource allocation strategies for network-coded video broadcasting services over lte-advanced. IEEE Trans Veh Technol 64(5):2186–2192
4. Akella AV, Xiong K (2014) Quality of service (QoS)-guaranteed network resource allocation via software defined networking (SDN). In: IEEE 12th international conference in Dependable, Autonomic and Secure Computing (DASC), pp 7–13
5. Lin T-L, Chen Y-S, Chang H-Y (2017) An ant colony optimization routing strategy for wireless sensor networks: A SDN-like perspective. J Comput 28(4):103–113
6. Govindarajan K, Meng KC, Ong H, Tat WM, Sivanand S, Leong LS (2014, May) Realizing the quality of service (QoS) in software-defined networking (SDN) based cloud infrastructure. In 2014 2nd International Conference on Information and Communication Technology (ICoICT). IEEE, pp 505–510
7. Wollschlaeger M, Sauter T, Jasperneite J (2017) The future of industrial communication: automation networks in the era of the internet of things and industry 4.0. IEEE Ind Electron Mag 11(1):17–27
8. Gungor VC, Sahin D, Kocak T, Ergut S, Buccella C, Cecati C, Hancke GP (2013) A survey on smart grid potential applications and communication requirements. IEEE Trans Industr Inf 9(1):28–42
9. Carabelli BW, Blind R, Dürr F, Rothermel K (2017) State-dependent priority scheduling for networked control systems. arXiv preprint arXiv:1703.08311
10. Wang C, Zhang G, Xu H, Chen H (2016) An ACO-based link load-balancing algorithm in SDN. In: 2016 7th International Conference on Cloud Computing and Big Data (CCBD), Macau, pp 214–218
11. Sathyanarayana S, Moh M (2016) Joint route-server load balancing in software defined networks using ant colony optimization. In: 2016 International Conference on High Performance Computing & Simulation (HPCS), Innsbruck, pp 156–163
12. Jing S, Muqing S, Yong B, Min Z (2017) An improved GAC routing algorithm based on SDN. In: 2017 3rd IEEE International Conference on Computer and Communications (ICCC), Chengdu, pp 173–176
13. Kulkarni R, Sharma K (2018) A Novel Quality of Service (QoS) routing algorithm for Software Defined Network (SDN) using Particle Swarm Optimization (PSO). Int J Sci Res Comput Sci Eng Inf Technol 3(1)

An Integrated AdaBoost Algorithm for Down Syndrome Disease Recognition

Pranshu Agarwal, Muskan Chaudhary and Rahul Nijhawan

Abstract Down syndrome (DS) is the most significant cause of particular birth flaws and medical condition. It is an identified genetic form of mental subnormality. Over the last 100 years, conventional epidemiological studies to determine the pervasiveness, cause and clinical significance of the syndrome have been conducted. Some advancement has been made in characterizing the distinct types of chromosome errors that cause DS. It governs both physical and perceptive development, and it produces an attribute composition. From the age of 30, DS leads to etiquette changes with loss of deftness, and psychomotoric deceleration and mutism occur frequently. Adults having down syndrome has to undergo medical examination as well as routine check-up with doctor. In this study, we have proposed an ensemble AdaBoost framework approach for down syndrome disease detection. Due to unavailability of dataset, another dataset was made for testing the execution of the anticipated model. Our proposed approach (94.49%) outperformed the other algorithms such as random forest (RF), support vector machine (SVM), stacking and K-nearest neighbor (KNN).

Keywords AdaBoost · Down syndrome · KNN · Stacking · Random forest

1 Introduction

Down syndrome (DS) is a genetic clutter caused by the existence of chromosome 21 and is also termed as trisomy 21. It is one of the most mutual chromosome deformities in living beings. It arises for approximately one per 1000 babies born per year [1].

P. Agarwal (✉) · M. Chaudhary · R. Nijhawan
Department of Computer Science Engineering, Graphic Era University, Dehradun, India
e-mail: pranshuagarwal66@gmail.com

M. Chaudhary
e-mail: muskanchoudhary1724@gmail.com

R. Nijhawan
e-mail: rahulnijhawan2010@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_6

Every gene that is grouped with chromosomes in the cells nucleus is contained in every cells of the body. There are 46 chromosomes in each cell, 23 passed down from the mother and 23 passed down from the father. DS arises when some cells of a living being have partial copy of chromosome 21. Physical and intellectual disabilities are caused by DS. Mental disabilities of an adult are similar to an 9–10-year-old children. They prototypically also have destitute immune system. People with DS may also have some characteristics that are a small chin, slanted eyes, poor muscle tone and a flat nasal bridge [2].

Boosting is an approach in machine learning that combines weak and inaccurate rules and in return creates accurate prediction rule. The most widely used first practical boosting algorithm was Freund and Schapire AdaBoost algorithm [3].

The challenges that we face include the unavailability of good images, diversity of images, unfocussed images, so we need an efficient dataset for best result.

In this paper, we proposed a novel AdaBoost algorithm for depicting different magnitude of down syndrome. We employed several combinations of input parameters. It was observed that our algorithm gives best results by using strengths of the supportive parameters. Further, by using several analytical methods, we performed accuracy assessment. The highest classification accuracy achieved after several combinations of parameters by proposed AdaBoost approach is 94.49%.

The order of paper is as follows: Introduction, Datasets, Methodology, Results and discussion and conclusion.

2 Dataset

Dataset is the most leading phase, and it constitutes to be one of the biggest AdaBoost problems. The skill in the AdaBoost approach requires an intense dataset for the models to be trained. The superior our model is trained and so is the accuracy obtained after testing. There is no datasets available for realms such as DS disease with wide range of images that can be used to improve medical diagnosis. We created an image due to the non-existence of the specific datasets for DS disease dataset keeping a set of approximately 600 images which belongs to different classes of disease. The cause and effects of the disease are shown in Fig. 1.

We have considered better quality images with proper aspect and color each representing the DS disease. 70% of the images in each category are randomly selected from the dataset to create a training set, and remaining was used to create a test set (Table 1).

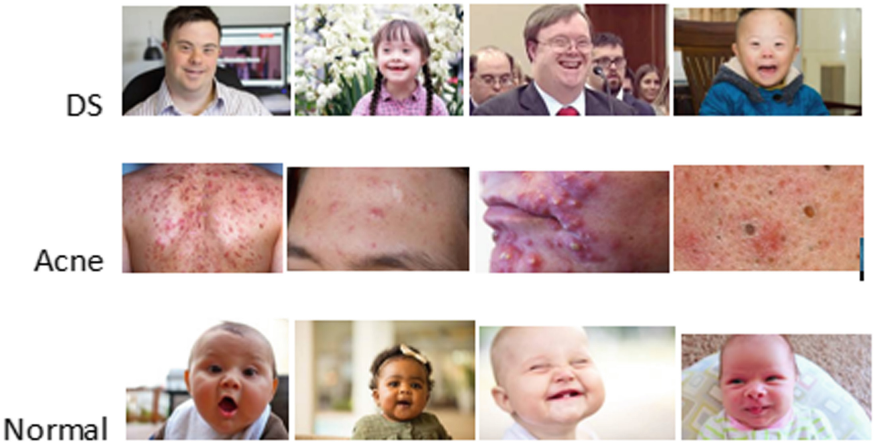


Fig. 1 Sample of diseases taken from dataset

Table 1 Total number of images corresponding to some diseases

Disease name	Number of images
Down syndrome	250
Acne	200
Normal	150

3 Methodology

In order to classify DS, an assemblage of decision trees is used. The configuration of machine on which we have executed our work constitutes of 8 GB RAM, an Intel i5 processor and 2 GB graphic card.

In order to find strong rule, weak learner and base learner are combined. Base learning algorithm is applied with different distribution to find weak rule. All these weak rules are combined into a strong prediction rule after much iteration by boosting algorithm [4].

The steps for opting distribution right are

Step 1: The base trainee allocates equal weight for each observation after taking out the dispensation.
Step 2: We have to pay higher attention if in case there is augury fault originated by initial base learning algorithm.
Step 3: Iterate step 2 till the highest accuracy is achieved.

The output from the weak learners is combined, and they create a strong learner which in the end improves the projection power of the model. The examples which have higher errors are paid higher focus by preceding weak rules.

Misclassification rate is classified as shown in Eq. 1.

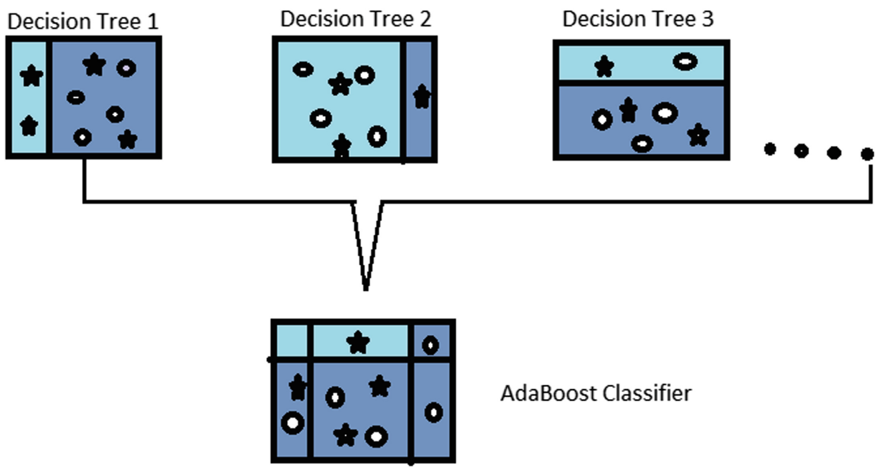


Fig. 2 AdaBoost classifier

$$\text{Error} = (\text{Correct} - N)/N \tag{1}$$

where error is the classification rate, correct is the number of training instance predicted correctly by the model, and N is the total number of training instances as shown in Eq. 1. For example, if the model predicted 88 of 100 training instances correctly, the error of misclassification rate would be (88–100)/100 or 0.12 (Fig. 2).

4 Results and Discussion

This section illustrates the following scenarios

(1) AdaBoost

AdaBoost is the descent starting point to learn the concept of boosting and is the first algorithm used for binary classification. It was originally termed as AdaBoost. M1 but may be referred to as discrete AdaBoost because it is used for classification instead of regression [3]. The highest accuracy achieved after using various combinations of parameter is 94.49% (Table 2).

(2) Random Forest

Random forest is also known as random decision forest and is an ensemble algorithm that is used for classification and regression. This algorithm basically corrects the overfitting habit of decision trees [3]. The highest accuracy achieved after using various combinations of parameters is 91.74%.

Table 2 Cross tabulation matrix of classified versus reference data for different garbage collection model

Predictive model	Classified data	Reference data			Producer's accuracy (%)	User's accuracy (%)	Overall accuracy (%)
		Down syndrome	Acne	Normal			
AdaBoost	Down syndrome	46	6	0	100	88.46	94.49
	Acne	0	20	0	76.92	100	
	Normal	0	0	37	100	100	
Random forest	Down syndrome	48	4	0	90.56	92.30	91.74
	Acne	5	15	0	78.94	75	
	Normal	0	0	37	100	100	
SVM	Down syndrome	50	0	2	86.20	96.15	89.90
	Acne	8	11	1	100	55	
	Normal	0	0	37	92.50	100	
Stack	Down syndrome	41	5	6	78.84	78.84	76.14
	Acne	9	8	3	57.14	40	
	Normal	2	1	34	79.06	91.89	
KNN	Down syndrome	39	2	11	76.47	75	72.47
	Acne	10	7	3	63.63	35	
	Normal	2	2	33	70.21	89.18	

(3) SVM

SVM stands for support vector machine algorithm and is used to set apart different types of classes. This algorithm is generally applied to different classification problems. It is also defined by a separating hyperplane [5]. The highest accuracy achieved after using various combinations of parameters is 89.90%.

(4) Stacking

Stacking is used to merge various types of models in order to get superior results. The most commonly used method for assembling is known as bagging. It is used to group different models to give the best results [6]. The highest accuracy achieved after using various combinations of parameters is 76.14%.

(5) KNN

KNN stands for K-nearest neighbor and is one of the effective algorithms that are generally used for both regression and classification. In this algorithm, we regularly search for K-nearest data points and then consider most frequent classes and

Table 3 Statistic measures of proposed models for the training (T) and validation (V) phase for mapping down syndrome

Dataset	Model	Classification				
		Accuracy	Precision	Specificity	AUC	Sensitivity
DS	AdaBoost	0.945	1.000	1.000	0.994	0.884
DS	Random forest	0.917	0.906	0.912	0.982	0.923
DS	SVM	0.908	0.862	0.859	0.972	0.961
DS	Stack	0.798	0.788	0.807	0.811	0.788
DS	KNN	0.771	0.765	0.789	0.867	0.750

assign that class to test data [6]. The highest accuracy achieved after using various combinations of parameters is 72.47%.

Out of the entire algorithms, AdaBoost is outperforming the other state-of-art algorithm as shown in Table 2. AdaBoost gives the best result due to the following two reasons: It reduces bias for little variance and tweaking of its parameters. Therefore, it gives the best results as compared to other state-of-art algorithms.

We can observe that the highest accuracy 94.5% with precision 100%, specificity 100%, AUC 99.4% and sensitivity 88.4% is achieved by AdaBoost algorithm as shown in Table 3.

ROC curve shown in Fig. 3, and disease down syndrome has been calculated. It is made by mapping "sensitivity" on y-axis and "specificity" on x-axis. This curve is used to create true positive rate against false positive rate. The true positive rate is also known as sensitivity [3].

5 Conclusion

In this paper, we have proposed a novel AdaBoost algorithm to detect down syndrome. The highest accuracy achieved after using different combinations of parameters is 94.49%. We have considered best quality of images with appropriate dimensions. The research site is primarily restricted into three different categories namely down syndrome, acne and normal. In normal, around 100 images have been examined, while in DS and acne, a total of about 450 images is clutch. It can be seen that AdaBoost gave the best result as compared to other state-of-art algorithms because of its tweaking feature. This paper attains much more difficulty due to the deficiency of datasets. Further, this model can also be applied for allied datasets of diseases.

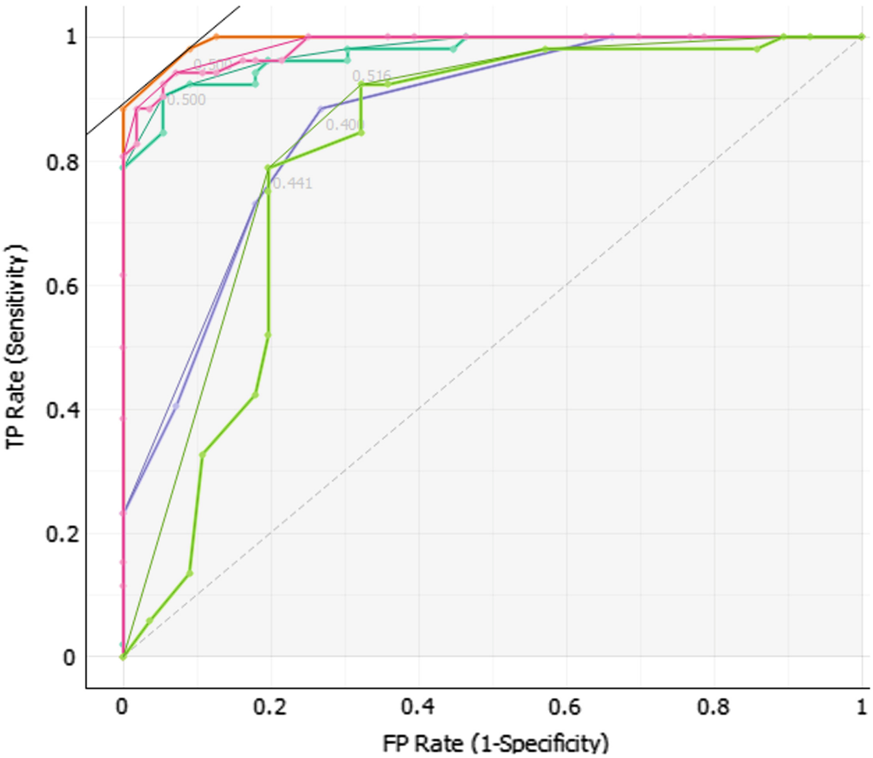


Fig. 3 ROC curve for specificity and sensitivity of trained model

References

1. Masters CL et al (1985) Amyloid plaque core protein in Alzheimer disease and down syndrome. Proc Natl Acad Sci 82(12):4245–4249
2. Korenberg JR et al (1994) Down syndrome phenotypes: the consequences of chromosomal imbalance. Proc Natl Acad Sci 91(11):4997–5001
3. Nijhawan R, Raman B, Das Josodhir (2018) Proposed hybrid-classifier ensemble algorithm to map snow cover area. J Appl Remote Sens 12(1):016003
4. Nijhawan R, Das J, Raman B (2018) A hybrid of deep learning and handcrafted features based approach for snow cover mapping. Int J Remote Sens 115
5. Nijhawan R et al. (2019) A futuristic deep learning framework approach for land use-land cover classification using remote sensing imagery. Adv Comput Commun Technol 87–96
6. Nijhawan R, Rana M (2016) Green computing and strategies for energy efficient cloud management. Int J Comput Appl 150(2)

A Comprehensive Healthcare Model for a Smart Left Ventricle Assisting Device

P. Joshua Ernest, Ameet Chavan and A. Subhananda Rao

Abstract An intelligent and reconfigurable, Internet of things (IoT)-based left ventricular assisting device (LVAD) system termed here as smart LVAD is proposed. The device can be remote accessed with the ability to disseminate information through a cloud server. The smart LVAD enables monitoring of the real-time physiological condition of the patient and that of LVAD efficiently from a remote place anytime over an API or a Web server. The wireless powered fully implanted VAD (FIVAD) also plans to overcome the necessity of an external driver or power source hence reducing the risk of infections and other diseases. With the help of machine learning that is based on data fusion and processing, reliable information is available for accurate diagnosis which helps faster treatment. The proposed smart LVAD allows dynamical decision rules to be adopted for maintenance management and can be used with high-dimensional and censored data problems

Keywords Smart healthcare · Sensor data fusion · Internet of things · LVAD · Medical devices

1 Introduction

The key challenges of a healthcare product manufacturer are to provide a safer, reliable, affordable, self-sustaining, unobtrusive and easy-to-maintain solution. The case in study of the presented work is for patients with life-support devices like ventricular

P. Joshua Ernest · A. Chavan (✉)
Department of ECE, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana 501301, India
e-mail: ameetchavan@sreenidhi.edu.in

P. Joshua Ernest
e-mail: josh.erne7@gmail.com

A. Subhananda Rao
Department of ME, Sreenidhi Institute of Science and Technology, Hyderabad, Telangana 501301, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_7

assist device (VAD). The operating model for this device is based on emerging technologies like Internet of things, artificial intelligence, machine learning and cloud. The model deploys body sensor network (BSN) with implantable bio-medical and external sensors to measure patients vitals such as blood pressure and glucose levels, heart rate, EEG, ECG and sends data, through a gateway to be monitored remotely by medical care providers. The diagnosis and reporting process is accelerated with the application of sensor data fusion and mobile API [1, 2], thus providing a fully integrated smart healthcare solution.

1.1 Traditional LVAD Working and Complications

An LVAD resembles a simple pump attached near the heart. One end is connected to left ventricle, whereas the other end is connected to the aorta. An LVAD has external and internal components [3]. These internal components include a pump and a tube which rest on adjacent to the heart's left ventricle and provides a route for blood to travel to the aorta. A driveline acts as a medium to interface and interconnect the power source, pump and the external controller located outside a body. To ensure proper functionality of the support system, the driveline and power source have to be connected at all times. These power sources can include a form of a battery or an adaptor. Controllers are built with a warning system to alert individuals or patients about the life of the batteries or if the battery is running low [4].

On an average, 75% of the patients fitted with LVADs have a survival rate of two years [5]. One of the essential and desirable aspects of LVAD is real-time continuous prognosis of the patient's health and the implanted device condition. The proposed model hereby provides a brief list of complications associated with LVADs [6, 7]. (1) ***Bleeding***: reports that around 30% patient require reoperation post-implant and nearly 81% of that group require blood transfusion due to bleeding. Further, the driveline tunnel and preperitoneal pocket can also be prone to bleeding. (2) ***Infection***: The infections listed here are specific to the device implant related and may include infections at the pump pockets or driveline and endocarditis that is related to the LVAD. Of the above list, driveline infections are of most concern as it requires surgical restoration and in the worst case may require pump restoration. (3) ***Pump thrombosis***: Defined as the pump malfunction or failure due to thrombus (blood clot) within the pump or the conduit supplying blood. This manifest increases in local heat generation, power elevations and infection. And in the worst case may lead to heart failure. (4) ***Device malfunction***: Apart from pump thrombosis, the other contributing factors to LVAD failures are variation in pump rotor speed, flow and power along with pulsatility index.

2 Proposed Smart Ventricular Assist Device

To implement a fully functional IoT-based smart device involves a compendium of external and internal devices working coherently with one another to monitor the human body conditions, store the information and provide real-time interface to continually monitor and track users. Figure 1 represents the comprehensive model of the proposed smart LVAD for patient monitoring and device life cycle management. [8] interprets sensor-based data by using data fusion techniques and algorithms based on health monitoring applications. Below mentioned are a set of devices that will be utilized to obtain the desired goal.

(A) **Implanted/ Internal Sensors**—(1) Inserted Cardiac Monitor (ICM): These are devices that are used for long-term monitoring of a patient's heart electrical activity [9]. (2) Transonic Tubing Sensors (Flow Measurement): [10–12] Determining the flow of coronary blood in small bypass grafts has been done using Doppler and electromagnetic flowmeters called flow measurement devices which are used for monitoring of a patient's heart rate and record any variations that could be caused due to patients vital or LVAD pump malfunction. (3) Glucose Sensor: A monitoring system that can be placed beneath the skin (usually in the abdominal or upper buttock area) to measure sugar levels and transmit data wirelessly to a smart device to track your blood sugar regular intervals and make informed treatment decisions [13].

(B) **External Sensors**—(1) Pulse Oximeter: It tells about the level of oxygen saturated or level of oxygen present in the blood which also indicates the flow of oxygen to different organs in the body. (2) Smart Watch: A multipurpose device whose main goal is to monitor the blood pressure and heart rate of an individual—ability to detect spiking and abnormal heart rates, sleep and blood monitoring capabilities and can detect arrhythmia. (3) Digital Camera: Traditional LVADs using drivelines can benefit from a sensor which can detect external inflammation on the skin around the driveline inserted [14] as seen in the adjacent image where the black markings indicate the inflammation.

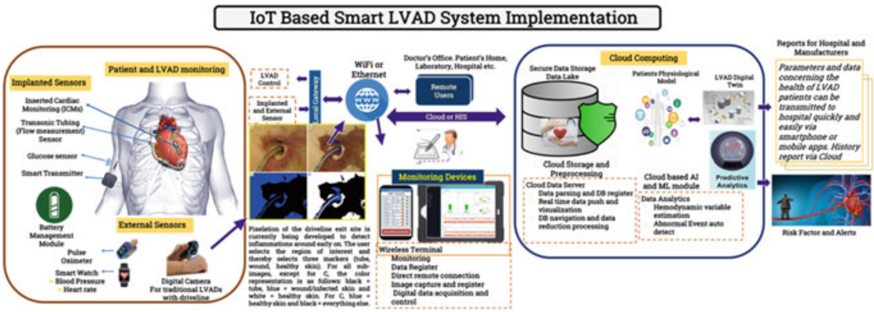


Fig. 1 Comprehensive model of the proposed smart LVAD for patient monitoring and device life cycle management

(C) **Wireless Powered Fully Implanted LVAD**—Driveline is a source of infection, re-hospitalization and diminished quality of life for VAD patients. Attempts have been made to get rid of the driveline, but they have not succeeded or made viably applicable. Pya et al. [15] have implemented a solution to this problem by using a coplanar energy transfer system. This system has two large rings using a coil-within-coil topology that ensures resonance energy transfer while allowing continuous circular support powered by an inbuilt battery source. The fully implanted ventricular device (FVAD) ensures that the wirelessly powered device is more user-friendly and allows patients to walk around freely without any physical problems.

3 Machine Learning Based on Data Fusion and Processing

As described in the previous section, there are two sets of sensors—external and internal which are responsible for data collection from the human body. The reciprocation and utility of this data to detect abnormal events or simple visualization involve a set of complex processes and algorithm, represented in Fig. 2. The step by

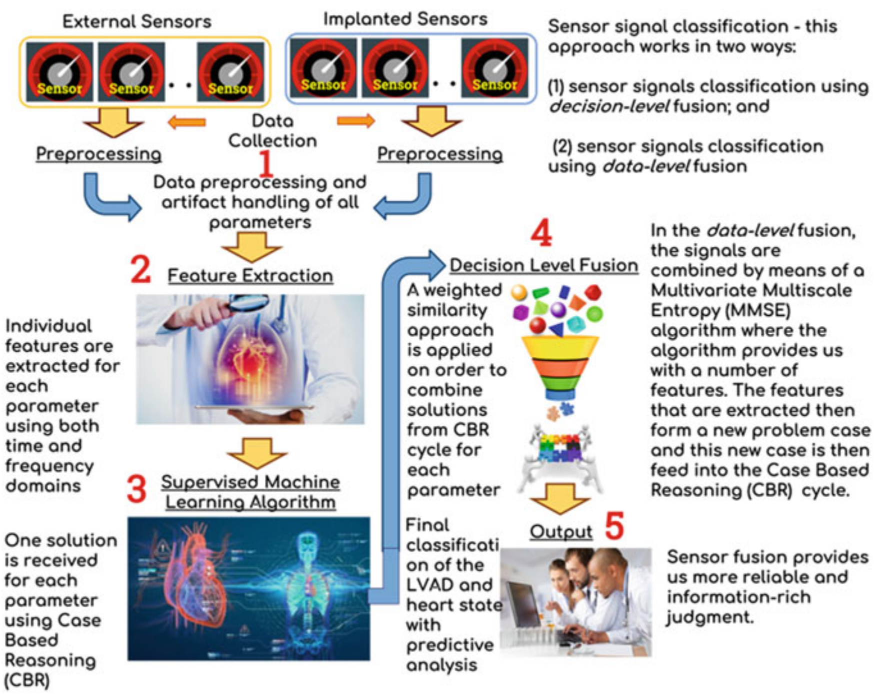


Fig. 2 LVAD machine learning-based sensor data fusion and processing

step process of machine learning using a smart LVAD involves

1. Data pre-processing: It is a technique that requires converting raw data into a human-perceivable format. Simply stated real-world data on its own is incomplete and lacks a certain level of understanding and usually has errors.
2. Feature extraction: Individual features are extracted or each parameter using both time and frequency domain.
3. Supervisor machine learning Algorithm: In supervised learning, each pair is a combination of vector and supervisory signal. This technique maps new examples and can correctly determine class labels of instances analyses with the help of the training data and implementing optimal scenarios. This requires algorithms to visualize unforeseen data in a generalized way.
4. Decision level fusion: Decision level fusion can make or choose a single decision from multiple theories obtained by the sensors, impersonator or real user, which maybe similar in nature in case of biometrics and other security services. Fusion is also implemented to improve accuracy and communication bandwidth [16].
5. Data fusion: It is the process of combining various data sources to produce accurate, consistent and necessary information and is categorized based on the levels of fusion. It initially begins at the lowest level of implementation and combination of raw data to produce descriptive and informative coherent data. Multivariate multi-scale entropy (MMSE) algorithm is used in the above process to combine the signals. The features extracted create a new case which is then fed into a case-based reasoning (CBR) cycle.

To identify classes, the proposed work employs multinomial logistic regression technique based on Softmax regression. Under this setup, the target variable y ranges over multiple classes, wherein each class specifies a particular issue with the LVAD. The probability of y being in each potential class $c \in C$, $p(y = c|x)$. The Softmax function takes a vector $z = [z1, z2, \ldots, zk]$ of k arbitrary values and maps them to a probability distribution, with each value in the range (0,1), and all the values summing to 1 [17]. Shown below is the pseudo-algorithm for the implementation of the machine learning technique to identify the complications with LVAD.

```
function Softmax (x,y,z)
# return classification by squashing values to 0 or 1
as Sigmoid
# x is the set of training inputs - sensor data X1, X2, ..Xn
# y is the set of training outputs (labels) Y1, Y2, ..Yn
# z is the set input to the Softmax function
```

$$\mathbf{softmax}(\boldsymbol{zi}) = \frac{e^{zi}}{\sum_{j=1}^{k} e^{zj}} \qquad \boldsymbol{p}(\boldsymbol{y} = \boldsymbol{c}|\boldsymbol{x}) = \frac{e^{wix+bc}}{\sum_{j=1}^{k} e^{wj.x+bj}}$$

$$1 \le i \le k$$

1. For each training tuple, $(X_{(i)}, Y_{(i)})$ Softmax computes the dot product between a weight vector w and an input vector x (plus a bias)

```
2. Separate weights are calculated for the K classes
3. Based on the relative values of the function will push
its possibility toward 1, and prunes inputs with smaller
probabilities.
```

4 Conclusion

A comprehensive model for patient monitoring and life-supporting device prognosis and management by integrating emerging fields of technologies such as Internet of things, cloud-based predictive analysis and machine learning is proposed. Data from internal and external sensors are used to train and test the logistic regression model. The work discusses various complications of a traditional LVAD which can be detected and mitigated with the application of smart LVAD. The presented work explores the deployment of various sensors and application of sensor data fusion models. Smart LVAD has high potential to improve the quality of life of the patients with higher accuracy percentage by the prediction model.

References

1. Reiss N, Schmidt T, Boeckelmann M et al (2018) Telemonitoring of left-ventricular assist device patients—current status and future challenges. J Thorac Dis 10(Supplement15)
2. Yan J, Chen C, Duan X, Huang A, Li Z (2010, December) A wireless healthcare system based on mobile internet platform. In: 2010 2nd international conference on information engineering and computer science, 25–26 Dec 2010
3. Abadeer A, Putnins M, Badach J, Kamdar P, Yang M (2013) Cardioresponsive left ventricular assist device. In: 2013 IEEE 39th annual northeast bioengineering conference, 5–7 Apr 2013
4. Chusri Y, Diloksumpan P, Naiyanetr P (2013) Current left ventricular assist device. In: IEEE 6th 2013 biomedical engineering international conference, 23–25 Oct 2013
5. Dyke DBS, Pagani FD, Chenoweth CE (2002) Nosocomial infections in left ventricular assist device recipients. Clin Infect Dis 34(10):1295–1300
6. Kilic A, Acker MA, Atluri P (2015) Dealing with surgical left ventricular assist device complications. J Thorac Dis. https://doi.org/10.3978/j.issn.2072-1439.2015.10.64
7. Wang Y, Simon M, Bonde P, Harris BU, Teuteberg JJ, Kormos RL, Antaki JF (2012) Prognosis of right ventricular failure in patients with left ventricular assist device based on decision tree with SMOTE. IEEE Trans Inf Technol Biomed 16:3
8. Kinga RC, Villeneuveb E, Whitea RJ, Sherratta RS, Holderbauma W, Harwina WS (2017) Application of data fusion techniques and technologies for wearable health monitoring. Med Eng Phys 42:1–12. https://doi.org/10.1016/j.medengphy.2016.12.011
9. Ciconte G, Giacopelli D, Pappone C (2017) The role of implantable cardiac monitors in atrial fibrillation management. J of Atrial Fibrillation 10(2):1590
10. Matre K, Birkeland S, Hessevik I, Segadal L (1994) Comparison of transit time and Doppler ultrasound methods for measurements of flow in aortocoronary bypass grafts during cardiac surgery. Thorac Cardiovasc Surg 42:170–174
11. Rozbicki J, Witek B, Steifer T, Lewandowski M (2017) Doppler-based blood pressure measurement system for patients supported by a continuous-flow rotary left ventricular assist device. In: IEEE international ultrasonics symposium (IUS)

12. Lim E, Karantonis DM, Reizes JA, Cloherty SL, Mason DG, Lovell NH (2008) Noninvasive average flow and differential pressure estimation for an implantable rotary blood pump using dimensional analysis. IEEE Trans Biomed Eng 55:8
13. Heo YJ, Kim S-H (2019) Toward long-term implantable glucose biosensors for clinical use. Appl Sci 9(10):2158. https://doi.org/10.3390/app9102158
14. Toda K, Sawa Y (2015) Clinical management for complications related to implantable LVAD use. Gen Thorac Cardiovasc Surg 63:1863–6705
15. Pya Y, Maly J, Bekbossynova M, Salov R, Schueler S, Massetti M, Zilbershlag M, Netuka I (2019) First human use of a wireless coplanar energy transfer coupled with a continuous-flow left ventricular assist device. J Lung Heart Transplant 38(4)
16. Osadciw L, Veeramachaneni K (2009) Fusion, decision-level. In: Li SZ, Jain A (eds) Encyclopaedia of biometrics. Springer, Boston
17. Jurafsky D, Martin JH (2019) Speech and language processing—an introduction to natural language processing, computational linguistics, and speech recognition 3rd edn, ISBN-13: 978-9332518414

Moving Hand Segmentation from H.264 Compressed Sign Language Videos

Kaushik Mazumdar, Anjan Kumar Talukdar and Kandarpa Kumar Sarma

Abstract Hand segmentation is the most critical step in sign language recognition. Many advanced video applications require manipulation of compressed domain video signals. Storage and network bandwidth are the main constraints due to which the video signals are needed to be compressed. Therefore, we proposed a system to segment hand gesture from a compressed domain video file. The only cue used for segmentation is the motion vectors (MVs). First, the MVs are preprocessed to get the motion information accurately that are related to the moving hand. The specific block's decision belongs to motion or no motion is done using classifiers based on Markov random field (MRF). The experimental result of this paper includes the testing of the proposed system for American Sign Language (ASL) and Indian Sign Language (ISL) under different environmental conditions of the background. The proposed system shows an average precision, recall, and F-measure of around 94.19%, 62.14%, and 75.11%, respectively.

Keywords H.264/AVC · Motion vector · MRF · Sign language · Hand segmentation

1 Introduction

Hand gesture recognition is the key to express thoughts and feelings that makes our life easier. For the deaf and dumb people, sign language serves as a key to make interaction among their community. To make interaction, different body parts are used viz. fingers, hand, etc. [1].

K. Mazumdar (✉) · A. K. Talukdar · K. K. Sarma
Department of Electronics and Communication Engineering, Gauhati University, Jalukbari, Assam 781014, India
e-mail: kaushikmazumdar01@gmail.com

A. K. Talukdar
e-mail: anjantalukdar@gauhati.ac.in

K. K. Sarma
e-mail: kandarpaks@gauhati.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_8

Any segmentation algorithm requires dividing the foreground image from the background scene, where segmentation of each section of video frames is usually carried out in the pixel domain, called uncompressed segmentation. The segmentation is achieved by using block matching [2], phase correlation [3], etc., as information about the motion is not easily available in uncompressed domain. Though accurate segmentation is possible in this domain, it cannot handle enormous data that is increasing day by day as uncompressed domain segmentation takes more time and data space than the compressed one.

One of the main advantages of compressed domain video segmentation is that motion information is readily available. The only limitation in the compressed domain segmentation is that it has a lower accuracy than the uncompressed domain segmentation since compression leads to loss of some information but still has the advantage of faster processing speed and lower computational costs [4]. Therefore, compressed domain analysis is more preferable for real-time applications. This paper presents a compressed domain moving hand segmentation for sign language recognition system that only uses the MVs to perform fairly accurate segmentation for H.264/AVC-coded video bit stream.

1.1 Related Work on Compressed Domain Segmentation

Hand segmentation is the key step for every sign language recognition system as it leads to efficient recognition of the signs. This paper presents an efficient segmentation of the moving hand(s) from the background for compressed videos. Due to the advantages of compressed domain segmentation as mentioned above, many works have been reported in this field. Maekawa and Goto [5] proposed a technique that uses both MVs and macroblocks (MBs) information. Initial areas are detected using threshold values for both MVs and MBs. Experimental results show a precision of 70.7% precise whereas accuracy drops to 37.2% using only MBs information. Okade and Biswas [6] combine the moving camera's global motion estimation (GME) and the global motion compensation (GMC) measures. The boundary of decisions dividing these two groups is learned from video data learning, GME, and GMC modules can arbitrarily switch on and off. This proposed algorithm shows an average of 83% precise. Chen et al. [7] proposed a technique that shows an average precision of 91% using a Markov random field (MRF)-based segmentation. The boundary of the segmented output is further processed to get proper segmentation. Sabirin and Kim [8] proposed graph-based spatiotemporal segmentation that properly deals with detection of moving object. 90% accuracy is obtained with quantization parameter 32. Khatoonabadi and Bajic [9] had done a MRF-based segmentation to segment compressed domain moving object. The segmentation is done only using the MVs and the MBs. The experimental result shows an average precision of 81.5% with quantization parameter 16. Liu et al. [4] segmented video objects using spatiotemporal normalization of motion vectors w.r.t. reference frame index. Iterative backward projection is done to accumulate motion vector that is global motion compensated. 92.2% precision is obtained using spatiotemporal segmentation scheme.

1.2 Overview of the Proposed Model

After the above observations, we proposed a moving object segmentation scheme in the compressed domain using MVs to efficiently segment moving hand from a sign language video bit stream.

First, the motion vectors are extracted from the compressed videos for each frame of the video sequence. Then MVs are preprocessed to get all the motion information related to the moving hand. The region of interest, i.e., the moving hand region is defined manually for the initial frame and after that the remaining frame segmentation is accomplished using the MAP-MRF framework.

To calculate the MRF, the MVs are taken as prior information. This information is the likelihood parameter for the MRF calculation. Then the macroblocks of the frames are checked along the MVs since it gives the initial and final positions of motion between frames. After that, the energy term is calculated by summing up for all the object values and the moving object is traced by taking the maximum value position. Figure 1 shows the flowchart of the proposed model.

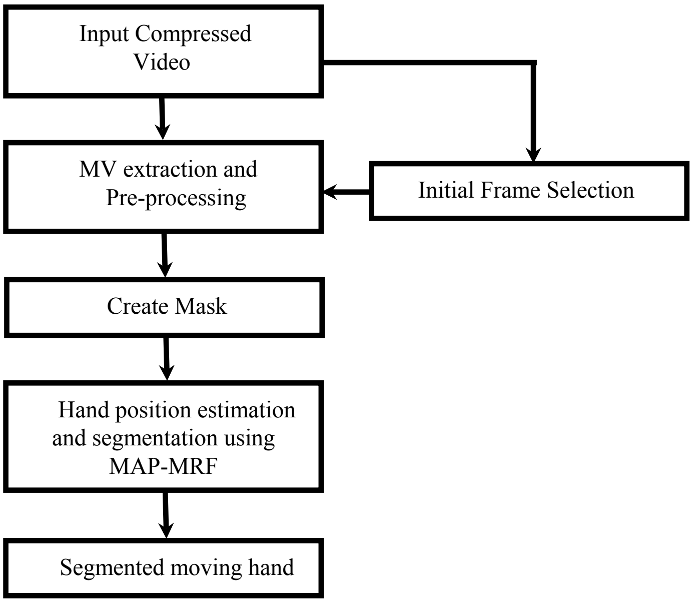


Fig. 1 Flow diagram of the proposed segmentation method

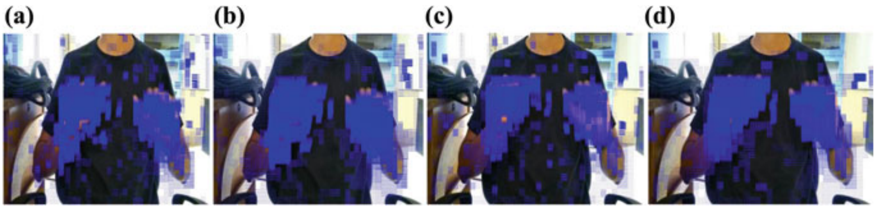


Fig. 2 Original and preprocessed (output) frames: for **a** input frame 4, **b** output of frame 4 and for **c** input frame 5, **d** output of frame 5

The paper is organized as follows: Sect. 2 describes the preprocessing of the MVs, Sect. 3 describes MRF segmentation, Sect. 4 describes the results obtained, and finally Sect. 5 concludes the work.

2 Preprocessing of the Motion Vectors

In video compression, the SKIP blocks have no associated MVs [9]. These blocks are required to assign with MVs to do the segmentation properly. For these, we have used the advantage of H.264/AVC coding which has its smallest partition 4×4. Now, each 4×4 blocks have MVs except the SKIP blocks. Directional spatial prediction is done for the blocks that are left without any MVs during encoding of video frames since the similar blocks location between two frames are left unencoded as they may have no motion between the frames. These blocks are predicted by using the concept that it has very close similarity with the neighboring blocks viz. blocks appearing above, side or diagonal. For these, we have checked for the MVs of the adjacent neighbors and those MVs are copied to the current MB. This is done for all the 4×4 MBs within the moving hand which have no associated MVs. Figure 2 shows the original frames and the motion predicted frames for some of the intermediate frames of our recorded Indian Sign Language (ISL) video.

3 MAP-MRF-Based Segmentation Using Threshold Value

Markov random field (MRF) theory provides us to model a priori probability of context-dependent pattern viz. object features and textures. For optimality in MRF vision modeling, maximum a posterior (MAP) probability is one of the most popular statistical criteria [10]. In MAP-MRF framework, the objective is to maximize the joint posterior probability. Here, the blocks having the object are taken as label 1 and non-object blocks are label 0. The aim is to put the block labels $O^t \in \{0, 1\}$ on the t frame from the given labels O^{t-1} of the frame $t - 1$ using the observed motion information MVs V^t. The block labels are assigned for the first frame using manually given threshold value. This will segment the moving hand more accurately. The criterion for choosing the best labeling is that 'it should maximize the posterior probability' $P(O^t|O^{t-1}, V^t)$ which is [9, 10]

$$P\left(O^t|O^{t-1}, V^t\right) = \frac{P\left(O^{t-1}|O^t, V^t\right) \cdot P\left(O^t, V^t\right)}{P(V^t)} \tag{1}$$

Now, this posterior probability has to be maximized. When both the prior and likelihood distributions are known, the best result is achieved by maximizing (1). Therefore, (1) becomes

$$O^t = arg\max\left[P\left(O^{t-1}|O^t, V^t\right) \cdot P\left(O^t, V^t\right)\right] \tag{2}$$

The calculation of (2) contains the joint probability distribution from the conditional probability distribution that turns out to be very difficult. The equivalence between the MRF and Gibbs distribution gives

$$P(f) = Z^{-1}\exp\left[-\frac{U(f)}{T}\right] \tag{3}$$

where T = constant, $U(f)$ = energy function, and $Z = \sum\exp\left[-\frac{U(f)}{T}\right]$ is the normalizing factor which is a constant.

Thus, (2) becomes

$$O^t = \frac{1}{Z_1}\exp\left[-\frac{\varphi\left(O^{t-1}|O^t, V^t\right)}{T_1}\right] + \frac{1}{Z_2}\exp\left[-\frac{\varphi\left(O^t, V^t\right)}{T_2}\right] \tag{4}$$

where T_1, T_2 are the scaling factors and φ is the energy term.

4 Experimental Results

The proposed algorithm is tested on two different sign languages viz. Indian Sign Language (ISL) and American Sign Language (ASL) for various signers. The ISL video (1920 × 1080 pixels) is recorded in an indoor environment with a static background and has a frame rate of 30 frames/second. The ASL video (324 × 312 pixels) has a frame rate of 30 frames/second. The ASL video is downloaded from online database [11]. These results are obtained on a PC with 4 GHz Intel i3 CPU and 8 GB RAM, implemented using JM 19.0 reference software [12].

Figures 3 and 4 show the segmented hand for ISL. Both videos are consisted of 230 frames and have 4 signs. Figure 5a, b show the segmented hand for ASL which consists of 96 frames and 108 frames, respectively. Apart from that, we have tested our system for different signer having different background conditions. From

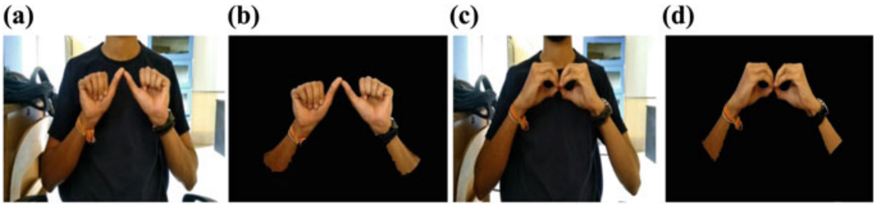


Fig. 3 Segmented hand of user 1 for ISL: for **a** input frame 13, **b** output of frame 13 and for **c** input frame 95, **d** output of frame 95

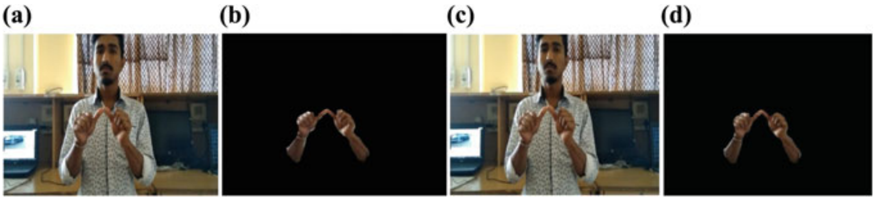


Fig. 4 Segmented hand of user 2 for ISL: for **a** input frame 9, **b** output of frame 9 and for **c** input frame 13 **d** output of frame 13

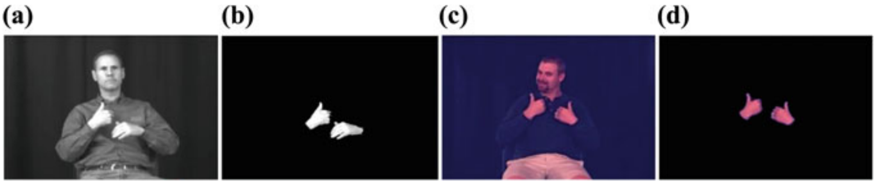


Fig. 5 Segmented hand for ASL: for **a** input frame 4 (video 1), **b** output of frame 4 and for **c** input frame 20 (video 2), **d** output of frame 20

the segmented output, it is clearly seen that our algorithm fits well for both kind of environment, i.e. simple and complex backgrounds.

4.1 Performance Measurement

The segmented outputs are compared with manually segmented ground truth and correctly labeled object pixels (True Positive—TP), non-object pixels incorrectly labeled as object pixels (False Positive—FP), and missed object pixels that are labeled as non-object pixels (False Negative—FN) are identified. The following parameters are used to measure the performance of the system (Table 1).

Table 1 Performance measurement

Video	Measure (in percentage)		
	Precision	Recall	F-measure
ISL (user 1)	95.31	61.53	74.78
ISL (user 2)	91.29	63.30	74.76
ASL (video1)	95.20	61.43	74.67
ASL (video 2)	94.96	62.27	75.22

Precision = TP/(TP + FP),
Recall = TP/(TP + FN) and
F-measure = (2 · Precision · Recall)/(Precision + Recall).

5 Conclusion

An approach to segment moving hand from sign language videos in H.264 domain is presented in this paper. The average time taken to segment each frame is around 4 ms. The proposed system shows an average precision, recall, and F-measure of around 94.19%, 62.14%, and 75.11%, respectively. Hence, it is seen that this system has a good precision and can be used in a sign language recognition system. In the future, real-time sign language segmentation can be one of the key focuses.

References

1. Rajam PS, Balakrishnan G (2011) Real time Indian sign language recognition system to aid deaf-dumb people. In: 2011 IEEE 13th international conference on communication technology 737–742
2. Ghanbari M (1990) The cross-search algorithm for motion estimation (image coding). IEEE Trans Commun 38(7):950–953
3. Stiller C (1997) Object-based estimation of dense motion fields. IEEE Trans Image Process 6(2):234–250
4. Liu Z, Lu Y, Zhang Z (2007) Real-time spatiotemporal segmentation of video objects in the H. 264 compressed domain. J Visual Commun Image Represent 18(3):275–290
5. Maekawa E, Goto S (2013) Examination of a tracking and detection method using compressed domain information. In: 2013 picture coding symposium (PCS), IEEE 141–144
6. Okade M, Biswas PK (2016) A novel moving object segmentation framework utilizing camera motion recognition for H. 264 compressed videos. J Vis Commun Image Represent 36:199–212
7. Chen YM, Bajic IV, Saeedi P (2011) Moving region segmentation from compressed video using global motion estimation and Markov random fields. IEEE Trans Multimedia 13(3):421–431
8. Sabirin H, Kim M (2012) Moving object detection and tracking using a spatiotemporal graph in H. 264/AVC bitstreams for video surveillance. IEEE Trans Multimedia 14(3):657–668
9. Khatoonabadi SH, Bajic IV (2012) Video object tracking in the compressed domain using spatio-temporal Markov random fields. IEEE Trans Image Process 22(1):300–313

10. Li SZ (2009) Markov random field modeling in image analysis. Springer Science & Business Media
11. ASL video link 1. http://secrets.rutgers.edu/dai/queryPages/querySelection.php
12. H.264/AVC Reference Software JM19.0. http://iphome.hhi.de/suehring/

CNN-Based Real-Time Indian Sign Language Recognition System

Alakesh Sarkar, Anjan Kumar Talukdar and Kandarpa Kumar Sarma

Abstract Sign language is a way by which deaf and dumb people can express their thoughts and feelings. Deaf and dumb people use hand shape, body movements, and facial expressions for communication. In this work, a vision-based Indian Sign Language Recognition system using a convolutional neural network (CNN) is implemented. The sign images are captured by a USB camera. To segment the hand region, background subtraction method is used. Two databases have been created for ISL. Each of the databases contains 26 alphabets having a total of 52,000 images. The system has been also tested in real time, where the sign alphabets by four signers in front of the camera are captured and it correctly recognized almost all of the signs. Accuracy of around 99.40% is obtained.

Keywords Indian sign language · Convolutional neural network · Real time

1 Introduction

Sign language is a way of communication between deaf and dumb people. Deaf and dumb people use sign language using different hand shapes, with different orientations and movements [1]. Researchers in the field of sign language are broadly categorized in two ways, data glove based and vision based. In the data glove-based method [2], the user needs to wear a glove. Glove consists of flex sensors, accelerometer, and motion tracker. In a vision-based system, sign images are captured through a Web camera and then processing is done on the sign images to recognize the

A. Sarkar (✉) · A. K. Talukdar · K. K. Sarma
Department of Electronics and Communication Engineering, Gauhati University, Jalukbari, Assam 781014, India
e-mail: alakesh236@gmail.com

A. K. Talukdar
e-mail: anjantalukdar@gauhati.ac.in

K. K. Sarma
e-mail: kandarpaks@gauhati.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_9

sign language. A wide range of researches have been done in American Sign Language (ASL) but a negligible amount of researches have been done in Indian sign language (ISL). There are various methods for recognition of sign language using statistical-based approach such as hidden Markov model (HMM) [3], support vector machine (SVM) [4], etc. In [5], a conditional random field (CRF)-based model is used for recognition of sign languages where images in RGB color space are converted into HSI color space. The system can detect one-handed ISL signs with a 90% recognition rate and two-handed ISL signs with 86% recognition rate. Adithya et al. [1] proposed an artificial neural network (ANN)-based method for automatically recognizing fingerspelling in ISL. Euclidean distance transform method is used for feature extraction. Ghotkar et al. [6] proposed the Cam-Shift method for hand tracking followed by genetic algorithm for recognition. Singha et al. [7] proposed eigenvalue-weighted Euclidean distance for feature extraction. Sharma et al. [8] proposed direct pixel value and hierarchical centroid techniques for feature extraction and KNN classifier and ANN for recognition. Tavari et al. [9] introduced a histogram of oriented gradient (HOG)-based method for feature extraction.

In all the above-mentioned techniques, the selection of features plays a crucial role. If the selected feature does not have the proper discrimination property, then it may affect the overall recognition process. This is one of the drawbacks of such techniques. In this paper, a vision-based ISL recognition system using convolutional neural network (CNN) is introduced where the features are automatically extracted. The signs that are considered for recognition are the 26 letters of English alphabets. A USB camera is used to capture the sign images. The background subtraction method is used to extract the signs from the background. A CNN model is designed to classify the sign language. The advantage of using CNN is that it does not require to extract the features of the images. Also, it has higher accuracy than the other methods. But the disadvantage of CNN is that it requires a large amount of database to train it.

The paper is organized as follows: Sect. 2 describes the proposed method, Sect. 3 describes the results obtained, and finally Sect. 4 concludes the work.

2 Proposed Work

The flowchart of the proposed work to design a system that can recognize ISL in real-time is shown in Fig. 1. At first, the hand is segmented out from the input frame. Then the system will predict the class of the frame from a CNN model which is previously trained with 52,000 samples of sign images. If there is a hand in the image, then the CNN model will give probability 1, in favor of a class and then the system will call a function to retrieve the class name of the images from a database. If there is no hand in the image, then the CNN model will give probability less than 1, i.e., not in favor of any class and the system will understand that there is no sign in the frame or the sign in the frame is not matching in the database and hence the system will ask to put a hand in front of the camera.

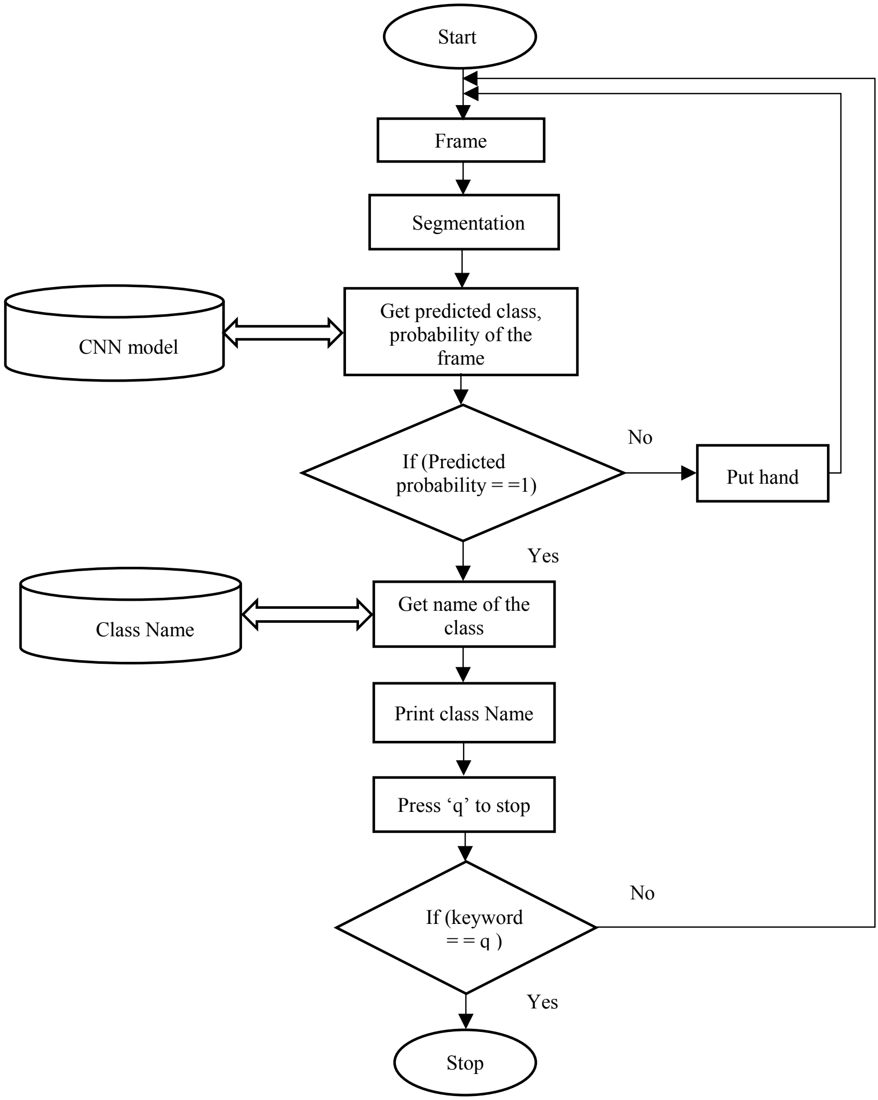


Fig. 1 Flowchart of the system

2.1 Image Acquisition

Image acquisition is the first step in sign language recognition. At first, the images are captured by a USB camera. A region of interest (ROI) is defined in the camera frame and images inside the ROI region are considered for recognition. Background subtraction is done on the image to segment out the foreground object which is discussed in the next section.

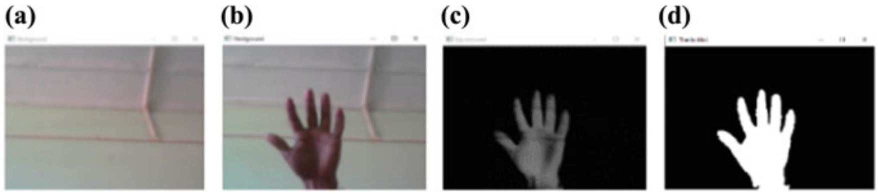


Fig. 2 **a** Background frame, **b** object frame, **c** background-subtracted frame, **d** binary frame after thresholding

2.2 Background Subtraction and Thresholding

To segment out the hand region, the background needs to be subtracted from the image. So to find out the background, here, the concept of running averages is used [4]. Here, the system is made to look over a particular scene for 30 frames. During this period, the system computes the running average over the current frame and the previous frames and the system considers the frame as background. After figuring out the background, sign language using hand is kept in front of the camera. The system will consider this frame as a frame containing hand object. Figure 2a, b, show the background frame and object frame, respectively. After that, the absolute difference between the background frame and the current frame is calculated to obtain a difference image that holds the newly added foreground object (hand) only and then thresholding is done on the image to convert it to a binary image. Figure 2c shows the background-subtracted frame. To perform the thresholding operation, a threshold value of 0.5 is considered. Then the system performs the thresholding operation on every pixel of the background-subtracted image frame. If the intensity value at the particular pixel coordinate is greater than the threshold value, then it replaced the pixel value as 1, else the pixel value is replaced by 0. Figure 2d shows the output binary image.

2.3 Database

To train the CNN, the first thing that comes into the picture is the database. ISL database is not easily available in public. In this paper, two databases have been created from the hand-segmented images [10]. Each of the databases contains 52,000 samples. Figure 3 shows the 26 alphabets of ISL that are used.

Fig. 3 26 alphabets of ISL

2.4 Proposed CNN Block Diagram

A CNN is designed with two convolution layers, two max-pooling layers, four rectified linear units (ReLu), one dropout layer, one flatten layer, and three dense layers followed by one softmax regressive layer. The proposed block of the network is shown in Fig. 4. The first convolutional layer has 30 filters of size 5 × 5. It will generate 30 feature maps of the input image frame. This convolutional layer extracts low-level features like edges, color, orientation, etc. The activation function ReLu is used for nonlinearity in the convolved image. Max-pooling is used for dimensionality reduction. Here, a kernel of size 2 × 2 is used. It gives the maximum value present inside a kernel. Max-pooling also extracts dominant features that are rotational and positional invariant. The second convolutional layer has 15 filters of size 3 × 3. It extracts the high-level features from the input image. A regularization technique called dropout is used to overcome the overfitting of the CNN model. It randomly deactivates some of the nodes while training the model. In this CNN model, 20 percent (0.2) of the total nodes are neglected. After that, the output is flattened and is fed to a regular ANN for classification. Three fully connected (Dense) layer is used, the first layer has 150 output nodes, the second layer has 50 output nodes, and the

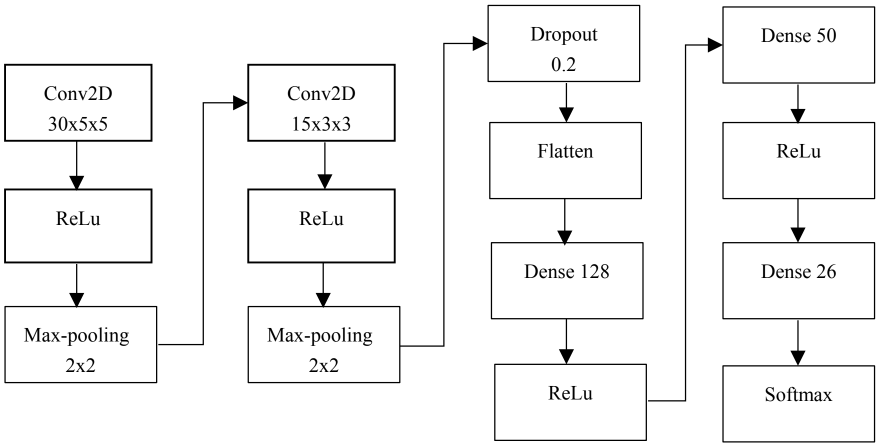


Fig. 4 Proposed block diagram of the CNN model

third layer has 26 output nodes which are equal to the number of classes. After that, a probability function called softmax is used that gives the probability of the output classes.

2.5 *Training the CNN Model*

The model is first trained using 52,000 samples database of image size 50 $\times$ 50 with 3, 5, 7, and 10 numbers of epochs. The training accuracy of the model is good but testing accuracy is not very good. To improve the accuracy, the database is augmented, where the image samples are arbitrarily translated, rotated, and zoomed. The image size is also reduced to 28 $\times$ 28 to improve training time. The model is trained again using 52,000 samples of images of size 28 $\times$ 28 with 10, 20, and 25 numbers of epochs. Figure 5a, b shows the training and validation accuracy plot of the model for different epoch numbers.

3 Results

3.1 *Training Results*

The system is trained with two sets of databases having images size of 50 $\times$ 50 and 28 $\times$ 28. Each of the databases contains 52,000 samples. The training and validation accuracy of the system is shown in Tables 1 and 2.

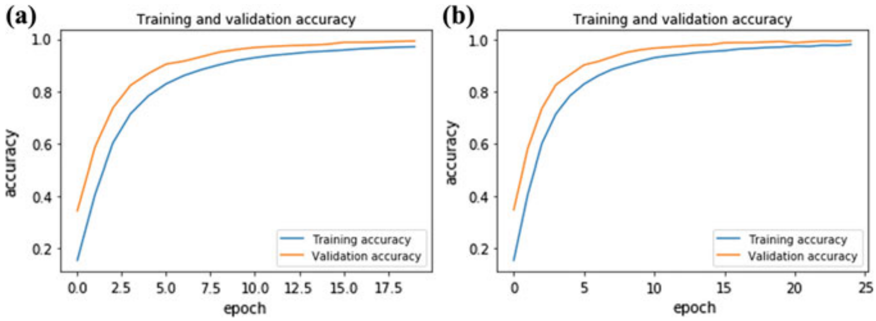


Fig. 5 Training and validation accuracy plot for **a** 20 epochs and **b** 25 epochs

Table 1 Training and validation accuracy for the image size 50 × 50

Database of image size 50 × 50	Epoch	Training accuracy (%)	Validation accuracy (%)
52,000 samples	3	96.75	98.93
52,000 samples	5	99.31	99.93
52,000 samples	7	99.74	99.90
52,000 samples	10	99.76	99.99

Table 2 Training and validation accuracy for augmented data of image size 28 × 28

Database of image size 28 × 28	Epoch	Training accuracy (%)	Validation accuracy (%)
52,000 samples	10	91.96	96.33
52,000 samples	20	97.14	99.33
52,000 samples	25	98.19	99.53

3.2 Testing Results

The system is tested with 10,400 samples. It is found that the system correctly classifies most of the input sample images. The accuracy of the model increases as the number of epoch increases but after a certain value of epoch, the accuracy of the model gets saturated. Table 3 shows the classification accuracy of the system.

The system is tested in real-time where the Indian signs are shown in front of the camera. It is found that the system classifies most of the signs. Figure 6 shows some of the Indian signs that are correctly classified by the system.

Table 3 Classification accuracy of the model

Database of image size 28 × 28	Epoch	Test samples	Correctly classified	Incorrectly classified	Classification accuracy (%)
52,000 samples	10	10,400	9844	556	94.65
52,000 samples	20	10,400	10,283	117	98.88
52,000 samples	25	10,400	10,338	62	99.40

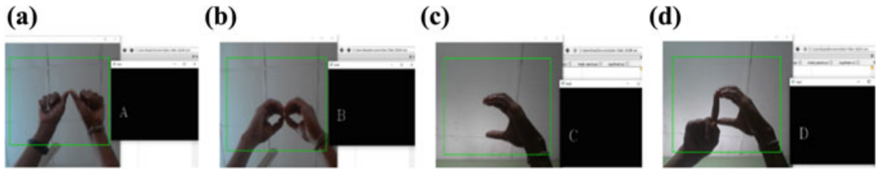


Fig. 6 Real-time recognition of Indian sign language

Table 4 Training time for the image of size 50 × 50

Database of image size 50 × 50	Epoch	CNN layers	Training time (approx.) [min]
52,000 samples	3	14	33
52,000 samples	5	14	64
52,000 samples	7	14	90
52,000 samples	10	14	130

3.3 *Training Time*

The model is trained in a PC having an Intel Pentium processor with 4 GB of RAM. Tables 4 and 5 show the training time of the model with image size [50 × 50] and [28 × 28] for different numbers of epochs, respectively.

Table 5 Training time for the image of size 28 × 28

Database of image size 28 × 28	Epoch	CNN Layers	Training time (approx.) [min]
52,000 samples	10	14	37
52,000 samples	20	14	69
52,000 samples	25	14	90

4 Conclusion

In this paper, we have presented a system that can recognize ISL in real time. We have used a background subtraction method to segment out the hand, and for classification, CNN is used. The advantage of using CNN is that it automatically extracts the features of the sign images. The system has been tested in real time with the sign images of four users. The system has correctly recognized most of the sign images. Here, we consider 26 alphabets of Indian sign images. The accuracy of the system is found to be around 99.40%. The limitation of the system is that it works only when the background of the scene is static.

References

1. Adithya V, Vinod PR, Gopalakrishnan U (2013) Artificial neural network based method for Indian sign language recognition. In: 2013 IEEE conference on information & communication technologies. IEEE, pp 1080–1085
2. Lokhande P, Prajapati R, Pansare S (2015) Data gloves for sign language recognition system. Int J Comput Appl 975:8887
3. Grobel K, Assan M (1997) Isolated sign language recognition using hidden Markov models. In: International conference on systems, man, and cybernetics. computational cybernetics and simulation, vol 1. IEEE, pp 162–167
4. Yi Z, Liangzhong F (2010) Moving object detection based on running average background and temporal difference. In: 2010 IEEE international conference on intelligent systems and knowledge engineering. IEEE, pp 270–272
5. Choudhury A, Talukdar AK, Sarma KK (2014) A conditional random field based Indian sign language recognition system under complex background. In: 2014 fourth international conference on communication systems and network technologies. IEEE, pp 900–904
6. Ghotkar AS, Khatal R, Khupase S, Asati S, Hadap M (2012) Hand gesture recognition for Indian sign language. In: 2012 international conference on computer communication and informatics. IEEE, pp 1–4
7. Singha J, Das K (2013) Recognition of Indian sign language in live video. arXiv preprint. arXiv:1306.1301
8. Sharma M, Pal R, Sahoo AK (2014) Indian sign language recognition using neural networks and KNN classifiers. ARPN J Eng Appl Sci 9(8)
9. Tavari NV, Deorankar AV (2014) Indian sign language recognition based on histograms of oriented gradient. Int J Comput Sci Inf Technol 5(3):3657–3660
10. ISL database. https://sites.google.com/a/gauhati.ac.in/ece/indian-sign-language-databse

Sarcasm Detection Using Multiple Occurrences of Emojis and Hashtagged Words

Kavita Tewani

Abstract The emojis have become an essential part of communication in text, mostly in an informal platform like social media where millions of people share content online. Another important trend is hashtags where people share the content on a particular event, and the hashtags are also used to create a small group of posts having views on similar topics. This paper proposes the use of both these recent additions in communication as cues to identify the presence of sarcasm in the post. The presence of multiple emojis is considered along with the text and hashtagged words to compare the polarities which are further processed to find the sarcasm. In this paper, naïve Bayes approach is used where polarities of multiple emojis, text, and hashtagged words are calculated and compared to reach the final solution. The work on using multiple emojis present in a post to find the sarcasm is the first of its kind.

Keywords Sentiment analysis · Sarcasm detection · Naïve Bayes · Natural language processing

1 Introduction

Expressing emotions using text is frequent these days with the exposure of social media where millions of people connect with each other. Social media gives a platform to write reviews about some products or share the view to the world. There are number of sources dedicated to find the polarity of the sentences to identify the linked sentiment. However, it is challenging to find the sentiment when there is the involvement of sarcasm. Different author defines sarcasm differently; to keep it simple, sarcasm occurs whenever there are positive situation and negative sentiment or vice versa. In these cases, the polarity of statement and writers' sentiment may not match, and hence, it is difficult to identify the underlying sentiment.

K. Tewani (✉)
Computer Science and Engineering Department, Institute of Technology, Nirma University, Ahmedabad, Gujarat, India
e-mail: kavitatewani012@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_10

The cues to identify sarcasm like emphasis on certain words and tone in which the message is being conveyed or even by the facial expression are important features when the conveyor is physically present but identifying sarcasm in written text is comparatively difficult as one cannot observe the intonations due to lack of physical presence; also, the audience is huge, and hence, the interpretation of sentence may vary. As per [1], people use sarcasm frequently in written text than face-to-face conversation.

Identifying sarcasm is a challenging task in the field of natural language processing. The topic has attracted many researchers to work in this domain to identify whether the sentiment expressed is in an intended way or it is just the wittiest way to express the feeling by involving sarcasm into the sentence. For human, it is easy to find sarcasm if the context, background, and subject are well known but to identify sarcasm by merely looking at a single sentence require detail analysis of the features that present in it.

Most of the work in the field of sentiment analysis is centered on review dataset to understand users' emotions and views on a product. Using the online comments given by people, it becomes easy to know about the success of products or services. The twist arises whenever there is the involvement of sarcasm in comments.

Researchers have claimed that the presence of hashtags in the tweets receives two times more engagement than those without hashtags. The social media has changed the way people communicate, and hashtag is one of the important factors. Other sign that plays a vital role in social media communication is involvement of emojis. The involvement of these two cues makes communication effective and easy to understand the sentiment behind the user.

The sentences like "The mathematics is so much of fun! #mathsmonster #mathslife" or "Getting my cavities pierced by the dentist is what I like" have sarcasm into them. When the above sentences are checked for sentiment analysis on available online tools, they consider these sentences as positive, the actual intention behind the sentences like fact, supporting cues like hashtags are not considered while identifying the sentiment.

This paper makes an effort to identify the sarcasm in text based on multiple emojis and hashtagged words used along with the textual data. Both of them are considered as key features to extract the polarity of sentence.

1.1 Types of Sarcasm

Sarcasm is not confined to a situation or event, and identifying sarcasm is a challenging task as the meaning (sentiment) behind the sentence changes multiple times in a single sentence. Even for human, identifying sarcasm is not easy as it requires a lot of features like the individual's background, the knowledge of universal fact, the event, etc. As per the data available online, sarcasm can be of various types and following are the most common:

1. Relational sarcasm: This depends on the person's interest and views. In this kind of sarcasm, the person's background plays vital role which can help to find the sentiment behind the message. The sentence "I love solving mathematics all day" may not be sarcastic for someone who loves mathematics but if someone does not like mathematics, then it considered as sarcastic.
2. Non-factual sarcasm: If someone says just opposite to the fact. This does not depend on person's choice, background, or context. Such messages are sarcastic irrespective of who is conveying the message or in which context. The posts like "Enjoying Monday morning work is as much fun as listening to Florence Foster Jenkins." The post has an irony as Florence Foster Jenkins is the world's worst singer, and hence, the person does not like to work on Monday mornings.
3. Context-based sarcasm: This kind of sarcasm depends on the context in which the conversation is taking place. The sentence "What a lovely sunny day!" may be contextual, if it is already summer and the sunny day is not helping but increasing the temperature, then it is considered as sarcastic. However, if it was raining or during wintertime and if the conveyor is waiting for such days, then it is not considered as sarcastic. Joshi [2] also focus on the role of context in sarcasm.

2 Related Work

The work on sarcasm detection has increased immensely in the past five years. Authors have followed mainly two kinds of approaches to find the sarcasm: (1) rule-based approach and (2) machine learning approach.

The authors in [3] have followed two approaches: parsing-based lexicon generation algorithm (PBLGA) and to detect sarcasm based on occurrences of interjection words. They used PBLGA for the phrases having positive sentiment, negative situation, negative sentiment, and positive situation. In second algorithm, the tweets that start with interjection words are considered to identify sarcasm. They also classified types of text, types of features, and types of domain to identify sarcasm. The sentences were checked for three kinds of polarities—positive, neutral, and negative. The neutral sentences were not considered for sarcasm detection, whereas positive and negative sentences were checked for the presence of actual positive or sarcastic sentiment and actual negative or sarcastic sentiment.

Suzuki et al. [4] show the work done on amazon review data to find the product review based on dependency parsing. They have applied sentiment check by breaking the sentences into phrases and worked on these phrases to identify sentiment phrase and situation phrase. They got a precision of 0.79 which was high compared to the proposed method.

The authors in [5] have worked on Facebook reaction as emotion signals to find sentiment of user. They extracted emotions from these reactions to find sentiment in English and Chinese language. They collected the data for testing by identifying intersection between reaction clicks and comments to enable matching between the response given by user and their comment on the post.

The authors in [6] utilized both the combination of manually labeled data and noisy labeled data for training purposes and claimed that the results are better compared by using any one of these kinds of data. They proposed a model called emoticon smoothed language model (ESLAM) to use noisy emoticon data for smoothing the language model trained from manually labeled data.

The authors in [7] worked on the tweets having #sarcasme. They gathered 3.3 million Dutch tweets to identify sarcasm. Their method correctly identified around 75% of tweets having #sarcasme.

The authors in [8] observed that the utilization of emoji characters along with text result in higher sentiment scores. Also, the usage of emoji characters has higher impact on overall sentiments of positive opinions. They filtered out the tweets on "The New Year Eve" on the same day in the year 2016 Istanbul attack happened where dozens of people were killed. Author worked on these tweets to identify the sentiment of users based on tweets posted on two different events.

In [9], authors divided the features into four sets having sarcasm as: contrast of sentiments, complex form of expression, written form of expression, and combination of all the three features mentioned. They applied 12 supervised learning algorithms on the datasets and got the best result in gradient boosting algorithm.

3 Proposed Work

The paper focuses on the tweets having emojis and hashtags. The use of emojis sends a strong signal to identify the sarcasm of the sentence. Use of emojis has increased dramatically these days and on social media users prefer expressing their sentiments using them. They are much more expressive compared to plain text; also, language is not a barrier while using them. Another important factor is the use of hashtags. These are the keywords to identify the users' perspective by simply focusing on cue words written along with hashtags. There comes a trend of hashtags on social media that goes viral within a little span of time. The user posts the message related to the topic and adds hashtag to show the involvement or contribution toward that discussion. This helps to know, what is called virtual community to go through the posts on topics of their interest and understand their fellow's view.

In the proposed work, dataset from twitter having emojis and hashtags is considered. Emojis and hashtags are assigned numerical values as per their polarity. Where positive sentiment is given, the highest value, i.e., $+1$, neutral sentiment is given a 0, and negative sentiment is given the lowest value, i.e., -1, similar to [10]. The previous work does not emphasize on the occurrences of multiple emojis in a tweet. In this paper, all the emojis present in the tweets are considered and found that their multiple occurrences can essentially help to understand the sentiments in much precise way.

The emoji dataset is used where they are classified as positive, neutral, or negative having corresponding values as $\{-1, 0, 1\}$, respectively. Many researchers divide the sentiments into two classes, i.e., positive and negative; however, the neutral sentiment plays an important role when used with cues such as emojis and hashtags. The twitter dataset having both emojis and hashtags is extracted and used to find the sarcasm present in the post; here tweepy is used to get the dataset. Every tweet is assigned three types of values: polarity of the tweet, polarity of emojis used, and polarity of hashtags. The tweets present in the dataset are cleaned with respect to spellings with multiple occurrences of other special characters such as @; the hyperlinks from the tweets were also removed. This makes the tweets composed of only text with no other noisy data.

For multiple uses of emojis, the polarity of each emoji is checked and they are grouped into different classes if their polarity is different. So if three emojis are positive and two emojis are negative, then they are placed in two classes. The emojis' group having maximum value (in the above example positive set) is considered as a final class for polarity and assigned the values as per the result. The next is hashtags; the polarity of each word used in hashtags is used to find the class of polarity in this; again the multiple hashtags are considered, and the polarity is computed. In this way, each tweet is divided into three types of polarities for further comparison. The polarity of all three features is compared.

As sarcasm changes, the polarity of sentence is observed that cues such as emojis and hashtags which have similar polarity in most of the cases. So the possibility of having different polarities in text as compared to emojis and hashtags is high. This is considered to identify whether the sarcasm is present in the tweet or not.

Here, sentiment of tweet ($S(t_i)$) is compared with sentiment of emojis ($S(e_i)$) and sentiment of hashtags ($S(h_i)$) separately. If the polarity of $S(t_i)$ does not match with the polarity of either $S(e_i)$ or $S(h_i)$, then the possibility of sarcasm is high. The cases of having different polarities in emojis and hashtags are rare, and such cases do not generate a robust polarity for the tweet.

4 Results

The tweets are tested for the three polarities as mentioned in the previous section as $\{1, 0, -1\}$ to show positive, neutral, and negative sentiment, and an attempt is made to identify the presence of sarcasm. Occurrences of multiple emojis are considered while identifying their polarity and emojis having varying emotions are also considered. The proposed work is checked on more than 650 tweets having both emojis and hashtags present into them. The following were the observations and results:

- Out of 650 tweets, more than 70% of them were having multiple emojis or hashtags.
- 30% of the most ranked tweets are sarcastic.

Table 1 Results of the proposed work

	Predicted sarcastic	Predicted non-sarcastic
Actual sarcastic	98	38
Actual non-sarcastic	121	393

- Out of 136 tweets, 98 were correctly classified as sarcastic which is 72% of the total.
- Out of remaining 514 tweets, 121 were wrongly classified as sarcastic.

The confusion matrix for the result is given in Table 1. The results show that simply focusing on the hashtags and emojis given precision of 0.72 and recall of 0.44. Although identifying sarcasm requires crucial features apart from these two, with limited background of the subject, context, and user's behavior, the proposed methodology gives noticeable results.

5 Conclusion and Future Work

This paper shows that multiple emojis are important to identify the sarcasm, and the presence of diverse emojis is helpful to get toward the results. Here, naïve Bayes approach is used to find the polarity of three features, including polarity of text, polarity of emojis, and polarity of hashtagged words. While calculating polarity of emojis, special care was taken to justify the multiple occurrences of them. The proposed method positively found 72% of the tweets as sarcastic using naïve Bayes approach, and it includes simple features without going through the background of conveyor.

With such results, the future work is definitely to go beyond the cues and to work on the context and background of the tweet to get more accuracy. There is a possibility of having multiple sentiments in a text sentence and such sentences have keywords having different polarities. Such sentences are to be processed, and future work focuses on finding sentiment them. There is much to be done in this field as identifying sarcasm is still an open challenge for researchers.

References

1. Hancock, JT (2004) Verbal irony use in face-to-face and computer-mediated conversations. J Lang Soc Psychol 23(4):447–463 (2004)
2. Joshi A, Bhattacharyya P, Carman MJ (2017) Automatic sarcasm detection: a survey. ACM Comput Surv (CSUR) 50(5):73
3. Bharti SK, Babu KS, Jena SK (2015) Parsing-based sarcasm sentiment recognition in twitter data. In: Proceedings of the 2015 IEEE/ACM international conference on advances in social networks analysis and mining 2015. ACM

4. Suzuki S, Orihara R, Sei Y, Tahara Y, Ohsuga A (2017) Sarcasm detection method to improve review analysis. In: ICAART (2)
5. Kuo PC, Alvarado FHC, Chen Y-S (2018) Facebook reaction-based emotion classifier as cue for sarcasm detection. arXiv preprint arXiv:1805.06510
6. Liu K-L, Li W-J, Guo M (2012) Emoticon smoothed language models for twitter sentiment analysis. In: Twenty-sixth AAAI conference on artificial intelligence
7. Liebrecht CC, Kunneman FA, van Den Bosch APJ (2013) The perfect solution for detecting sarcasm in tweets# not
8. Shiha M, Ayvaz S (2017) The effects of emoji in sentiment analysis. Int J Comput Electr Eng (IJCEE) 9(1):360–369
9. Ahuja R et al (2018) Comparative study of different sarcasm detection algorithms based on behavioral approach. Procedia Comput Sci 143:411–418
10. Novak PK, Smailović J, Sluban B, Mozetič I (2015) Sentiment of emojis. PloS one 10(12)

Multiclass Multiple Object Tracking

Roshan Nalawade, Prathamesh Mane, Yashodhara Haribhakta and Rutuja Yedke

Abstract Efficient and accurate object detection, classification and tracking have played a very important role in the advancement of computer vision systems. With the rise of deep learning techniques, the accuracy of visioning systems has increased a lot. This proposed work targets to incorporate state-of-the-art technology with the aim of achieving very high accuracy for real-time multiclass multiple object tracking with occlusion handling. A real-time multiclass multiple object tracker (MOT) is proposed using state-of-the-art object detection framework and deep convolutional neural networks. The proposed model is developed using YOLOv3 architecture for object detection and for real-time tracking, and a longer period of occlusion handling simple online and real-time tracking (SORT) is used as a base algorithm. The velocity and acceleration of objects along with their appearance information are used to predict the object location upon occlusion. Later detections are compared with MOT dataset detections and the YOLO bounding boxes, and based on their IOU matrix, normalized detections are provided.

Keywords Multiclass multiple object tracking (deep learning, computer vision) · YOLO · SORT · Occlusion · IOU

1 Introduction

Multiple object tracking (MOT) is an emerging technology used in many real-world applications such as surveillance systems, robot vision system, gesture recognition, human–robot interaction, and drones. Due to recent advancements in the field of object detection and classification, tracking-by-detection has become the principal model in tracking multiple objects or MOT. The challenge is drifts or shifting of tracking points due to appearance variations caused by illumination, noises, interactions, pose, cluttered background, occlusion, and camera movement. For careful tracking, we need to handle all these problems. But most of the tracking algorithms do not

R. Nalawade (✉) · P. Mane · Y. Haribhakta · R. Yedke
College of Engineering Pune, Pune, India
e-mail: dn.roshan2@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_11

handle all these difficulties. More the number of problems we handle, more robust will be our model. In autonomous driving for the proper estimation of where the car is moving and prediction of its position in future, camera needs to track dynamic and static objects correctly, in order to assign correct track id's and perform occlusion handling in cases where objects being occluded by other objects or obstacles.

However, building a multiclass multiple object tracker that works in real time is difficult to achieve and not as easy as it seems to be. First tried GOTURN [1] and Mask R-CNN [2] for object detection, and the performance of both was satisfactory. GOTURN, which stands for Generic Object Tracking Using Regression Networks, is deep learning-based object tracking algorithm. To a great extent, it changed the way we apply deep learning to the problem of object tracking in an offline manner. It is trained on hundreds and thousands of video sequences offline and no need to perform any learning at run-time. It has very good tracking speed, but it lacks accuracy.

Mask R-CNN is based on Faster R-CNN. It extends further Faster R-CNN. For bounding box recognition, it adds a branch for predicting an object mask in parallel with existing branch. Mask R-CNN adds only a small overhead to Faster R-CNN and is simpler to train. It has very good accuracy, but it lacks in speed as compared to YOLOv3. Comparatively, YOLOv3 is better than both Mask R-CNN and GOTURN. YOLOv3 uses a completely different approach as compared to other object detection algorithms used in the past. It uses a regression approach for object detection unlike the object classification approach used by other models.

2 Literature Review

Redmon [3] came up with a completely new approach for object detection called YOLO. This approach used regression method using class probabilities and bounding boxes, unlike other approaches which used classification method for solving object detection problem. YOLO used a technique where it divides the given image as input into S * S grid unlike the earlier region proposal-based and sliding window techniques. The grid cell in which the centre of an object falls is responsible for detecting that particular object. Each of these grid cells predicts B anchor boxes or bounding boxes and confidence scores for these boxes. These confidence scores tell how confident the model is about the presence of object in the box and also how accurate it thinks the box is than it predicts. Confidence score is defined formally as Pr(Object) * IOU. But YOLO has limitation over detection of number of nearby objects, since each grid box can detect only one object. YOLO model struggles in detecting smaller objects appearing in a group or near to each other such as a flock of birds, a bunch of flowers. Small errors in large bounding box can be ignored but the same in small bounding box can cause much greater effect in IOU.

In one more paper later, Redmon [4] came up with updates to YOLO with little design changes, more accuracy and speed. In the new version, they added predictions of bounding boxes, classes, feature extractor and predictions across scales. Logistic regression is used to predict object score. If the overlap of ground truth object with bounding box prior is more than any other bounding box prior, then it assigns a value of 1. Each ground truth object is assigned only one bounding box prior. Binary cross-entropy and independent logistic classifiers are used instead of softmax to avoid any overlapping in case if YOLOv3 is used in more complex domains such as Open Image Dataset.

Agarwal [5] used deep convolutional neural networks for building a real-time multiple object tracking (MOT) model for autonomous navigation. He combined Faster R-CNN with modified GOTURN architecture. His model performed well for real-world scenarios and showed that such end-to-end modular approach is really good as compared to the currently available computer vision techniques for MOT performance.

3 Methodology

The stepwise methodology to be applied for the whole process is object detection, classification, and tracking. For the initial stage of object detection and classification, YOLOv3 model is used (Fig. 1).

3.1 Detecting and Classifying Multiple Objects Using Modified YOLOv3

YOLOv3 framework was not capable of detecting very small objects; due to relatively larger anchor box sizes, a modified YOLOv3 framework is proposed which is capable of detecting small objects. For training of YOLOv3, COCO dataset is used that has a total of 80 classes of objects.

3.1.1 Object Detection and Classification

Problem of object detection can be tackled in multiple ways and can be approached either as a regression problem or as a classification problem. In the classification approach, the images are divided into small patches or regions, each of which passes through a classifier to determine whether there are objects in the patch. The bounding

Fig. 1 Different steps performed from start to end. Steps from start to finish involve input video, object detection, classification, tracking, occlusion handling and result output

boxes are assigned to patches with positive classification results. Whereas in the regression approach, the whole image runs through a convolutional neural network directly, in which the result generates one or more bounding boxes around objects in image.

YOLOv3 uses a regression approach, and it generates bounding box coordinates directly from convolutional neural networks (CNN). The YOLOv3 approach of the object detection works in two parts: first, the neural network part that predicts a vector from an image, and secondly the post-processing part that interpolates the vector as boxes coordinates and class probabilities (Figs. 2 and 3).

The proposed method approaches detection as a regression problem. Complete image is divided into an $S * S$ grid and then predicts B bounding boxes for each grid

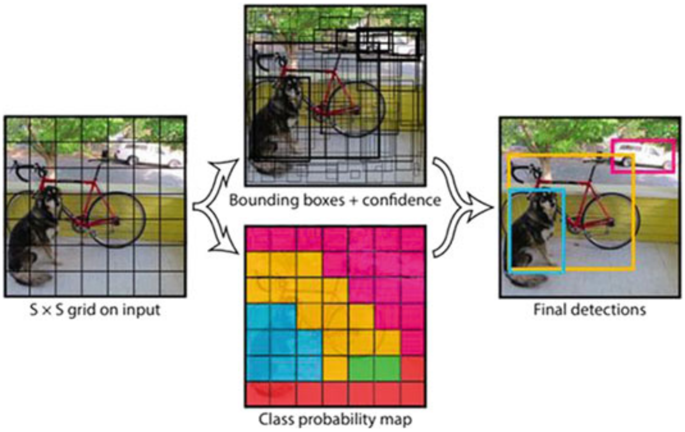
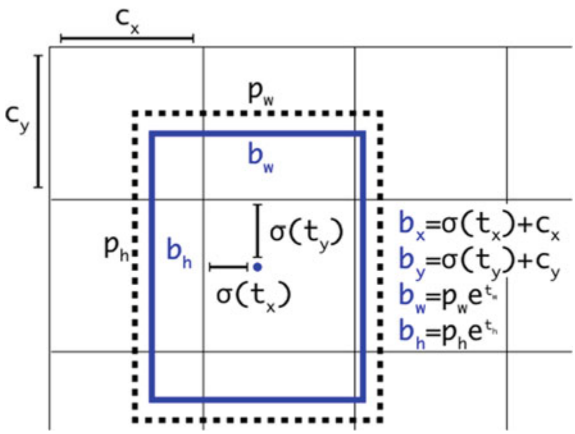


Fig. 2 YOLOv3 architecture design [3]

Fig. 3 Bounding boxes with dimension priors and location prediction [6]



cell, confidence score for those boxes, and C class prediction probabilities. An $S * S * (B * 5 + C)$ tensor is used to encode these predictions. The bounding box sizes are modified to detect small objects like a flock of birds and a bunch of flowers.

3.2 Real-Time Tracking of Classified Objects and Handling Object Occlusion

The base algorithm of simple online real-time tracking has been modified to handle real-time tracking and occlusion handling of classified objects. The position, velocity, and acceleration of an object are considered for occlusion handling. Also, the appearance information is used for better matching of tracks after occlusion. The end result is objects shown with bounding boxes and each bounding box with a class label and an object identifier id. The object id is added to each object so that we can verify whether the object id remains the same even after occlusion. These id's are uniquely assigned to each new object detected. If the object id remains the same, it indicates that we have successfully tracked the object even after occlusion.

3.2.1 Object Tracking and Occlusion Handling

After successfully detecting objects and classifying them into their respective classes using modified YOLOv3 model, our next task is to track those objects and assign unique id's to each object.

The obtained object detection output using YOLOv3 framework is passed on to modified SORT for further tracking. Each detected object is allotted a unique id in each frame, and these id's remain the same as far as the object remains in the frame even after occlusion. After sometime when the object is visible, the same id's are assigned to objects in the frame indicating that it is the same object which has been detected earlier and is now tracked successfully after occlusion (Fig. 4).

Various techniques are used for handling different tasks like Kalman filter for track handling using velocity and acceleration, Hungarian algorithm for assignment of predicted Kalman frame and newly arrived frame (assignment problem); Mahalanobis distance is used to incorporate motion information, matching cascade to solve assignment problem in a series of subproblems and deep appearance descriptors.

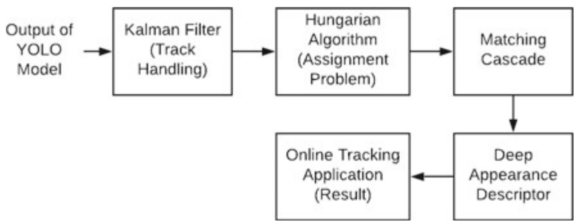


Fig. 4 Steps involved in the modified SORT model for tracking

3.2.2 Kalman Filter

Kalman filter is derived from the base paper [3] where this eight-dimensional state space is used to define the object tracking scenario: (u, v, γ, h, $\dot{x}$, $\dot{y}$, $\gamma^{\cdot}$, $\dot{h}$) where (u, v) denote the centre of the bounding boxes, γ is the width to height ratio, i.e. aspect ratio, h is the height and ($\dot{x}$, $\dot{y}$, $\gamma^{\cdot}$, $\dot{h}$) are the respective velocities in the image space.

Kalman filter makes one assumption that velocity and position (in our case) both variables are Gaussian distributed and random. Each variable has a variance σ^2, which is the uncertainty and a mean value μ, which is the centre of the random distribution (and its most likely state). Standard Kalman filter is used with the constant velocity motion and linear observation model with a scenario where the camera used is uncalibrated and no ego-motion information is available.

There is a need to define the relationship between the previous states in Kalman filter and newly computed measurements. Hence, deep sort uses square Mahalanobis distance for the same, where the jth bounding box detection is denoted by dj and projection of the ith track distribution into measurement space by coordinates (y_i, S_i) [7]:

$$d_{(1)}(i, j) = (d_j - y_i)S_i^{-1}(d_j - y_i) \tag{1}$$

The second metric incorporates uncalibrated camera motion, an appearance descriptor r_j, for each bounding box detection d_j. Further, a gallery $R_k = \{r_k^{(i)}\}_{k=0}^{L_k}$, of the last $L_k = 100$ associated appearance descriptors for each track k is maintained [7].

$$d^{(2)}(i, j) = \min\left\{1 - r_j^T \cdot r_k^{(i)} | r_k^{(i)} \in R_i\right\} \tag{2}$$

where $d^{(2)}$ (i, j) matrix gives the minimum cosine distance between jth detection and ith track. Then based on the threshold value, tracks are decided. To improve further on bounding box assignments, overlap between YOLO detections and the provided detections from MOT dataset [8] is used. The Intersection over Union (IOU) is defined as a ratio of overlap area to the area of intersection. The IoU matrix is used to find the likeliness of YOLO outputted bounding box to the candidate detections provided by the MOT. IoU value is normalized by subtracting from 1. The output value ranges from 0 to 1, where 0 means more likely, whereas 1 means less likely [7].

$$b(i) = [1 - \mathrm{IOU}(d(\mathrm{yolo})_i, d(\mathrm{MOT})_j)]_{j=0}^{k} \tag{3}$$

where $b(i)$ is the intersection over union matrix of the ith bounding box outputted by YOLO, d(yolo), to every candidate detection, d(mot).

If the IoU value is below $T_{\mathrm{det},}$ then YOLO bounding boxes are used for the output [7].

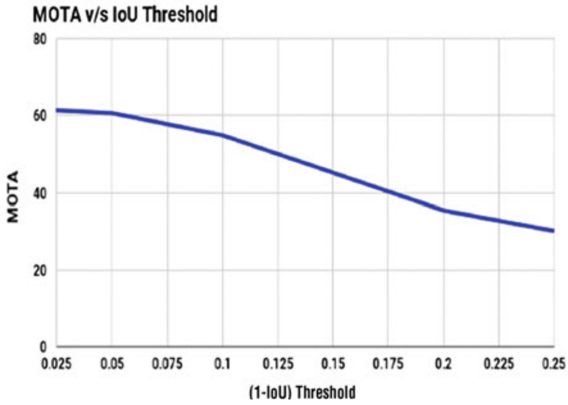


Fig. 5 IoU threshold versus MOTA graph displays how the MOTA values changes as IoU threshold is changed

$$O_i = [b(i) < T_{\text{det}}] \tag{4}$$

Based on the experimental results (Fig. 5), it is observed that MOTA decreases with increase in IoU threshold, and it is found to be constant from 0.025 IoU threshold values. So IoU score of 0.025 is chosen as optimal score.

4 Experiments

Combined YOLOv3 model and SORT model to make a single model for detection, classification and tracking, by passing detected bounding boxes of YOLOv3 to SORT model which uses those bounding boxes to track them in further frames. MOT detections are compared with YOLOv3 bounding boxes, and based on their IOU matrix, normalized detections are provided. Also, YOLOv3 has a problem with detecting small objects [3] due to the fixed and large size of anchor boxes and modified those anchor boxes to make the model suitable for our dataset and added two custom classes to original COCO dataset, i.e. house and flower. Shell script written for adding these two classes can further be used for any other classes by just giving input images and annotations file. Also, the dataset provided by MOT only consists of bounding boxes without any mention of classes and modified this so that it can track only those classes of objects in which user needs (Table 1).

Table 1 MOT16 results

MOT16 results							
Model	Dataset ↑	MOTA ↑	MOTP ↑	MT ↑	ML ↓	FP ↓	FN ↓
Modified SORT	MOT16	61.4	79.1	32.8%	13.8%	12,915	56,379

Table 2 YOLOv3 results

YOLOv3 results		
Model	Dataset	mAP
YOLOv3-416	COCO	55.3
YOLOv3-416	Custom	33.8

5 Results

5.1 YOLOv3 Results for Object Detection and Classification

Table 2 displays the results obtained for YOLOv3 model after training on COCO dataset. Mean average precision (mAP) is used in measuring the accuracy of object detectors. Average precision computes the average precision value for recall value over scale of 0–1.

5.2 YOLOv3 Training on Custom Dataset

YOLOv3 is trained for the detection on custom dataset [9] and added custom classes (flowers and houses) to COCO dataset. Below graph shows the training loss graph of on it.

5.3 MOT16 Dataset Results for Object Tracking

Table 1 shows the results for MOT16 dataset [10] obtained from MOT challenge platform. Figures 6, 7 and 8 show the video output images for different cases. Figure 6 shows both cases correct labelling and incorrect labelling. Figure 7 shows the case where occlusion has been handled correctly. Figure 8 shows the case where occlusion

Fig. 6 Left and right figures show correct and incorrect labelling, respectively

Fig. 7 Case where occlusion has been handled correctly (see figures from left to right direction)

Fig. 8 Case where occlusion has been handled incorrectly (see figures from left to right direction)

has been handled incorrectly due to a longer period of occlusion. Evaluation is carried out based on the below standard metrics:

- Multi-object tracking accuracy (MOTA): Summary of overall object tracking accuracy is expressed in terms of false positives, false negatives and identity switches [7].
- Multi-object tracking precision (MOTP): Summary of overall tracking precision that is expressed in terms of bounding box overlap between ground truth and reported location [7].
- Mostly tracked (MT): Percentage of ground truth tracks those having the same label for at least 80% of their life span [7].
- Mostly lost (ML): Percentage of ground truth tracks which are tracked for at most 20% of their life span [7].
- False positive (FP): It indicates the total number of cases where the system assigns wrong id's to the tracked object in the next frame [7].
- False negative (FN): It indicates the total number of cases where system fails to track previously tracked objects in the current frame [7].

The proposed model stands overall 18th on MOT16 challenge leaderboard out of total 138 publications at the time of publication. The proposed system performs quite well as compared to other models with good MOTA score and better ML score. This is due to the age assigned to every track along with the comparison of track with every other candidate tracks based upon various parameters described previously. The current model can be improved by choosing the optimal track lifetime and encoding additional features for tracked objects (Figs. 9, 10).

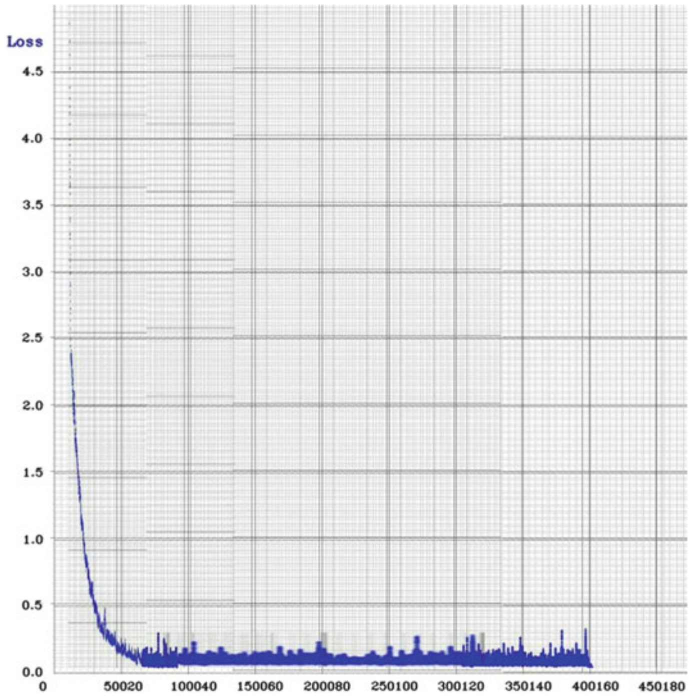


Fig. 9 Training loss graph for COCO dataset

6 Conclusions

Real-time object detection, classification, and tracking have become so important today than they ever have been in the past. In an era of fast-growing automation technologies and robots, these image processing technologies will play a very vital role. It has a very wide scope in today's world. The proposed model introduced modified YOLOv3, a unified model for object detection and classification. Due to modified simple online and real-time tracking (mSORT), it is able to achieve real-time tracking of an object through longer periods of occlusion. There is huge future scope for object detection and tracking system in mobile robots, in general, autonomous machines (e.g. quad-copters, drones, self-driving cars, etc.), in nano-robots used in medical or research fields or for robots that can explore remote areas not approachable to humans, such as deep oceans and other planets in space explorations.

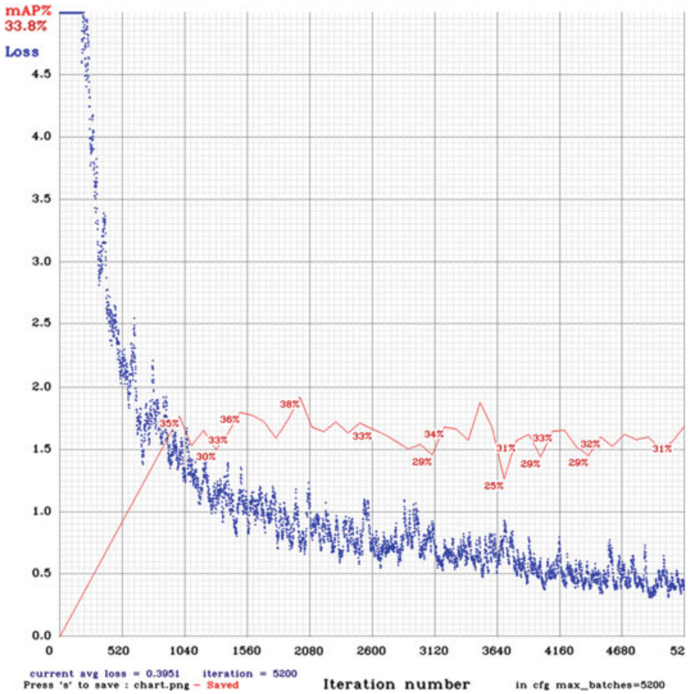


Fig. 10 Training loss graph for custom dataset used for training on two classes other than those given in COCO model

References

1. Held D, Thrun S, Savarese S (2016) Learning to track at 100 FPS with deep regression networks. Department of Computer Science Stanford University
2. He K, Gkioxari G, Dollar P, Girshick R (2018) Mask R-CNN. Facebook AI research (FAIR). arXiv:1703.06870v3 24 Jan 2018
3. Redmon J, Divvala S, Girshick R, Farhadi A (2016) You only look once: unified, real-time object detection. University of Washington, Allen Institute for AI, Facebook AI Research
4. Redmon J, Farhadi A (2018) YOLOv3: an incremental improvement. University of Washington.
5. Agarwal A, Suryavanshi S (2017) Real-time* multiple object tracking (MOT) for autonomous navigation
6. Redmon J, Farhadi A (2017) Yolo9000: better, faster, stronger. In: 2017 IEEE conference on computer vision and pattern recognition (CVPR). IEEE, pp 6517–6525 (1, 2, 3)
7. Wojke N, Bewley A, Paulus D (2017) Simple online and realtime tracking with a deep association metric. arXiv:1703.07402v1 21 March 2017
8. Bewley A, Ge Z, Ott L, Ramos F, Upcroft B (2017) Simple online and realtime tracking. arXiv:1602.00763v2
9. Google OpenImages dataset for custom dataset training and testing. https://storage.googleapis.com/openimages
10. Dataset of MOT16 for training and testing. https://motchallenge.net/

Dimensionality Reduction in Hyperspectral Images Using Auto-encoders

Syam Kakarla, Priyaranjan Gangula, C. Sai Charan Singh and T. Hitendra Sarma

Abstract Dimensionality reduction has become an important aspect in machine learning. It is often considered as a preprocessing step to solve machine learning problems such as classification and clustering. In general, the accuracy of any classification and clustering algorithm will be influenced by the number of dimensions or features. The feature extraction algorithms reduce the number of dimensions of the dataset, thereby paving the way for the classifiers to generate comprehensive models at a reduced computational cost. This paper presents a nonlinear for dimensionality reduction using *auto-encoders*. The performance of the proposed model is compared with other popularly used methods like *PCA* and kernel PCA (*KPCA*) using the classifiers *KNNC, weighted KNNC* on benchmark data sets obtained from Computational Intelligence Group (CIG) data repository. Experimentally, it has been proved that the proposed technique using auto-encoders outperforms the existing dimensionality reduction techniques *PCA* and *KPCA*.

Keywords Auto-encoder · Feature extraction · PCA · KPCA · KNNC and weighted KNNC

1 Introduction

Classification algorithms aims to train a model using the existing labeled data which can be further used for decision making in case of unseen data. In most of the real-time

S. Kakarla (✉) · P. Gangula · C. S. C. Singh · T. H. Sarma
Srinivasa Ramanujan Institute of Technology, Anantapur, Andhra Pradesh 515701, India
e-mail: syamkakarla98@gmail.com

P. Gangula
e-mail: priyaranjanreddy.g@gmail.com

C. S. C. Singh
e-mail: Chandrapalsaicharansingh@gmail.com

T. H. Sarma
e-mail: t.hitendrasarma@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_12

problems, each data item is represented by a greater number of dimensions or features. The efficiency of the classification technique depends on the size of the training data and the number of features (dimensions). If the dimensionality of the training data is high, then the model gets over-fitted which leads to poor generalisability. So, identifying the potential features to represent the data in a reduced feature space will always improve the performance of any classifier. The following are the two approaches for dimensionality reduction [1].

Feature Selection is a process in which the features are automatically or manually selected based on random selection or following some specific criterion like *the most significant features which contribute most to the prediction variable or output* are to be selected.

Feature Extraction is a process of finding new features by selecting and/or combining the existing features to create reduced feature space, while still accurately and completely describe the data set without loss of information.

Based on the criterion function and process of convergence, *dimensionality reduction techniques* are also classified as *convex* and *non-convex*. Some popular dimensionality reduction techniques include *PCA, LDA, GDA, kernel PCA, Isomap, local linear embedding (LLE), Hessian LLE, etc.* [2].

In the recent years, more research is being carried out on *hyperspectral image (HSI) analysis*, as HSI provides a wide range of spectral information which can be used to address a variety of problems like *crop analysis, geological mapping, mineral exploration*, etc. Due to the presence of large number of bands in the data, dimensionality reduction (DR) has become more prominent to improve the accuracy of pixel classification. Interestingly, it is shown that 'no single DR technique is suitable to cater all applications' [3]. Hence, there is a need for much more investigation in finding new or improving the existing DR Techniques.

One of the recent advancements in dimensionality reduction techniques is applying the concepts of neural networks [4, 5]. **Auto-encoder** [6] is a multilayer deep neural network which can be trained to achieve much improved nonlinear dimensionality reduction. This paper presents the new idea of applying auto-encoders for dimensionality reduction in hyperspectral image data.

This paper is organized as follows. The proposed DR technique using auto-encoders is presented in Sect. 2. The experimental study is presented in Sect. 3. Section 4 presents the conclusions.

2 Auto-encoder (AE)

This section describes the proposed *auto-encoder* (AE)-based dimensionality reduction technique.

Auto-encoder [7–9] is an unsupervised feature extraction technique. It is a deep neural network which contains an encoder stage, a code layer, and a decoder stage. Encoder and decoder stages contain the fully connected hidden layers. The parameters of the entire network will be updated so as to reduce the overall cost, which is the reconstruction error of input from the output. In the finely tuned auto-encoder, the code layer gives the latent representation of the input vector. The architecture and visualized description of *auto-encoder* is shown in Figs. 1 and 2.

The architecture of an auto-encoder typically contains four main components:

1. **Encoder**: Encoder is a subpart of auto-encoder comprising a series of layers with decreasing number of nodes. It represents the input data by reducing the input data into latent view representation. It can be represented by an encoding function where x is input data.
$$e = f(x) \tag{1}$$
2. **Latent View Representation**: Latent view represents the lowest possible dimensional space of input data in which the input data is reduced and information is preserved.
3. **Decoder**: Decoder is similar to that of encoder, but in this case, the number of nodes in each layer increases gradually and output data is almost similar output. It reconstructs the input data from the latent space representation. It can be represented by a decoding function
$$d = g(e) \tag{2}$$

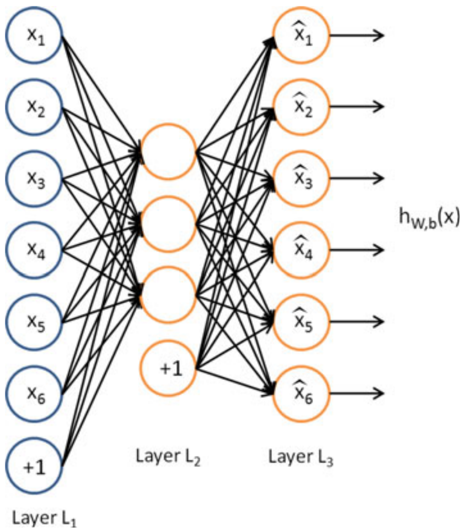


Fig. 1 Architecture of auto-encoder

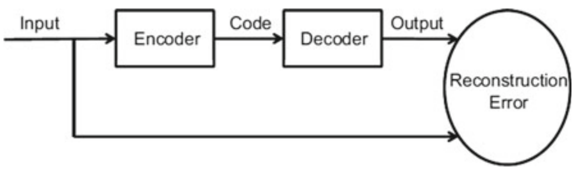


Fig. 2 Visualized description of auto-encoder

where e is encoded format of input data which is considered from latent view representation.

4. **Reconstruction Error**: The reconstruction error measures how different the reconstructed data is from the original data. We should minimize the reconstruction loss by adjusting the parameters in encoder and decoder.

$$L\left(x, \hat{x}\right) = \| x - \hat{x} \|^2 \tag{3}$$

3 Experimental Study

This section describes the experiments performed on two benchmark hyperspectral image datasets *Indian Pines* and *Salinas-A*. These datasets are collected from the GRSS data and algorithm standard evaluation (DASE) Web site (http://dase.grss-ieee.org).

Indian Pines image was captured by *AVIRIS* sensor. It has 145 × 145 pixels with 200 bands. The ground truth contains 16 classes. The details of *ground truth classes* of the data is shown in Fig. 3.

2. Salinas-A hyperspectral image was acquired by *AVIRIS* sensor. It contains 86 × 83 pixels with 204 bands. All the pixels are grouped into six classes as shown in the *ground truth* of the data, presented in Fig. 4.

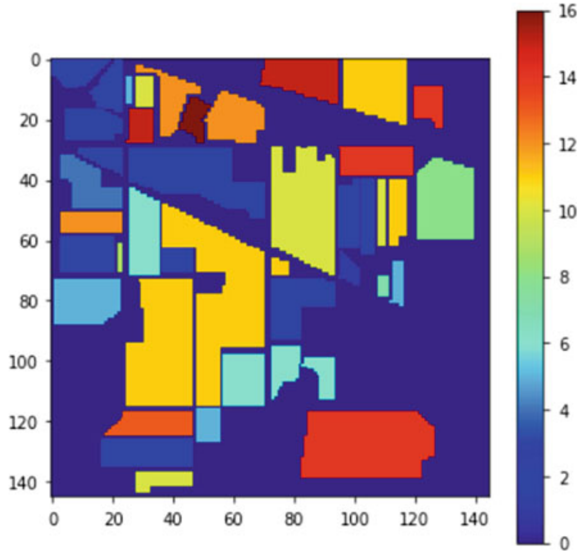


Fig. 3 Ground truth of Indian Pines dataset

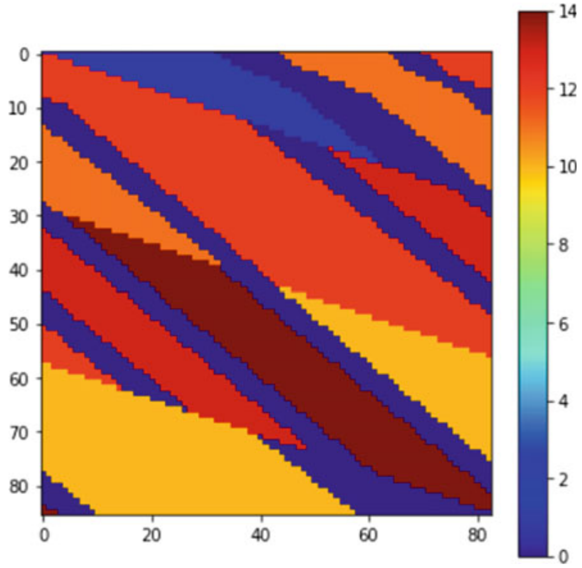


Fig. 4 Ground truth of Salinas-A dataset

3.1 Results

The auto-encoder architecture used in this experimental study mainly comprises *seven layers* in both encoder and decoder. Coming to input and output layers, the number of nodes is equal to the original dimensions of the data. After rigorous experimental study, the number of nodes in latent space are confined to 75.

In the experimental study, for *training* the auto-encoder, the *optimizer* used is *Adam* which is a refinement of stochastic gradient descent, the loss metric used is *Mean squared error (MSE)*, the number of *epochs* used is 500, and the *batch size* for each *epoch* is 32.

The classification accuracies (CA) achieved by *k-nearest neighbor* (*KNNC*) and *weighted k-nearest neighbor* (*weighted KNNC*) with respect to *principal component analysis* (*PCA*), *kernel principal component analysis* (*KPCA*), and *auto-encoder* (*AE*) are shown in Table 1 from which it is evident that the classification accuracy (CA) with respect to auto-encoder is high than the rest of the dimensionality reduction techniques.

The resultant **classification maps** of *auto-encoder* (**AE**) with respect to *KNNC* and *weighted KNNC* are shown in Fig. 5, where Fig. 5a, b refers to *Indian pines* and Fig. 5c, d refers to *Salinas-A* datasets.

From the presented results, it is observed that the proposed technique on dimensionality reduction using auto-encoder performs well when compared to *principal component analysis* (**PCA**) and *kernel principal component analysis* (**KPCA**).

Table 1 Classification accuracy's

Method	Indian Pines	Salinas-A
PCA + KNNC	73.483875	83.633053
PCA + WKNNC	74.017121	85.527544
KPCA + KNNC	72.368421	86.201307
KPCA + WKNNC	72.669625	86.788048
AE + KNNC	75.237793	87.081699
AE + WKNNC	75.507293	88.714285

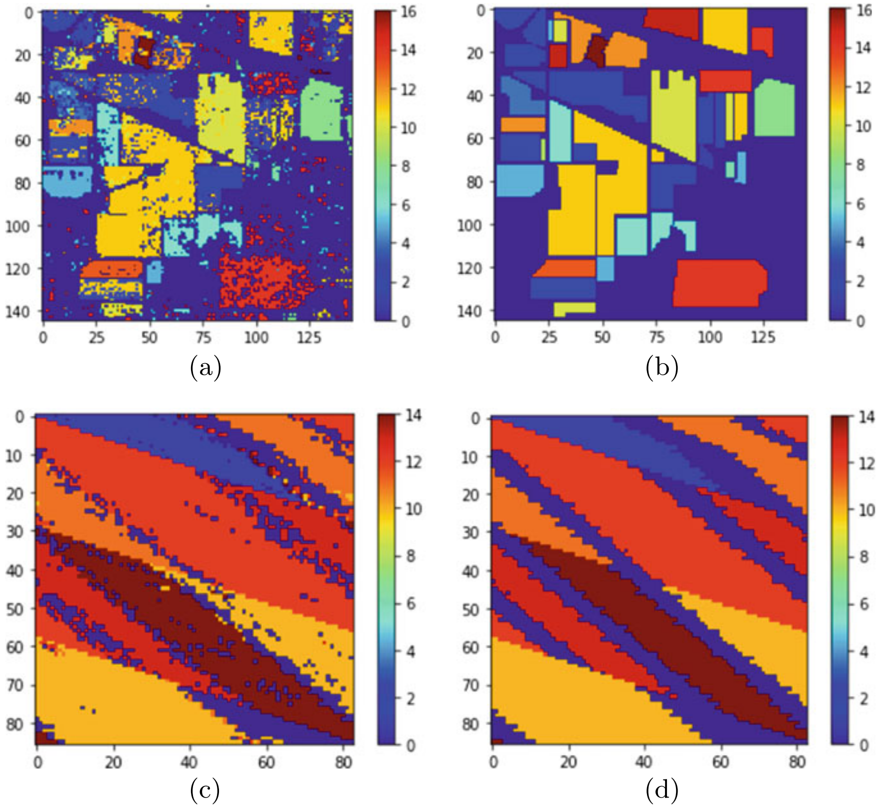


Fig. 5 Classification map's of auto-encoder (AE), where **a**, **c** and **b**, **d** represents AE + KNNC and AE + weighted KNNC

4 Conclusions and Discussion

The paper formally introduced the dimensionality reduction problem and its importance in hyperspectral image analysis. Recent neural network-based technique called auto-encoders is explained in detail. Experimental studies are conducted on widely used hyperspectral benchmark data sets *Indian pines* and *Salinas-A* which are taken from the Computational Intelligence Group (CIG) to verify the efficiency of auto-encoder-based DR along with KNN and weighted KNN. Classifiers and the results are compared with conventional dimensionality reduction techniques PCA and KPCA. Empirical results show that kernel PCA performs well compared to PCA by projecting data into new feature space using different kernels. *Auto-encoder (AE) provides better accuracy when compared to both PCA and KPCA*. The proposed technique can be easily implemented and works efficiently for dimensionality reduction. Future work is to tune the auto-encoder (AE) for different datasets.

References

1. Van Der Maaten L, Postma E, Van den Herik J (2009) Dimensionality reduction: a comparative. J Mach Learn Res 10(66–71):13
2. Damodaran BB, Nidamanuri RR, Tarabalka Y (2015) Dynamic ensemble selection approach for hyperspectral image classification with joint spectral and spatial information. IEEE J Sel Top Appl Earth Obs Remote Sens 8(6):2405–2417
3. Damodaran BB, Nidamanuri RR (2014) Assessment of the impact of dimensionality reduction methods on information classes and classifiers for hyperspectral image classification by multiple classifier system. Adv Space Res 53(12):1720–1734
4. Paoletti ME, Haut JM, Plaza JM, Plaza A (2017) A new deep convolutional neural network for fast hyperspectral image classification
5. Gao Q, Lim S, Jia X (2018) Hyperspectral image classification using convolutional neural networks and multiple feature learning. Remote Sens 10(2):299
6. Wang Y, Yao H, Zhao S (2016) Auto-encoder based dimensionality reduction. Neurocomputing 184:232–242
7. Hinton GE, Salakhutdinov RR (2006) Reducing the dimensionality of data with neural networks. Science 313(5786):504–507
8. Xu C, Wu L, Wang S (2019) Unsupervised dimension reduction for image classification using regularized convolutional auto-encoder. In: Science and information conference. Springer, pp 99–108
9. Goodfellow I, Bengio Y, Courville A (2016) Deep learning. Book in preparation for mit press. http://www.deeplearningbook.org

Improved Registration of Infrared Images Using EOH Descriptor

P. Sita Sowjanya, B. Sandhya and J. Prasanna Kumar

Abstract Feature-based image registration involves overlaying two images of the same area by extracting features, matching and computing geometric transformation. Multimodal image registration is useful in a variety of applications as the unique information contained in diverse images can be combined. Descriptors proposed for multimodal image matching such as edge-oriented histogram (EOH), log-Gabor histogram (LGHD) can address the photometric variation between the visual and infrared images better than conventional image descriptors such as SIFT. However, the invariance of such descriptors to geometric variations such as scale and rotation is poor. To address the geometric variations in addition to photometric variations, the region around the feature point is preprocessed using scale and rotation information of detector before deriving the descriptor. Different datasets are composed of images obtained in visible light and infrared spectra images, and IR images contain variations to compare scale, rotation, noise, blur, etc., to the performance with those of state-of-the-art algorithms.

Keywords Multimodal image matching · EOH · LGHD · Key point error · Ground truth homography

1 Introduction

Image registration is the process of transforming different images of the same scene into one coordinate system. Change in images could be because of acquisition from different sensors (multimodal analysis), times (multi-temporal analysis), depths

P. Sita Sowjanya (✉) · B. Sandhya · J. Prasanna Kumar
MVSR Engineering College, Nadergul, Hyderabad, India
e-mail: sowjipavan14@gmail.com

B. Sandhya
e-mail: sandhya_cse@mvsrec.edu.in

J. Prasanna Kumar
e-mail: pkumar62@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_13

(model registration), or viewpoints (multi-view analysis). Registration is widely used across multiple domains and applications such as image stitching [1], change detection [2], 3D reconstruction [3, 4] and image alignment [5]. Multisensory or multispectral image registration is gaining popularity due to availability of wide variety of image capturing sensors. For instance, images created by different medical diagnostic modalities, MRI and SPECT [6], are used to visualize and localize a tumor in an image, or multispectral satellite images of the earth's surface are compared to see how a river has migrated or how an area is flooded. However, finding similar features between such images is challenging due to intense radiometric variations in addition to geometric distortions [7]. The form of the work reported in this paper is to register visual and infrared images using feature-based method. Conventionally, two major categories of image registration exist which are: area-based, feature-based. Area-based methods employ similarity measures such as normalized cross-correlation, mutual information and optimize a function to find the control points. In feature-based method, interest points like Harris corners, scale invariant features, speed-up robust features, etc., are first extracted from images [8]. The features are matched based on the similarity or dissimilarity metrics, such as Euclidean and cosine. In this paper, in Sect. 2, image registration and matching for multimodality images are reviewed. The approach that was proposed is presented in Sect. 3. Evaluation of registration performance across various descriptors is presented in Sect. 4.

2 Related Work

Feature-based image registration typically has feature detection, feature matching, mapping function design, image transformation and resampling. Key point extraction and descriptor computation techniques have been widely applied in computer vision or pattern recognition. Though SIFT [9] and its variants have been widely used for matching similar spectral images, they fail to effectively address large photometric variations of multispectral images. To address such variations, descriptors based on orientations of edges have been proposed. The EHD descriptor [10] describes the spatial edge distribution around a point computing an orientation histogram of 80 bins. Region around each interest point is divided into 16 smaller subregions (4×4), and for each subregion, an orientation histogram of 5 bins is computed using the strongest pixel value for one of the 5 oriented sobel filters (horizontal, vertical, 35°, 135° and non-oriented). The edge-oriented histogram (EOH) [11] similar to EHD computes descriptor vector using only edge points of the region around key point [12]. Log-Gabor histogram descriptor (LGHD) [13] is proposed for matching pair of images with nonlinearity in variations, such as significant illumination change, cross-spectral modal image pairs and cross-spectral image pairs. The log-Gabor histogram descriptor (LGHD) [14], describes local patches in a similar way to EHD but describes the neighborhood of feature points using log-Gabor filters of multiple scales and orientations. Later, RIFT [15] has been proposed to increase the invariance of LGHD descriptor toward rotation deformation.

Table 1 lists some of the research proposed in the area of multimodal/multispectral image matching. It can be observed that the focus of most of the approaches is to address radiometric variations of the images. Hence, conventional feature detectors used for similar image matching such as SIFT and FAST are combined with descriptors modified for cross-spectral image matching.

Table 1 Literature survey

Paper	Images	Features used for comparison	Similarity	Evaluation
[16]	Remote sensing, multisensor images	SIFT, LoG, Harris corner detector edge detection: Canny, phase convergence model anisotropic directional derivatives (ANDD)-based edge strength map(ESM)	Normalized mutual information based registration method (NMI)	Root mean square error (RMSE), precision
[17]	Remote sensing images, Visual-NIR, Visual-LWIR, multispectral images	Descriptors : SURF, SIFT, NGSIFT EOH, LGHD, MFD, HODM, HOSM	Euclidean distance	precision, recall, F1-score, computation time
[18]	Remote sensing images	Detector: Laplace, canny, Phase congruency, Descriptor: SIFT, SAR-SIFT, SURF, PSOSIFT, RIFT, RSCJ, LDSR, GLPM	Euclidean distance	RMSE, no. of correct matches, time
[19]	Remote sensing images (visible, infrared)	Detector: MMPC-lap, Har-lap, DoG, MSER, Descriptor: LHOPC, SURF, ASIFT, DAISY	Euclidean distance	Precision, recall from matches
[20]	Multispectral images, Visible (RGB-NIR, RGB-LWIR)	Detector: FAST, Descriptor: LGHD, SIFT, MFD, EOH, SURF	Euclidean distance	computation time, precision, recall, F1-score
[21]	Visible-SWIR,LWIR,NIR	SIFT-SIFT, SIFT-GISIFT, FAST-SIFT, Harris-SIFT, Harris-GISIFT	Euclidean distance	Repeatability, precision, recall, matching ratio
[6]	RGB-depth, RGB-LWIR, RGB-NIR, Flash-No Flash	SIFT, EHD, PCEHD, GSIFT, LGHD	Euclidean distance	Resulting matching, precision
[14]	Six types of multi modal image datasets are selected[a]	RIFT Descriptor, SIFT, FAST Detector	Euclidean distance	No of correct matches, success rate, RMSE, ME

[a] optical-optical, infrared-optical, SAR-optical, depth-optical, map-optical and day-night

3 Proposed Approach

Feature-based image registration pipeline involves key point detection, descriptor computation, matching corresponding key points of the images and computing transformation matrix. Features are detected from the given input image pairs using detector SIFT, and features are described using descriptors using EOH. However, to handle the geometric variations between the images, each patch extracted from SIFT is preprocessed using rotation information of the key point. Figure 1 shows the details. From the image, key points are detected, and for each key point, a patch of size 100×100 is extracted. The extracted patch is rotated by an angle corresponding to the key point. From the rotated patch, the center-cropped patch will be identified with size 60×60. From this patch, EOH descriptor computes 80 values. The matching technique finds nearest key points by using nearest neighbor matching with Euclidean distance in the descriptor space. Appropriate transformation of reference and target images is estimated using random sample consensus (RANSAC), which detects the inliers from the corresponding feature points. Quality of registration is evaluated using the following measures:

- **Key point error**: The matched key points of source image are transformed using the ground truth homography matrix to the target image. Euclidean distance between transformed matched points of source image and target image matched key points is known as key point error. However, ground truth information is not available for 100 VS/LWIR images (dataset-I), and hence, it is generated for a more accurate evaluation. Ground truth is generated manually by selecting key points from both images, and from these, key points ground truth homography matrix is estimated.
- **Number of True positive matches**: The matched key points of source image are transformed using the ground truth homography matrix. A match is considered true

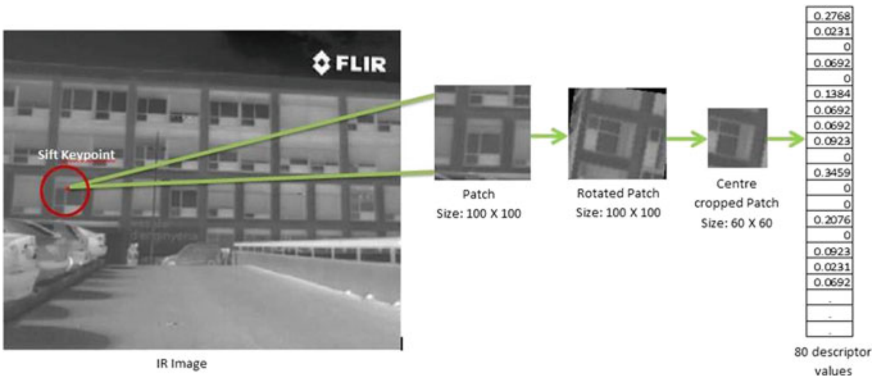


Fig. 1 Patch extraction, rotation and preprocessing

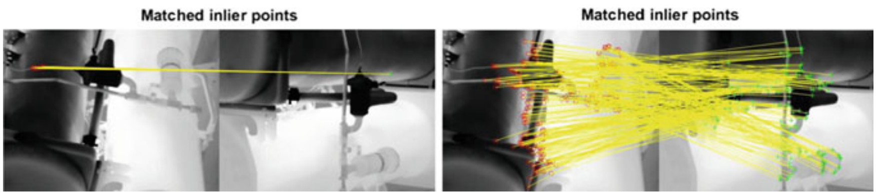
positive if the distance between transformed match point and the corresponding matched key point of target image is less than 3 pixels.
- **Inlier Ratio**: The ratio of number of inliers to the total number of matches. A high value of this ratio indicates that the correspondences made between the feature points are mostly useful.

4 Experimental Results

Evaluation Dataset Two datasets are used for evaluation:

- Dataset-I: consists of 100 VS/LWIR pairs available through website (http://www.cvc.uab.es/adas/projects/simeve/) [11]
- Dataset-II: A new infrared image database of 53 images with ground truth having deformations like viewpoint, rotation, blur, down sampling, noise, scale from (http://www.csc.kth.se/atsuto/dataset.html) [15].

Figure 2 Shows the matches between the IR reference and source image which varies with the rotation angle of 80°. We can observe the maximum number of matched inlier points after preprocessing. Figure 3 shows the ground truth key point error



Matches without patch rotation ::::: | ::::: Matches with patch rotation

Fig. 2 Matches between two IR images which vary by rotation angle 80°

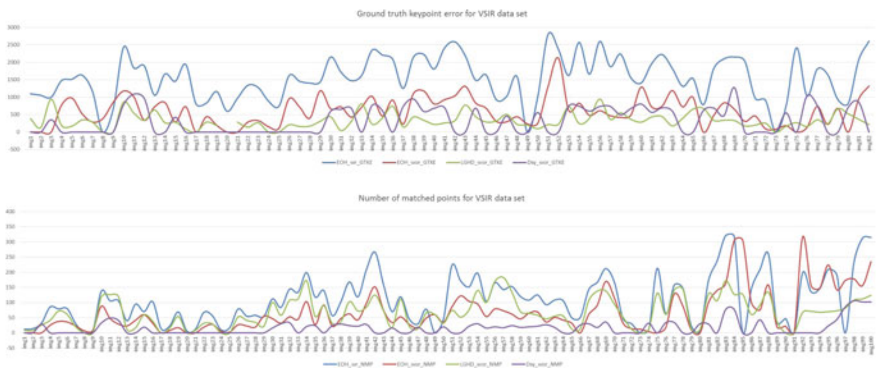


Fig. 3 Comparison of EOH with preprocessing against EOH, LGHD, Daisy on Dataset-I

and number of matched points for EOH with rotation against EOH, LGHD, Daisy of Visual and Infrared (100)images of Dataset-I. It can be observed that number of matches is more, and error in most cases is either similar or less for the proposed approach. Hence, preprocessing of patch does not affect the performance of descriptor in the case of multispectral images, in this case, visual and IR images. To test the geometric invariance, results are generated for 18 rotation varying image pairs of Dataset-II using the proposed approach (EOH_WR), EOH, LGHD and DAISY. Figure 4 shows the comparison of four approaches in number of matched points, inlier ratio, ground truth key point error and true positive matches for 18 rotation varying images in Dataset-II. It can be observed that the proposed approach improves the performance quite considerably in this case.

The proposed preprocessing of patch is implemented in LGHD descriptor also. Figure 5 shows number of true positives and inlier ratio across 10 images which vary by Blur from Dataset-II with rotation of patch and without rotation for LGHD-SIFT.

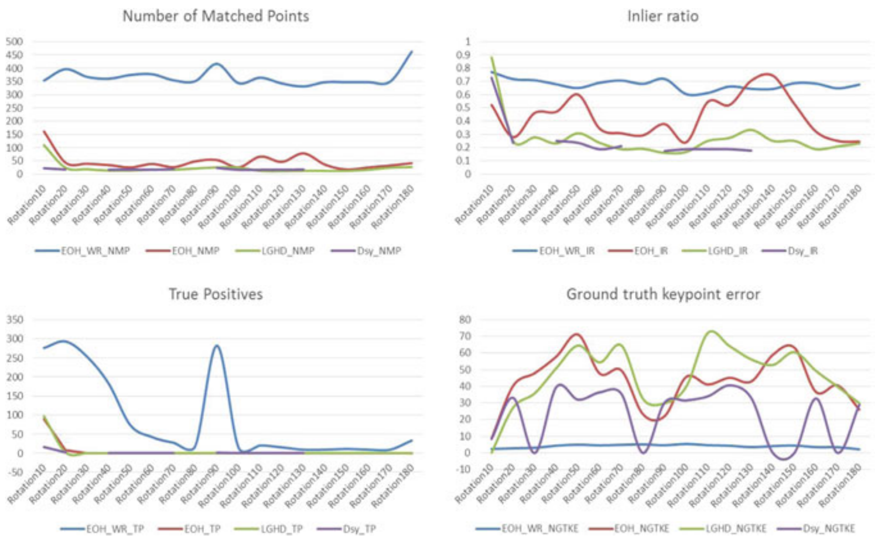


Fig. 4 Comparison of EOH with patch preprocessing against EOH, LGHD and Daisy

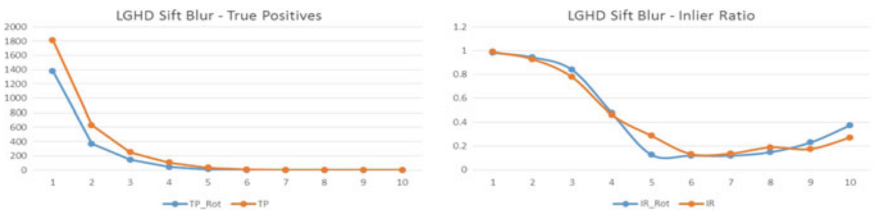


Fig. 5 Comparison of LGHD with patch preprocessing and without on Blur varying images of dataset II

5 Conclusion

Registration of infrared and visual images is challenging due to the inherent differences in the characteristics of images. Widely used feature descriptors such as SIFT fail to address such variations in intensity values. Descriptors such as EOH and LGHD have been proposed to address matching of visual and IR images. However, such descriptors are not robust to geometric variations like rotation and scale. To improve the performance, scale and rotation information of key point detector is incorporated in descriptor computation by preprocessing the patch before computing EOH or LGHD. Experiments are carried out on a dataset of IR images with geometric variations. Performance of various descriptors is compared using objective evaluation measures computed from the ground truth. Results indicate that the proposed approach greatly enhances the matching and registration performance of the algorithms.

References

1. Adel E, Elmogy M, Elbakry H (2014) Image stitching based on feature extraction techniques: a survey. Int J Comput Appl (0975–8887) 99(6)
2. Bonardi F, Ainouz S, Boutteau R, Dupuis Y, Savatier X, vasseur P (2017). PHROG: a multimodal feature for place recognition. Sensors 17:1167. https://doi.org/10.3390/s17051167. www.mdpi.com/journal/sensors
3. Yuanxin Y, Jie S, Siyuan H, Lorenzo B, Yao Q (2018) A local phase based invariant feature for remote sensing image matching. ISPRS J Photogramm Remote Sens 142:205–221. https://doi.org/10.1016/j.isprsjprs.2018.06.010
4. Ahmadabadian AH, Robson S et al (2013) A comparison of dense matching algorithms for scaled surface reconstruction using stereo camera rigs. Int Soc Photogramm Remote Sens Inc (ISPRS) 78:157–167 (Published by Elsevier)
5. Ye Y, Shen L, Hao M et al (2017) Robust optical-to-SAR image matching based on shape properties. IEEE Geosci Remote Sens Lett 14(4):564–568
6. Mohammed HA (2016) The image registration techniques for medical imaging (MRI-CT). Am J Biomed Eng 6(2):53–58. https://doi.org/10.5923/j.ajbe.20160602.02
7. Amit DBTAP, Patel VPPM (2016) Geometric distortion and correction methods for finding key points: a survey. IJSRD 4(02):094
8. Tola E, Lepetit V, Fua P (2010) Daisy: an efficient dense descriptor applied to wide-baseline stereo. IEEE Trans Pattern Anal Mach Intell 32(5)
9. Jindal R, Vatta S (2014) Sift: scale invariant feature transform. Int J Adv Res, Ideas Innov Technol 1(1)
10. Mura MD, Prasad S, Pacifici F, Gamba P, Chanussot J, Atli J (2012) Challenges and opportunities of multimodality and data fusion in remote sensing. J Latex Cl Files 11(4)
11. Aguilera C, Barrera F, Lumbreras F, Sappa AD, Toledo R (2012) Multispectral image feature points. Sensors 12:12661–12672. https://doi.org/10.3390/s120912661
12. Tola E, Fua P (2008) A fast local descriptor for dense matching. EPFL/CVLAB2007.08
13. Nunes CFG, Padua FLC (2017) A local feature descriptor based on log-Gabor filters for keypoint matching in multispectral images. IEEE Geosci Remote Sens Lett 14(10)
14. Aguilera CA, Sappa AD, Toledo R (2015) LGHD: a feature descriptor for matching across non-linear intensity variations. In: IEEE international conference on image processing (ICIP)

15. Jiayuan L, Hu Q, Mingyao A (2016) RIFT: multi-modal image matching based on radiation-invariant feature transform. https://sites.google.com/site/jiayuanli2016whu/home
16. Li K, Zhang Y, Zhang Z, Lai G (2019) A coarse-to-fine registration strategy for multi-sensor images with large resolution differences. Remote Sens 11:470. https://doi.org/10.3390/rs11040470
17. Ma T, Ma J, Yu K (2019) A local feature descriptor based on oriented structure maps with guided filtering for multispectral remote sensing image matching. Remote Sens 11:951. https://doi.org/10.3390/rs11080951
18. Ma W, Wu Y et al (2018) Remote sensing image registration based on phase congruency feature detection and spatial constraint matching. IEEE Acess. https://doi.org/10.1109/ACCESS.2018.2883410
19. Yea Y, Shanb J, Haoc S, Bruzzoned L, Qine Y (2018) A local phase based invariant feature for remote sensing image matching. ISPRS J Photogramm Remote Sens 142:205–221
20. Fu Z, Qin Q, Luo B, Sun H, Wu C (2018) HOMPC: a local feature descriptor based on the combination of magnitude and phase congruency information for multi-sensor remote sensing images. Remote Sens 10:1234. https://doi.org/10.3390/rs10081234
21. Bonardi F, Ainouz S, Boutteau R, Dupuis Y, Savatier X, Vasseur P (2017) PHROG: a multimodal feature for place recognition. Sensors 17:1167. https://doi.org/10.3390/s17051167

Fine-Grained Analysis of Bridging Social Capital with Triadic Analysis in a Co-author Network

V. Akila, V. Govindasamy and V. Seethalakshmi

Abstract Co-authorship network is a particular case of collaboration network that captures the behavior of academicians. Analysis of the collaboration network can reveal latent information pertaining to the collaboration behavior in an academic setting. In the current research scenario, the researchers are assessed using individual metrics such as such as h-index and citation count. But, these metrics fail to capture the collaboration efficiency of an individual. It is to be noted that the collaboration is an important aspect of research sharing, proliferation, etc. Social capital encodes the capital of an individual in a social environment. Bridging social capital is a type of social capital. This paper presents a collaborative method that uses triadic analysis to perform fine-grained analysis on the bridging social capital in an academic setting.

Keywords Collaboration efficiency · Social capital · Triadic analysis

1 Introduction

A social network generally comprises of a set of people, organizations, or social entities. These entities are associated by friendship, as colleagues, family relation, as batch mates, or as acquaintances. Collaboration network is a specialization of social network. It consists of a range of entities (e.g., organizations, people, and groups) that are largely independent, distributed, and diverse in nature. The entities generally work together to achieve common objective [1, 2].

Co-authorship network is an instance of collaboration network. In this network, the co-authorship of a paper can be envisioned as documenting a collaboration between two or more authors, and these collaborations form a co-authorship network. Co-authorship qualifies as the most substantial forms of research collaboration. Co-authorship networks allow a chain of relationships, in which knowledge resources are shared, viz. research setup, technical writing skills, coding knowledge, etc., through social interactions [1, 2].

V. Akila (✉) · V. Govindasamy · V. Seethalakshmi
Pondicherry Engineering College, Puducherry, India
e-mail: akila@pec.edu

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_14

Co-authorship generally exists predominantly among faculty members of higher education. The co-authorship of papers may extend among members of the same institution or may span across other education institutions or members from the industry. While there are several individual-centric measures like citation count or h-index to compute the research outcome, there is a paucity of measures and mechanism to compute the collaboration efficiency in an academic setting. The first step in designing metrics in a collaborative setting is to understand the role played by an author in a collaborative setting i.e., co-authorship network. This kind of analysis is required to judge quantitatively the research outcome of an academic institution so as to regulate the research grants allocation, etc. [1, 2].

Social capital is the owned capital of the members of the social network. It has three dimensions: structural, cognitive, and relational. Structural capital further is comprised of bridging and bonding capital. Relational capital deals with the assets created by people through influence of personal relationships. Cognitive Capital pertains to resources an individual requires and develops for understanding and knowledge gain. Assessing the social capital of an individual is of paramount importance in a co-authorship network. The study of the social capital among individuals can shed light on important latent features in the network. In particular, the bridging capital is important because it captures the important individuals who connect different sub-networks that exist in the co-authorship network [3, 4].

To this end, this paper proposes a fine-grained analysis framework to analyze the bridging capital of an individual in a co-authorship network. The bridging metric essentially identifies researchers who act as bridges between research groups.

2 Related Work

The paper [5] begins with the formation of knowledge networks using article keywords and examines the relationships among collaboration networks This paper concludes that knowledge and collaboration networks differ through factors of cohesion and integration. Structural holes in co-authorship networks have no significant effect on paper citation count. Further, the papers reiterate that structural holes are positively influenced paper citations. The paper hypothesis that the actors and their corresponding actions are interdependent. The network structural environment provides an opportunity for constraint action in networks that focuses on individuals [6].

It is hypothesized that betweenness centrality index though essential in the analysis of social networks is computationally intensive in terms of both time and space [7]. The state of the out approaches regarding the identification of roles within a social network about the roles (positions, behaviors, or virtual identifies) in the social network is presented. A block model methodology is used. It is defined as the smaller graph structure coded by a square binary matrix. It also uses probabilistic models on textual content for estimating roles. Usually, the social role of actors who participate in online discussions depends on their interests, their activity, and their recognition about others. Thus, it is concluded that these characteristics are not defined the same way by everyone [8].

A study on what is social networking and the roles in it is made [9]. It explains about four methods to identify the roles in social networks. The first one is based on the equivalence classes. The second method relies on identification of core/periphery structure. The third one uses the analysis of basic measures such as the user's structural position. This is defined by the number of neighbors and relies on various centrality measures, i.e., local or global structural features. The fourth one is based on clustering feature vectors. The feature vector represents the behavior and relationship of a member with the other members of the community [9].

The contribution of the study presented is to define the following social indicators, i.e., degree centrality, betweenness centrality, prolific co-author count, team exploration, closeness centrality, and publishing tenure. The paper also investigates the interaction of these indicators interact and their effect on citations [10]. The results from the paper showed that betweenness centrality exploits the co-authorship network in terms of non-redundant sources. This measure significantly affects citations for publications. Further, it was found that citation count was influenced by team exploration, prolific co-author count, and publishing tenure in an indirect manner. The citation count as well as researchers centrality are affected by co-authoring with high prolific scholars.

The study takes a structural approach that exploits the interplay between brokerage and closure. An online health social network was tracked for about three months. The number of comments that were utilized to perform the evaluation is three thousand two hundred and seventy. The results showed that informational and network support could be predicted with network brokerage and emotional support that could be predicted with network closure [11].

3 Proposed Model

The co-authorship network "*C*" is modeled as a weighted undirected graph with the nodes being the author represented as "*A*" and the link between them as the number of papers co-authored represented by "*L*."

$$C = \{A, L\}$$

A $1 > a > n$ (n is the number of unique authors)
L $1 < l < m$ (m is the number of links).

The system is modeled as the co-authorship network with nodes as the authors and the links as the co-authored papers. First, the area of expertise of each author is extracted from the papers published. To perform this, the titles of the papers published for each author are extracted and are preprocessed using with stop word removal, etc. The bag of words is constructed, and the term frequency is computed. On this data

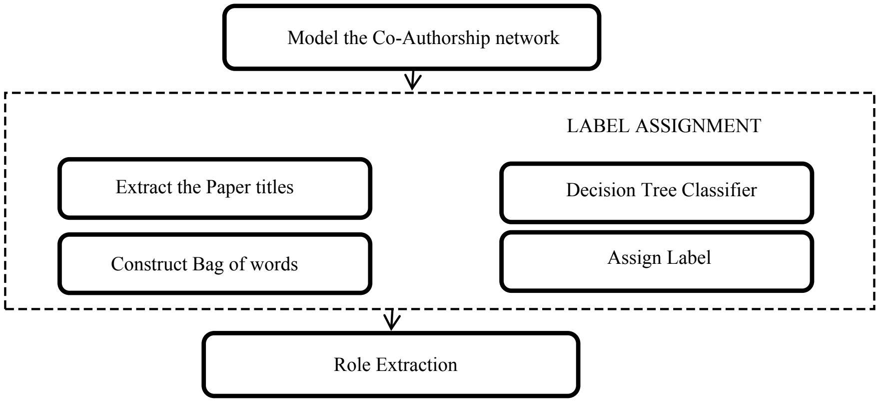


Fig. 1 Architecture of Fine Grained analysis

set, the decision tree classifier algorithm is applied to classify the authors according to the area of expertise (Fig. 1).

3.1 Role Extraction Algorithm

The role extraction algorithm (REA) is then applied. The basis for REA is triadic analysis. A three-member subgraph of a network is a triad. A closed triad is where all the three links are present in the triad. In the REA algorithm given Fig. 2, the

Procedure REA()
$g_{a:}$ Gate Keeper count
$l_{i:}$ Liason count
$G=\{ g_{1,}\ g_{2..}\ g_n\}$ where n : Number of classes
Begin
Step 1: Vector $<g_a, l_i>$ for each author initialized to 0
Step 2: Let $S= \{s_1,s_2..s_n\}$ set of authors
Step 3: For each author $s_i \in S$ extract the set of closed triads $T=\{t_1,t_2..t_m\}$
For each Triad t_j with b as s_i
If $(((a\&b) \in g_n \ \&\ c\in\{ G-\{ g_n\}\}) \,||\, ((a\&c) \in g_n\ \&$
$b\in\{ G-\{ g_n\}\}))$
$g_a=g_a+1$
If $((a\&c) \in g_n\ \&\ b\in\{ G-\{ g_n\}\})$
$l_i=l_i+1$
Step 4: For each author $s_i \in S$//Assign Role
If $((l_i!=0)$ OR $(g_a!=0))$ && $(g_a!>li)$ then "Gatekeeper"
Else then "Liaison"
End

Fig. 2 Role extraction algorithm

Procedure Weighted_REA()
Begin
Step 1: Vector $<g_a, l_i>$ for each author initialized to 0
Step 2: Let S= $\{s_1,s_2..s_n\}$ be the set of authors
Step 3: ***For*** each author $s_i \in S$ extract the set of closed triads $T=\{t_1,t_2..t_m\}$
    For each Triad t_j with b as s_i
    If $(((a\&b) \in g_n \;\&\; c\in\{G-\{g_n\}\}) \,||\, ((c\&b) \in g_n \;\&\; a\in\{G-\{g_n\}\}))$
        $g_a=g_a+wt$
    If $((a\&c) \in g_n \;\&\; b\in\{G-\{g_n\}\})$
        $l_i=l_i+wt$
Step 4: ***For*** each author $s_i \in S$//Assign Role
    If $((l_i!=0)$ OR $(g_a!=0))$ && $(g_a!>l_i)$ then "Gatekeeper"
    Else then "Liaison"
End

Fig. 3 Weighted role extraction algorithm

whole network is partitioned according to the area of expertise.

All the triads of this network is extracted and examined. Each node in the triad is examined for the area of expertise.

The members among the triads are categorized as follows [12, 13].

- *Gatekeeper:* "a" && "b" are from the same group, while "c" belongs to a different one.
- *Liaison:* "a", "b", and "c" are from different groups.

The REA algorithm uses the authors' expertise alone to fine-grain the bridging capital as Gatekeeper or Liaison. The Weighted_REA in Fig. 3 factors in the area of expertise as well as the number of publication of the author. The number of publications of the author is adjusted according the recency of publication year as shown below.

Each node A = {wt, lab}

$$\mathrm{wt} = \sum_{\mathrm{y}i=\mathrm{cy}}^{\mathrm{y}i=1} (1 - ((\mathrm{cy} - \mathrm{y}i) * \alpha)\mathrm{np})$$

cy Current year
y Year of publication
np Number of publication in a year
lab Labeled according to the area of research.

$\alpha = 0.05.$

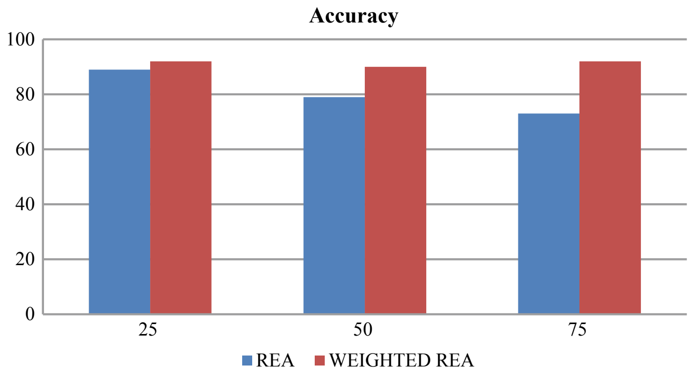


Fig. 4 Accuracy

4 Performance Evaluation

The experiments were performed using a Pentium IV machine with a hard disk of size 40 GB and random-access memory with a size of 512 MB. The system was installed with a Windows XP operating system, and the .NET platform was used.

The experimental setup was with ASP.NET 3.5 as front end and SQL sever 2008 as database. The data set utilized is co-authorship network derived from the publications made in one academic institution from the year 2013 to 2019. The experiments were repeated for 25,30,50,75, and 80 authors. The results of the experiments are shown in Fig. 4. It can be inferred from the results that the Wieghted_REA performs better.

5 Conclusion

Social capital is a value that is discerned due to the connection between individuals. Computing the social capital in an academic setting shows the collaboration nature of authors. This information can help in shaping the research directions of institutions. This paper has implemented a method to fine-grain the bridging social capital using triadic analysis as well as the adjusted publication count.

Acknowledgements This work was supported by the UGC Minor Research Project with Proposal Number: 2477 (F. NO:4-4/2015-16 (MRP/UGC-SERO)).

References

1. Akila V, Govindasamy V (2018) Progressive K-clique mining in co-authorship network based on temporal concept analysis. Indian J Comput Sci Eng 9(2)
2. Akila V, Govindasamy, V (2018) Missing link prediction in collaborative research based on triadic analysis. ARPN J Eng Appl Sci 13(7)
3. Morel RP, Coburn C (2019) Access, activation, and influence: how brokers mediate social capital among professional development providers. Am Educ Res J 56(2):247–288
4. Cofré-Bravo G, Klerkx L, Engler A (2019) Combinations of bonding, bridging, and linking social capital for farm innovation: how farmers configure different support networks. J Rural Stud 69:53–64
5. Guan J (2017) The impact of collaboration and knowledge networks on citations. J Inf 11(2):407–422
6. Some R (2013) A survey on social network analysis and its future trends. Int J Adv Res Comput Commun Eng 2(6):2403–2405
7. Brandes U (2001) A faster algorithm for betweenness centrality. J Math Sociol 25(2):163–177
8. Forestier M, Stavrianou A, Velcin J, Zighed DA (2012) Roles in social networks: methodologies and research issues. Web Intell Agent Syst: Int J 10(1):117–133
9. Zygmunt A (2014) Role identification of social networkers. Encycl Soc Netw Anal Min 1598–1606
10. Li EY, Liao CH, Yen HR (2013) Co-authorship networks and research impact: a social capital perspective. Res Policy 42(9):1515–1530
11. Meng J, Chung M, Cox J (2016) Linking network structure to support messages: effects of brokerage and closure on received social support. J Commun 66(6):982–1006
12. Lind BE, Tirado M, Butts CT, Petrescu-Prahova M (2008) Brokerage roles in disaster response: organisational mediation in the wake of Hurricane Katrina. Int J Emerg Manag 5(1–2):75–99
13. Neal JW, Neal ZP, Kornbluh M, Mills KJ, Lawlor JA (2015) Brokering the research–practice gap: a typology. Am J Community Psychol 56(3–4):422–435

A Multi-factor Biometric-Based User Authentication Protocol for IoT Networks

M. Kameswara Rao and S. G. Santhi

Abstract User identity has become important in the growing environment of the Internet of things (IoT). Many technologies and resources have emerged with IoT in areas such as control, health care, and safety. The services offered by the client can be requested from anywhere, via smart device applications at any time. This renders IoT key to security and privacy. Security in IoT is therefore of vital importance, enabling reliable access to the services; authentication of dual factors could provide high security. This chapter suggests a mobile user authentication focused on flexible biometric authentication and a key management framework for protect IoT service entry.

Keywords Authentication · Biometric · Perceptual hashing · Internet of things

1 Introduction

In order to create a potential networking and application architecture, IoT aims at creating a network infrastructure that usually uses spatially dispersed physical objects to serve smart and sophisticated devices. This network of physical objects comprises mobile devices, technologies for tracking, control and data collection of users' environment [1], cameras, RFID tags, or actuators. Using data gathered from devices will facilitate smart and all-present consumer resources like mapping, medical services, and obstruction of security traffic. IoT applications render communicating with the actual world simpler for phones. In addition, IoT services operate in the backdrop, which may or may not be aware of position-based user data. If the client forgets to uninstall such background applications, serious privacy concerns can occur. However, many IoT services could record private information about the customer in the

M. Kameswara Rao (✉) · S. G. Santhi
Department of Computer Science and Engineering, Annamalai University, Chidambaram, India
e-mail: mkraoau2016@gmail.com

S. G. Santhi
e-mail: sgsau2009@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_16

background without informing their users. This also leads to several security issues, such as confidentiality and integrity in the sensitive exchange of information [2]. Remote users can access IoT installations via intelligent phone applications in the unmonitored IoT world to link to any base station or sensor unit. When linked, the client may access the required data using certain nodes. In IoT settings, remote consumer identity is necessary so that certain legitimate users may access IoT systems while on their smart devices using any software [3]. The core feature of the conventional user authentication schemes is information requirements including passwords. In recent years, however, user credential-based authentication frameworks have been observed as simple to break and thus inadequate to guarantee protection. A key factor based on the user's own biometrics can therefore enable the creation of a better authentication system. Scientists have also suggested several authentication protocols based on intelligent cards with the use of biometrics to improve user-friendliness and to provide many safety implications [4]. Biometric implementation provides many benefits, such as hard-to-create or disseminates, not lost, and not replicated. Biometrics provide an extensible factor that many organizations can use to maintain secure user authentication for both them and their customers. However, the speed of Internet connection with "stuff" permits the encryption of mixed factors to provide a viable alternative to IoT network privacy and security.

2 Related Works

Numerous IoT security researchers have performed a variety of inquiries and tests. In addition, Atzori et al. [5] conducted a study in RFID systems and wireless networks regarding IoT confidentiality, data security, and honesty issues. In order to achieve a high level of security to smart buildings, the researchers established confidentiality and authorization protocols for entry to the network. IoT has been experiencing various security issues for Li and Zhou [6]. They suggested a safety architecture that announces IoT protection in three ways, i.e., security, network layer, and security domain. Ma et al. addressed three key IoT targets in [7]. Based on these priorities, he addressed core problems and science questions emerging during IoT implementation. In [8], Thoma et al. conducted an investigation on the use of IoT applications and IoT technology. Nguyen et al. [9] have examined the impacts on wireless communication networks for use in IoT settings of new IP-based Internet security policies. A range of light and attack-resistant alternatives for WSN and IoT safety have been researched by Ren et al. [10]. These protocols have been assessed to define multiple IoT safety requirements and problems. Several biometric-based mobile user identity schemes have secure network access. Some systems are designed to set up a method of encrypting the client to the ground or portal device. Lee et al. [11] have supplied a multi-factor authentication system with intelligent card and thumbprint. For the program to authenticate authorized clients, no password table surveys are needed. However, the cryptanalysis shows that the system may conspire attacks and cover-up attacks. In order to make it safe to portray assaults, Lin and Lai[12] proposed an enhanced version of the protocol system mentioned above. A highly secure variant of multi-factor authentication based on a single session method for wireless sensor networks (WSN) has been suggested by Chen et al [13]. Police have studied key assaults and safety requirements for two-factor authentication. The system suggested is also resistant to smart card theft. Das and Goswami [14] evaluated An's security scheme [15] and proposed the use of anonymous biometrics to implement a strong distant user authentication scheme. Li and Hwang [16] proposed a distant user authentication system based on intelligent biometric cards, with comparatively low cost for the replacement. The multi-factor system uses one-way hash, smart cards, and biometric checks. The researchers Liao and Hsiao [17] proposed that the ECC and the RFID devices embedded into the ID verifier transmission protocol should provide a thorough authentication. The Internet authentication scheme of Jing et al. has been tested by Ndibanje et al. [18], and its evaluation has shown that during communication returns the protocol has a high price, and that the protocol lacks protection.

3 Proposed Model

The suggested biometric user authentication multi-factor comprises of following stages:

- User Registration
- User Authentication.

User Registration Phase: During this process, the client (Ci) who wants to use his/her smart device to access the IoT platform will need to enroll with the gateway base station (GN). Once the client has penetrated the gateway network, the associated sensor nodes will be able to gain access to the IoT system on demand. The registration process is depicted in Fig. 1.

The consumer completes the encryption stage to generate a mutual session key that is used to connect safely. In fact, an IoT network and network nodes can be authenticated by the user after successful activation. Ci uses the following steps to register with the gateway node (GN) and IoT node(s).

- Step 1: Client—Ci produces CIDi—Client ID, CPWi—Client password, biometric—CBi, and a random number, ni.
- Step 2: The client computes the following hidden values for identity, password, and biometric

$$\mathrm{HPi} = \mathrm{H}(\mathrm{ni} \| \mathrm{CPWi}), \mathrm{HIi} = \mathrm{H}(\mathrm{ni} \| \mathrm{CIDi}),$$
$$\mathrm{HBi} = \mathrm{h}(\mathrm{ni} \| \mathrm{CBi})$$

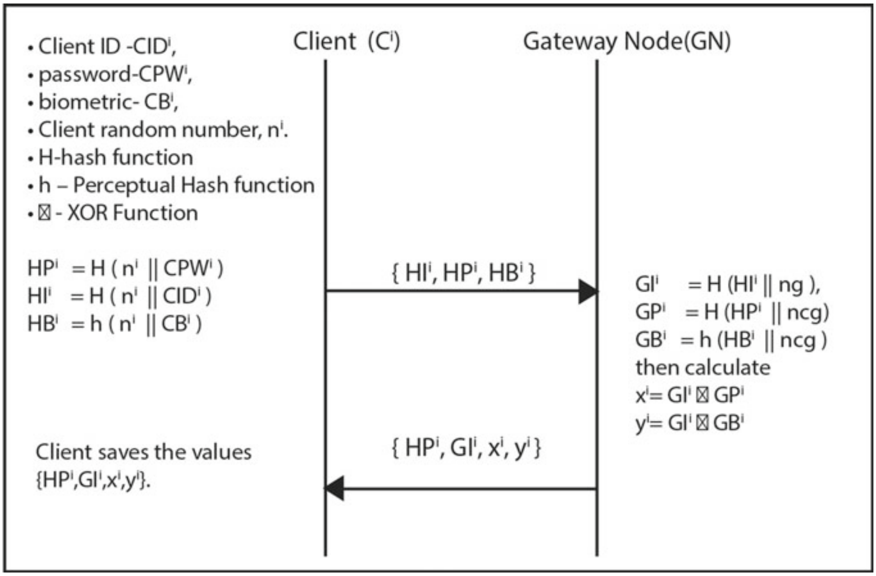


Fig. 1 User registration process

The client then sends the triplet {HIi, HPi, HBi} through a secure channel as the next message to the gateway node, GN.

- Step 3: The gateway (GN) calculates the following values with the triplet sent by the client.

$$\text{Gli} = \text{H(Hi}\|\text{ng)}, \text{GPi} = \text{H(HPi}\|\text{ncg)}, \text{GBi} = \text{h(HBi}\|\text{ncg)}$$
$$\text{then calculate xi} = \text{Gli} \oplus \text{GPi}, \text{yi} = \text{GIi} \oplus \text{GBi}$$

- Step 4: Gateway node (GN) gives parameters to the client {HPi, GIi, xi, yi}.
- Step 5: Client Ci gets the parameters and transfers them to the memory of his smart device.

User Authentication Phase: The client sends the request for verification to the specified node (Nj) inside the IoT network and not the gateway device (GN) in order to gain access to the IoT service by any node. Once registration is complete, Client Ci will connect to any required node within the IoT platform via the authentication point. To start the authentication stage, the customer must first login to the required IoT service implementation on his/her smart phone, such as health surveillance and smart home tracking. The user authentication process is shown in Fig. 2.

The suggested system enables users to enroll and authenticate using biometrics and password. For authentication purposes, the client, Ci, must conduct the following operations to submit the verification request message to IoT node, Nj:

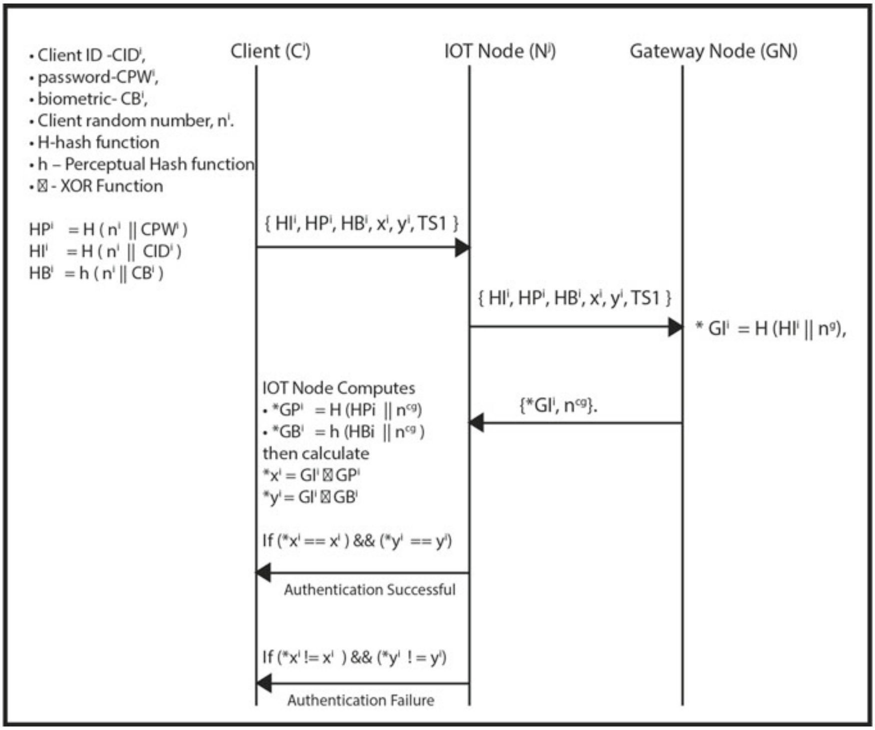


Fig. 2 User authentication process

- Step 1: Client Ci launches the request for the IoT service, enters his/her identity—CIDi, password—CPWi, biometric—CBi. The smart device then calculates

  – $\text{HPi} = \text{H}(\text{ni}\|\text{CPWi}), \text{HIi} = \text{H}(\text{ni}\|\text{CIDi})$

  $\text{HBi} = \text{h}(\text{ni}\|\text{CBi})$ using the clients nonce value (ni).

  The client then sends the parameters {HIi, HPi, HBi, xi, yi, TS1} through a secure channel as a request signal to the IoT node (Nj).
- Step 2: IoT node (Nj) then sends the parameters to gateway node (GN) for further processing.
- Step 3: The gateway (GN) calculates the following values with the triplet sent by the IoT node along with a time stamp (TS2).

$$^{*}\text{GIi} = \text{H}(\text{HI}\|\text{ng}),$$

- Step 4: Gateway node (GN) gives parameters to the IoT node {GIi, ncg}.
- Step 5: IoT node (Nj) computes the following with the given parameters

$$^{*}\text{GPi} = \text{H}(\text{HPi}\|\text{ncg}), {}^{*}\text{GBi} = \text{h}(\text{HBi}\|\text{ncg})$$

$$\text{then calculate}\quad {}^{*}xi = GIi \oplus GPi,\ {}^{*}yi = GIi \oplus GBi$$

- If (*xi == xi) && (*yi == yi), then client passes the process checks and continues to proceed. Otherwise, either false password or incorrect biometric data is given by the customer or both and the method of login is terminated.

4 Security Analysis

Safety analyses are important for any authentication system. The proposed system creates a standard encryption, guarantees protection for passwords, and avoids different assaults from threat models. IoT nodes are resource-constrained, all-round hardware. To this end, the efficacy of the existing encryption scheme must be reviewed to ensure that the cost of operation is negligible. This can be done on the basis of various criteria, including the evaluation of interaction expense, space, and additional overheads required. Assume the client's smart device is destroyed or stolen. Use the energy assessment assault to collect all the delicate data contained in the memory of the stolen unit. Therefore, the attacker is assumed to know the formation of {HPi, GIi, xi, yi}. The user identification, CIDi, is not recorded in the memory straight; it is placed in a disguised type. Moreover, the password and biometric data are mixed with hidden random ni, and the intruder has no way to get these values. The suggested system is therefore safe against assaults robbed by smart devices. Imagine that the intruder accesses the relayed texts {HPi, GIi, xi, yi} and {HPi, GIi, xi, yi, TS1} during the authentication phase. The likelihood of discovering n^{cg} and x^{i} effectively is very difficult based on the available information. This action is not feasible in the suggested protocol as the client must first link to the node, Nj, in the IoT network to begin the authentication stage and not the gateway node in order to access the IoT service. After the client starts the authentication method, the node, Nj, links to the gateway (GN). The node, Nj, moves the method of authentication to the node of the portal (GW) and verifies both the nodes, Nj and HIi. The suggested system utilizes only XOR functions and hash computations that make it safe and lightweight, thus promoting stronger efficiency in IoT for resource-constrained systems.

5 Conclusion

As security breaches decrease, new authentications must integrate customers' private biometrics to increase the security of the system. Several technologies and implementations have been developed, including monitoring, health care, and safety. IoT. Embedded sensors or intelligent system costs will also become a standard feature. IoT privacy and security standards are needed. Given the fact that IoT is focused on specifying the linked material, there are tremendous security difficulties; it is therefore critical for IoT protocols to include the amount of protection required even when they surpass the network power. This paper proposes a lightweight multi-factor authentication protocol for remote users. The protocol uses the gateway node design that the user needs to enter via the gateway node first. When enrolled, customers can use their intelligent system to link directly to the sensor node needed to stop operation. The suggested protocol is small, because it only uses perceptive hash functions and computationally cheaper XOR operations, rendering the protocol highly ideal for IoT systems that are resource-restricted. Defense analysis shows that defense attacks with various tips are successful.

References

1. Challa S, Wazid M, Das AK, Kumar N, Reddy AG, Yoon EJ, Yoo KY (2017) Secure signature-based authenticated key establishment scheme for future IoT applications. IEEE Access 5:3028–3043
2. Wazid M, Das AK, Odelu V, Kumar N, Conti M, Jo M (2018) Design of secure user authenticated key management protocol for generic IoT networks. IEEE IoT J 5(1):269–282
3. Dammak M, Boudia ORM (2019) Token-based lightweight authentication to secure IoT networks. IEEE CCNC
4. Park Y, Park Y (2017) Three-factor user authentication and key agreement using elliptic curve cryptosystem in wireless sensor networks. Sensors 16(12):2123
5. Atzori L, Iera A, Morabito G (2010) The internet of things: a survey. Comput Netw
6. Li H, Zhou X (2011) Study on security architecture for Internet of Things. In: Applied informatics and communication. Springer, Berlin, Heidelberg, pp 404–411
7. Ma HD (2011) Internet of things: Objectives and scientific challenges. J Comput Sci Technol 26(6):919–924. https://doi.org/10.1007/s11390-011-1189-5
8. Thoma M, Meyer S, Sperner K, Meissner S, Braun T (2012) On IoT-services: survey, classification and enterprise integration. In: 2012 IEEE international conference on green computing and communications (GreenCom), Nov 2012. IEEE, pp 257–260
9. Nguyen KT, Laurent M, Oualha N (2015) Survey on secure communication protocols for the Internet of Things. Ad Hoc Netw 32:17–31
10. Ren CX, Gong YB, Hao F, Cai XY, Wu YX (2016) When biometrics meet IoT: a survey. In: Proceedings of the 6th international Asia conference on industrial engineering and management innovation. Atlantis Press, pp 635–443
11. Lee JK, Ryu SR, Yoo KY (2002) Fingerprint-based remote user authentication scheme using smart cards. Electron Lett 38(12):554–555
12. Lin CH, Lai YY (2004) A flexible biometrics remote user authentication scheme. Comput Stand Interfaces 27(1):19–23
13. Chen L,Wei F, Ma C (2015) A secure user authentication scheme against smart-card loss attack for WSN using symmetric key techniques. Int J Distrib Sensor Netw 1–10. https://doi.org/10.1155/2015/704502
14. Das AK, Goswami A (2015) A robust anonymous biometric-based remote user authentication scheme using smart cards. J King Saud Univ-Comput Inf Sci 4
15. An Y (2012) Security analysis and enhancements of an effective biometric-based remote user authentication scheme using smart cards. J Biomed Biotechnol 1
16. Li C-T, Hwang M-S (2010) An efficient biometrics-based remote user authentication scheme using smart cards. J Netw Comput Appl 33(1):1–5. https://doi.org/10.1016/j.jnca.2009.08.001
17. Liao YP, Hsiao CM (2014) A secure ECC-based RFID authentication scheme integrated with ID-verifier transfer protocol. Ad Hoc Netw 18:133–146
18. Ndibanje B, Lee H-J, Lee SG (2014) Security analysis and improvements of authentication and access control in the internet of things. Sensors 14:14786–14805

Leveraging Topic Models with Novel Word Embeddings for Effective Document Clustering

Thayyaba Khatoon Mohammed, Rajasekhar Rangasamy, V. S. K. Reddy and A. Govardhan

Abstract A large amount of data is stored in flat files. They are documents that are subjected to machine learning for clustering, classification and host of other operations. In all such use cases of text mining, there is need for representing documents for efficient processing. One such model which is widely used is known as latent Dirichlet allocation (LDA). This model is the basis for deriving many other models. For instance, topic models came into existence to perform document clustering. Many existing solutions suffer from the lack of sufficient word embeddings. To overcome this problem, in this paper, we propose a generative process model derived from LDA. Its novelty is that it exploits Word2vec for latent feature vector representations. These are from pre-trained word embeddings obtained from large document corpus. The proposed model leverages topic model and improves the performance of document clustering. It is evaluated with a prototype that shows utility of the proposed model.

Keywords Topic models · LDA · Document clustering · Word embeddings · Word2vec

---

T. Khatoon Mohammed · V. S. K. Reddy (✉)
MRCET, Medchal, Telangana, India
e-mail: vskreddy2003@gmail.com

T. Khatoon Mohammed
e-mail: thayyaba.khatoon16@gmail.com

R. Rangasamy
St. Peters Engineering College, Medchal, Telangana, India
e-mail: rajasekaratr@gmail.com

A. Govardhan
JNTUH, Kukatpally, Telangana, India
e-mail: govardhan_cse@jntuh.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_17

1 Introduction

LDA [1] is one such proven approach that is widely used. Moreover, it supports different models like topic model, author model and author-topic model. There are many variants of LDA that are used for customized modeling and processing. Conventional topic modeling made with LDA and its variants can inter distributions like topic-to-word and document-to-topic. It is based on the co-occurrence of words within given documents. More information on probabilistic topic models can be found in [2], while modeling hidden topics is studied in [3]. Topic models have got supervised and unsupervised extensions as investigated in [4].

Though topic models have been around with many LDA variants, of late, the notion of latent features is introduced. Latent feature (LF) vectors are widely being used to process NLP tasks. Latent features permit a range of values that become a part of high-dimensional space which has proved to be efficient for modeling large corpus. Two latent feature models based on LDA and Dirichlet multinomial mixture model (DMM) are explored in this paper. Based on these baseline process models, Word2vec-based variants are introduced and used for effective modeling of latent feature word representations. Our contributions in this paper are as follows.

1. We proposed two generative process models considering latent features that are based on LDA and DMM, respectively.
2. We exploited the latent feature topic models for better representation or modeling to leverage performance of text mining operations like document clustering.
3. We built a prototype application to show the effectiveness of the proposed generative process models with latent feature vectors.

The remainder of the paper is structured as follows. Section 2 presents review of literature based on generative process models for systematic modeling of document corpora. Section 3 presents the LDA for modeling. Section 3 covers derivation of latent feature models that are used for improving text mining operations by using Word2vec toolkit. Section 4 presents experimental results, while Sect. 5 provides conclusions besides directions for future work.

2 Related Work

This section reviews the literature on the LDA [1, 5] and its variants for topic modeling. Generative process models like LDA became instrumental in processing text documents. Rosen-Zvi et al. [6] derived author model from LDA to give importance to author-based processing of documents. Shen et al. [1] on the other hand proposed a latent topic model that is meant for processing documents to obtain latent friends. An author-topic model focuses on both authors and topics at the same time. This model is proposed by Rosen-Zvi et al. [2] for text mining algorithms. Similarly, to represent topic and author community, Liu et al. [7] proposed a model known as topic-link

LDA. While all the models can be used for different mining purposes, Melnykov and Maitra [3] focused on clustering applications that are based on generative process models. Rajani et al. [4] used microblogs data in order to extract topics based on authors and other attributes like recipients and contents. Bishop [8] explored these models for machine learning as part of information retrieval (IR).

From LDA, many variants of topic models came into existence. One such variant is proposed by Blei [9] for generating probabilistic topic models. With respect to word co-occurrence statistics, Bullinaria and Levy [10] extracted semantic representations for better accuracy of processing textual content. Cai et al. [5] proposed a generative model for modeling hidden topics toward enhancing performance of text clustering. Cao et al. [11] on the other hand introduced a neural network model for getting artificial intelligence (AI) from textual documents. More on topic models can be found in [12] for improvements in single-label text categorization.

Natural language processing (NLP) is crucial for text mining. Toward this end, Collobert and Weston [13] proposed a unified framework for NLP. From the literature, it is understood that there is need for further improvement in the performance. Toward this end, in this paper, we proposed novel models with Word2vec usage for better performance as it provides vectors that are rich in coverage and useful for text mining algorithms.

3 Derivations of Latent Feature Topic Models from LDA

Two novel models are derived from the LDA. Two probabilistic models are known as LF-LDA and LF-DMM. These two models help in achieving latent feature topic models (Fig. 1). Figure 2 shows the models used in this paper along with Word2vec which generates a set of vectors or feature vectors for words in the given corpus. The usage of Word2vec provides higher level of accuracy in text mining applications.

These two models are formed by original LDA and DMM models, respectively. The traditional models are replaced by two-component mixture of a topic-to-word Dirichlet multinomial component and latent feature component. Both have resemblance with the original LDA or generative process models. The difference is that the latent feature models define probability of a word given the topic with respect to categorical distribution. This relation is represented as in Eq. 1.

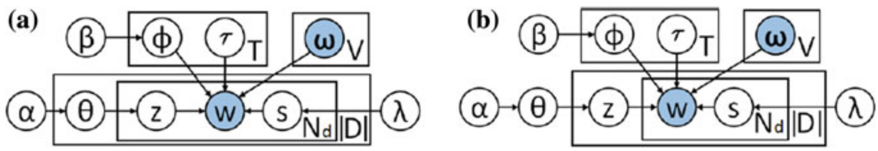


Fig. 1 Latent feature topic models LF-LDA (**a**) and LF-DMM (**b**)

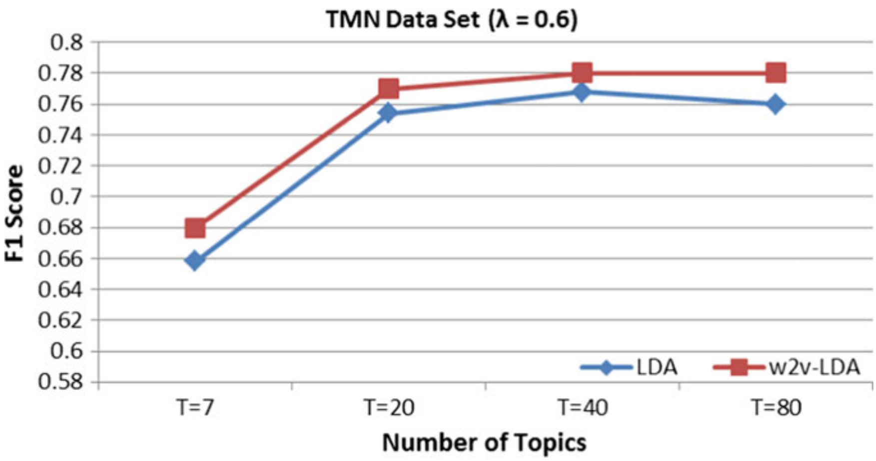


Fig. 2 Number of topics versus $F1$ score

$$\text{CatE}(w|T_t w^T) = \frac{\exp(T_t w_w)}{\sum w^1 \in W \exp(T_t w_{w^1})} \tag{1}$$

The generative process model for the LF-LDA is as shown below.

$$\theta_d \sim \text{Dir}(\alpha) \quad zd_i \sim \text{Cat}(\theta_d)$$

$$\emptyset_z \sim \text{Dir}(\beta) \quad \text{w}d_i \sim \text{Ber}(\lambda)$$

$$wd_i \sim (1 - sd_i)\text{Cat}\left(\emptyset_{d_i}\right) + sd_i\,\text{CatE}\left(Tz_{d_i}\omega^T\right)$$

Similarly, for LF-DMM, the generative process model is given as follows.

$$\theta \sim \text{Dir}(\alpha) \quad zd \sim \text{Cat}(\theta)$$

$$\emptyset_z \sim \text{Dir}(\beta) \quad sd_i \sim \text{Ber}(\lambda)$$

$$wd_i \sim (1 - sd_i)\text{Cat}\left(\emptyset_{z_d}\right) + sd_i\text{CatE}(Tz_d\omega^T)$$

The word—topic assignment probability is explored for each world. Thus, inference models are created for LF-LDA and LF-DMM. Then, these models are used along with W2V in order to have observations on different datasets. The datasets used for empirical study are TMN and TMN title, and $F1$ measure is used for performance analysis. With respect to document clustering, the W2V model has shown better performance as presented in Sect. 4.

4 Experimental Results

Results are evaluated with $F1$ measure which is widely used to know the performance of text mining algorithms. TMN dataset and TMN title dataset [14] are used with different number of topics like 7, 20, 40 and 80 for empirical study. However, the value of λ is set to 0.6 for empirical study. The results are as follows.

As presented in Fig. 4, the number of topics is shown in horizontal axis and the vertical axis provides $F1$ score values against number of topics. The experimental results revealed that the number of topics has its influence on the $F1$ score. Another important observation found is that the proposed method has shown improved performance over the baseline LDA method.

As presented in Fig. 4, the number of topics is shown in horizontal axis and the vertical axis provides $F1$ score values against number of topics. The experimental results revealed that the number of topics has its influence on the $F1$ score. Another important observation found is that the proposed method has shown improved performance over the baseline DMM method.

As presented in Fig. 4, the number of topics is shown in horizontal axis and the vertical axis provides $F1$ score values against number of topics. The experimental results revealed that the number of topics has its influence on the $F1$ score. Another important observation found is that the proposed method has shown improved performance over the baseline LDA method.

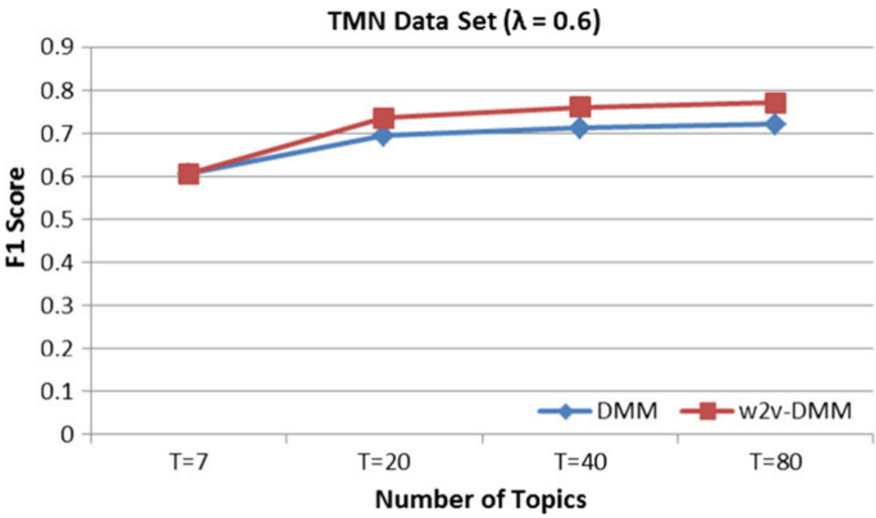


Fig. 3 Number of topics versus $F1$ score for baseline and proposed DMM

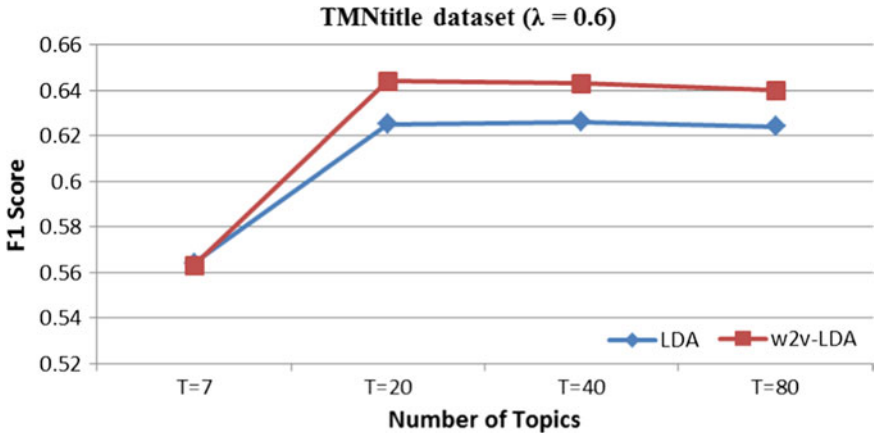


Fig. 4 Number of topics versus $F1$ score for baseline and proposed LDA (TMN title dataset is used)

5 Conclusion and Future Work

In this paper, we proposed novel topic models that are directly or indirectly derived from LDA generative process models. The new models are probabilistic and used to discover latent topics in document collections. The latent feature model is made up of LF-LDA and LF-DMM. Besides, the models are integrated with the Word2vec for having vectors with high quality suitable for discovering latent topics. The proposed model is capable of producing enhanced performance in text mining algorithms like document clustering. The empirical results revealed that the proposed model performs better than the state of the art. As of now, the proposed system is slow when a large corpus is used. Therefore, the system can be extended further to incorporate more efficient solution and evaluated with large corpora. Another direction for future work is to apply the system for medical document and provide privacy preserving text mining.

References

1. Shen D, Sun J-T, Yang Q, Chen Z (2006) Latent friend mining from blog data. IEEE, pp 1–10
2. Rosen-Zvi M, Chemudugunta C, Griffiths T, Smyth P, Steyvers M (2010) Learning author-topic models from text corpora. ACM 28(1):1–38
3. Melnykov and Maitra (2010) Model-based clustering. IEEE, pp 1–15
4. Rajani NF, McArdle K, Baldridge J (2014) Extracting topics based on authors, recipients and content in microblogs. ACM, pp 1–4
5. Cai D, Mei Q, Han J, Zhai C (2008) Modeling hidden topics on document manifold. In: Proceedings of the 17th ACM conference on information and knowledge management, pp 911–920

6. Rosen-Zvi M, Griffiths T, Steyvers M, Smyth P (2003) The author-topic model for authors and documents. IEEE, pp 1–8
7. Liu Y, Niculescu-Mizil A, Gryc W (2009) Topic-link LDA: joint models of topic and author community. In: Machine Learnings. ACM, pp 1–8
8. Bishop CM (2006) Pattern recognition and machine learning (information science and statistics). Springer-Verlag, New York, Inc.
9. Blei DM (2012) Probabilistic topic models. Commun of the ACM 55(4):77–84
10. Bullinaria JA, Levy JP (2007) Extracting semantic representations from word co-occurrence statistics: a computational study. Behav Res Methods 39(3):510–526
11. Cao Z, Li S, Liu Y, Li W, Ji H (2015) A novel neural topic model and its supervised extension. In: Proceedings of the twenty-ninth AAAI conference on artificial intelligence, pp 2210–2216
12. Cardoso-Cachopo A (2007) Improving methods for single-label text categorization. Ph.D. thesis, Instituto Superior Tecnico, Universidade Tecnica de Lisboa; Chang J, Gerrish S, Wang C, Boyd-graber J-L, Blei DM (2009) Reading tea leaves: how humans interpret topic models. Adv Neural Inf Process Syst 22:288–296
13. Collobert R, Weston J (2008) A unified architecture for natural language processing: deep neural networks with multitask learning. In: Proceedings of the 25th international conference on machine learning, pp 160–167
14. Deerwester S, Dumais ST, Furnas GW, Landauer TK, Harshman R (1990) Indexing by latent semantic analysis. J Am Soc Inf Sci 41(6):391–407

Survey on Access Control Mechanisms in Cloud Environments

B. Ravinder Reddy and A. Anil Kumar

Abstract Cloud computing is a rising paradigm used to store and compute the statistics remotely in the cloud. As the data on the server is shared with many users, providing the security has become a vital issue. To encrypt the information securely, various cryptographic algorithms are used. Attribute-based encryption (ABE) is exploited for providing safety as well as fine-grained access control. Access control (AC) is presented before the information is outsourced into the cloud. In this study, based on the security requirement, various attribute-based encryption schemes are exposed. In order to encrypt the documents/information more efficiently, distinct encipher projects are presented in a future enhancement.

Keywords Cloud computing · Access tree · Attribute-based encryption · CP-ABE · HABE · MABE · FH-ABE · Searchable encryption · Access control

1 Introduction

Cloud computing is an information technology paradigm which allows considerable admittance to share resources and provide higher-level services over the network. For a considerable amount of data, cloud service provides security, scalability, elasticity, fine-grained control in the cloud [1]. For information protection apprehensions, the encryption tool [2] is consumed, as it formulates as incredible for a cloud server to conduct information recovery operations. The searchable encryption mechanism is used in order to search and retrieve the files securely over cloud server. Encryption: the technique of changing records or data into a code, mainly to prevent unauthorized access. To obtain the plain text back, the data user has to decipher the data using decryption.

B. Ravinder Reddy (✉) · A. Anil Kumar
Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, India
e-mail: ravinderreddycse@cvsr.ac.in

A. Anil Kumar
e-mail: akulaanil77@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_18

Identity-based encryption (IBE) is a cryptographic scheme projected by Shamir in 1984 [3]. In this scheme, the person can communicate securely without changing the keys. The messages (or) records can be encrypted based on the precise recipient identification inclusive of the IP address (or) electronic mail-id. Attribute-based encryption (ABE) was initiated by Waters and Sahai [4]. In this pattern, ciphertexts are not encrypted to at least one unique consumer, but relatively, encoded text and user's decoding keys were mutually related through a group of traits. A person can decrypt ciphertext as long as there is a counterpart among decoding key and ciphertext. ABE structure is categorized into key policy ABE and ciphertext-policy ABE, relying on what way characteristics and the policy are interrelated to encoded transcripts and handlers' decoding keys. In key policy, the attribute gains fine-grained AC and flexibility depending upon keys supplied refer to the ciphertext. The scheme does not trust the key issuer, because the data owner cannot select a group of attributes describing the statistics with the person non-public key. Fundamentals for attribute-based cryptography scheme are data confidentiality, data integrity, availability, scalability, revocation of users, collision resilient.

2 Schemes for Search and Accessing Data

2.1 Searching on Encrypted Data

Each document can be allotted into "words," each size of 64-bit block. Each "word" is considered as a token; an English word, a sentence, or numerous different atomic quantities [5]. There are two kinds of approaches to search the data. One possibility is to accumulate an index. An alternative is to carry out a consecutive scan lacking an index. The drawback of the use of an index is loading and modernizing the catalog. Searchable encryption is a crucial technique which lets operators accomplish search inquiries over encoded data. To resolve the problem in searching over encrypted information, the SE method permits cloud to reclaim encoded facts on behalf of information proprietors without lack of information confidentiality. In order to gain distinct functionalities, various security models are proposed such as single-keyword Boolean search, single-keyword ranked search, and multi-keywords Boolean search.

2.2 Access Tree

Access tree [2, 6] is constructed based on the attributes. It contains leaf and non-leaf nodes, which is denoted by *T*. Private-keys are recognized through an access tree arrangement wherein every internal node of the hierarchy represents a threshold gate, besides leaves are relating to attributes. Every single non-leaf nodule of a hierarchy denotes a threshold gate. A group of access trees is known as access structure. Hierarchical access tree [7] represents a cohesive access for a group of records.

2.3 Bilinear Map

Bilinear maps [8, 9] are the tool of pairing-based cryptographic. It establishes the relationship between cryptographic groups. Let R_1 and R_2 and R_T be cyclic groups with the same order. Typically, R is an elliptic curve. The bilinear map is denoted with e. The function e: $R_1 \times R_2 \rightarrow R_T$.

(1) **Bilinearity**: $(u_1^a, u_2^b) = e(u_1, u_2)^{ab}$. u_1 and u_2 are generators of R_1 and R_2 correspondingly, $a, b \in Z$. Here, R_1 and R_2 are source group, and R_T is a target group.
(2) **Admissible**: The map e is a permissible bilinear plot if $e(u_1, u_2)$ generates R_T.
(3) **Non-degeneracy**: $e(u_1, u_2)! = 1$. The map does ot direct all pairs of R_T.

3 Techniques and Policies for Encryption

3.1 Attribute-Based Encryption

Based on user attributes, ABE [4, 8] allows one to several encryptions, and it permits customers to encode and decode the statistics. The secret key and ciphertext are inferior toward user attributes. The records are scrambled through information owner by a public key and clique of evocative attributes. The information client can decrypt the information together with its non-public key via authority. Decryption is possible when the wide variety of equal attributes in the encrypted data of user key matches with a variety of characteristics in the ciphertext. The principal aim of ABE is to impart safety and access control. The ABE consists of four steps: setup, key-production, encryption, and decryption.

Limitations: To encode document, proprietor of data needs to utilize each approved user's public key. ABE is restricted.

3.2 Key Policy

This scheme was proposed by "Goyal." KP-ABE [8] method is done for one to many communications. Ciphertext in KP-ABE is labeled relying upon the group of attributes and the non-public key's related to monotonic access structure. It also supports fine-grained access control and crucial secret responsibility.

Drawbacks: The decryption of information is not decided by the encoder. Kp-abe lacks in flexibility and scalability.

3.3 Ciphertext-Policy

Ciphertextpolicy is unique among all crucial encryption techniques, which lets the encoding of information by stipulating an admittance control policy across characteristics, in order that most effective users with a group of characteristics sustaining the procedure which can decrypt the related data. The structure of CP-ABE was anticipated by Bettencourt et al. [9] that can be demonstrated beneath difficult conventions. In this way, the revocation for every unique quality may additionally influence the alternative users within the system [10]. Ciphertext-policy schemes support delegation keys for attribute cliques which are subclasses of particular attribute sets. This requires identical attribute covered in the attribute group of the secret key possess a separate key constituent so that the share can contribute to reconstructing the secret key to be used in decryption. But a delegator's secret key is engendered by a key originator, subsequently, without knowing the secret key of key generator [11]. To resolve the security dispute, the user's isolated keys as well as group's clandestine key are linked. Therefore, if the handler's secret group key is rescinded, the related private key is unfeasible. CP-ABE against steady-sized encrypted texts was proposed by Herranz et al. [5]. The design also deals with a steady magnitude unscrambling key whose dimension can be as little as 672 bits (80-bit refuge). The secure CP-ABE structure is represented by the access structure of the AND gates.

Drawbacks: It has restrictions in the stipulation of strategies also in the management of their attributes. The decryption keys used in the scheme are systematized logically in the form of solitary set.

3.4 Hierarchical Attribute-Based Encryption (HABE)

This model comprises of root master, which is correlated with the master of multiple trusted third-party domains. It generates the key hieratically. HABE [7, 12] provide admissible delegation much for flexible encryption of ABE. The attributes in the HABE scheme are presented in the form of a matrix. It protects the sensitive data stored in cloud. It also suppresses the proxy re-encryption scheme. CP-HABE scheme is formulated by using linear secret sharing (LSS) to achieve the access structure.

Drawbacks: It lacks in implementing the scheme. The same attribute is used by multiple domain masters.

3.5 File Hierarchy Attribute-Based Encryption (FH-ABE)

In this structure, files are encoded based on the access structure by levels. File hierarchy ciphertext-policy ABE scheme [13] contains encoded facts with an integrated access structure. The benefits of a structure are that information clients be able to

Table 1 Comparison of ABE schemes

S. no.	Fundamental	Key policy attribute	Ciphertext policy attribute	Hierarchical attribute	File hierarchical attribute	Multi authority attribute
1	Data confidentiality	Nah	Yeah	Yeah	Yeah	Yeah
2	User accountability	Nah	Nah	Nah	Nah	Yeah
3	Collision resistant	Yeah	Yeah	Yeah	Yeah	Yeah
4	Scalability	Nah	Yeah	Nah	Nah	Yeah
5	User revocation	Nah	Nah	Yeah	Yeah	Yeah
6	Efficiency	Average	Average	Better	Flexible	Scalable

unscramble all approved archives via registering secret key formerly. Consequently, the outlays of encrypt and decrypt time are saved.

Drawback: It is demonstrated to be safe under the standard suspicion (Table 1).

3.6 Encryption Based on Multiple Authority Attributes (MABE)

The MABE pattern [14, 15] uses several authorities to allocate traits to users. It consists of several element authorities and a single central authority. The user can decrypt facts in the attribute set and the decryption keys of the attribute sets. In MABE structure, a receiver is not defined by a specific chain yet by a set of attributes.

Disadvantages: the difficulty in the scheme of various authorities is that it requires the central authority to keep the disjoint set of attributes.

4 Preliminaries of an Access Control Mechanism and Prototype

4.1 Access Control

Access control framework [14] is a collection of segments and strategies that determine the events performed by valid users based on pre-configured permissions and access privileges. Granting rights to access a resource is known as authorization. The vital goal of any access control structure is to limit a handler to access resources and keep facts from unauthorized access. For each AC structure has its private attributes, strategies, and capacities, which originate from a policy or set of policies. Access registers and identifications are two similar access control mechanisms.

4.2 Role-Based Access Control (RBAC)

RBAC is a coarse-grained AC model. "Role" is compliance to achieve an action on an entity. The term "object" is defined as stored information and resources. RBAC model anticipates a powerful way to satisfy the access control needs [16]. The formal explanation of role-based AC in the vocabulary of groups and relations, of access control based on the role, is defined as:

For every subject, effective role is one most currently used by the subject:
AR (subject: s) = {active role for the subject}
Every subject might be authorized to accomplish unique or additional roles:
RA (subject: s) = {authorized roles for the subject}
Every role can be authorized to achieve at least one operation:
TA (role: r) = {transactions authorized for the role}.
Subjects can perform transactions. The exec (s, t) predicate is true if the subject can perform a transaction at this time. Or else, it is false:
exec (subject, transaction) = exact if the subject scan completes the transaction.

Three elementary principles are needed:

1. **Assignment of roles**: a subject be able to implement transaction merely if the subject is preferred or allotted a role: ∀s: subject, t: transaction (exec ⇒ AR (s) O /).
2. **Role authorization**: the active role of a subject needs to be approved for the subject: ∀s: subject, (AR (s) RA (s)). With the (1) above, this instruction confirms that handlers can only assume roles for which they are approved.
3. **Authorization of the transaction**: subject can implement a deal merely if the operation is authorized for the active role of the subject: s: subject.

Limitations: It grants access rights centerd on user role. RBAC is an explosion of roles, which means that more roles are represented to encapsulate permissions.

4.3 Attribute-Based Access Control

In attribute-based AC, accessing of resources by subjects can be determined by distinct attributes such as name, IP address, etc. [17]. It allows only the authorized users to assign permissions between users and objects based on the attributes. ABAC provides a case of role alignment and dynamic designing of AC systems. It empowers fine-grained AC by combining innumerable attributes of authorized elements.

It enables mutual strategy administration across multiple organizations. Benefits: ABAC is dynamic and fine-grained approach control.

5 System Model

The strategic model for the proposed architecture represents the fine-grained access control structure for encoded document.

1. **Cloud server**: the virtual server which runs over a cloud environment, the cloud server provides query/results to the user of the data by verifying the credentials.
2. **Data holder**: an information proprietor has administrative control on the system.
3. **Facts user**: a data user is a person who can access data via the cloud server.
4. **A certificate authority (CA)**: It is a trusted entity which is used to provide the digital certificates. The CA center releases the secret keys to the authorized user.

The way toward executing a record query is represented in Fig. 1. The data holder is accountable for the collection and previous processing of the documents.

The cloud server is reliable for depositing the encoded records and implementing them dependent over the structure of the index. The user of the data must register as an authorized person at the CA center to search documents [18]. The mystery key

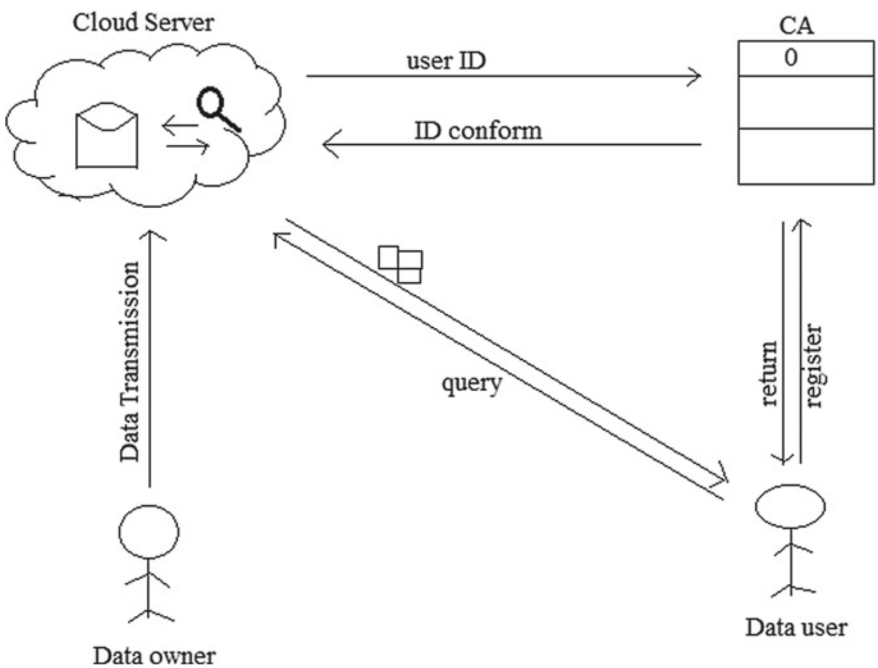


Fig. 1 System model

allied with the element set is released to the user by CA. The priority interacts with the CA to verify the user's ability to defend the data and the set of attributes. The encrypted files are extracted based on the structure of the index and directed to the data user. Therefore, the facts handler can decode the material with the secret key.

6 Conclusion

Security is the primary factor that needs to be addressed for various encryptions based on attributes evolved in the cloud environment. The multiple schemes designed are useful to attain scalability, flexibility, security, privacy, data confidentiality, and accurate access to external data in cloud. In CP-ABE scheme, hierarchical archives are proficiently encoded with an integrated access structure Therefore, both the storage of the encrypted text and the cost of the encryption time are preserved. In the access control model, the data user can access resources by collecting privileges in a very dynamic and simple way. The central access policies used are KP-ABE and CP-ABE. Additional schemes are attained based on these policies.

References

1. Ray I (2014) Trust-based access control for secure cloud computing. In: Han K, Choi BY, Song S (eds) High performance cloud control and applications. Springer, New York
2. Ma J, Li X, Zhang J, Miao Y (2017) Attribute based keyword search over hierarchical data in cloud computing. IEEE Trans IT Serv Bol 99
3. Shamir A (1985) Identity-based crypto systems and signature schemes. In: Advances in cryptology. Springer, pp 47–53
4. Waters B, Sahai A (2005)"Fuzzy Identity-based encryption. In: Proceedings of progress in cryptology, Euro Crypt, pp 457–473
5. Herranz J, Attrapadung N, Panafieu De E, Libert, B (2012) Attribute-based encryption schemes with constant-size ciphertexts. Theor Comput Sci 15–38
6. Moon S, Park Y, Rifki S (2015) A fully secure ciphertext policy attribute-based encryption with a tree-based access structure. J Inf Sci Eng
7. Liu Q, Wu J, Wang G (2010) Hierarchical attribute-based encryption for fine-grained access control in cloud storage services. In: As part of the 17th ACM. ACM, pp 735–737
8. Pandey O, Waters B, Goyal V, Sahai A (2006) Attribute based encryption for fine-grained access control of encrypted data. In: Proceedings of ACM conference on computer and communications
9. Bettencourt J, Water B, Sahai A (2007) Ciphertext-policy attribute-based encryption. IEEE symposium on security and privacy (SP '07), pp 321–334
10. Li J, Yao W, Han J, Zhang Y, Shen J (2018) User collusion avoidance CP-ABE with efficient attribute revocation for cloud storage. In IEEE Syst J 12(2):1767–1777
11. Qin B, Wu Q, Deng H, Liu J, Zhang L (2014) Ciphertext-policy hierarchical attribute-based encryption with short ciphertexts. Inf Sci 275:370–384
12. Wang G, Wu J, Guo M (2011) Hierarchical attribute-based encryption and scalable user revocation for sharing data in cloud servers. Comput Secur 30(5)
13. Zhou J, Wang S, Chen J, Xie W (2016) An efficient file hierarchy attribute-based encryption scheme in cloud computing. IEEE Trans 6(11)

14. Zhang B, Jia X, Yang K (2013) Effective data access control for multiauthority cloud storage system. In: Proceedings of IEEE information communication
15. Chase M (2007) Multi-authority attribute based encryption. In: Vadhan SP (eds) Theory of cryptography. TCC 2007. Lecture notes in computer science, vol 4392. Springer, Berlin, Heidelberg
16. Coyne E, Sandhu R (1996) Role-based access control model. IEEE Comput 29(2):38–47
17. Ferraiolo D, Vincent H, Sandlin K, Schnitzer A, Miller R (2014) Guide to attribute based access control (ABAC) definition and considerations. Special Publication in NIST
18. Sandhia GK, Bhaskar GK (2016) Secure data sharing using attribute based encryption in cloud computing. J Chem Pharm Sci 9(4)

Sales Analysis and Performance of Super Store Using Qlik GeoAnalytics

Siddhartha Ghosh and Kandula Neha

Abstract Data analytics is the science of predicting the future trends that support the study of gift information and past information that create inroads into the retail sector. Massive information analytics will offer insights into rather more than simply inventory levels and also the quality of various products. So as to create the simulation insensitive against short transient changes, a longitudinal analysis ought to be applied, to boot to the common crosswise analysis. For this purpose, we make use of Qlik Sense, Tableau, Python, R language to visualize the behavior of the sales data of a superstore which varies with time. While Qlik Sense and Tableau are the tools used for data visualization purpose, Python and R language are the programming languages used to draw patterns by coding. This paper also depicts the basic differences between the four tools used for data visualization. This paper proposes a Qlik Sense-based solution for the mentioned problem definition in the field of data analytics. Data patterns and trends are observed to draw the conclusions on the sales. As the major motto of retailer is to make profits by selling the products, there is a need for him to understand the data variations with the change in time, climate, regions, and customer's interest. Thus to make his work easier, will use the resulted visualizations formed out of the sales data. Hence, this paper provides efficient ways of analyzing the sales data of a superstore, finding the reasons for the increase and decrease in the sales, controlling product imports, and attaining a profitable business.

Keywords Analytics · Superstores · Geo analytics · Visualizations Qlik patterns

S. Ghosh · K. Neha (✉)
Department of CSE, Vidya Jyothi Institute of Technology, Hyderabad, India
e-mail: neha09kandula@gmail.com

S. Ghosh
e-mail: siddhartha@vjit.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_19

1 Introduction

Running an excellent store is usually difficult. There square measure varied merchandise to manage, several of that spoil quickly, typically leading to an important quantity of waste successively resulting in an excellent loss. The most task of distributor is not solely to get the merchandise and sell them to the specified customers; however, additionally to create large profits out of them. That the distributor can have to be compelled to face several issues and difficulties in managing the merchandise to be purchased, commerce them, rating and fixing the worth for the merchandise [1] bound facts have to be compelled to be drawn supported the customer's interest to get merchandise. Few things ought to be unbroken in mind whereas importation and commerce, fixing costs and discounts etc. It is additionally not acceptable to draw knowledge patterns and trends basing on the manual witness. To avoid this case, careful designing and robust analysis of information square measure are essential [2].

1.1 Data Analytics

Knowledge analysis could also be a way of inspecting, cleansing, reworking, and modelling data with the goal of discovering useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple sides and approaches, encompassing varied techniques beneath a ramification of names, in varied business, science, and subject-field domains. Analysis refers to breaking an entire into its separate parts for individual examination. Analytics applications involve quite merely analyzing data considerably on advanced analytics, the desired work takes place direct, in aggregation, group action in getting data ready thus developing, testing and editing analytical models to substantiate that they end up correct results [3]. Analysis knowledge is collected and analyzed to answer queries, take a look at hypotheses or confute theories.

1. Aggregating the info
2. Cleansing the info
3. Analysing the info
4. Interpreting
5. Reflecting.

So data analytics is all regarding the past data, gift analysis, and future outcomes. Data analytics (DA) is that the tactic of examining datasets thus conclusions are drawn regarding the data they contain. Data analytics technologies and techniques are unit wide utilized in business industries to alter organizations to make more-informed business selections and by scientists and researchers to verify or negate scientific models, theories, and hypotheses [4]. Reckoning on the actual application, that is analyzed will comprise either historical records or new info that has been processed for fundamental quantity analytics uses. To boot, it will come from a mixture of internal systems and external data sources [5].

2 How Geo Analytics Helps

Geo Analytics: It provides comprehensive mapping and geospatial operations. geo analytics geo-operations, like period of time, within, and highest square measure combined with made mapping options that may address a broad vary of refined geo analytics use cases. Maps and spatial knowledge will forthwith facilitate users discover new insights and communicate extra effectively with every co-workers and customers alike [6].

Use of Geo Map Analytics—For Visualization: Agglomeration and heat maps, KML layers, thematic maps, and routes. For Analytics: difficult filtering, numeric aggregates, dataset management, and charting. For Management: Territory management, automatic assignment plans, mass updates, and custom markers and shapes.

3 Qlik GeoAnalytics—Tool for Analytics

With Qlik Sense you will be able to analyze information and build information discoveries on your own. It helps you to raise and get outcome for your own queries and follow your own methods to insight. Qlik Sense is one in every of the foremost economical tools for information analytics and image. Qlik Sense provides people the likelihood to undertake out Qlik Sense and build personalized, interactive information visualizations, reports and dashboards from multiple information sources.

Qlik Sense provides following options to seek out its method in information analytics.

- Self service: Easy-to-use self-service image with intuitive tools for making analytics and getting ready information, from spreadsheets to huge information.
- Mobile: provides identical expertise of creation, exploration, and sharing, from any device—phone, tablet, or desktop.
- Smart visualizations reveal hidden insights and explore multiple information sources in an exceedingly single app. Smart search provides you final flexibility and rich information story telling helps you collaborate and share insights.

3.1 Why Qlik?

Ability to develop information visualizations: Over time, self-service news has invariably been a liability of business intelligence resolution. Ability to create dashboards on ad hoc information sources: Having the end-users being autonomous is not solely associated with their ability to develop new information visualizations. Ability to make information stories: Time is currently gone once all the analysis was drained a business intelligence resolution and, therefore, the restitution in PowerPoint because of a brand new key feature provided by Qlik Sense and known as "Story Telling."

3.2 How QLIK GeoAnalytics Tool Is Better Than Other Analytics Tool?

Traditional metal—need a two-bedded design when you run a report, the information is filtered from information layer and comes up to the appliance layer. If it takes longer, it cannot be real time. Qlik GeoAnalytics for Qlik Sense permits you to make simple to use layer-based maps in Qlik Sense and analyze your geographic information. Qlik GeoAnalytics not solely provides comprehensive mapping capabilities.

- Improve understanding by exploring all geo info at the side of any relationships among one map image, efficiently access, visualize and analyze any existing geospatial connected info and applications.
- Gain insight into patterns not simply understood through a few patterns broad location-related use cases with a correct mapping and geospatial capabilities that share a typical set of tools and techniques, Qlik Geo Analytics will meet the needs of Associate to the outsized form of geographical locations by use cases.
- Deliver mapping and location-related analytics to every user overall the organization and on the way aspect to one's system. The square measure many totally different layer parts for various varieties of visualizations:
  - Bubble Layer—symbols on points which may be colored and scaled by measures.
  - Line Layer—displays lines either from a begin purpose to associate finish purpose.
  - Area Layer—shows areas in colors controlled by measures.
  - Heat map Layer—displays purpose density with a color scale.
  - Geo data Layer—visualizes background map knowledge, either from a tile service or from a file.

Location IDs square measure names of options that may be used rather than actual coordinates. These square measures are typically referred to as geo keys.

4 Qlik GeoAnalytics Data Visualization of Super Stores Experimental Results

This Qlik application explains how geo analytics data will benefit for customer's who uses our site. Using the Qlik GeoAnalytics, your analytics data can easily be uploaded in the Qlik Sense application by giving the information in detail manner. Qlik geo analytics Connectors: Tracking store performance and finding new locations, sales of different stores, analysis of new stores, and drive-time calculation of near by stores. We have taken few US datasets of super stores and found of a few visualizations using Qlik GeoAnalytics from QLIK website.

Figure 1 gives the overview of performance of stores in few selected in city level of the country USA. It gives the count of customers, penetration and revenue per average customer, and the number of shops present in that particular locations.

In Fig. 2, this experimental result, we have selected a particular location of Canada. By this selection, we can get the exact number of shop details nearby that area and the approx time to travel from one store to other nearby store. It also gives the count of number of stores nearby that location within the time travel area.

The above visualization of Fig. 3 shows how far the majority of customers travel to the stores in particular selected locations. The accumulated 70% proportion is highlighted in the frequency bar charts.

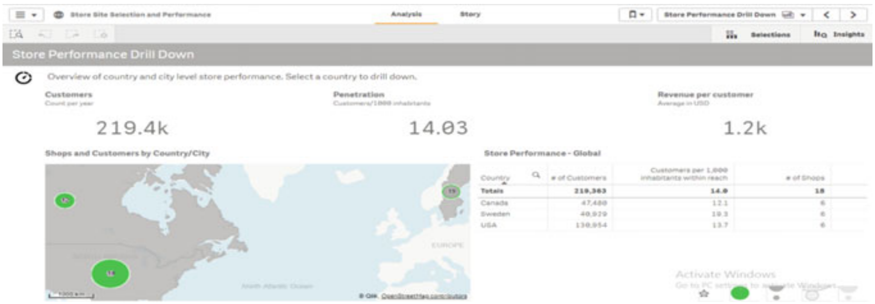


Fig. 1 Store performance

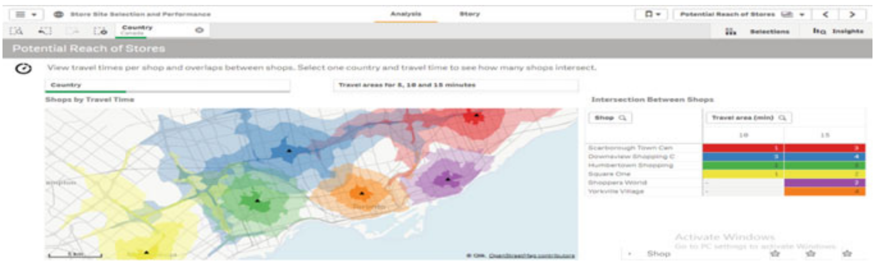


Fig. 2 Potential reach of stores

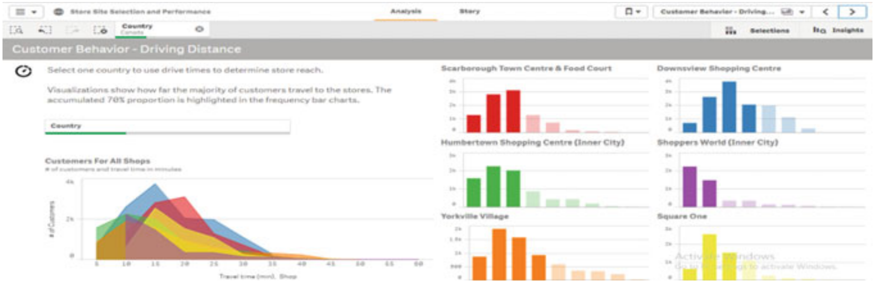


Fig. 3 Customer behaviour and driving distance

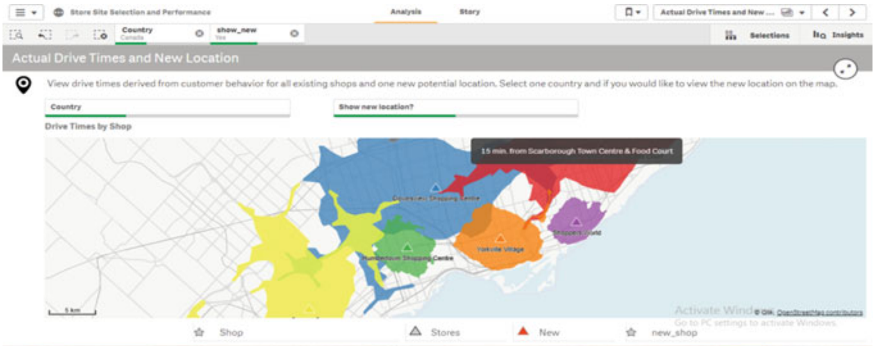


Fig. 4 Drive time and new locations

Figure 4 describes the drive time for the customers travelling from one store location to another store location by giving the new store location details. It helps the individual customer to choose the short and nearest route to travel from one store location to another one.

In the above visualization, Fig. 5 gives the details of sales and profits of the super stores in some particular selected region. Through this visualization, the store owners can get their profits and this will help them to grow their sales.

Fig. 5 Sales and analysis for region

5 Conclusions

This paper offers the summary of Qlik tools that helps organizations improve their sales management activities, as well as prediction of revenue and trailing of performance against goals. Sales managers will freely explore their team's performance and pipeline, from high-level groups all the way down to the individual group action level, to quickly spot and reply to outliers and considerations. This tool is very easy to use, sales managers do not ought to have confidence analysts or IT to provide reports or answer follow-up queries. They will produce their own territory and team analysis, group action knowledge from multiple sources, and find out distinctive relationships between client shopping for behaviors in respect to their activity. These end up in a additional certain and effective sales method at the team, regional, and company levels, allowing users to check the full story that lives inside their knowledge. This paper offers the analytic capabilities that unlock the ability of knowledge for sales management. The Qlik GeoAnalytics accustomed increase forecast accuracy and results like Sales managers rely on insights from historical performance to raised verify future forecasts, allot resources, define target accounts, and suitably set compensation and incentives.

References

1. ASTM International (2002) Manual on presentation of data and control chart analysis. MNL 7A, ISBN 0-8031-2093-1
2. Vance (2011) Data analytics: crunching the future. Bloomberg Business Week. Hair J (2008) Marketing research, 4th edn. McGraw Hill. Data analysis: testing for association. ISBN 0-07-340470-5
3. Chambers JM, Cleveland WS, Kleiner B, Tukey PA (1983) Graphical methods for data analysis. Wadsworth/Duxbury Press. ISBN 0-534-98052-X
4. Lewis-Beck MS (1995) Data analysis: an introduction. Sage Publications Inc, ISBN 0-8039-5772-6
5. Diggle PJ, Liang K-Y, Zeger SL (1994) Analysis of longitudinal data. Oxford University Press, New York
6. Adèr HJ, Mellenbergh GJ (2008) Advising on research methods: a consultant's companion (with contributions by D.J. Hand). Johannes van Kessel Publishing, Huizen, The Netherlands

Assessment of Crop Rotation using multi-polarized Sentinel-1 temporal SAR data over parts of the Kumaun Region of Uttarakhand, India

Aditya Allamraju and Hari Shanker Srivastava

Abstract Accurate information about crop rotation is essential for administrators, managers and various government departments for assessment, monitoring and management of various resources for crop escalation. Radar remote sensing, because of its all-weather capability and assured uninterrupted data supply, can show a substantial part in the evaluation of crop rotation. Twenty-Nine (29) Level-1 Ground Range Detected (GRD) product Sentinel-1 C-band scenes acquired in the Interferometric Wide (IW) swath mode during the period from 11 November 2017 to 30 November 2018, over Kumaun region, Uttarakhand, were utilized to explain the feasibility of multi-temporal SAR data for crop rotation. Principal component analysis was adopted to demarcate different crop rotation trends throughout the study area. The results show that 'wheat to paddy' is the highest practised crop rotation with 27.95% coverage, whereas 'mustard to sugarcane' is the lowest practised crop rotation with 2.86% coverage of the entire area of study provided with 80% of an overall accuracy acquired from the ground truth data from IIRS/ISRO. It is a benefit for the decision-makers, administrators and policymakers to take reliable decisions about a particular region regarding land management and natural resources.

Keywords SAR · Multi-temporal · GRD · IW · Crop rotation · Decision-makers · Land management

1 Introduction

The gradually rapid deterioration of the environmental quality is now at the major emphasis, prompting many policymakers and legislators to discover ways to confront this process [1]. Land use/land cover maps offer vital evidence to numerous aspects of

A. Allamraju
CSSTEAP, Indian Institute of Remote Sensing (IIRS/ISRO), Dehradun 248001, India
e-mail: allamraju_aditya@ieee.org

H. S. Srivastava (✉)
Indian Institute of Remote Sensing (IIRS/ISRO), Dehradun 248001, India
e-mail: hari.isro@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_20

land use preparation and policy expansion as a criterion for monitoring and demonstrating environmental change [2–4]. Crop mapping is a significant input within numerous issues solving like crop area estimation, crop yield predicting and environmental impact analysis [5]. The all-season ability of radar remote sensing makes it more appropriate than several other remote sensing techniques for constant crops' monitoring [6]. The quantity of SAR signal that is diminished as a result of foliage volume depends on the frequency, the polarization of the transmit and receive signal and the incidence angle [7]. Consequently, a specified incidence angle, frequency and polarization of the SAR signal are the utmost fundamental sensor parameters that mark the backscatter from the plant cover [8, 9]. It is well-recognized evidence that the variety familiarized by multi-temporal results and multiple-sensor outlines expressively boons crop description, since various crops rejoin with diverse temporal and spectral signatures. Data accessibility must be consequently measured as the dominant subject in agricultural land classification.

The present study area comes under the Kumaun region of the Uttarakhand state of India. It is narrowed between the boundary (28.84° N, 78.88° E), (29.35° N, 78.87° E), (29.36° N, 79.76° E) and (28.85° N, 79.77° E).

2 Methodology

2.1 Data Acquisition

In this project, Sentinel-1A data is used with multi-temporal dataset assimilated from the European Space Agency's (ESA) Copernicus programme which is freely available dataset. The source link is given alongside as the following: https://scihub.copernicus.eu/dhus/#/home.

2.2 Pre-processing

The pre-processing was conducted using Sentinel-1 toolbox in the Sentinel Application Platform software provided by the ESA. The steps include radiometric calibration, terrain correction and speckle filtering.

Radiometric Calibration. In this step, the acquired product of Sentinel-1 data is calibrated. The digital number (DN) values of SAR data is converted into backscattering values in decibel (dB) scale. The following equation was used to compute the vertical–vertical (VV) and vertical–horizontal (VH) backscattering coefficient value on the dB scale [10].

$$\sigma^0(\mathrm{dB}) = 10 \times \log_{10}\left[\left(\mathrm{DN}^2 + \text{offset}\right)/\text{gain}\right] + 10 \times \log_{10}(\sin(\alpha)) \tag{1}$$

where

σ^0(dB) = Radar surface backscattering coefficient
DN = Digital number of pixel value.

Terrain Correction. Terrain correction is performed to recompense for the distortions arising due to landscape deviations of a region and the inclination of the sensor, so that the geometric illustration of the image will be near to the real world. During this step, a 25 m Shuttle Radar Topography Mission (SRTM) data has been utilized and the data was resampled to a pixel size of 20 m ground resolution.
Speckle Filtering. Speckle elimination is essential for quantifiable analysis of SAR data. In speckle filtering step, the SAR data is filtered by a 3 × 3 kernel by means of "Enhanced Lee" approach.

2.3 Layer Stack

After the completion of the pre-processing stages, the temporal data was stacked for taking subsets of VV and VH individually for analysis. The images were stacked using nearest neighbourhood resampling method; minimum output extent was selected for co-registration.

2.4 Principal Component Analysis

The PCA compresses the information content of number of band channels into few principal component images. It is used to demarcate different trends/patterns of crop rotation in the whole season (Rabi + Kharif seasons) images of SAR. Figures (Figs. 1

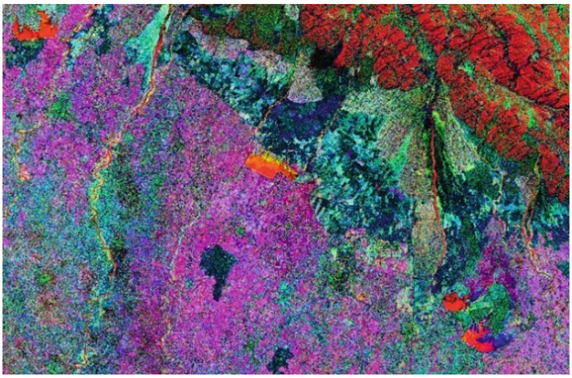


Fig. 1 PCA image of whole season VH (11 Nov 2017 to 30 Nov 2018)

Fig. 2 PCA image of whole season VV (11 Nov 2017 to 30 Nov 2018)

and 2) show the PCA images of the study area in VH and VV polarizations of whole seasons.

2.5 *Unsupervised Classification*

The unsupervised image classification technique used in the study is k-means clustering method with 10 clusters; after which, they were labelled with different crop rotation classes using the field data from our institution. In the present study, the unsupervised classification is adopted because there was only broad ground-truthing using which a pin-point information could not be acquired.

3 SAR Dataset

Sentinel-1A data is used with multi-temporal dataset that are available free of cost from the ESA's Copernicus programme. The GRD product Interferometric Wide mode of 250 km swath with spatial resolution of 20 m and pixel spacing 10 m, dual polarized SAR data has been used from 11th November 2017 to 30th November 2018 with 12 days interval for monitoring the entire growth cycle of Rabi and Kharif season on the Kumaun region of Uttarakhand state.

4 Results

The crop rotation map has been generated to find out various crop rotation classes pertaining to the study area. The results derived show that wheat to paddy covers 27.95% being the highest category followed by wheat to bare (22.19%), bare to

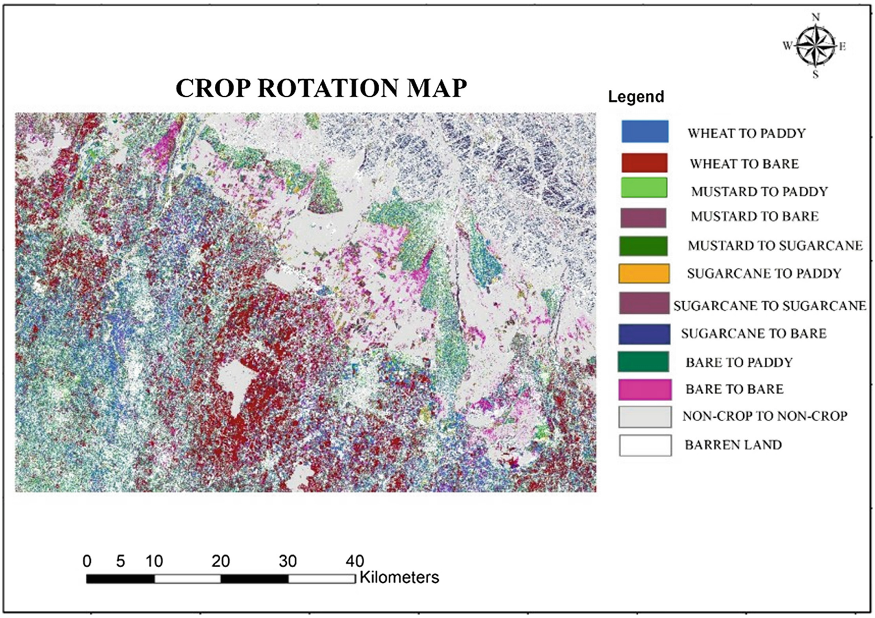


Fig. 3 Crop rotation map of study area

paddy (16.10%), bare to bare (10.43%), mustard to paddy (7.95%), sugarcane to bare (4.27%), sugarcane to sugarcane (4.17%), sugarcane to paddy (4.08%) and mustard to sugarcane with 2.86% being the lowest category (Figs. 3 and 4).

The crop accuracy map has been generated to access the accuracy of various crop rotation classes of the study area. The map and the accuracy results are shown in Fig. 5 and Table 1 respectively.

5 Conclusions

The present work clearly demonstrates that surety of uninterrupted data supply due to all-weather competence of SAR data coupled with sensitivity of SAR towards physical, geometrical and di-electrical properties of various crops can be successfully exploited to monitor crop rotation over a large agricultural area. Analysis of the results indicates that maximum area is enclosed by ‘wheat to paddy’ class with 27.95%, whereas minimum area is covered by ‘mustard to sugarcane’ class with 2.86% with an overall accuracy of 80% by validating with the availability of broad ground truth taken in the same season and year. The benefits of a crop information system can therefore be summarized as accurate estimates resulting in price stability; timely and accurate forecasts of production allowing governments to plan domestic and foreign policy and actions; accurate forecasts enabling optimal utilization of

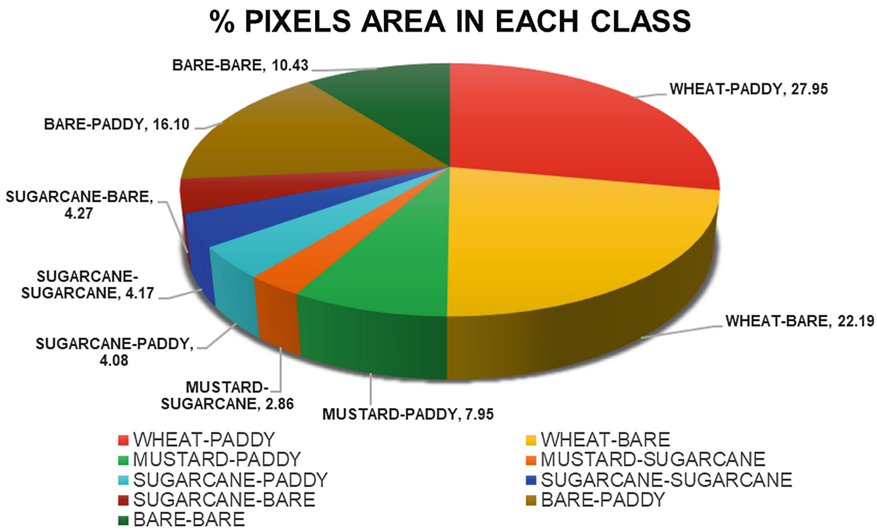


Fig. 4 Pixel area in percentage of crop region

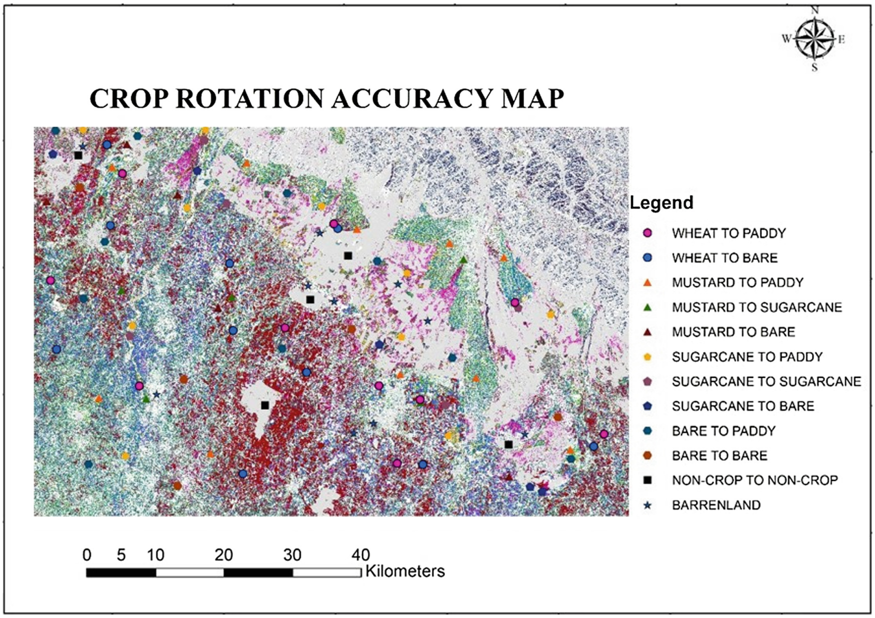


Fig. 5 Crop rotation accuracy map of study area

Table 1 Accuracy table of various crop rotation categories

	Kharif crops			
Rabi crops	Crop	Paddy	Sugarcane	Bare
	Wheat	100	NA	90
	Mustard	90	60	80
	Sugarcane	70	80	60
	Bare	90	NA	80

storage, transportation and processing facilities along with assessment, monitoring and management of various resources for crop intensification. The present study aimed to explore the potential of Sentinel-1 SAR data for the valuation and monitoring of crop pattern of the monsoon season and winter season crops using large temporal dataset of Twenty-Nine (29) Level-1 GRD Sentinel-1A C-band scenes acquired in the IW swath mode during the period from 11th November 2017 to 30th November 2018 over Kumaun region, Uttarakhand.

References

1. Chauhan S, Srivastava HS (2016) Comparative evaluation of the sensitivity of multi-polarized SAR and optical data for various land cover classes. Int J Adv Remote Sens GIS Geogr 4:01–14
2. Skriver H, Mattia F, Satalino G, Balenzano A, Valentijn Pauwels RN, Niko Verhoest EC, Davidson M (2011) Crop classification using short-revisit multi-temporal SAR data. IEEE J Selected Top Appl Earth Observations Remote Sens 4:423–431
3. Abdikan S, Sanli FB, Ustuner M, Calò F (2016) Land cover mapping using Sentinel-1 SAR data. Int Arch Photogrammetry Remote Sens Spat Inf Sci XLI-B7: 757–761
4. Srivastava HS, Sivasankar T, Patel P (2018) The sensitivity of C-band hybrid polarimetric RISAT-1 SAR data to leaf area index of paddy crop. ISPRS Ann Photogrammetry Remote Sens Spatial Inf Sci IV-5:215–222
5. Kussul N, Skakun S, Shelestov A, Kussul O (2014) The use of satellite SAR imagery to crop classification in Ukraine within JECAM project. IGARSS 2014, pp 1–21
6. Sivasankar T, Kumar D, Srivastava HS, Patel P (2018) Advances in radar remote sensing of agricultural crops: a review. Int J Adv Sci Eng Inf Technol 8:1126–1137
7. Mishra M, Patel P, Srivastava HS (2015) Approach for absolute radiometric calibration of RISAT-1 SAR data using standard target. Int J Remote Sens Geosci 4:28–32
8. Patel P, Srivastava HS, Panigrahy S, Parihar JS (2006) Comparative evaluation of the sensitivity of multi-polarized multifrequency SAR backscatter to plant density. Int J Remote Sens 27:293–305
9. Srivastava HS, Patel P, Sharma Y, Navalgund R (2009) Multi-frequency and multi-polarized SAR response to thin vegetation and scattered trees. Curr Sci 97:425–429
10. Srivastava HS, Patel P, Sharma Y, Navalgund R (2009) Large-area soil moisture estimation using multi-incidence-angle RADARSAT-1 SAR data. IEEE TGRS 47:2528–2535

Spatiotemporal and Delay Dynamics on a Prey–Predator Fishery Model

K. Shiva Reddy, G. Ranjith Kumar, M. N. Srinivas, C. V. Pavan Kumar and K. Ramesh

Abstract The results of intra-explicit contention including predators in the predator–prey condition are what this present examination centers around. To offer bits of knowledge into the significant results, that are a consequence of the exchange of deterministic, deferred, and dispersion process, a careful outline of the examination is offered scientifically. In particular, the dauntlessness and bifurcation examination of this model is remarkable in its own specific manner. Rivalry among the predator populace, without a sad remnant of uncertainty, obliges for different predator–prey models by keeping the populace stable at a positive inside balance. The suppositions that oversee the examination are upheld by the numerical arrangements acquired for the model's help.

Keywords Prey–predator · Delay · Bifurcation · Diffusion

1 Introduction

The evolving and dynamic relation between the predator and the prey is noteworthy by nature. From the perception of the Homo sapiens, the abuse of natural resources and harvest of masses have been routinely practiced in fishery, officer administration,

K. Shiva Reddy · G. Ranjith Kumar (✉) · K. Ramesh
Anurag Group of Institutions, Hyderabad, Telangana 500088, India
e-mail: ranjithreddy1982@gmail.com

K. Shiva Reddy
e-mail: shivareddy.konda@gmail.com

K. Ramesh
e-mail: krameshrecw@gmail.com

C. V. Pavan Kumar
Department of Mathematics, Apex Math Excel Center, Carolina 27560, USA
e-mail: cheruvu.pavankumar76@gmail.com

M. N. Srinivas
Department of Mathematics, Vellore Institute of Technology, Vellore, India
e-mail: mnsrinivaselr@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_21

and untamed life on the board. There exists a wide extent of energy for the usage of bio-economic exhibiting to get an understanding into the coherent organization of reasonable resources. Results dependent on non-spatial frameworks uncover that the impact of prey asylum accepted a noteworthy activity in choosing the dynamical results of predator–prey structures [1–6]. Combining the effect of prey refuge into the considered predation system, the down-to-earth reaction depicts the per capita utilization paces of predators relying on prey thickness and measures the essentialness move between trophic estimations, as in Holling I, II, III, and IV responses [7, 8]. The conclusions are the framework understanding of the considered predation structure being counterbalanced and the evening out thickness of prey similarly as predator was improved by the advancement of prey shelter [2, 5, 7, 9–12]. Hassel [13] demonstrated that adding an enormous asylum to a model, which showed disparate motions without a shelter, supplanted the oscillatory conduct with a steady balance. McNair [14] acquired that a prey asylum with genuine entry–exit elements was very equipped for enhancing instead of damping predator–prey motions. Even today now, prey asylums are generally accepted to avert prey elimination and moist predator–prey motions.

Time delay has a key job in significant segments of prey–predator, which has been believed to contribute in a general sense to the unsure outcomes of prey masses in perspective on predation [15]. It is reasonable to expect that the downfall of prey is prompt when ambushed by their predator anyway its promise to the improvement of predator masses must be deferred by some time delay [16]. Samanta [17, 18] fought that the effect of time delay happens as a result of the time required in going from the adolescent stage to the adult stage, brooding period, et cetera. Three particular techniques for uniting a relentless time delay into the prey–predator models were shown by Martin and Ruan [19], Cantrell [20]. In this present examination, we would fuse scattering structures in the two people. As we have referenced previously, a sensible prey–predator model should join both presence delays. Choudhury [21] analyzed Turing bifurcations and model game plans in predator–prey models that fuse both scattering and Volterra-type dispersed deferrals in the interspecies affiliation terms. The paper [22] is centered around deferred Lotka–Volterra prey–predator system with scattering effects and Neumann limit conditions. Sen et al. [23] managed the time delay-started instability of the homogeneous steady state of the two-part reaction scattering systems. Roused by [24, 25], we propose a postponed and diffusive prey–predator model with Holling type system. We plan to research and address the dynamical impacts of time delay in the development of every person, dynamical impacts of dispersion going with request through our illustrative and numerical results.

1.1 Model Construction

We consider an ecological system, where prey and predator species live together with the spatiotemporal effect along with Holling type-II interaction between the species. Assume that the prey species are growing logistically and the predator purely depends on prey for food with Holling type-II interaction. Also, it is ignoring the mortality rate of prey but is considering the mortality rate of predator species. Let D_1 and D_2 speak to the consistent dispersion coefficient of the prey and predator species; x speaks to biomass thickness of prey species; y speaks to bio mass thickness of predator species; K represents the carrying capacity of prey species; $q_1,\ q_2$ represents catch ability coefficients of prey and predator, respectively; $E_1,\ E_2$ represents efforts applied to harvest the prey and predator populations; c represents coefficient of predation rate; A represents constant; t is time variable; u represents space variable; keeping these in view, the mathematical model of the system is governed by the following equations.

$$x_t = ax(1 - (x/K)) - (cxy/(x + A)) - q_1E_1x + D_1x_{uu} \tag{1}$$

$$y_t = (cxy/(x + A)) - ey - q_2E_2y + D_2y_{uu} \tag{2}$$

With the accompanying states of the populace

$$x(u,t) \text{ and } y(u,t) \text{ in } 0 \le u \le L\ L > 0 \tag{3}$$

as

$$x_t(0,t) = x_t(L,t) = y_t(0,t) = y_t(L,t) = 0 \tag{4}$$

2 Analysis of (1)–(2) Without Diffusion

The objective of this section is to identify the dynamics of the structure (1)–(2) in the absence of diffusion. The model (1)–(2) becomes the following in the absence of diffusion,

$$x'(t) = ax(1 - (x/K)) - (cxy/(x + A)) - q_1E_1x \tag{5}$$

$$y'(t) = (cxy/(x + A)) - ey - q_2E_2y \tag{6}$$

and the concentration of this analysis is mainly about interior steady sate (x^*, y^*) with $x^* = [A(e + q_2E_2)]/[c - (e + q_2E_2)]$, for x^* to be positive provided $c > (e + q_2E_2)$ $y^* = \left[K(x^* + A)(a - q_1E_1) - \left(ax^{*2} + aAx^*\right)\right]/Kc$, for y^* to be positive provided, $K(a - q_1E_1) > ax^*$.

2.1 *Dependability Analysis*

2.1.1 Stability

The Jacobean network of the given framework (5)–(6) about (x^*, y^*) is $J = \begin{bmatrix} a-(2ax/K)-\left(cAy/(x+A)^2\right)-q_1E_1 & -cx/(x+A) \\ cAy/(x+A)^2 & 0 \end{bmatrix}$. It is observed that $|J| = c^2Ax^*y^*/(x^*+A)^3 > 0$ and trace of J are negative provided $y^* < a(x^*+A)^2/Kc$. Clearly, the system (5)–(6) is locally asymptotically stable.

3 Diffusion Analysis

In this section, we inspected, in the presence of diffusion, the steadiness of the system (1)–(2). Ecologically, it means that the movement of species is in any direction for several reasons. Now we consider linearized the system (1)–(2) about the interior steady state as

$$X_t = -(a/K)x^*X - cx^*Y + D_1x_{uu} \tag{7}$$

$$Y_t = cy^*X + D_2y_{uu} \tag{8}$$

Let us assume the solutions in the form $X(u,t) = \alpha_1e^{\lambda t}e^{iku}, Y(u,t) = \alpha_2e^{\lambda t}e^{iku}$, where λ and k are "frequency and wave numbers," respectively. Then, the characteristic equation of the model (7)–(8) is given by

$$\mu^2 + A\mu + B = 0 \tag{9}$$

$$A = k^2(D_1 + D_2) + \left((ax^*)/K\right)$$

and $B = D_1D_2k^4 + k^2(D_2ax^*/K) + c^2x^*y^*$.

Let us rewrite B as a function of k^2 say $G(k^2)$ and is as follows.

$$G(k^2) = D_1D_2k^4 + k^2(D_2ax^*/K) + c^2x^*y^*. \tag{10}$$

The system (7)–(8) is unstable if one of the above roots of (9) is positive. A necessary condition for a root to be positive is:

$$(ax^*/K) + k^2(D_1 + D_2) > 0, \text{then } k^2 < (ax^*)/K(D_1 + D_2) \tag{11}$$

Since the wave number k is real, the above statement is feasible if $ax^* > 0$. The sufficient condition for positivity of "one of the roots of (10) is $G(k^2) < 0$." Let

$(k^2)_{\min}$ be the corresponding value of k^2 for minimum value of $G(k^2)$ then

$$(k^2)_{\min} = ax^*/2D_1 > 0 \tag{12}$$

Thus, the diffusion of the prey–predator populations derives the ecological system into unstable oscillation when (11) and (12) are satisfied.

Theorem 2 (i) *If the interior equilibrium of the non-diffusive system is globally stable, and then the respective uniform steady state of the diffusive model* (7)–(8) *under* (3) *and* (4) *is also globally asymptotically stable.* (ii) *If the interior equilibrium of the non-diffusive system is unstable, then the respective uniform steady state of the diffusive model* (7)–(8) *under* (3) *and* (4) *can be made stable by increasing diffusion coefficients appropriately.*

Proof Let us deliberate $V_1(t) = \int_0^R V(X, Y)\mathrm{d}u$

$$V(X, Y) = X - X^* - X^* \ln\left[X/X^*\right] + l\left\{Y - Y^* - Y^* \ln\left[Y/Y^*\right]\right\}$$

$$(V_1)_t = \int\limits_0^R (V_X X_t + V_Y Y_t)\mathrm{d}u = I_1 + I_2$$

where $I_1 = \int_0^R V'(t)\mathrm{d}x;\ I_2 = \int_0^R \left(D_1 V_X X_{uu} + D_2 V_Y Y_{uu}\right)\mathrm{d}u$
we get $I_2 = -D_1 \int_0^R \left(X^*/X^2\right) X_u^2 \mathrm{d}u - D_2 \int_0^R \left(Y^*/Y^2\right) Y_u^2 \mathrm{d}u$.

From the above results, we observed that if $I_1 < 0$ then $V_1'(t)$ is negative. If $I_1 > 0$, then it can be noted that by increasing the diffusion coefficients D_1 and D_2 sufficiently large, $V_1'(t)$ can be made negative.

Example 2 (Fig. 1).

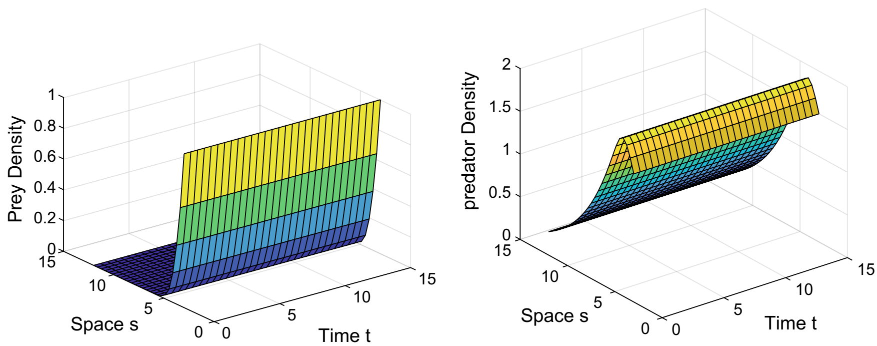


Fig. 1 Represents variation of prey species and variation of predator species with respect to time and space variables with the parameters $A = 0.3$, $K = 0.7$, $a = 0.8370$, $c = 0.7350$, $q_1 = 0.1$, $E_1 = 0.1$, $q_2 = 0.1$, $E_2 = 0.1$, $e = 0.25$, $D_1 = 10$, $D_2 = 20$

4 Delay Analysis

In this section, we are analyzing the dynamics of the model (1)–(2) with time delay and without diffusion. In view of this, the model (1)–(2) can be rewritten as

$$x'(t) = ax(1 - (x/K)) - ((cx(t-\tau)y(t-\tau))/(x(t-\tau) + A)) - q_1 E_1 x \quad (13)$$

$$y'(t) = (cx(t-\tau)y(t-\tau))/(x(t-\tau) + A) - ey - q_2 E_2 y \quad (14)$$

Now, the Jacobian matrix J about the steady state $E(x^*, y^*)$ is

$$J = \begin{bmatrix} a - \frac{2ax^*}{k} - \left(Acy^* e^{-\lambda\tau}\right)/\left((x^*+A)^2\right) - q_1 E_1 & -\left(cx^* e^{-\lambda\tau}\right)/(x^*+A) \\ \left(Acy^* e^{-\lambda\tau}\right)/\left((x^*+A)^2\right) & \left(cx^* e^{-\lambda\tau}\right)/(x^*+A) - e - q_2 E_2 \end{bmatrix} \quad (15)$$

where $x^* = (A(e + q_2 E_2)/c - (e + q_2 E_2))$
and $y^* = \left(K(x^* + A)(a - q_1 E_1) - \left(ax^{*2} + aAx^*\right)\right)/Kc$
The characteristic equation of (15) is

$$\lambda^2 + P_1\lambda + P_2 + e^{-\lambda\tau}(Q_1\lambda + Q_2) = 0 \quad (16)$$

where $P_1 = -a + (2ax^*/k) + q_1 E_1 + e + q_2 E_2$,

$$P_2 = -ae - aq_2 E_2 + 2aex^* + 2aq_2 E_2 x^* + eq_1 E_1 + q_1 E_1 q_2 E_2$$
$$Q_1 = \frac{Acy^*}{(x^*+A)^2} - \frac{cx^*}{x^*+A},$$
$$Q_2 = \frac{Acx^*}{x^*+A} - \frac{2acx^{*2}}{x^*+A} + \frac{Aecy^*}{(x^*+A)^2} + \frac{Acq_2 E_2 y^*}{(x^*+A)^2} - \frac{q_1 E_1 cx^*}{x^*+A}$$

If $\tau > 0$, supposed that there is a positive τ_0 such that Eq. (16) has pair of purely imaginary roots $\pm i\omega, \omega > 0$. Then, ω satisfies

$$-\omega^2 + P_1\omega i + P_2 + (Q_1\omega i + Q_2)[\cos\omega t - i\sin\omega t] = 0 \quad (17)$$

which is equivalent to

$$\omega^4 + (P_1^2 - 2P_2 - Q_1^2)\omega^2 + (P_2^2 - Q_2^2) = 0 \quad (18)$$

If $P_1^2 - 2P_2 - Q_1^2 > 0,\ P_2^2 - Q_2^2 > 0$, then Eq. (16) has no real root. Along these lines, the genuine pieces of all Eigen estimations of (16) are negative for all $\tau \geq 0$. If $P_2^2 - Q_2^2$ is negative, there is an extraordinary positive ω_0 fulfilling (18) and at that point there is a positive τ_0 to such an extent that condition (16) has pair of simply non-existent roots as $0 < \tau < \tau_0$. From (17), τ_k corresponding to ω_0 can be obtained

$$\tau_k = \frac{1}{\omega_0}\arccos\left[\frac{(Q_2 - P_1 Q_1)\omega^2 - P_2 Q_2}{Q_1^2\omega^2 + Q_2^2}\right] + \frac{2n\pi}{\omega_0},\ n = 0, 1, 2 \ldots\ldots \quad (19)$$

4.1 HOPF Bifurcation

Based on the above results, we have the following.

Theorem 3 *Assume that* $y^* < a(x + A)^2/Kc$ *then there is a positive* τ_0 *to such an extent that the accompanying outcomes hold.* (i) *If* $0 < \tau < \tau_0$, Eq. (13–14) *has steady state equilibrium which is locally asymptotically steady* (ii) Eq. (13–14) *can experience a Hopf-bifurcation if* $\tau > \tau_0$, *and an occasional circle exists in the little neighborhood of the harmony.*

Proof To acquire the Hopf bifurcation, we have to check the transversal condition for the non-existent eigenvalues of the relentless state balance at $\tau = \tau_0$. Then, from Eq. (16), we have $\lambda'(t)\left[2\lambda + P_1 + Q_1 e^{-\lambda\tau} - (Q_1\lambda + Q_2)\tau e^{-\lambda\tau}\right] = \lambda(Q_1\lambda + Q_2)e^{-\lambda\tau}$

$$\begin{aligned}
\left(\lambda'(t)\right)^{-1} &= \left(2\lambda + P_1 + Q_1 e^{-\lambda\tau} - (Q_1\lambda + Q_2)\tau e^{-\lambda\tau}\right)/\lambda(Q_1\lambda + Q_2)e^{-\lambda\tau} \\
&= \mathrm{Re}\left[\frac{1}{\omega_0}\left(\frac{2i\omega_0 + P_1}{P_1\omega_0 + (\omega_0^2 - P_2)i} + \frac{Q_1}{(-Q_1\omega_0 + Q_2 i)} + \tau i\right)\right] \\
&= \frac{2\omega_0^2 + (P_1^2 - 2P_2 - Q_1^2)}{(Q_1^2\omega_0^2 + Q_2^2)}
\end{aligned}$$

Under the ailment $P_1^2 - 2P_2 - Q_1^2 > 0$, we have $(\mathrm{Re}(\lambda))' > 0$ at $\lambda = i\omega_0$ Thus, the transversality condition holds and Hopf bifurcation happens at $\omega = \omega_0$, $\tau = \tau_0$, where $\tau = 3$ is the bifurcation point. To explain above analytical method by numerical example, we consider the parameter values for the delay system as given below. For the parameter values, $A = 0.9; k = 0.7; a = 0.837; c = 0.7350;$ $q_1 = 0.01;$ $E_2 = 0.1; e = 0.025; q_2 = 0.1;$ we obtained the critical positive time delay $\tau_0 = 0.28$ and we know that when $o \le \tau < \tau_0$, the interior equilibrium is stable. If τ crosses the time, a delay of $\tau_0 = 0.28$, the interior equilibrium losses its stability and a family of periodic solutions bifurcate from the interior equilibrium (observed in Figs. 2, 3 and 4).

5 Concluding Remarks

Ecology consists of many species which are intra- and interrelated with one another through different types of interactions such as Holling types I, II, III, IV. We considered such an ecological system which includes prey and predator with Holling type-II

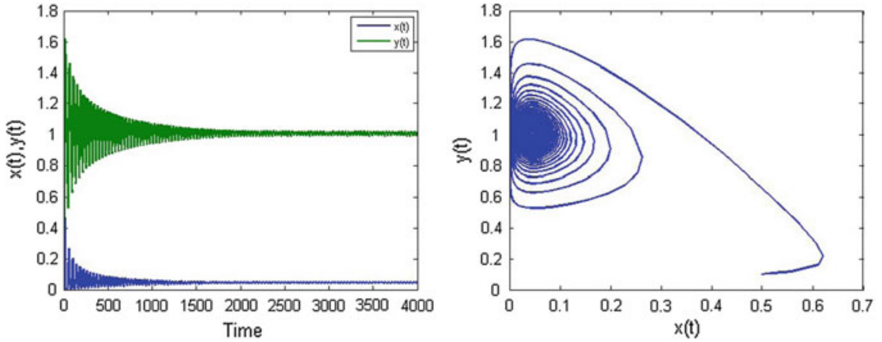


Fig. 2 Directions and stage charts of the framework (13–14) when $\tau = 0.25$

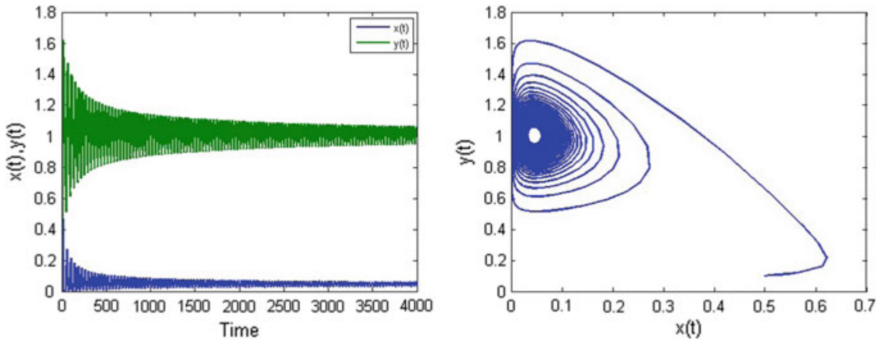


Fig. 3 Directions and stage charts of the framework (13–14) when $\tau = 0.28$

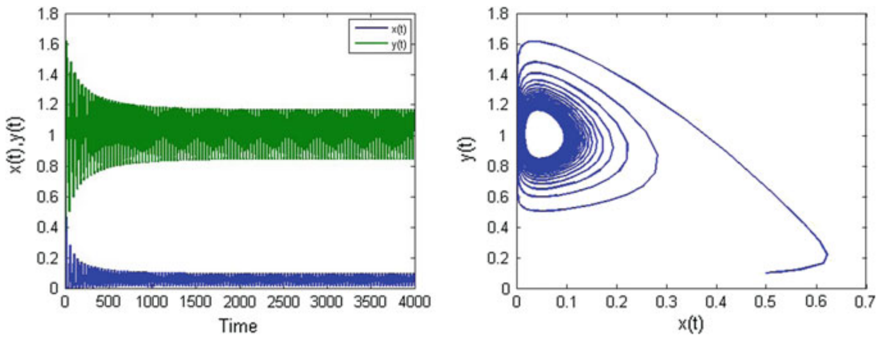


Fig. 4 Directions and stage charts of the framework (13–14) when $\tau = 0.3$

interaction and studied stability analysis on both diffusive and non-diffusive structures. Further, an economical strategy tool "delay" in the interaction is introduced for better harvesting management.

Also, we observed that the periodic orbits bifurcate from interior equilibrium point. From a biological point of view, the delay here has an influence on the interaction of the prey and predator.

Acknowledgements We express our heartfelt gratitude to anonymous reviewers for their valuable suggestions and questions.

References

1. Jana D, Ray S (2016) Impact of physical and behavioral prey refuge on the stability and bifurcation of Gause type Filippov prey-predator system. Model Earth Syst Environ 2:24
2. Kar TK (2005) Stability analysis of a prey-predator model incorporating a prey refuge. Commun Nonlinear Sci Numer Simul 10:681–691
3. Jana D, Agrawal R, Upadhyay RK (2015) Dynamics of generalist predator in a stochastic environment effect of delayed growth and prey refuge. Appl Math Comput 268:1072–1094
4. Ruxton GD (1995) Short term refuge use and stability of predator-prey models. Theor Popul Biol 47:1–17
5. González-Olivares E, Ramos-Jiliberto R (2003) Dynamic consequences of prey refuges in a simple model system: more prey, fewer predators and enhanced stability. Ecol Model 166:135–146
6. Huang Y, Chen F, Li Z (2006) Stability analysis of prey-predator model with Holling type response function incorporating a prey refuge. Appl Math Comput 182:672–683
7. Taylor RJ (1984) Predation. Chapman & Hall, New York
8. Real LA (1977) The kinetics of functional response. Am Nat 111:289–300
9. McNair JM (1986) The effects of refuges on predator-prey interactions: a reconsideration. Theor Popul Biol 29:38–63
10. Murdoch WW, Oaten A (1975) Predation and population stability. Adv Ecol Res 9:2–132
11. Ma Z, Li W, Zhao Y, Wang W, Zhang H, Li Z (2009) Effects of prey refuges on a predator-prey model with a class of functional responses: the role of refuges. Math Biosci 218:73–79
12. Wang J, Pan L (2012) Qualitative analysis of a harvested predator-prey system with Holling-type III functional response incorporating a prey refuge. Adv Differ Equ 96
13. Hassell MP (1978) The dynamics of arthropod predator-prey systems. Princeton University Press, Princeton
14. McNair JN (1987) Stability effects of prey refuges with entry-exit dynamics. J Theor Biol 125:449–464
15. Kuang Y (1993) Delay differential equations with applications in population dynamics. Academic Press, Boston
16. Saha T, Bandyopadhyay M (1986) Dynamical analysis of a delayed ratio-dependent prey-predator model within fluctuating environment. Appl Math Comput 196(1):458–478
17. Samanta GP (1986) The effects of random fluctuating environment on interacting species with time delay. Int J Math Ed Sci Tech 27(1):13–21
18. Chen SS, Shi JP (2012) Stability and Hopf bifurcation in a diffusive logistic population model with nonlocal delay effect. J Differ Equ 253(12):3440–3470
19. Arino J, Wang L, Wolkowicz GSK (2006) An alternative formulation for a delayed logistic equation. J Theor Biol 241(1):109–119

20. Cantrell RS, Cosner C (2003) Spatial ecology via reaction-diffusion equations. Wiley, Chichester, Hoboken
21. Choudhury SR (1994) Turing instability in competition models with delay I: linear theory. SIAM J Appl Math 54(5):1425–1450
22. Yan XP (2007) Stability and Hopf bifurcation for a delayed prey-predator system with diffusion effects. Appl Math Comput 192(2):552–566
23. Sen S, Ghosh P, Riaz SS, Ray DS (2009) Time delay induced instabilities in reaction-diffusion systems. Phys Rev E 80(4):046212
24. Hadeler KP, Ruan SG (2007) Interaction of diffusion and delay. Discrete Contin Dyn Syst Ser B 8(1):95–105
25. Su Y, Wei JJ, Shi JP (2009) Hopf bifurcations in a reaction-diffusion population model with delay effect. J Differ Equ 247(4):1156–1184

An Efficient Intrusion Detection System with Convolutional Neural Network

V. Maheshwar Reddy, I. Ravi Prakash Reddy and K. Adi Narayana Reddy

Abstract Cyber security in the networked systems is the most challenging and risky aspects of the modern digital world. Due to the availability of computational resources, the area of deep learning is extensively used in many fields. In this proposal, we use IDS using convolutional neural network. Intrusion detection system with convolutional neural networks helps us to detect, analyze, and categorize the incoming or outgoing traffic into normal or attack. In this paper, we implemented IDS with CNN for binary classification and multiclass classification on given traffic data. The results proved that the proposed IDS using CNN is better than the other existing IDS models using machine learning.

Keywords Convolutional neural networks · Deep learning · Neural network · Security · Intrusion detection system · Decision tree · Pattern reorganization

1 Introduction

The different types of intelligent cyber threats are quite dangerous to the security of information. So, network security becomes a very immerge focused area for many researchers and also for organizations. The intrusion detection system was proposed by Denning [1], which is a panacea to solve any type of complex, new, and dynamic attacks. Intrusion detection system dynamically analyzes and identifies the illegal behavior of incoming and outgoing traffic from a host/network [2]. It plays a significant role in network security compared with other traditional security measures.

V. Maheshwar Reddy (✉)
ACE Engineering College, Telangana, India
e-mail: mahesh.vancha@gmail.com

I. Ravi Prakash Reddy
G. Narayanamma Institute of Technology and Science, Telangana, India
e-mail: irpreddy@gnits.ac.in

K. Adi Narayana Reddy
BVRITH College of Engineering for Women, Telangana, India
e-mail: aadi.iitkgp@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_22

Intrusion detection systems are generally categorized as misuse intrusion detection systems and anomaly intrusion detection system. The misuse IDS uses pre-defined rules for detecting abnormal behavior in network traffic, but it is suffering from false alarm and it cannot handle any new type of abnormal behavior. In contrast, anomaly-based IDS recognizes an intrusion which deviates the regular traffic pattern.

There are many challenges faced by many researchers in the development process of dynamic, efficient, and flexible IDS. The first challenge is there are very few standard datasets with labeled data that are available for building IDS. The second challenge is these standard datasets contain a large number of features after pre-processing, and it is a necessity to use a better feature extraction method. The extracted proper optimal subset of features works well for specific attacks, and the same extracted features may not identify another set of attacks efficiently. Tremendous efforts are required by the researchers to extract the features to categorize the attack.

Machine learning is an application of artificial intelligence that allows systems to automatically learn and improve from experience without explicit programming. Machine learning models like decision tree, naïve Bayes, artificial neural network, SVM, and fuzzy control have enhanced attack detection. The deep learning theory proposed by [3] is witnessing a dramatic rise in the field of machine learning in the recent past. On the basis of this theory, some theoretical papers have been produced, and more significant achievements have been achieved in practice and research.

The paper is divided into five sections. Section 2 covers literature on intrusion detection system. Section 3 presents the approach and architecture of the proposed CNN model. The experimental setup and results are presented in Sect. 4. Section 5 concludes the paper.

2 Related Work

Recently, deep learning has become a very popular methodology applied in many areas. Many researchers built their models using deep learning algorithms. The convolutional neural network is one of the widely used techniques for classification of images. It is also used for natural language processing (NLP).

For page segmentation of historical handwritten document images, Chen et al. [4] used a convolutional neural network. Ning et al. [5] suggested a ROLO approach for visual object tracking based on supervised recurrent convolutional neural network and also explored high-level visual feature analysis of LSTMs [6]. Poria et al. [7] presented a method for determining sentiment polarity in video clips of people speaking on CNN. In their presentation, deep CNN extracts features from text and uses multiple kernel learning (MKL) to classify multi-models of different fused feature vectors.

Kang et al. [8] have proposed an efficient IDS model for the safety of the in-vehicle network using DNN. DNN parameters were trained with probability-based feature vectors extracted from the in-vehicular network packet followed by a convoluted stochastic gradient descent method. Gao et al. [9] proposed the IDS model using Deep Belief Networks, which experimented with the KDD CUP 99 dataset and contrasted with the SVM and ANN models. Hsu et al. [10] proposed two deep learning models to classify the network traffic using LSTM only and CNN-LSTM. CNN is used for feature extraction, and LSTM layer classifies the network traffic on NSL-KDD Test + and KDD Test-21 dataset and achieved 94.12 accuracies in the 2-category model and 88.95 accuracies in the 5-category model. Yin et al. [11] discussed an RNN-IDS model on NSL-KDD dataset, performed various operations with different hidden nodes and learning rate and achieved 99.53% during train time and 81.29% during test time with the number of hidden nodes 80 and learning rate 0.5 for the 5-category model. RNN-IDS model produced 99.81% accuracy during training time and 83.28% accuracy during test time with a number of hidden nodes 80 and learning rate 0.1. Nguyen et al. [12] used two layers in the proposed CNN model. The first layer is designed with 64 filters with size [3 × 3], and 128 filters with size [7 × 7 × 128] are used for the second convolutional layer. The activation function is ReLU in both layers. The proposed model detected only DoS attack with an accuracy of 99.8%.

Based on the literature, we observed that CNN models give more accurate results as compared with the traditional machine learning models. Details of the proposal are presented in the next section.

3 Approach

In the proposed model, CNN is used to classify the intruders as genuine or abnormal. The datasets used for the model are KDD Cup 99 and NSL-KDD. There are 41 features and 1 class labels for each traffic record, including basic features (No.1–No.10), content features (No.11–No.22), and traffic features (No.23–No.41). Based on the characteristics, the attacks are categorized into Denial-of-Service (DoS), Root to Local (R2L), Probing (Probe) , and User to Root (U2R). There are 38 numeric features and three categorical features in the KDD Cup 99 and NSL-KDD datasets. For simple and efficient computations, we converted categorical features into binary by using one-hot encoding. For instance, the 'protocol type' feature has three categories, namely 'TCP,' 'UDP,' and 'ICMP,' and encoded as binary vectors (1, 0, 0), (0, 1, 0), and (0, 0, 1). Similarly, the feature 'service' has 70 categories, and the feature 'flag' has 11 categories. After one-hot encoding, the total number of features became 122. The class label is also label encoded as 0(normal) and 1(attack) in the 2-class model. While in the 5-class model, the class label is conceded as 5-labeled binary vector using one-hot encoding. For example, if a class label value is DoS, then it is encoded as a [0, 1, 0, 0, 0]. Table 1 shows the distribution of records into train and

Table 1 Distribution of attack and normal data for 5-class IDS with CNN model

Classification	KDD Cup 99	NSL-KDD
Normal	97277	67343
DoS	391458	45927
R2L	1126	995
U2R	52	52
Probe	4107	11656

test in KDD Cup 99 and NSL-KDD datasets. The normalization is applied on the features.

CNN Model

The CNN is a special type of standard computational feed-forward network. CNNs consist of several convolutional layers with nonlinear ReLU or tanh activation functions. Each layer of CNN consists of many convolutional kernels that are used to generate a different feature map. Each region of the adjacent neurons is connected to the neurons of the feature map; all the spatial locations of the input are shared by the kernel. Due to the sharing of weights in CNN, the model can learn the same pattern that occurs at different input positions. The pooling layers reduce the computational overload by reducing the number of connections from the convolutional layers.

At each CNN layer, a set of n kernels $w = \{w_1,\ldots,w_n\}$and their biases $b = \{b_1,\ldots,b_n\}$ is convolved with input data. The convolution between the data and each kernel generates a new X_1^k map feature. These features are convoluted using a nonlinear transform function$f()$. Transformation is carried out by (1) for each convolutional layer L:

$$x_k^1 = f\left(w_k^{l-1} * x^{l-1} + b_k^{l-1}\right) \tag{1}$$

During the CNN model learning process, a small window slides over the inputs and the bias values and the weights can be optimized from the different input data features without their position within the input data (Fig. 1).

CNN is mostly used in computer vision applications where images are used as inputs. Each image can be represented as a two-dimensional array, but the KDD Cup 99 and NSL-KDD intrusion detection datasets are one-dimensional. So we converted the 119 features (after pre-processing) of KDD Cup 99 dataset to 2D array by applying appropriate functions. Similarly, NSL-KDD dataset with 121 features is also converted to 2D array. Each time, the convolutional layer slides over four feature data with 32 filters and kernel size four. The transformed features are fed into the drop out layer to avoid over fitting the model. On the output, max pooling is applied with pool size two. Optimal feature subset is extracted by the convolutional layer from the given high-dimensional dataset. These extracted features are supplied in a fully connected dense layers for standard or a specific attack classification of the traffic data (only attack). A CNN consists of single convolutional layer, one drop layer, one max pooling layer, and two fully connected dense layers. The proposed

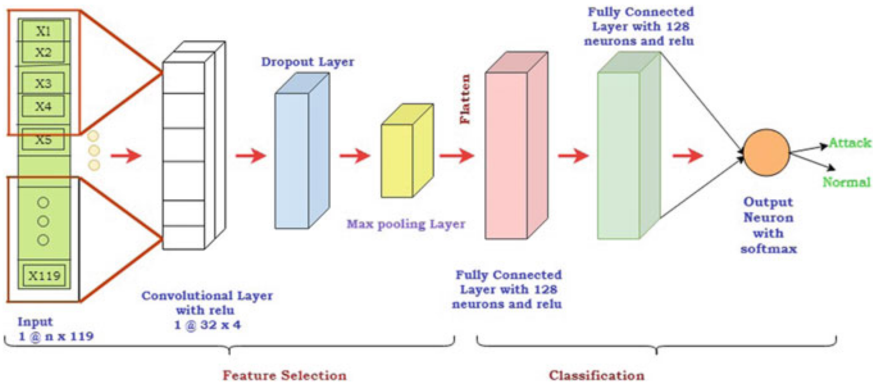


Fig. 1 Architecture of 2-class CNN model

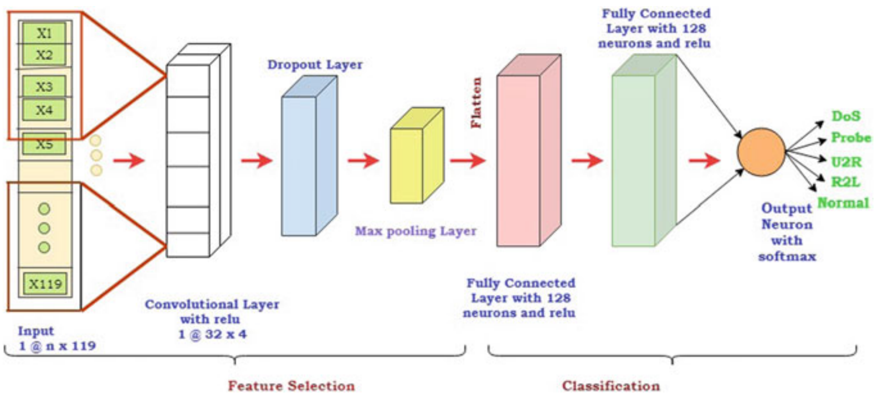


Fig. 2 Architecture of 5-class CNN model

5-class CNN model is shown in Fa fully connected dense layers for standard or a specific attack classification of the traffic data (only attack).ig. 2. We have considered accuracy, precision, recall, and f-score performance metrics for 2-class as well as 5-class IDS-CNN models.

4 Experimental Setup and Results

In this proposal, the IDS with CNN are used for 2-class classification as well as 5-class classification on NSL-KDD and KDD Cup 99 datasets. The model was built on a computer equipped with 6 GB RAM and Intel Core i3 processor installed with Windows 8 using Python, Keras and TensorFlow (deep learning library modules).

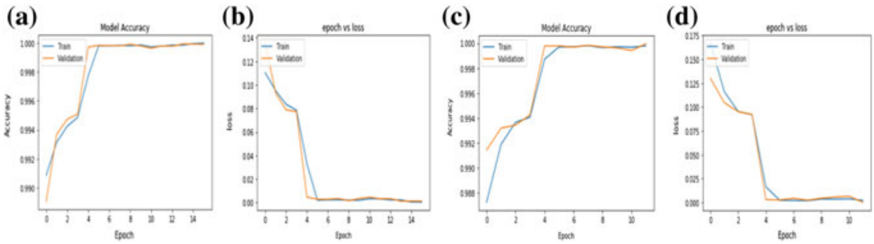


Fig. 3 **a** Accuracy of 2-class IDS-CNN model on KDD Cup 99, **b** loss of 2-class IDS-CNN model on KDD Cup 99, **c** model accuracy of 5-class IDS-CNN model on the KDD Cup 99, **d** model loss of 5-class IDS-CNN model on KDD Cup 99

As discussed in Figs. 2 and 3, one convolutional layer, one pooling layer, and two fully connected layers are used. The kernel size of the convolutional layer is [32*4], and pooling size is two. Each of the two fully connected layers consists of 128 neurons. To prevent over fitting, a drop out by 0.3 is considered. The activation function in the convolutional layer and two fully connected layers is the rectified linear unit (ReLU), and the activation of the output layer is sigmoid for the CNN model of two classes and softmax for the CNN model of five classes. For optimization, adaptive moment estimation (Adam) technique is used, and we tried with different batch sizes and epochs. In the end, we concluded with 20 epochs and batch size is 128, which gives more effective results.

The given dataset is divided into train, validation, and test datasets, which are 64%, 16%, and 20%, respectively. 2-class CNN model consists of attack and normal as class label, whereas in 5-class, CNN model consists of 5 class labels, namely normal, DoS, Probe, U2R, and R2L. Table 1 shows the data distribution for the 5-class IDS model with CNN. Given traffic data is distributed as normal, DoS, Probe, R2L, and U2R.

Figure 3a, b shows the accuracy and loss of data of proposed IDS-CNN model on KDD Cup 99 dataset. It is observed that, after four epochs, the proposed model consistently provides the accuracy of 99.99 and with loss of 0.002. The average training time for building the model is 135 s 428 μs.

Figure 3c, d shows the 5-class IDS-CNN accuracy and loss of KDD Cup 99 dataset. The model consistently produced 99.98 accuracies on train and validation datasets with minimum loss of 0.034. The number of epochs we tested is 20, but the model constantly produced 99.98 accuracies after four epochs. The average training time for building the model is 148 s 468 μs.

Table 2 demonstrates the performance metrics evaluated on the KDD Cup 99 dataset for the 2-class and 5-class IDS-CNN models. Nearly every metric gives the result much closer to 100%.

Figure 4a, b presents the model accuracy and loss of 2-class IDS-CNN model on NSL-KDD dataset. After seven epochs, model consistently produced 99.857 accuracies with negotiable loss of 0.0021. The average training time for building the model is 42 s 526 μs.

Table 2 Classification report of 2-class and 5-class IDS-CNN model on KDD Cup 99 and NSL-KDD datasets

Report	KDD Cup 99		NSL-KDD	
	2-class model	5-class model	2-class model	5-class model
Accuracy	99.996	99.9838	99.85711	99.996
F1-Score	99.996	99.9898	99.85712	99.998
Recall	99.996	99.9838	99.85711	99.996
Precision	99.996	99.996	99.85738	99.996

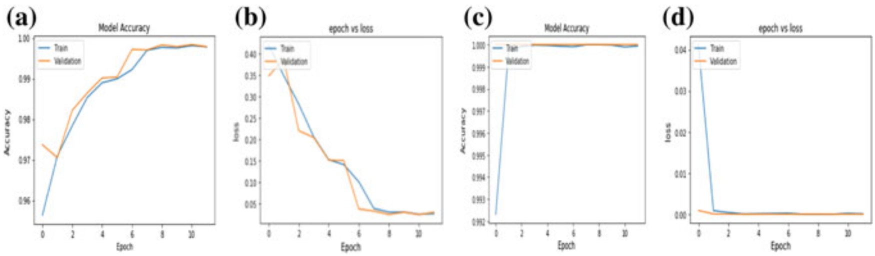


Fig. 4 **a** Model accuracy of 5-class IDS-CNN model on NSL-KDD, **b** model loss of 5-class IDS-CNN model on NSL-KDD, **c** model accuracy of 5-class IDS-CNN model on NSL-KDD, **d** model loss of 5-class IDS-CNN model on NSL-KDD

Figure 4c, d shows the model accuracy and loss of 5-class IDS-CNN model using NSL-KDD dataset. It is observed that after four epochs, model constantly produced 99.996 accuracy with very minimal loss of 0.0021. The average training time for building the model is 30 s 377 μs.

Table 3 shows our model produced better performance compared to the traditional machine learning models. We contrasted our model with existing deep neural models. Table shows our proposed model reached almost 100% accuracy on given

Table 3 Comparison of proposed model with traditional models

Model	Dataset	Test accuracy
Proposed 2-class IDS_CNN Model	KDD Cup 99	99.996
	NSL-KDD	99.857
Proposed 5-class IDS_CNN Model	KDD Cup 99	99.838
	NSL-KDD	99.996
2-category RNN_IDS [13]	NSL- KDD	99.81
5-category RNN_IDS [13]	NSL- KDD	99.53
4-class IDS with Random Forest [14]	NSL-KDD	99.73
CNN + LSTM with 2-category [10]	NSL-KDD	94.12
CNN + LSTM with 5-category [10]	NSL_KDD	79.37

two datasets. Both 2-class classifier and multiclass classifier produced efficient and better results compared with the traditional and existing models.

5 Conclusions

We proposed a deep learning-based method for developing a dynamic, flexible, and efficient IDS-CNN model. The main focus of the paper is to build an IDS model with CNN for more accurate results. CNN was not implemented in the field of intrusion detection system to the best of our knowledge, but our experimental results indicate that CNN is a good classifier and extracts the features according to the target class labels. The proposed model can improve the model's accuracy efficiently; it can also identify the type of intrusion at the same time. The intrusion detection system is implemented on KDD Cup 99 and NSL-KDD datasets using CNN in this proposal. The model is converged after five epochs. The results show that the model being proposed is better than the other existing IDS based on machine learning. The advantage of this model is that the features are automatically extracted. The precision, f1-score, and recall are 99.9 percentage on both datasets. The model neither over fits nor under fits. The train, validation, and test accuracy are more than 99.9 percentages.

References

1. Denning DE (1987) An Intrusion detection model. IEEE Trans Soft Eng 222–232
2. Mehra L, Guptha MK, Gill HS (2015) An efficient & secure approach for the detection and efficient searching of network intrusion detection system. In: IEEE International Conference on Computer, Communication and Control (IC4 2015)
3. Hinton GE, Osindero S, Teh YW (2006) A fast learning algorithm for deep belief nets. Neural Comput 18
4. Chen K, Seuret M (2017) Convolutional neural network for page segmentation of historical document images. IEEExplore 2017
5. Niag G, Zhang Z, Huang C, He Z (2017) Spatially supervised recurrent convolutional neural network for visual object tracking. In: IEEE International Symposium on Circuits and Systems (ISCAS)
6. Lawrence S, Giles CL, Tsoi AC, Back AD (1997) Face recognition: a convolutional neural-network approach. IEEE Trans Neural Netw 8(1)
7. Poria S, Cambria E, Gelbukh A (2015) Deep convolutional neural network textual features and multiple Kernal learning for utterance level multi-model sentiment analysis. In: Conference on empirical methods in natural language processing, pp 2539–2544
8. Kang M-J, Kang J-W (2016) Intrusion detection system using deep neural network for in-vehicle network security. PLOS One
9. Gao N, Gao L, Gao Q, Wang H (2015) An intrusion detection model based on deep belief networks. IEEE Xplore Digital Library 2015
10. Hsu C-M, Hsieh H-Y, Prakosa SW, Azhari MZ, Leu JS (2019) Using long-short-term memory based convolutional neural networks for network intrusion detection. Springer Nature, LNICST 264, pp 86–94

11. Yin C, Zhu Y, Fei J, He X (2017) A deep learning approach for intrusion detection using recurrent neural networks. IEEE Access, 7 Nov 2017
12. Nguyen S-N, Nguyen V-Q, Choi J, Kim K (2018) Design and implementation of intrusion detection system using convolutional neural network for DoS detection. ACM Digital Library
13. Yin C, Zhu Y, Fei J, He X (2017) A deep learning approach for intrusion detection using recurrent neural networks. IEEE Access 5:21954–21961
14. Wang W, Sheng Y, Wang J, Zeng X, Ye X, Huang Y, Zhu M (2017) HAST-IDS: learning hierarchical spatial-temporal features using deep neural networks to improve intrusion detection. IEEE Access 6

Supervised Machine Learning Approach for Identification of Malicious URLs

Srinivasu Badugu and Ramakrishna Kolikipogu

Abstract Malignant URL is a normal and certifiable risk to cyber security. A malicious URL has a grouping of unconstrained substance as phishing and spam so as to dispatch assaults. Guiltless clients visit such sites to advance towards getting to be setbacks of different sorts of tricks, including fiscal misfortune and burglary of private data (identity, credit-cards, etc.). It is fundamental to recognize and catch up on such perils in an ideal manner. In this paper, we had applied two procedures for distinguishing malignant URLs with two extraordinary datasets and verified at execution of Naïve Bayes and support vector machines (SVM) as per two datasets.

Keywords Malicious URL · Machine learning · Naïve Bayes · Support vector machines (SVM) · Internet security · Cyber security · Phishing URLs

1 Introduction

Machine learning (ML) is an artificial intelligence branch that pushes forward the idea that machines can learn and solve a problem through a model by giving an access to right data [1]. The approach of new communication technologies has huge impact on the growth and promotion of businesses across wide range of applications, including e-commerce, health, agriculture, online-banking and social networking. In fact, in today's age, it is almost compulsory to have an online presence to run a successful business. As a result, the World Wide Web's importance has steadily

S. Badugu (✉)
Department of Computer Science and Engineering, Stanley College of Engineering and Technology for Women, Abids, Hyderabad 500001, India
e-mail: srinivasucse@gmail.com

R. Kolikipogu
Department of Research and Development, Stanley College of Engineering and Technology for Women, Abids, Hyderabad 500001, India
e-mail: krkrishna.cse@gmail.com

Department of IT, Stanley College of Engineering and Technology for Women, Abids, Hyderabad 500001, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_23

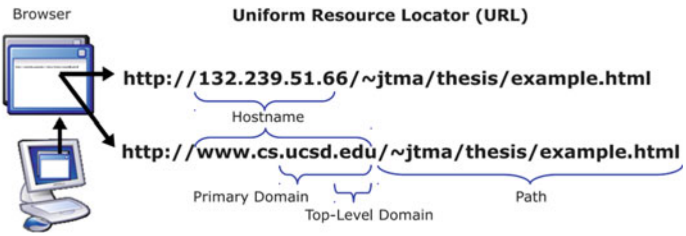


Fig. 1 URL pattern

increased. Unfortunately, the advancements in technologies have come along with new sophisticated techniques to attack and scamming users in their day-to-day digital activities. These attacks include rogue Web sites that sell counterfeit goods and financial fraud that leads users into revealing sensitive information which eventually leads to theft of money or identity, or even malware installation in the system of user. There is a wide range of techniques for implementing such attacks, including explicit hacking attempts, drive-by exploits, social engineering, phishing, watering hole, man-in-the-middle, SQL injections, devices loss/theft, denial of service, distributed denial of service and many more. It is very difficult to build a system to detect various potential attacks and ensure cyber security. The exponential growth of security threats invites the rapid growth in technology domains and it further causes shortage of security professionals. Most of these attacking techniques are accomplished by spreading compromised URLs (or spreading such URLs is a critical part of the attacking operation) [2, 3]. Figure 1 depicts the pattern which consists of <protocol>://<hostname>/<path>triplet [4].

Huge research has been done to prevent users from visiting malicious Web sites on the Web. Phishing, social engineering and spam are popular malicious URL attacks [2]. URL is the formalized information for location and access of resources via the Internet which is represented as a compact string of syntax and semantics for resource available via the Internet [4]. A standard observation is to use a blacklist of malicious URLs, which may be created from numerous sources, notably human feedbacks that square measure extremely correct. The disadvantage of blacklisting-based approach is that the unknown URLs are not detected.

2 Literature Survey

Different techniques have been proposed for noxious URLs discovery. Abdi and Wenjuan [5] experimented on convolution neural system using SVM and LR methods and found that yields of the classifier are vindictive at 96% in identifying malevolent URLs. Huang et al. [6] had a technique to recognize phishing URL dependent on SVM by putting highlight vectors as the columns of a scanty network and observed 99%

precision by and large that the phishing URLs accomplished is downloaded in phishtank. Babagoli et al. [7] have portrayed a technique for phishing site discovery which uses a meta-heuristic-based nonlinear relapse calculation alongside a component determination approach and obtained rate of 96.32% accuracy by using wrapper system. Ma et al. [8] used URL classification with mathematical strategies to get the lexical and host-based properties of malicious URLs detection and used Naive Bayes, support vector machine (SVM) and regression for analysis. The ensuing classifiers got 95–99% accuracy. Basnet et al. [9] have planned a machine learning approach to discover phishing Web content. They used random forests, support vector machines (SVM) with RBF linear kernels, Naive Bayes, C4.5, linear regression (LR). They need used 179 Web site options like lexical primarily based options, keyword primarily based options, program feature and name-based options to demonstrate their approach. Results show that the planned approach has discovered phishing Web pages with an accuracy of 99.9%, false-positive rate of as low as 0.00% and false-negative rate of 0.06%. Eshete et al. [10] have given a light-weight approach, referred to as BINSPECT that mixes static analysis and emulation. They need extracted options like address options, page-source options and social-reputation options. In line with their experimental analysis, BINSPECT achieved 97% of accuracy with low false signals.

3 A Model to Detect Malicious URLs on the WWW

A set of supervised machine learning approaches, Naïve Bayes and SVM algorithm, are used in this work to identify malicious Web links and study the patterns. The proposed model is shown in Fig. 2 and has three stages. data collection, train the model and predict malicious URLs over test set. The process has been repeated till good accuracy is plotted in detecting malicious URLs.

Dataset collection: A benchmark dataset1 [11] and dataset2 [5] are taken from https://www.kaggle.com/xwolf12/malicious-and-benign-websites and https://www.github.com/faizann24/URLs/tree/master/data, respectively. 21 features from dataset1 [11] and two more features from dataset2 [5] are taken into consideration to detect malicious URLs.

Splitting the data: Dataset is initially divided into 80 and 20% for training and testing purposes.

Lexical features: Malicious URLs, particularly those for phishing assaults as a rule have discernable examples in their URL. Among these lexical choices, the domain/path token length (delimited by "'.', '/', '?', '=', '-', ") is viewed as a component. In view of the considerable number of words in every one of the URL, a lexicon was assembled. In the event, if the word is available in URL, then the estimation of the asset is 1 else 0. This is otherwise called the bag-of-words (BoW) model.

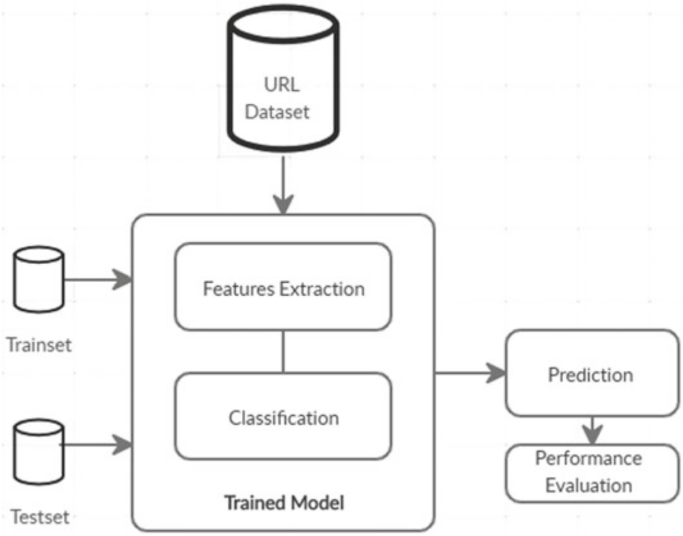


Fig. 2 Supervised machine learning model

This BoW model is a portrayal of content that depicts the event of words inside an archive. It includes two things: (1) A jargon of known words. (2) A proportion of the closeness of known words.

3.1 Naive Bayes Machine Learning Model

Naive Bayes Rule is the basis for many machine learning and data mining methods. This rule [12] is used to create predictive models and helps to explore and understand data in different ways. It is used when data is high and expects an efficient output compared to other methods.

Naïve Bayes is a probabilistic model: The probability model is a conditional model over a dependent class variable with limited number of outcomes as classes and conditions on the features as attribute variables $\boldsymbol{x_1}$ to x_n.

$$P(c|x_1, x_2, x_3 \ldots x_n) \tag{1}$$

If the value of n is large, basing a model is infeasible. Then, we reformulate the model as feasible or tractable.

$$P(c|x_1, x_2, x_3 \ldots x_n) = P(x_1, x_2 \ldots x_n)\, v\, C \tag{2}$$

Formula (2) can be represented as *Posterior* = (*Prior* × *Likelihood*)/*Evidence*. In reality, we concentrate only on numerator, because denominator will not depend on the class *c* and values of attribute *x*.

Naive Bayes-based machine learning algorithm

INPUT : *Training dataset, and URLs to be tested.*
OUTPUT : *Classifying* URLs by *Predicting Benign and Malicious*

```
Step 1.Extract the features set from the training data
Step 2.Call Naïve Bayes Algorithm to create classifier
Step 3.Calculate Prior probability for each URL class
Step 4.Calculates likelihoodness for each URL feature in the class
Step 5.Run Trained Classifier over test samples.
Step 6.Measure Posterior for each class, Benign and Malicious
Step 7.Analyze posterior values of each class.
Step 8.Among Two classes, class with greater value of posterior is
        assigned to testing URLs.
```

Testing Pseudocode:

```
Open a testing file with read mode;
Open an output file with write mode;
For each line in testing file: Remove white spaces;
Split the data using delimiter comma(,);
Split the URL using delimiter slash(/);
For each token in url :
          If find dot(".") in token:
            Split the token using delimiter dot(.);
            Append each token to test token dictionary;
          Else if  find underscore("_") in token:
            Split the token using delimiter underscore("_");
            Append each token to test token dictionary;
          Else:
          Append token to test token dictionary
End for loop
// Calculate Posterior probability of token w.r.t good and bad
For each token in test token dictionary:
 Calculate probability of tokens with good class;
 Value=Multiply all the probability of good class tokens;
 Calculate probability of tokens with bad class;
 Value1=Multiply all the probability of bad class tokens;
End for loop;
 Posterior probability of good=Multiply Value with probability of
                  good class;
 Posterior probability of bad=Multiply Value1 with
                              probability of bad class;
 Compare both the probabilities and assign greater
 class to URL;
 Store resultant URL in output file;
End for loop
Close the output file
Close the testing file.
```

Validation Pseudocode:

```
// Pseudo code to test whether the classes are correctly classified or
not.
  Open an output file with read mode;
  Initialize the variables;
  For each line in output file:
    Remove white spaces;
    Split the data using delimiter comma (,);
    If actual class is good:
      If actual class is equal to predicted class:
         Increment true positive value;
      Else: Increment false negative value
      End if
    Else:
    If actual class is equal to predicted class:
      Increment true negative value
    Else:Increment false positive value
    End Else
  End for loop
```

3.2 SVM Machine Learning Algorithm

SVM is a supervised machine learning model used for classification and regression [13]. As SVM is a generalized linear classifier, it can simultaneously minimize the empirical classification error and maximize the geometric margin, and hence, it is called as maximum margin classifiers. Structural risk minimization (SRM) can be done using SVM by mapping input vectors to a higher dimensional space where a maximal separating hyperplane is constructed. Two parallel hyperplanes are constructed on each side that separates the data. The separating hyperplane maximizes the distance between the two parallel hyperplanes. An assumption is made that the larger the margin or distance between these parallel hyperplanes the better the generalization error of the classifier will be [13]. We consider data points of the form

$$\{(x_1, y_1), (x_2, y_2), (x_3, y_3), (x_4, y_4), \ldots (x_n, y_n)\} \tag{3}$$

where $y_n = 0/1$, a constant denoting the class to which that point x_n belongs. n = number of sample. Each x_n is p-dimensional real vector. Mathematically, hyper plane is denoted as: $w{\cdot}x - b = 0$, where b is scalar and w is p-dimensional vector. The vector w points perpendicular to the separating hyperplane.

SVM-based machine learning algorithm

INPUT: Training dataset, URLs to be tested.
OUTPUT: Predicting whether given URL is good or bad (Benign and Malicious)

```
Step 1.Input URL Data from Training Set.
Step 2.Extract Features from input.
Step 3.Apply classifier to get malicious and benign classes.
Step 4.Find the best classifier which has maximum margin
       and separate into 2 classes.
Step 5.Verify whether the classifier generate valid
       classes or not by using Test dataset as input.
```

Validation: Validation is done for both Naive Bayes and SVM models in the same fashion on their output. The output files were compared with malicious URLs using python language. In this stage, we have constructed a confusion matrix to non-ambiguously portrait the predicted classes of a classifier. Seven measures (i.e., accuracy, error rate, precision, recall, sensitivity, specificity and *F*-measure) are used to evaluate the quality of the classifier performance. Accuracy is the proportion of the total number of predictions which correctly calculated. Precision is the ratio of the correctly classified cases to the total number of misclassified cases and correctly classified cases. Recall is the ratio of correctly classified cases to the total number of unclassified cases and correctly classified cases. Also, we used the *F*-measure to balance the recall and precision of the model [14].

4 Results and Observations

Naive Bayes classifier using raw URLs dataset: In Naive Bayes, the entropy of the class plays a major role in the final predicted results. If a particular feature occurs in more than one class that feature is said to be a dominant feature in data sample. Table 1 illustrates the entropy of the dataset.

Naive Bayes classifier gave 88% accuracy with 88% precision, 99% recall, 93% *F*-measure, 99% sensitivity, 11% specificity and 11% of error when total raw URLs dataset is passed as an input. With the feature extracted URLs, the model produced an accuracy of 96.6% with 99.3% precision, 96.3% recall, 98% *F*-measure, 96.3% sensitivity, 95.3% specificity and 3.4% error. The same results are shown in Figs. 3 and 4, correspondingly.

Table 1 Class distribution in dataset

Dataset	Good	Bad	Total
Original	344821 (82%)	75643 (18%)	420464 (100%)
Training	34483 (53%)	30258 (47%)	64741 (100%)
Testing	310338 (87%)	45385 (13%)	355723 (100%)

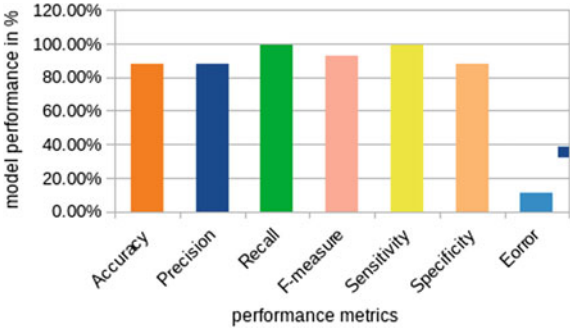


Fig. 3 Naïve Bayes using raw URLs

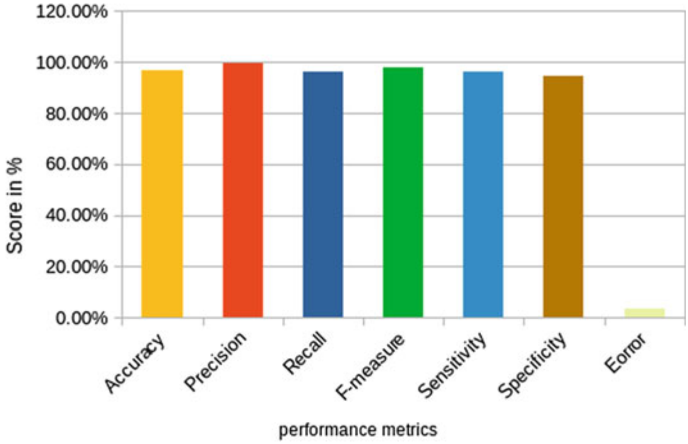


Fig. 4 Naïve Bayes using extracted feature

SVM classifier using raw URLs dataset: In SVM, we cannot supply complete dataset as input due to memory constraints, i.e., as number of URLs increased, vocabulary size and unique words increase as well. So, training data of 1000, 2000, 3000 and 4000 are given in the ratio of good and bad URLs (50:50, 60:40 and 80:20) by randomly selecting them from dataset that they may be repeated. Each time, testing data of 200 URLs were passed to classifier randomly in the ratio of 50:50 that is 100 good URLs and 100 bad URLs. The highest precision is achieved by 2000 URLs with ratio of 50:50, i.e., 91%, and the least by 1000 URLs with ratio of 50:50, i.e., 68%. The highest recall is achieved by 2000, 3000 and 4000 URLs with ratio of 80:20, i.e., 98%, and the least by 1000 URLs with ratio of 60:40, i.e., 88%. The same data is given in Table 2.

The highest *F*-measure is achieved by 2000 URLs with ratio of 50:50, i.e., 92%, and the least by 1000 URLs with ratio of 50:50, i.e., 68%. The highest accuracy is achieved by 2000 URLs with ratio of 50:50, i.e., 92%, and the least by 1000

Table 2 Comparison of different evaluation metrics of SVM classifier

No. of URL and ratio	Precision	Recall	*F*-measure	Accuracy	Error	Sensitivity	Specificity
1000 (50:50)	84	91	87	87	13	91	17
1000 (60:40	84	88	86	86	14	88	16
1000 (80:20)	68	97	80	76	24	97	45
2000 (50:50)	91	93	92	92	08	93	09
2000 (60:40)	83	91	87	86.5	13.5	91	18
2000 (80:20)	71	98	82	79.5	20.5	98	39
3000 (50:50)	86	93	89	89	11	93	15
3000 (60:40)	75	96	84	82.5	17.5	96	31
3000 (80:20)	71	98	82	79	21	98	04
4000 (50:50)	82	90	86	85.5	14.5	90	19
4000 (60:40)	78	96	86	85	15	96	26
4000 (80:20)	75	98	85	83	17	98	32

URLs with ratio of 80:20, i.e., 76%. The highest error is achieved by 1000 URLs with ratio of 80:20, i.e., 24%, and the least by 2000 URLs with ratio of 50:50, i.e., 8%. The highest sensitivity is achieved by 2000, 3000 and 4000 URLs with ratio of 80:20, i.e., 98%, and the least by 1000 URLs with ratio 60:40, i.e., 88%. The highest specificity is achieved by 2000 URLs with ratio of 50:50, i.e., 91%, and the least by 1000 URLs with ratio of 50:50, i.e., 55%. SVM classifier using feature-extracted URLs dataset: SVM classifier when implemented with the feature-extracted URLs dataset with some modifications in the data has produced the below results. In SVM classifier, accuracy is 96.6% using feature-extracted URLs, precision is 99.3%, recall is 96.3%, *F*-measure is 98%, sensitivity is 96.3%, specificity is 95.3% and error is 3.4%. The same data is shown in Fig. 5.

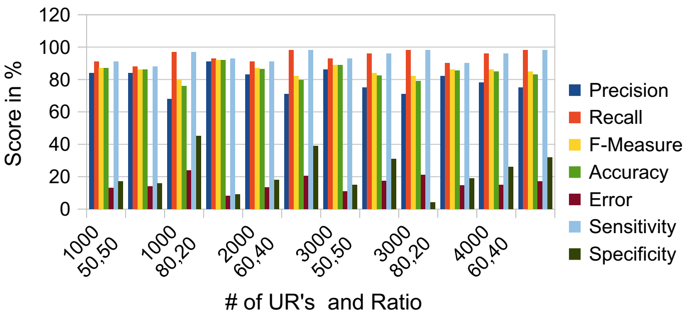


Fig. 5 Comparison of different evaluation metrics of SVM classifier

5 Conclusion and Future Work

In this work, we have described how a machine can able to judge the URLs based upon the given feature set. Malicious URL detection plays a critical role for many cyber security applications. Automated detection of malicious URLs remains a very challenging open issue as URLs are dynamic in nature. However, new URLs can be generated every day very easily.

References

1. Marsland S (2015) Machine learning: an algorithmic perspective. CRC press
2. Patil DR, Patil J (2015) Survey on malicious web pages detection techniques. Int J u- e-Serv Sci Technol 8(5):195–206
3. Hong J (2012) The state of phishing attacks. Commun ACM 55(1):74–81
4. Berners Lee T, Masinter L, McCahill M (1994) Uniform Resource Locators (URL). WWW Project CERN, RFC 1738, pp 1–24, Dec 1994
5. Abdi FD, Wenjuan L (2017) Malicious URL detection using convolutional neural network. Int J Comput Sci Eng Inf Technol (IJCSEIT) 7(6). https://doi.org/10.5121/ijcseit.2017.7601
6. Huang H, Quin L, Wang Y (2012) A SVM based technique to detect phishing URLs. Inf Technol J 11(7):921–925. ISSN 1812-5638. https://doi.org/10.3923/itj.2012.921.925
7. Babagoli M, Aghababa MP, Solouk V (2018) Heuristic nonlinear regression strategy for detecting phishing websites. Soft Comput, pp 1–13
8. Ma J, Saul LK, Savage S, Voelker GM (2011) Learning to detect malicious URLs. ACM Trans Intell Syst Technol 3(2):1–24. https://doi.org/10.1145/1961189.1961202
9. Basnet R, Mukkamala S, Sung AH (2008) Detection of phishing attacks: a machine learning approach. In: Soft computing applications in industry, pp 373–383. Springer, Berlin, Heidelberg
10. Eshete B, Villafiorita A, Weldemariam K (2012) BINSPECT: holistic analysis and detection of malicious web pages. In: International conference on security and privacy in communication systems, pp 149–166
11. Urcuqui C, Navarro A, Osorio J, Garcıa M (2017) Machine learning classifiers to detect malicious websites. In: CEUR workshop proceedings, vol 1950, pp 14–17

12. All about malware and information privacy—TechAcute (2014). https://techacute.com. 31 Aug 2014
13. Vapnik V (2013) The nature of statistical learning theory. Springer Science & Business Media.
14. Han J, Kamber M, Pei J, Data mining: concepts and techniques, 3rd edn. ISBN 978-0-12-381479-11

A Unified Framework for Stress Forecasting Using Machine Learning Algorithms

P. B. Pankajavalli and G. S. Karthick

Abstract In the fast-emerging world, the population is rapidly increasing where healthcare provider is constantly decreasing. As a result, there is a predominant need to develop new technological systems to monitor the health status of people over their life span. In particular, stress is a major frequently occurring health issue around the globe which may affect everyday activities of lives, develops a negative mental illness, depression and anxieties. Precise and well-timed diagnosis of stress is important for improving the quality of life which is impossible through traditional methodologies and that is considered as unreliable under many facets. In order to classify healthy subjects and subjects with stress, machine learning algorithms are found to be consistent and efficient. This research work focuses on developing a unified machine learning framework for forecasting the stress. The framework includes two feature selection algorithms and six classification algorithms which have been evaluated under various metrics. The proposed framework identifies and classifies the subjects with stress from healthy subjects efficiently.

Keywords Stress forecasting · Feature selection · Classifier · LASSO · Relief · ANN · SVM · K-NN · Logistic regression

1 Introduction

Stress is the commonly occurring health issues in the world, and a study explained that one in four persons was mentally absent from their normal routines due to the stress-triggered problems [1]. The nature of the human body is to release the stress hormones like adrenaline and cortisol as emotional responses to a particular situation. Stress may highly influence the physical processes of the autonomic nervous system (ANS) which tends to increased muscle tensions and abnormal changes in heart rate

P. B. Pankajavalli · G. S. Karthick (✉)
Department of Computer Science, Bharathiar University, Coimbatore, Tamil Nadu, India
e-mail: karthickgs@outlook.com

P. B. Pankajavalli
e-mail: pankajavalli@buc.edu.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_24

and concentrations [1]. The stress can be categorized into three various categories [2]: acute, episodic and chronic stress. The acute stress can be portrayed as an instant provocation where the human body reverts back to its normal state after the retirement of stress factor [2]; the dataset used in this article focuses on the acute category of stress.

The historical detection techniques used to identify the stress were highly complex, and its complication is the major reason that affects the quality of life. Hence, accurate diagnosis of the stress subjects is essential for reducing the associated risk factors and improving the quality of life.

The aim of the proposed framework is to design a forecasting framework for predicting the stress subjects. In this article, various machine learning predictive algorithms like artificial neural network (ANN), Naïve Bayes (NB), decision tree (DT), support vector machine (SVM), logistic regression and K-nearest neighbor (K-NN) have been used for classifying the healthy subjects and stress subjects. Relief feature selection (R-FS) and least absolute shrinkage and selection operator feature selection (LASSO-FS) algorithms are used for selecting the significant and correlated features which highly influence the target values of the classifier. The classifier's performance has been evaluated upon k-fold cross-validation methods using the metrics accuracy, error rate, specificity, sensitivity and Matthews's correlation coefficient (MCC). Furthermore, these techniques were applied to the stress dataset which has been collected using wearable devices and available in the PhysioNet repository. The main contributions of this proposed framework are as follows:

- The performance of all the classifiers has been analyzed on full features and significant features by the two feature selection algorithms in terms of various performance measures.
- Finally, this article recommends the feature selection algorithm which is computationally operational with the best classification algorithms for designing the unified system for stress prediction.

The remaining sections of this article are organized as follows: Sect. 2 deals with the information of stress dataset and literature of the algorithms involved in this research work. In addition, the cross-validation techniques and performance evaluation metrics have been discussed. Section 3 explores the experimental results of the proposed framework, and finally, Sect. 4 concludes this article.

2 Framework and Methods

The following subordinate sections briefly describe the frameworks and methods used in this article.

2.1 Dataset

The dataset is taken from the PhysioNet repository, and this has been used in this research work for developing a unified framework for stress forecasting [3]. This stress dataset has been procured directly from humans via wearable devices, whose sample size is 4132 subjects and 23 features. During the preprocessing stage, 529 data samples have been eliminated because of missing values and totally 3603 data samples with 23 features were considered as an input, which can be used for stress forecasting. The target labels have two classes that represent healthy subjects and subjects with stress.

2.2 Unified Machine Learning Framework

The unified framework is anticipated with the goal to classify the subjects with stress and healthy subjects are shown in Fig. 1. The performance of six important predictive machine learning models was tested with the full and selected set of features. In this regard, two FS algorithms such as R-FS and LASSO-FS have been used for feature

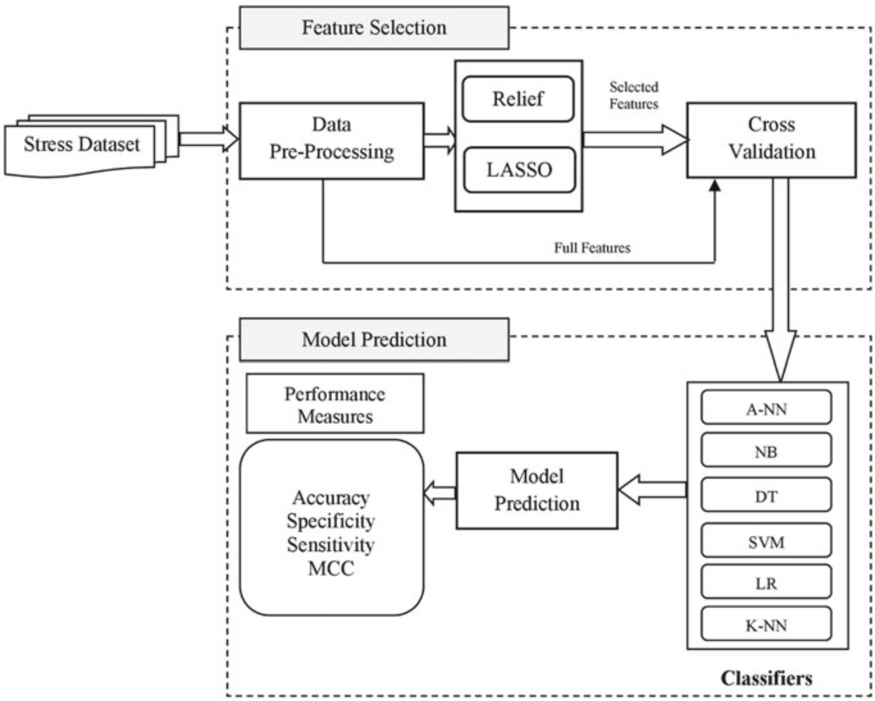


Fig. 1 Unified framework for stress forecasting

selection, and the classifier's performance was tested on the selected features. Finally, the models have been validated, and their performance was evaluated using various metrics. Figure 1 illustrates the unified stress forecasting framework.

2.2.1 Data Preprocessing and Feature Selection Algorithms

The data preprocessing improves the effective classification ratio; hence, the preprocessing methods like the elimination of missing values and MinMax scale were used for standardizing the dataset. In machine learning, feature selection is one of the predominant phases which discards the irrelevant features and helps in improving the accuracy of machine learning techniques used. In this framework, two FS algorithms have been used for increasing the classification accuracy by extracting the important features. R-FS initially assigns the weight for the features, and such weights are updated by means of iterations [4]. R-FS algorithm extracts reliable features which have the highest weights and omits the features with the smallest weights. LASSO-FS creates the feature subsets based on its absolute coefficient values in which the zero coefficient values are discarded and the coefficients with higher values will be added to the feature subsets [5].

2.2.2 Classification Techniques

This section discusses the theoretical background of various machine learning classifiers which includes SVM, ANN, NB, DT, logistic regression and K-NN. ANN is a supervised technique which incorporates activation functions, inputs, hidden and output layers [6]. The input layers operate on the weights and feature values, where the feature weights are altered at the training phases of the ANN. The output layer predicts the class, and the weight is recursively computed to reduce the error rate with respect to the bias. SVM is a commonly used kernel-based machine learning classifier which minimizes the training error and also provides higher accuracy during the testing phase. At the training phase, the margin value is maximized between the class boundary and the training data which eliminates insignificant data from the training dataset. The accuracy provided by SVM is appreciably high that is evidenced in major applications [7, 8]. NB is a supervised classifier that functions on conditional probability for identifying the class of new data samples [9]. Initially, NB calculates the conditional probability value for each feature of a given class label and based on the computed value, the new features are classified. DT is a well-known supervised classification algorithm, and it consists of internal nodes and external nodes which are interconnected with each other [6, 10], in which the internal nodes are liable to make decisions and the external nodes are leaf nodes that are associated with class labels.

Logistic regression is an eminent classification technique which may be utilized for binary classification and multi-classification problems [11]. This technique classifies the two classes A and B by forming a hypothesis $h(\theta) = \theta^{\mathrm{T}} X$, and the output of the classifier will be $h\theta(x) = 0.5$. Logistic regression classifies the data samples as class B when $h\theta(x) \geq 0.5$ and classifies it as class A when $h\theta(x) \leq 0.5$. Therefore, the logistic regression prediction follows the rule $0 \leq h\theta(x) \leq 1$. K-NN is a classifier which forecasts the class label of a new input data sample by using the similarities of a new input data sample to its training data samples [6].

2.2.3 Classifiers Validation Techniques

This section details the k-fold cross-validation technique in which the dataset is split into k equal parts, where k-1 parts were utilized for training the machine learning classifiers and the part left behind is utilized for verifying the outperformance of the classifiers. In this experiment, tenfold cross-validation has been used, and the performance measures were averagely calculated.

2.2.4 Performance Evaluation Metrics

The classifier's performance has been assessed using the metrics such as accuracy, sensitivity, specificity, MCC and processing time were used in this experiment. The 2×2 confusion matrix specifies the classifiers correctly predicted and incorrectly predicted measures. Table 1 demonstrates the confusion matrix.

Based on the confusion matrix, the following parameters have been computed: TP determines the number of correctly classified stress subjects where TN determines the number of correctly classified healthy subjects. FP determines the number of incorrectly classified stress subjects as healthy subjects where FN determines the number of incorrectly classified healthy subjects as stress subjects.

Classification Accuracy: The overall performance of the classifiers which can be calculated as follows (1):

$$\text{Classification Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} + 100\% \tag{1}$$

Classification Error: The overall incorrectly classified ratio of the classifiers is computed as follows (2):

Table 1 Confusion matrix

	Forecasted stress subjects	Forecasted healthy subjects
Actual stress subjects	True Positive (TP)	False Negative (FN)
Actual healthy subjects	False Positive (FP)	True Negative (TN)

$$\text{Classification Error} = \frac{\text{FP} + \text{FN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} + 100\% \quad (2)$$

Sensitivity: It explores the relationship between the correctly classified stress subjects to the entire stress subjects which can be written as follows (3):

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FN}} + 100\% \quad (3)$$

Specificity: It represents the relationship between the correctly classified healthy subjects to the entire stress subjects which can be written as follows (4):

$$\text{Specificity} = \frac{\text{TN}}{\text{TN} + \text{FP}} + 100\% \quad (4)$$

MCC: It denotes the forecasting capacity of the classifiers with values ranging from $[-1, 1]$, in which $+1$ specifies that the classifier forecastings are outstanding, whereas -1 specifies that classifiers forecastings are entirely wrong. But the value near to 0 indicates the unreliable forecastings of the classifier. The MCC can be obtained as follows (5):

$$\text{MCC} = \frac{\text{TP} \times \text{TN} - \text{FP} \times \text{FN}}{\sqrt{(\text{TP} + \text{FP})(\text{TP} + \text{FN})(\text{TN} + \text{FP})(\text{TN} + \text{FN})}} \times 100\% \quad (5)$$

3 Result Analysis and Discussion

This section discusses about the classifier models and its results from various perceptions. Initially, the performance of six classifiers was checked on full features using k-fold cross-validation technique. Then, R-FS and LASSO-FS are used for extracting the reliable features, and the performance of classifiers was analyzed on the selected features using the k-fold cross-validation technique.

3.1 Analysis on Selected Features by R-FS and LASSO-FS Algorithms

Relief FS extracts significant features based on the feature weights. The experiments carried out on various selected features and the classifier's performance were reported good performance on seven features in which electrocardiogram (ECG), electromyogram (EMG) and heart variability (HR) are considered as highly significant features. Table 2 depicts the features selected by R-FS, and Fig. 2 shows the selected features rankings.

Table 2 Important features by R-FS and its rank scores

S. No	Feature ID	Feature name	Rank scores
1	2	Electrocardiogram	0.293
2	3	Electromyogram	0.287
3	5	Heart rate	0.275
4	9	Respiratory rate	0.248
5	16	Foot galvanic skin response (GSR)	0.227
6	17	Hand galvanic skin response (GSR)	0.217
7	18	Time intervals in seconds	0.131

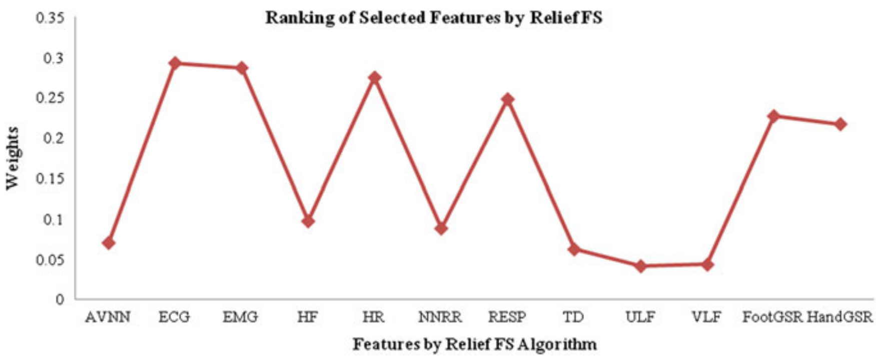


Fig. 2 Selected features by R-FS and its rank score analysis

The LASSO-FS algorithm extracted 11 highly significant features and eliminated the 12 insignificant features along with rankings. Table 3 depicts the features selected by LASSO-FS, and Fig. 3 illustrates the selected features rankings.

3.2 *Performance Analysis of Classifiers on Full Features (n = 23)*

The full dataset was verified on six classifiers using tenfold cross-validation technique in which 90% of the dataset has been used for classifiers training and the remaining 10% has been used for testing the classifiers. The average performance of all the classifiers was evaluated under tenfold cross-validation is described in Table 4. From the results, the SVM providing best outperformance with the 84% accuracy and the second-best classifier was NB with 83% of accuracy (Fig. 4).

Table 3 Important features by LASSO-FS and its rank scores

S. No	Feature ID	Feature name	Rank scores
1	2	Electrocardiogram	0.760
2	3	Electromyogram	0.723
3	5	Heart rate	0.711
4	9	Respiratory rate	0.709
5	16	Foot galvanic skin response (GSR)	0.689
6	17	Hand galvanic skin response (GSR)	0.633
7	18	Time intervals in seconds	0.590
8	15	VLF of HR intervals	0.575
9	7	Low frequency of HR intervals	0.542
10	4	High frequency of HR intervals	0.520
11	6	Ratio between LF_HF	0.486

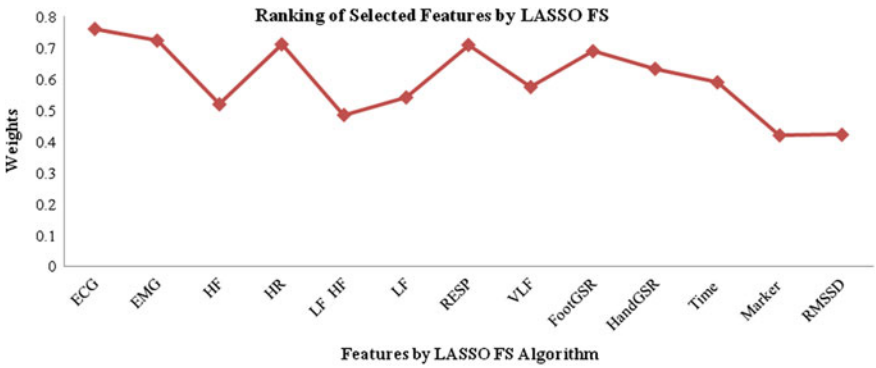


Fig. 3 Selected features by LASSO-FS and its rank score analysis

Table 4 Performance of classifiers on full features

Classifiers	Performance evaluation metrics of classifiers			
	Accuracy (%)	Specificity (%)	Sensitivity (%)	MCC
Artificial neural network	74	76	68	75
Support vector machine	84	85	83	89
Naïve Bayes	83	70	94	82
Decision tree	74	73	84	50
Logistic regression	74	73	74	50
K-NN	76	74	73	68

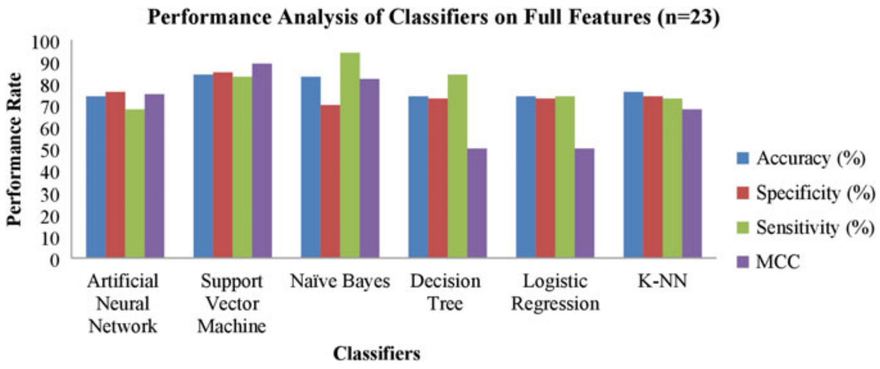


Fig. 4 Performance analysis of classifiers on full features

3.3 Performance Analysis of Classifiers with Features Selected by R-FS

In this analysis, the features extracted by R-FS algorithm were verified on six classifiers with tenfold cross-validation techniques. Initially, the most important three selected features and next six features were applied; then likewise nine important features and at last 11 important features were used. The classifier's performance was averagely evaluated under tenfold cross-validation, and the classifier's performance was highly outstanding at the application of six important features. From the results, the SVM providing the best outperformance with 89% of accuracy and the second-best classifier was NB with 85% accuracy that is described in Table 5 (Fig. 5).

Table 5 Performance of the classifiers with features selected by R-FS

Classifiers	Performance evaluation metrics of classifiers			
	Accuracy (%)	Specificity (%)	Sensitivity (%)	MCC
Artificial neural network	79	82	81	79
Support vector machine	89	98	76	88
Naïve Bayes	85	87	78	80
Decision tree	80	97	60	79
Logistic regression	74	98	47	72
K-NN	75	80	72	76

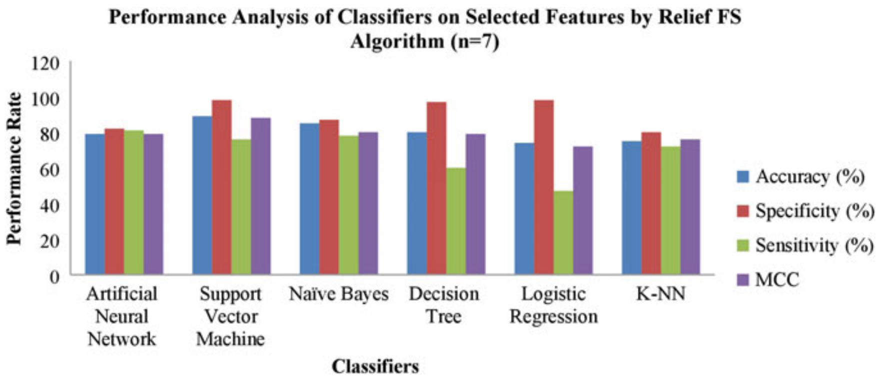


Fig. 5 Performance analysis of the classifiers with features selected by R-FS

3.4 *Performance Analysis of Classifiers with Features Selected by LASSO-FS*

In this analysis, the features extracted by LASSO-FS were verified on six classifiers using tenfold cross-validation technique. Initially, the most important five selected features and the next seven features were applied; then similarly 11 important features and at last 13 important features were used. The classifier's performance was averagely evaluated under tenfold cross-validation, and the classifier's performance yielded high accuracy rate at the application of 11 important features which are described in Table 6. From the results, the SVM provides best outperformance with 87% accuracy. Then, the second-best classifiers are found to be NB and DT with 83% of accuracy (Fig. 6).

Table 7 depicts the accuracy of SVM classifier which is improved from 84 to 89% on features selected by R-FS. Likewise, the accuracy of NB improved from 83 to 85% when applying features selected by R-FS.

Table 6 Performance of the classifiers with features selected by LASSO-FS

Classifiers	Performance evaluation metrics of classifiers			
	Accuracy (%)	Specificity (%)	Sensitivity (%)	MCC
Artificial neural network	71	88	38	69
Support vector machine	87	97	76	87
Naïve Bayes	83	88	78	82
Decision tree	83	90	70	83
Logistic regression	75	82	67	74
K-NN	81	88	73	84

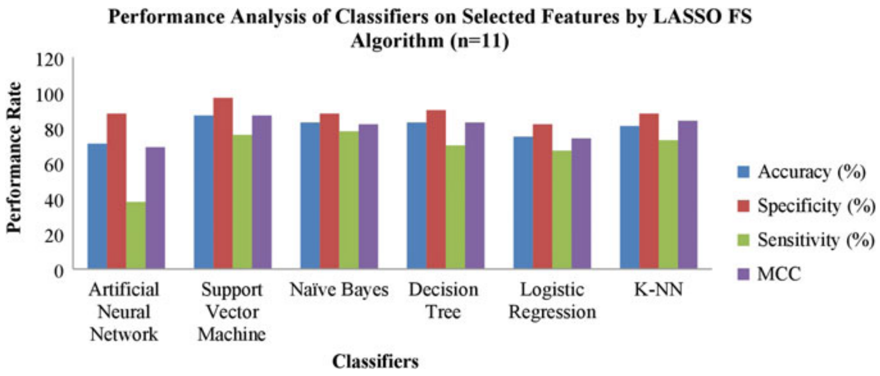


Fig. 6 Performance analysis of the classifiers with features selected by LASSO-FS

Table 7 Analysis of best classifiers performance

Classifiers	Accuracy (%) before FS	Accuracy (%) after FS
ANN	83	85
SVM	84	89

4 Conclusion

In this experimental research, a unified framework was proposed for stress forecasting. The framework was evaluated on the PhysioNet stress dataset using two feature selection algorithms and six well-known machine learning classifiers. This framework was validated using k-fold cross-validation technique, and the various performance evaluation metrics were incorporated. The SVM classifier with tenfold cross-validation endowed 89% of accuracy than other three classifiers such as ANN, NB and DT. As a result, the SVM with relief FS algorithm is endowed as a better stress forecasting classifier in terms of accuracy. In the future, real-time dataset will be used to evaluate this framework by incorporating optimization techniques.

Acknowledgements The authors thank the Department of Science and Technology-Interdisciplinary Cyber Physical System (DST-ICPS), New Delhi, (DST/ICPS/IoTR/2019/8) for the financial support to this research work.

References

1. Villarejo MV, Zapirain BG, Zorrilla AM (2012) A stress sensor based on Galvanic Skin Response (GSR) controlled by ZigBee. Sensors (Basel). 12(5):6075–6101
2. Bakker J, Pechenizkiy M, Sidorova N (2011) What's your current stress level? detection of stress patterns from GSR sensor data. In: 2011 IEEE 11th international conference on data mining workshops, Vancouver, BC, pp 573–580
3. Goldberger A et al. (2008) Stress recognition in automobile drivers (Online). Available at https://physionet.org/physiobank/database/drivedb/. Accessed 07 July 2019
4. Silva AMD (2015) Feature selection, vol 13. Springer, Berlin, Germany, pp 1–13
5. Tibshirani R (1996) Regression shrinkage and selection via the lasso: a retrospective. J Royal Stat Soc Ser B (Methodol) 73(3):273–282
6. Wu X, Kumar V (2007) Top 10 algorithms in data mining. Springer, Berlin, Germany
7. Mourão-Miranda J, Bokde ALW, Born C, Hampel H, Stetter M (2005) Classifying brain states and determining the discriminating activation patterns: support vector machine on functional MRI data. NeuroImage 28(4):980–995
8. S´anchez VD (2003) Advanced support vector machines and kernel methods. Neurocomputing 55(1–2):5–20
9. Friedman N, Geiger D, Goldszmidt M (1997) Bayesian network classifiers. Mach Learn 29(2–3):131–163
10. Wagacha PW (2003) Induction of decision trees. Found Learn Adapt Syst 12:1–14
11. Harrell FE (2015) Ordinal logistic regression. In: Regression modeling strategies. Springer, Berlin, pp 311–325

Investigation and Analysis of Crop Maintenance Using IoT and KNN and Naïve Bayes Techniques

G. Balakrishna and J. Kavya

Abstract In countries like India, agriculture is the primary source for living. Most of the population is depending on agriculture. Agriculture productivity depends on many parameters. Soil type is one of them, and soil type can be determined by finding pH value, soil moisture values, temperature values and humidity of the soil. Soil moisture is an essential parameter. It helps in controlling the exchange water and temperature between the field surface and atmosphere through evapotranspiration. Soil moisture plays an important role in the development of weather patterns and the production of condensation. The main aim of this work is to detect the soil type by finding pH values. Here, we are using sensors that are connected to the microcontroller; sensors are injected into the soil for retrieving soil pH values, soil moisture, temperature values. These values are compared with the different values, and the analysis is done by using KNN and naive Bayes algorithms. After the analysis, we can predict which crop is better for a particular soil. By using this concept, we can help farmers to predict which land can be used for which crop.

Keywords Internet of Things (IoT) · Agriculture · pH · Soil moisture · Temperature and humidity sensor

1 Introduction

IoT is the latest trend. IoT builts systems that are capable of automatically sensing and responding to stimuli from the real world without human interaction. Internet is basically a network that is formed by connecting computers globally, and the Internet provides data highways to share information over the network from one place to another in the entire world.

G. Balakrishna · J. Kavya (✉)
Department of Computer Science and Engineering, Anurag Group of Institutions,
Hyderabad, Telangana 500038, India
e-mail: kavyajupaka@gmail.com

G. Balakrishna
e-mail: balakrishnacse@cvsr.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_25

IoT is an interconnected network of physical objects (lights, fans, sensors, etc.) and virtual components (virtual machines, simulated objects, etc.) which have the ability to communicate over the Internet and share information with each other.

Agriculture is an essential sector in any country. Especially, when it is a developing country like India. Agriculture sector contributes to the country's economy more than any other sector. Before independence and at the time of independence, agriculture productivity is very high when compared to the present situation of agriculture. Agriculture is the backbone of the country's economic growth. Most of the population occupation is agriculture in our country. Since India is still developing country, agriculture is the crucial sector for economic growth, and also it is the only occupation on which more than 50% of the population is in agriculture directly.

The agriculture sector also includes livestock. It provides the fodder for livestock. Livestock provides quality food to human beings in the form of milk. Agriculture fulfills the food requirements of the people. Agriculture is one of the main sources of our national income. According to NIC and CSO, it contributes 52, 42.2, 41.8, 32.4% to national income in the years 1960–61, 1976–77, 1981–82, 2001–02, respectively. By seeing these values, we can say that productivity is decreasing year by year, and there are many reasons for this decrement in productivity.

Agriculture plays an essential role in import and export, i.e., international trade and foreign exchange; we can earn money by exporting our products to foreign countries; it helps to our economy. It was also crucial in transportation. It supports roadways and railways, which involve transporting a massive amount of agriculture products from and to mandies and factories. In our country, we are facing the problem of unemployment since ages; in this situation, only the agriculture sector can provide more employment chances. It is also the primary source for many state governments, getting good revenue in the form of taxes from farmers, taxes like land revenue, agriculture income tax, irrigation tax.

IoT and Agriculture:

Farmers are still using manual methods for crop monitoring, disease detection, and other activities. There are some disadvantages when we use manual methods like they take time, we need to present there on the farm, and they fail to detect the exact situation. We can use technology in an efficient way to get accurate results and to save time.

Now we will see technology in agriculture; there are many technologies, but nowadays all are preferring IoT for agriculture-related work; sometimes, IoT solely handles the project and sometimes IoT with any other technologies which can be useful and compatible.

With the help of technology, we can monitor the crop from anywhere, and we can provide water to field from a remote location; crop detection can also be done without being on the field.

2 Background Work

Ansari and Tabassum [1] Adoption of sustainable agriculture practices, it explains the behavioral approach. According to the RAA/TPB approach based on some factors, we will suggest which is the best crop to farm in a particular field. Factors considered in this framework are farmer's characteristics, farm characteristics, contextual factors, information, relative advantage, complexity, compatibility, observability, trialability.

Veenadhari et al. [2] had applied data mining and machine learning algorithms on agriculture data. They used K-means algorithm to classify crops and soil. ID3 algorithm is used to provide an advisory system to tomato growers. Decision tree induction algorithm is used in disease detection and explains about online analytical processing (OLAP). Ravisankar et al. [3] data mining techniques used to the classification of agriculture data but accuracy is lower when compared to data analytics techniques. In this, they proposed a big data techniques, Hadoop cloud-based analytics map reduction techniques for data analysis. Big data provides advantages over data mining. Simple linear regression and decision tree algorithms are used.

Data mining algorithms are used to extract critical information from huge information. There are two steps, namely classification and clustering. Various algorithms are used for various purposes. For the classification, ID3, J48, LMT, KNN algorithms are used, and for clustering, EM and K-means algorithms are used. These algorithms are tested with massive agriculture data [4].

Manjula and Narsimha [5] suggested a framework called XCYPF. It is a flexible and dynamic framework which is used to find any crop's crop yield prediction. It takes a different kind of input and provides a single and appropriate output. This framework helps in making strategic decisions.

Surai et al. [6] proposed a smart agriculture monitoring system with the help of a soil moisture sensor. This sensor is used to measure the moisture percentage of soil, and based on that percentage, system will take the decision whether the soil needs water or not. If there exists the need of water, it automatically switches ON the pump.

By noting various environment properties and soil properties continuously, a smart agriculture monitoring system will detect the risk, i.e., animal detection and provide proper irrigation from a remote location.

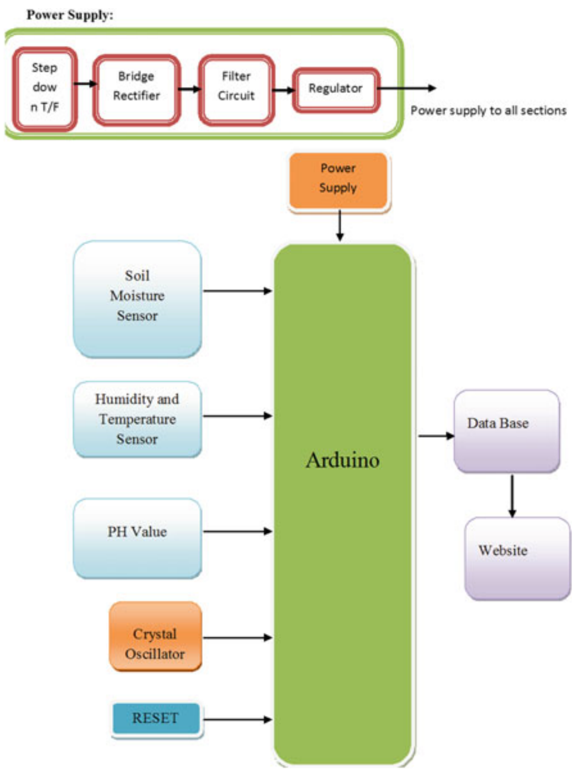
Suma et al. [7] designed a system with the aim of combining IoT and image processing technologies for developing a smart agriculture-based system. In this system, there are four modules they are as follows: data collection module—here data from various sensors will be collected in the form of images and text format. The second module is a gateway module which acts as a connector for connecting various sensors and cameras by wireless communication. The third module is cloud server data storage module. In this module, data is collected, compared, and analyzed for decision-making. In the last module web and mobile application decision will send to the user.

Mushtaq [8] proposed a smart agriculture monitoring system to detect the risk, i.e., animal detection, and to provide proper irrigation from a remote location. Jagadesh et al. [9] proposed a wireless sensor network-based agricultural monitoring system which helps farmers to monitor the various changes in the agriculture field. It is a single system with multiple applications. Data is collected from various sensors and stored in the Raspberry PI using ZigBee.

3 Proposed System

We have seen the previously done work, and there are water monitoring systems, crop disease detection systems, crop productivity prediction techniques that are available. All these are used after starting the harvesting. We can reduce a lot of issues by predicting what kind of soil is suitable for which crop. Our proposed method is to determine the soil type based on required parameters; they are soil moisture percentage, pH values, temperature, and humidity. Figure 1 shows the block diagram of the proposed system.

Fig. 1 Block diagram



3.1 Hardware Components

Arduino

Arduino is single board microcontroller which is mainly used for building various kinds of digital devices. It can also control and interface with various electronic components such as sensors, actuators, and many more. It has its own static RAM and stores data at flash memory and EEPROM. It uses programming languages like C, C++, and java.

Soil Moisture Sensor

Soil moisture sensor is used to measure the water content in soil. It senses the moisture content based on soil properties like resistance, dielectric constant, interaction with neutrons, and based on environmental factors like soil type, temperature, electrical conductivity. This uses two probes which are inserted into field when current passes through probes based on resistivity moisture percentage will be measured. This sensor probe is made up of multiple soil moisture sensors.

pH Sensor

The pH sensor is used to measure the pH value of the solution. pH value is measured as 0–14; 0–6 is acidic, 7 is neutral, and 8–14 is non-acidic or basic. It measures the pH value based on hydrogen ion concentration, which is measured by pH electrode. The response time is lesser than 2 min. Temperature range is around 0–600. Input range voltage is 5 V, and output range is 414.12 μV.

Temperature and Humidity Sensor

The DHT11 is a basic, ultra low-cost digital temperature, and humidity sensor. This sensor is made of two parts, a capacitive humidity sensor and a thermistor. Humidity sensor is used to sense, measure, and report both moisture and air temperature. Temperature range is 0–500 °C, and humidity range is 20–90%.

Parameters:

Water content in soil is measured using soil moisture sensor.

Temperature and humidity of soil are measured with the help of DHT11 sensor.

pH values are detected using a pH sensor.

Working Process:

- First of all, we will take four types of soil (e.g., red soil, white, clay, and sand soil).
- Next, we will insert all these three sensors into the soil; then, we will get the temperature, humidity, soil moisture, and pH values for a particular soil.
- In the Website, there is already a dataset with some real values called sample data. We will get live values from our kit using the KNN algorithm and naïve Bayes algorithm. After comparing live values with the sample data, we will get the crop name as a result. As shown in Fig. 2 and Table 1.

Fig. 2 Architecture of system

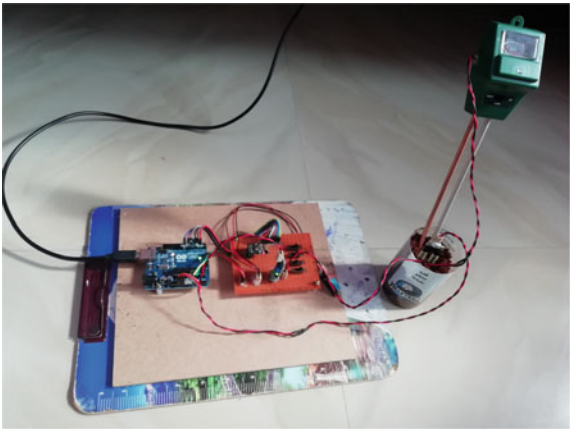
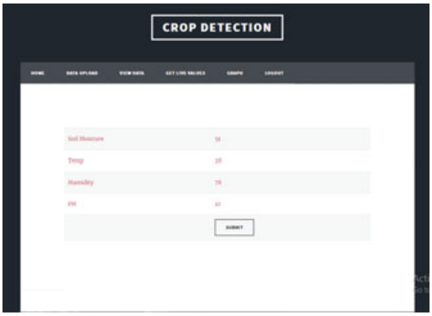
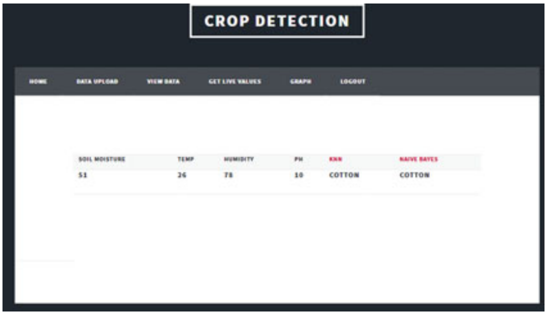


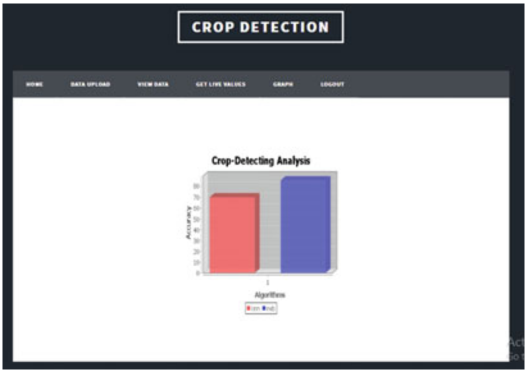
Table 1 Sample dataset

Soil name	Soil moisture	Temperature	Humidity	pH values	Crop type
Red	1	13	2	21	Rice
Black	23	45	23	34	Wheat
Red black	12	12	12	45	Corn
Green	24	34	34	23	Sweet corn
Red	23	14	12	21	Corn

4 Results







These results are generated after performing the KNN algorithm and Naive Bayes algorithms on the dataset; after that, data that is generated from sensors; KIT is compared with predefined data and gives the suitable crop name for particular farming land.

5 Conclusion

In this paper, we proposed a technique which is used to pre-estimate which crop is suitable for a specific land-based on some parameters which affect agriculture productivity. In this method, we used temperature and humidity sensor, pH sensor, soil moisture sensor. This project helps the farmers to pre-estimate which land can be used for what purpose. In future, we can add more sensors like nitrate sensor to detect the nitrate concentration in surface water to an existing system to get more accurate and realistic results.

References

1. Ansari SA, Tabassum S (2018) A new perspective on the adoption of sustainable agricultural practices: a review, vol 6(2)
2. Veenadhari S, Mishra B, Singh CD (2011) Data mining techniques for predicting crop productivity—a review article. Int J Comput Sci Eng
3. Ravisankar K, Sidhardha K, Prabhadevi (2017) Analysis of agricultural data using big data analytics. J Chem Pharm Sci 10:1132
4. Shettar AA, Angadi SA (2016) Efficient data mining algorithms for agriculture data. Int J Rec Trends Eng Res, vol 02
5. Manjula A, Narsimha G (2015) XCYPF: a flexible and extensible framework for agricultural crop yield prediction. In: IEEE sponsored 9th international conference on ISCO, 2015
6. Surai S, Kundu R, Ghosh R, Bid G (2018) An IOT based smart agriculture system with soil moisture sensor. J Innov Res, vol 1
7. Suma N, Samson SR, Saranya S, Shanmugapriya G, Subhashri R (2017) IOT based smart agriculture monitoring system. Int J Rec Innov Trends Comput Commun 5:177
8. Mushtaq S (2018) Smart agriculture system + image processing. Int J Adv Res Comput Sci, vol 9
9. Jagadesh M, Rajamanickam S, Saran SP, Sai SS, Suresh M (2018) Wireless sensor network based agricultural monitoring system. Int J Creat Res Thoughts 6:502

Enhancement of Anisotropic Diffusion Filtered Cardiac MR Images Using Contrast-Based Fuzzy Approach

G. N. Beena Bethel, T. V. Rajinikanth and S. Viswanadha Raju

Abstract Image denoising is an important preprocessing step done with MRI images to remove various kinds of noise like speckle noise, Gaussian noise, pepper and salt noise, etc. Some filtering mechanisms have been eliminating the required parts of the image along with the noisy pixels of the image, a phenomenon called over-filtering. Anisotropic diffusion is a denoising technique having an iterative process that computes a set of functions to acquire a good degree of smoothening without loss of actual contents of the images. A filtering technique using anisotropic diffusion and application of fuzzy logic has been presented in this paper as it has given a better sharpness of the image, with a good PSNR while it was simulated over 33 MRI cardiac images.

Keywords Cardiac MRI images · Anisotropic diffusion · Contrast-based fuzzy enhancement

1 Introduction

Anisotropic diffusion (Perona–Malik diffusion) aims at reducing the noise present in the image without significantly confiscating the content of the image, usually, the lines, edges and other parts which interpret the image. This process uses partial derivatives through which an image produces a parametrized group of blurred images as a result of diffusion process and is a combination of given input image and a filter. It conserves the edges of an image using a threshold function that prevents diffusion

G. N. B. Bethel (✉)
CSE Department, GRIET, Hyderabad, India
e-mail: beenabethel@gmail.com

T. V. Rajinikanth
CSE Department, SNIST, Hyderabad, India
e-mail: rajinitv@gmail.com

S. Viswanadha Raju
CSE Department, JNTUHCEJ, Jagityal, Telangana, India
e-mail: svraju.jntu@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_26

across edges. The process of anisotropic diffusion is a set of computations that are repeatedly computed for each consecutive image until enough degree of smoothening is acquired. Ultimately, the original image is being transformed into a nonlinear and space-variant structure. This technique ensures the removal of noise without blurring the edges of the digital images.

2 Related Work

Many researchers working on digital image processing have used anisotropic diffusion (AD) in their work, as it mainly preserves the images without much distortion. Some work done by researchers along this method includes: Kazmi et al. in [1] have applied the anisotropic diffusion on an image to enhance it using forward and backward diffusion using interpolation technique. Padmashree et al. in [2] have made a comparison of performance between a bilateral filter and an anisotropic diffusion for processing fractal compressed images. Tanyeri et al. in [3] have worked on wavelet-based adaptive anisotropic diffusion filter, which greatly reduces the speckle noise from the images compared their results with the conventional Lee filter and Wiener filter. Cappabianco et al. in [4] have worked on weighted non-local anisotropic diffusion filter and experimented over MRI images and on radiotherapy images. Kushwaha et al. in [5] have proposed a hybrid filter on combining Butterworth band pass filter with anisotropic filter and the quality of the image was enhanced using particle swarm optimization (PSO) which together led to better PSNR values. Keeling et al. in [6] have developed a nonlinear anisotropic diffusion filter that sharpens the edges of images over a broad array of slope scales and the experimentation was done over both synthetic and MRI image datasets. Palma et al. [7] have worked on an improved ADF by manipulating the estimated parameters. Kamalaveni et al. [8] have improved the anisotropic diffusion using edge-stopping functions. Guidotti in [9] has worked on the differences between the analytical properties and numerical implementations of the AD. Wei in [10] has worked on direct edge enhancing using super diffusion operators and chose statistical methods for robust edge stopping and integrated both with quasi-interpolating wavelet method. Tang et al. in [11] have worked on an improved anisotropic diffusion filter using adaptive threshold selection and a new gradient computation method, which is robust to noise. Chen et al. in [12] have introduced an anisotropic diffusion model based on the Lattice Boltzmann method, fast anisotropic smoothing of medical images.

3 Proposed Methodology

In the process of finding out a better denoising filter, our previous work has tried over five types of conventional filters, like mean filter, median filter, Weiner filter, Gaussian filter and NAFSM filter. Out of these, NAFSM filter showed a better PSNR over others. This work has been proposed to find out a better denoising technique through anisotropic diffusion over the same cardiac MRI images to know the difference. Later, contrast-based fuzzy enhancement is being applied over the preprocessed images and it proved to give better PSNR values.

4 Anisotropic Diffusion

Anisotropic diffusion in [13] is specifically a denoising technique that eliminates noise and retains the essential parts of the image like lines, edges and other content of the image. This process uses partial derivatives through which an image produces a parametrized group of blurred images as a result of diffusion process and is a combination of given input image and a filter. It preserves the edges of an image using a threshold function that prevents diffusion across edges. In this, a set of computations are iteratively computed for each consecutive image until enough degree of smoothening is acquired. Eventually, the original image gets transformed into a nonlinear structure that varies in space. This process can eliminate noise from the digital images apart from retaining edges.

If $\Omega \subset \mathbb{R}^2$ $\Phi \subset \mathrm{R}^2$, $I(\cdot,t)$: $\Phi \rightarrow R$ respectively represents $I(\cdot, t) : \Omega \rightarrow \mathbb{R}$ subset of the plane, then the anisotropic diffusion (AD)

$$\frac{\partial I}{\partial t} = \mathrm{div}(c(x, y, t)\nabla I = \nabla c \cdot \nabla I + c(x, y, t)\Delta I \tag{1}$$

5 Fuzzy Logic

Fuzzy logic or fuzzy inference systems have been applied very successfully in various image processing experiments. Earlier, we simulated a constant bit compressor using fuzzy logic in our previous work [14], which gave a better enhancement of the image. The success of fuzzy systems is mainly due to its simplicity and closeness to human interpretation. The main modules of fuzzy inference system are the process of fuzzification, resultant rule base and the process of defuzzification. Fuzzification and defuzzification transform the external inputs into fuzzy information and vice versa, and fuzzy inference system has a strong knowledge base consisting of fuzzy rules for appropriate reasoning.

One of the widely used applications of intensity transformations is contrast enhancement, where the process of enhancing a grayscale image can be best understood by the rules. In terms of output, darker is considered as degrees of darkness, brighter as degrees of brightness and gray as degrees of intensity in the gray scale. The constant intensities among output member functions are considered singletons and their degree of intensities range from [0, 1]. The output membership function is described by the equation

$$V_0 = \frac{\mu_{\text{dark}}(Z_0) \times V_d + \mu_{\text{gray}}(Z_0) \times V_g + \mu_{\text{bright}}(Z_0) \times V_b}{\mu_{\text{dark}}(Z_0) + \mu_{\text{gray}}(Z_0) + \mu_{\text{bright}}(Z_0)} \tag{2}$$

where V_0 is the output to any given input Z_0.

The output membership functions are constants modified by the fuzzified values. Fuzzy image processing is computationally intensive as the whole process of fuzzification must be applied to every pixel of the input. And, singleton significantly reduces the computational requirements and these savings can be significant in applications where the speed of processing is important.

6 Experimental Results

Conventional filtering methods have been used to preprocess the cardiac MRI images in our previous work. NAFSM filter [15] proved to give a good PSNR value when compared to other filters. Anisotropic diffusion is being used to filter the images in this paper and it proved to give a better PSNR than all the previous conventional methods. Figure 1 shows the input membership function, Fig. 2 shows the output membership function, Fig. 3 shows rule viewer and Fig. 4 shows the surface viewer.

The output images along with their PSNR values for twelve images are being displayed in Table 1 after applying anisotropic diffusion. There is a good improvement of signal to noise ratio after application of anisotropic diffusion over the images, as listed out in Table 1. The PSNR values after filtering with NAFSM filter, after filtering with anisotropic diffusion and after fuzzy-based enhancement over the images are listed in Table 2. The signal to noise ratio has further improved after fuzzy enhancement as seen in the table below. The work has been carried out on 33 cardiac MR images but for the availability of space, a sample of only twelve is shown in the tables.

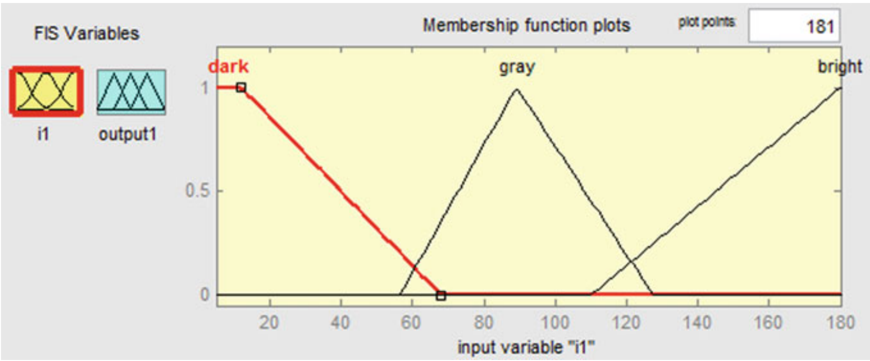


Fig. 1 Input membership function

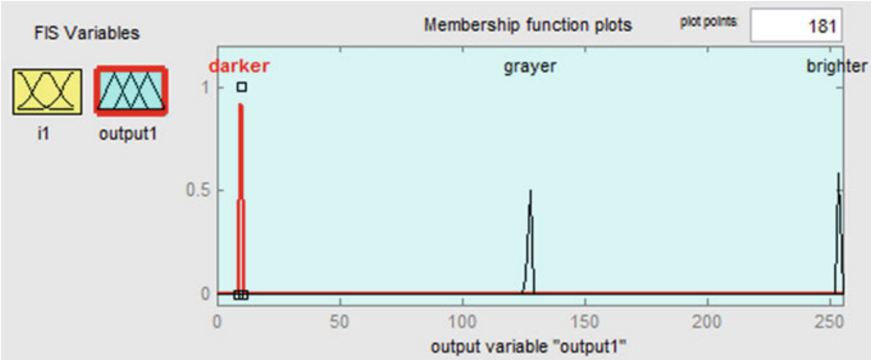


Fig. 2 Output membership function

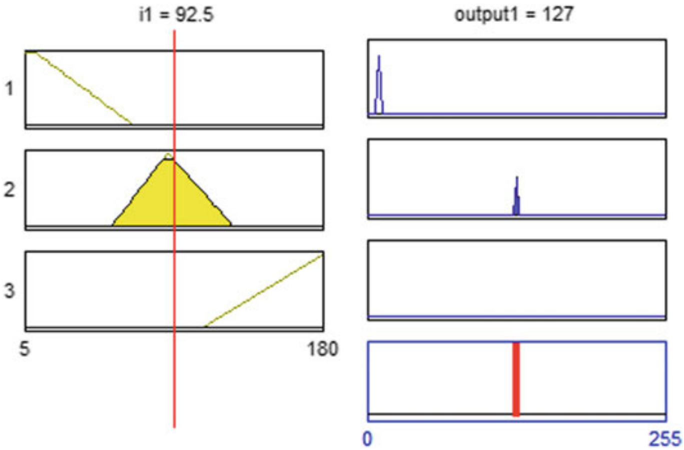


Fig. 3 Rule viewer

Fig. 4 Surface viewer

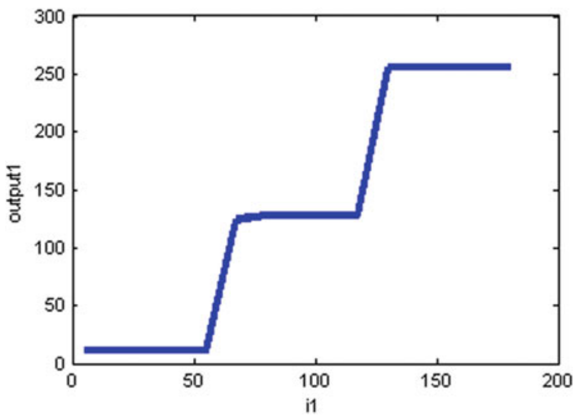


Table 1 Comparing NAFSM, anisotropic diffusion filters and fuzzy enhancement over 12 samples

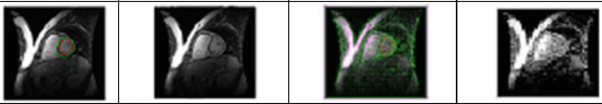
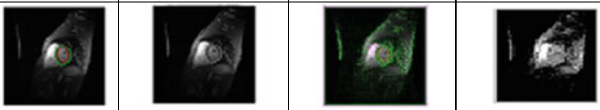
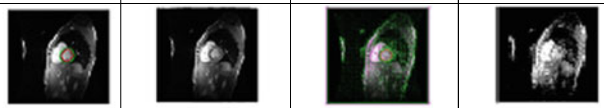
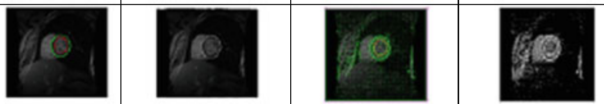
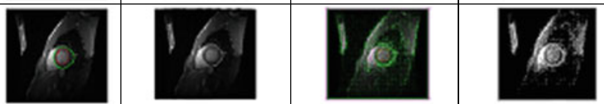
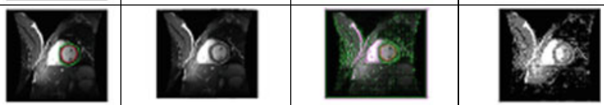
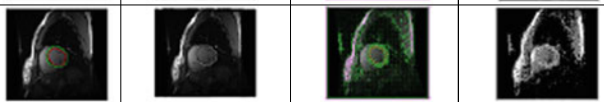
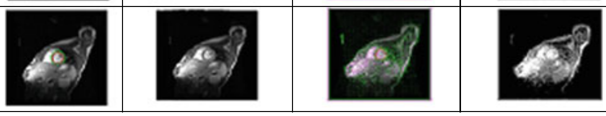
Image Name	Input image	After filtering the image with NAFSM filter	After application of anisotropic diffusion	Resultant image after fuzzy enhancement
P1.jpg				
P2.jpg				
P3.jpg				
P4.jpg				
P5.jpg				
P6.jpg				
P7.jpg				
P8.jpg				
P9.jpg				
P10.jpg				
P11.jpg				
P12.jpg				

Table 2 Twelve sample images and their PSNR values before and after fuzzy enhancement

Image name	PSNR value with NAFSM filter	PSNR value after anisotropic diffusion	PSNR value after fuzzy enhancement
P1.jpg	28.9906	33.1984	39.4806
P2.jpg	29.0063	34.5417	38.5242
P3.jpg	26.5736	34.1627	38.8438
P4.jpg	27.9424	33.4211	39.2886
P5.jpg	26.5527	34.1291	38.8004
P6.jpg	26.8404	34.4877	38.5009
P7.jpg	30.1076	33.9573	38.8320
P8.jpg	27.2619	34.4175	38.6170
P9.jpg	28.0004	33.1482	39.3883
P10.jpg	28.7978	33.6595	39.0412
P11.jpg	28.9898	33.9580	38.9396
P12.jpg	28.2624	33.8408	38.9671

Figure 5 shows the enhancement of anisotropic plus fuzzy enhancement over the NAFSM filter that was used earlier.

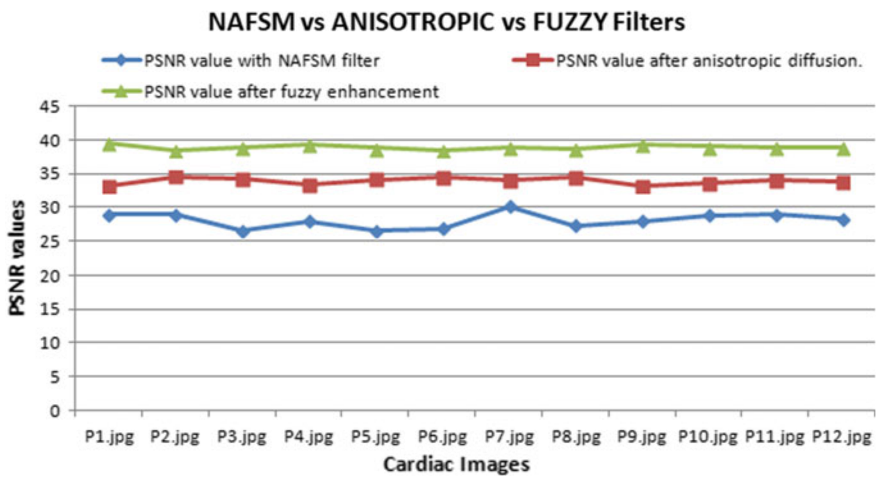


Fig. 5 Comparison of NAFSM, anisotropic filter and fuzzy enhanced outputs

7 Conclusions and Future Work

Cardiac MRI images were first preprocessed using five types of conventional filters namely mean filter, median filter, Wiener filter, Gaussian filter and NAFSM filter, out of which NAFSM filter has given better PSNR values over other filters [15]. In this paper, the set of cardiac images were preprocessed using anisotropic diffusion filter, which computes for partial derivatives iteratively and it has given better PSNR values than NAFSM filter. The output filtered images from anisotropic diffusion filter were subjected to contrast-based fuzzy enhancement technique. The PSNR values of the fuzzy enhanced output images have further improved. Therefore, the hybrid approach (contrast-based fuzzy enhance approach over an isotropic diffusion filter) gave better enhancement images. Further, this work will be extended with deep learning techniques after being preprocessed using anisotropic diffusion. Deep learning techniques are likely to have a better classification over conventional neural networks, so the preprocessed images will be subjected to convolutional neural networks for classification.

References

1. Kazmi QA, Agrawal KK, Upadhyay V (2013) Image enhancement processing using Anisotropic diffusion. Int J Comput Sci Eng Inf Technol Res (IJCSEITR) 3(1):293–300. ISSN 2249-6831
2. Padmashree S, Nagapadma R (2015) Performance measure analysis between anisotropic diffusion filter and bilateral filter for post processing of fractal compressed medical images. Int J Comput Appl (0975–8887) 123(12):36–43
3. Tanyeri U, Demirci R (2018) Wavelet-based adaptive anisotropic diffusion filter. Adv Electr Comput Eng 18(4):99–106
4. Cappabianco FAM, da Silva PP (2018) Non-local operational anisotropic diffusion filter. arXiv:1812.04708v1[eess. IV], 11 Dec 2018
5. Kushwaha S, Singh RK, A new hybrid filtering technique for minimization of over-filtering issues in ultrasound images. https://doi.org/10.4066/biomedicalresearch.29-18-762
6. Keeling SL, Stollberger R (2002) Nonlinear anisotropic diffusion filtering for multiscale edge enhancement. Inv Probl 18(1):175
7. Palma CA, Cappabianco FAM, Ide JS, Miranda PAV (2014) Anisotropic diffusion filtering operation and limitations—magnetic resonance imaging evaluation. In: Proceedings of the 19th World Congress, the international federation of automatic control cape town, South Africa, 24–29 Aug 2014, pp 3887–3892
8. Kamalaveni V, Rajalakshmi RA, Narayanankutty KA (2015) Image denoising using variations of Perona-Malik model with different edge stopping functions. Procedia Comput Sci 58:673–682. In: Second international symposium on computer vision and the internet (VisionNet'15), Elsevier
9. Guidotti P (2015) Anisotropic diffusions of image processing from Perona-Malik. Adv Stud Pure Math 99:1–30
10. Wei Guo W (1999) Generalized Perona-Malik equation for image restoration. IEEE Signal Process Lett 6(7):165–167
11. Tang J, Sun Q, Liu J, Cao Y (2007) An adaptive anisotropic diffusion filter for noise reduction in MR images. In: 2007 international conference on mechatronics and automation, IEEE explore, Sept 2007. https://doi.org/10.1109/icma.2007.4303737

12. Chen Y, Yan Z, Qian YH An anisotropic diffusion model for medical image smoothing by using the lattice Boltzmann method. In: 7th Asian-Pacific conference on medical and biological engineering. IFMBE proceedings, vol 19, Springer, Berlin, Heidelberg
13. Perona P, Malik J (1990) Scale-space and edge detection using anisotropic diffusion. IEEE Trans Pattern Anal Mach Intell 12(7):629–639
14. Bethel GNB, Meenakshi K (2014) Design and simulation of constant bit rate compressor using fuzzy logic. In: IEEE explore, first international conference on networks & soft computing, 978-1-4799-3486-7/14/$31.00, 2014 IEEE, pp 343–347
15. Bethel GNB, Rajinikanth TV, Raju SV (2017) Application of pre-processing and segmentation methods on cardiac MR images. Indian J Comput Sci Eng (IJCSE–UGC approved) 8(3), June–July 2017, ISSN 0976-5166

Social Media Ecosystem: Review on Social Media Profile's Security and Introduce a New Approach

Vishnu Dutt Sharma, Santosh Kumar Yadav, Sumit Kumar Yadav and Kamakhya Narain Singh

Abstract Social media is a platform for maintaining a connection among like-minded people. It provides business opportunities, alliances, career opportunities, friendships, relationships, developing social skills, online communication, virtual community and many more. From the last one decade, social media is popular medium for communication among cardinal online users. They provide communication mechanism that enables users to be connected among family and friends. Social media plays a vital role for users because it cringes geographical borders. While the popularity and usefulness of social media make a speculative toward users with regards to data security. In this paper, we have analyzed different social network attack techniques with its subsequences. On the basis of analysis, we propose the machine learning-based system for better security arrangement and data security.

Keywords Social media profile · Social media security · Data security · Social media ecosystem

1 Introduction

Social media (SM) is a platform that felicitates almost all kind of activity. Communication and data sharing are very important aspects where users used to publicize their

V. D. Sharma · S. K. Yadav
Department of Computer Science, Shri Jagdish Prasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India
e-mail: vashistha31@gmail.com

S. K. Yadav
e-mail: drskyadav@hotmail.com

S. K. Yadav
Department of Computer Science, IGDTUW Delhi, New Delhi, India
e-mail: sumitarya007@gmail.com

K. N. Singh (✉)
School of Computer Applications, KIIT Deemed University, Bhubaneswar 751024, India
e-mail: kamakhya.vphcu@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_27

fascinate, snap, video and many more. The importance of these activities is because of factual about personal information, conversation among other members and browsing other user profiles. SM plays a vital role for users because it cringes geographical borders also. In addition, they are also using for job searching, entertainment, news, etc.

In the last many years, we are observing exponential growth toward data being created on SM. In the history of technological revolution, SM proliferated is unprecedented toward speedy growth [1]. The rapid progress of technology toward SM platform has led to an ecosystem where users use various devices for various platforms to interact with a variety of ideas, services and products [2]. There are three types of SM ecosystem: owned media like blog or company website, paid media like advertisement or sponsorship and earned media like viral message [3] (Fig. 1).

There are 7.7 billion total population in the universe, 4.3 billion internet users, 3.4 billion active users on SM. On average, a person has 5.54 SM accounts; the average daily time spent is 116 min per day. SM users grew by 121 million between Q2 2017 and Q3 2017 [4]. In every 15 s, a new SM user account is created. Facebook, WhatsApp, Twitter, LinkedIn, Instagram, Google+, Pinterest etc. are more popular SM. While the popularity and usefulness of SM make a high risk toward end users in terms of data security. Data generates when you register for SM. During sign up, you need to be filled certain details like name, gender, date of birth, email, mobile number, etc. These data along with additional personal information like school name, maiden name, current city, native place, employer, various group, friend in network, IP address user used for every logging, and all of the user's activity ever used to target. SM like Facebook maintains its activity log as a list of your posts, story,

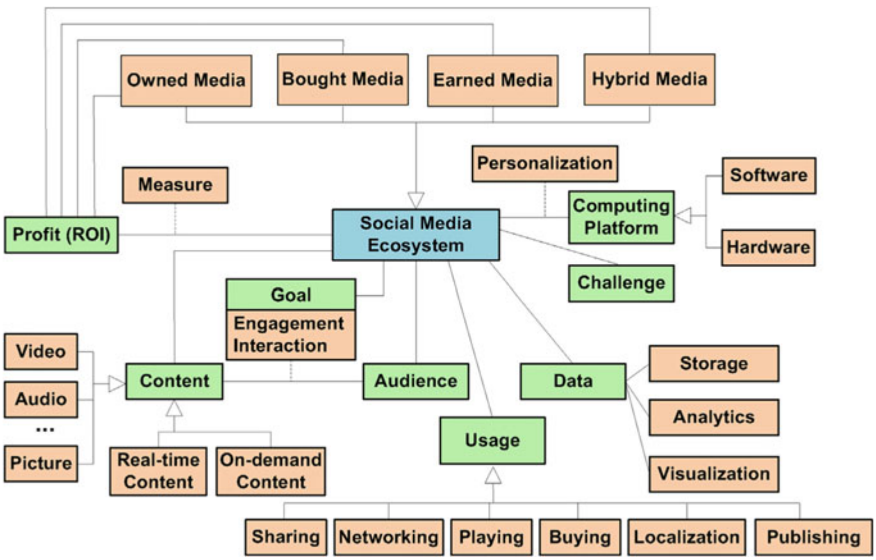


Fig. 1 Social media ecosystem

tagging, like, share, comment, added someone as a friend, status change and search of another person from today back to the very beginning. Hackers target these data. Various attacks for instance identity theft, spam, social bots and malware are used with these hacking techniques—keylogger, denial of service, waterhole attacks, fake WAP, clickjacking attacks, virus or Trojan, phishing, eavesdropping (passive attacks), etc.

The literature survey is given in Sect. 2; working mechanism of proposed model is presented in Sect. 3. The last section presents future work and conclusions.

2 Literature Review

SM platforms invite a various of attacks in them, which provide scope to steal users' identity and trust over a network. There are three major types of security attacks in social media which put users' shared data at risk [5]. The first type is the traditional security attacks like phishing, malware, Sybil, spamming, clickjacking, deanonymization, inference and profile cloning attack. The second class comprises the threat in multimedia content which is shared on SM and used to expose SM users. In this metadata, shared multimedia content, ownership data, multimedia shared links, multimedia content exposure, transparency of data centers, static links, tagging, steganography, video teleconference, and data disclosure by unauthorized attackers. In the third category, it contains threats in which intruder sets up a social relationship with social media users to threaten them. Cyberbullying and grooming, corporate espionage, and cyberstalking are in this category.

In addition, adversaries can find any other relevant credentials, such as bank account, date of birth, by inspecting the user's personal data present in social media and can commit internet crimes, for example, bank fraud [1]. Usually, SM attacks can be account hijacking, impersonation attacks, fraud and malware distribution. An advanced attack can also compromise enterprise networks [6]. Facebook collects and stores user's personal data that can be used to populate target users' ads for marketing. It includes what users' likes, dislikes, shares and friends. Using Facebook, all kind of data is produced and shared but mostly multimedia data. In Zephoria Digital Marketing (ZDM) [7] report, approximately 136,000 photos are uploaded in every 60 s on Facebook website. According to statistics on SM, it shows that the average viewing and sharing rate of videos is rapidly increasing. In the current year, approximately eight billion videos per day are viewed on Facebook, which is doubled view count of the year 2015 [8]. Because of the availability of enormous multimedia data on various social platforms such as Facebook, security risks are also rising in its own pace. An intruder user can share objectionable information on any social media. In addition, an adversary can extract a user's essential information from those multimedia data, such as user's location, relationships and identity [9]. Twitter safeguards the users' data and preserves the confidentiality of their private information; however, intruder can analyze the sequence of a user's posts on a social network (SN) and can infer their private information. MySpace social platform was attacked in 2005 by the Sammy worm. The worm exploited the vulnerabilities in MySpace and spread quickly over it [3]. The malicious code did not steal users' secret information; rather, it had effect on general operations of MySpace. Later in 2009, the social site Twitter get affected by malicious Mikeyy worm, which replaced users' data with some objectionable information. In the same year, May 2009, Facebook was again attacked by a malware named Koobface worm. It stole important information of users, for example, a user's password, etc. [10]. A report by Internet Security Threat Report (ISTR) [11] projected that the overwhelming use of SMS by attackers cannot be overlooked. In 2015, those services acted as a source for malware and malicious spam. Those were further used as a pathway of earning illegal money on the internet. In recent times, Pinterest and Twitter accounts of Facebook CEO Mark Zuckerberg's were hacked. In that, the attacker exploited his LinkedIn profile credentials [12]. In a similar way, many other attackers compromised the SN accounts of Delta Air Lines Inc. and Newsweek. They used fake message post for it [2].

From the above attacks, we infer that SM is the most available pathway for an adversary to commit cybercrimes. Many researchers have proposed various solutions to withstand such attacks, for example, digital oblivion and watermarking steganalysis [13]. Many other solutions to mitigate traditional threats are also proposed such as phishing detection and spam detection [14]. Many researchers have investigated and stated various security problems in SNs. Gao et al. [15] in their research classified the prime security issues in social media into four: first, network structural-based attacks; second, malware attacks; third, privacy issues and fourth, viral marketing. The research elaborated the security problems and their corresponding defense security mechanisms. Author's studied user's behavior in SMS from four prospects: (1) traffic activity, (2) connection and interaction, (3) malicious behavior and (4) mobile social behavior [16].

Viejo and Sánchez [17] provided a comprehensive study on various security and privacy threats in SMS. Those are primarily segmented the threats into four classes: (1) classic threats, (2) modern threats, (3) threats targeting children and (4) combination threats. They also proposed a classification of existing solutions for protecting SNS users. Kayes and Iamnitchi [18] presented a categorization of possible traditional security threats in SMS based on the SN stakeholders. Authors classified the various attacks as attacks on social network security (SNS) infrastructure. Author also provided many defense mechanisms to mitigate these sets of SMS security attacks. However, various challenges that occur in using these mechanisms are real-world implementation. Kumar et al. [19] provided many noted attacks in SMS, including identity theft, phishing attacks, Sybil and other malware exploiting flaws in real-world implementations (Table 1).

Table 1 Social security solutions, key methods and descriptions

Machine learning approach	Related work	Algorithm description
AdaBoost	[16, 17]	Weak results from my other decision tree are taken together to create a boosted classifier
Boosted classifier	[4, 13]	Simple logistic regression used in Bayesian generalized linear algorithm
J48	[6, 15]	J48 is a decision tree algorithm
KKNN	[14, 20]	Clustering in K-nearest neighbors is used group and further predict classifications type
Nnet	[8, 21, 22]	A neural network mimics the principle of neurons in a brain for classification problem
.rf	[6, 13]	Random forests are made up of a set of decision trees to obtain the optimized accuracy with one such tree
Rpart	[6, 18]	Recursive partitioning tree is also can be used as a decision tree
SVM Linear	[2, 19]	SVMs classifier used for high-dimensional features classifications. It also classifies the nonlinear feature space

3 Proposed Work

There are various methods used by machine learning to analyze data, broadly grouped into supervised and unsupervised. For making enhanced decision in the future, learning starts from observation of data, understanding and training examples to search pattern [21]. Classification and regression algorithms come under supervised learning. Prediction can be done on the basis of trained dataset along with input data and corresponding desire output for the new example.

While unsupervised learning applies untrained dataset using cluster analysis method. Dataset is grouped into various clusters using Euclidean or else probabilistic distance.

Comprising different types of data is enormous in volume which is challenging to make statistical analysis. Because of inadequate technology and possible redundancy data are noisy and heterogeneous. To bring effective conclusion from high-resolution measurement requires machine learning approaches. We apply logistic regression (LR) and support vector machine (SVM) classifier training methods. By removing redundancy, dimensionality of data portion is decreased.

LR is used to classification which accepts only two values, i.e., 0 and 1 to predict.

Here will use a and b district value toward classification and apply LR to attempted to calculate b given a.

We know that $b \in \{0, 1\}$ and so $h\theta(a)$ must belong within 0 and 1.

For this purpose, we will take

Where $h\theta(a) = g(\theta T a) = 1/1 + \mathrm{e}^{-\theta T a}$ and $g(c) = 1/1 + \mathrm{e}^{-c}$ belong to logistic or sigmoid function. $g(c)$ tends toward 1 as $c \to \infty$, and $g(c)$ tends toward 0 as $c \to$

$-\infty$. Moreover, $g(c)$, and so $h(a)$, always bounds between 0 and 1. As before, we are keeping the convention of letting $a0 = 1$, so that $\theta T(a) = \theta 0 + \sum_{i=1}^{n} \theta_j a_j$.

The classification model is endowed with a number of probabilistic assumptions to fit θ for it, and then the parameters are fitted using maximum likelihood.

Let us assume that

$$P(b = 1|a; \theta) = h\theta(a)$$
$$P(b = 0|a; \theta) = 1 - h\theta(a)$$

This can be presented more efficiently as

$$P(b|a; \theta) = (h\theta(a))b(1 - h\theta(a))1 - b$$

SVM is also applied for linear kernel, classification and training [8, 12]. SVM applies hyperplane to segregate two kinds of data as a generalized maximal margin classifier. From the training examples, maximal margin hyperplane has to be selected. The distance of given segregating hyperplane from training example has to be calculated. The margin should be minimum distance from hyperplane to example. Above hyperplanes can be represented like:

$$a \cdot b - x = 1 \text{ and}$$
$$a \cdot b - x = -1$$

Obviously, to get 2/||z|| $\sum$ to get maximized, the value of z should be minimum.

4 Conclusions and Future Scope

SM is a platform that provides various types of services like share and like photos, videos, story, interest, comment, feelings, etc. SM makes billions of Web users engage among them without geographical restriction. We have proposed to provide the latest approach on various secrecy and security challenge that occurs from some of their important characteristics. To realize the challenges, we recap several latest attack data and security details. Moreover, we described the ecosystem of SM. Furthermore, we have done analysis of the existing schemes to protect users from social network threats. We explored here two classifier training methods LR and SVM for developing or updating new system. For future work, need to implement using machine learning-based approach or artificial analysis, which can provide better result based on content. Finally, the testing of system and result analysis will be done for use.

References

1. Carminati B et al (2011) Semantic web-based social network access control. Comput Sec 30(2–3):108–115
2. Squicciarini AC, Griffin C, Sundareswaran S (2011) Towards a game theoretical model for identity validation in social network sites. In: 2011 IEEE third international conference on privacy, security, risk and trust and 2011 IEEE third international conference on social computing, IEEE, 2011
3. Novak E, Li Q (2012) A survey of security and privacy in online social networks. College of William and Mary computer science technical report, pp 1–32
4. Savage J (2017) Top 5 Facebook video statistics for 2016 [Infographic]. EriÇim, vol 26
5. Pang J, Zhang Y (2015) A new access control scheme for Facebook-style social networks. Comput Sec 54:44–59
6. Singh KN, Misra C, Seth S, Mantri JK, Dash SR (2017) A framework for social service volunteers: a social network representation. Int J Pure Appl Math 114(10):11–23
7. Cao J, Li Q, Ji Y, He Y, Guo D (2016) Detection of forwarding-based malicious URLs in online social networks. Int J Parallel Prog 44(1):163–180
8. Zhang Z, Gupta BB (2018) Social media security and trustworthiness: overview and new direction. Future Gener Comput Syst 86:914–925
9. Rathore S et al (2017) Social network security: issues, challenges, threats, and solutions. Inf Sci 421:43–69
10. Smith K (2016) Marketing: 96 Amazing social media statistics and facts for 2016. Retrieved from https://www.brandwatch.com/2016/03/96-amazing-social-media-statistics-and-facts-for-2016
11. Gao H, Hu J, Huang T, Wang J, Chen Y (2011) Security issues in online social networks. IEEE Int Comput 15(4):56–63
12. Miller Z, Dickinson B, Deitrick W, Hu W, Wang AH (2014) Twitter spammer detection using data stream clustering. Inf Sci 260:64–73
13. Lee JD, Sin CH, Park JH (2014) PPS-RTBF: privacy protection system for right to be forgotten. J Converg 5(3740.16)
14. Singh KN, Misra C, Seth S, Mandal SK, Kumar BA (2019) Robust framework for socially responsive services: a constraint-based social network representation. In: Innovations in soft computing and information technology. Springer, Singapore, pp 163–177
15. Gao Y, Hu S, Tang W, Li Y, Sun Y, Huang D et al (2018) Physical layer security in 5G based large scale social networks: opportunities and challenges. IEEE Access 6:26350–26357
16. Jin L, Chen Y, Wang T, Hui P, Vasilakos AV (2013) Understanding user behavior in online social networks: a survey. IEEE Commun Mag 51(9):144–150
17. Viejo A, Sánchez D (2016) Enforcing transparent access to private content in social networks by means of automatic sanitization. Expert Syst Appl 62:148–160
18. Kayes I, Iamnitchi A (2017) Privacy and security in online social networks: a survey. Online Soc Netw Media 3:1–21
19. Kumar S, Saravanakumar K, Deepa K (2016) On privacy and security in social media–a comprehensive study. Procedia Comput Sci 78:114–119
20. Rubin VL (2017) Deception detection and rumor debunking for social media. The SAGE handbook of social media research methods. SAGE, p 342
21. Noyes D (2017) Zephoria digital marketing. The top 20 valuable facebook statistics. Viitattu 17.11. 2017
22. Sedhai S, Sun A (2017) Semi-supervised spam detection in Twitter stream. IEEE Trans Comput Soc Syst 5(1):169–175

An Investigation on Managing Patient Flow at Hospital Emergency Care Unit Using Tree-Based Data Mining Techniques

Rubeena Sultana, Sandeep Rawat, G. Vishnu Murthy and Naveen Kumar

Abstract Increase in population over last decade resulted in overcrowding in emergency care unit (ECU) departments in hospitals, which had a negative consequences on patients. Thus, it is necessary to find new methods that can prevent crowding and avoid bottleneck patient flow. The present paper makes an investigation on various tree-based data mining (DM) prediction models such as decision tree (DT) and boosting trees. Although the earlier studies were able to predict 80.06% hospital admissions accurately using DT, a modern technique light gradient boosting machines was proposed to increase the efficiency and speed compared to existing ones.

Keywords Data mining · Classification · Triage · Emergency care unit · Predictive models

1 Introduction

For many years, the emergency care unit (ECU) has been the most neglected and often the weakest department in the hospital. ECU attenders may arrive through ambulance or main entrance. As shown in Fig. 1, each emergency patient detail is recorded at administrative systems of main reception area before the triage causing crowding at ECUs. Overcrowding at hospitals can cause an increase in patient's

R. Sultana (✉) · S. Rawat · G. Vishnu Murthy
Department of Computer Science & Engineering, Anurag Group of Institutions, Hyderabad, Telangana, India
e-mail: rubeenasultana19@gmail.com

S. Rawat
e-mail: srawatcse@cvsr.ac.in

G. Vishnu Murthy
e-mail: hodcse@cvsr.ac.in

N. Kumar
IGNOU, New Delhi, India
e-mail: naveenkumar@ignou.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_28

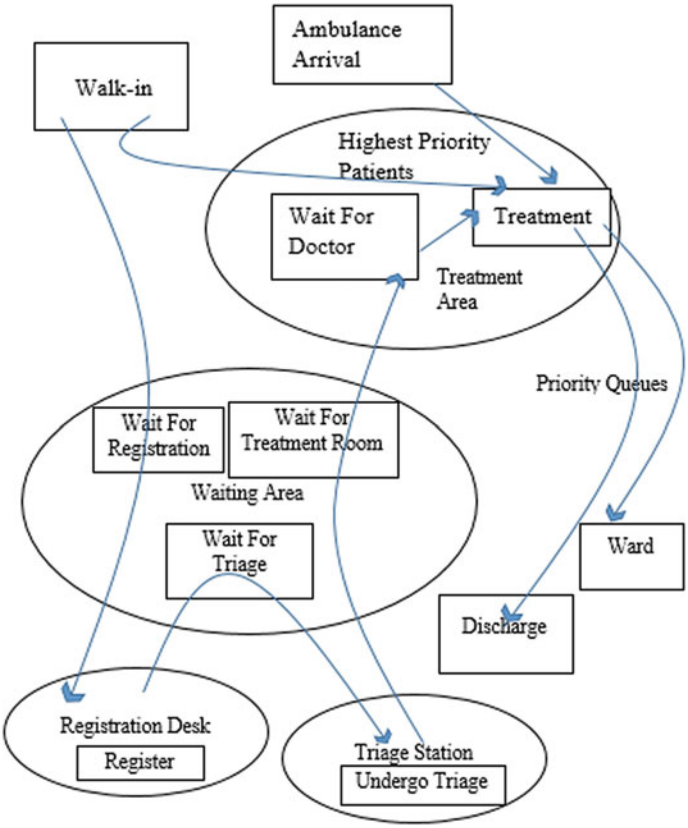


Fig. 1 Patient undergoing various stages at emergency care unit

illness, adverse effect on hospital staff and management, and finally decreasing the patient life safety. In general, efforts are required from doctors, management, society, and modern techniques to identify the causes and to plan resources accordingly in advance. In this study, DM classification techniques such as boosted machines and DTs are discussed to design and develop patterns that could facilitate in predicting future admissions.

The paper is arranged in following manner: Sect. 2 gives the literature works, Sect. 3 presents the methodologies to manage patient flow, and Sect. 4 gives the conclusion and the future scope.

2 Literature Review

Crowding at ECU has been noticed as a major issue in many countries around the world. Many researchers [1, 2] showed a wide interest in finding the effects and causes of overcrowding at ECUs. Also the use of technology [3, 4, 6, 7] was helpful in building models that could predict hospital admissions for better treatment and planning. However, Table 1 gives the brief description about the comparison of models proposed by various authors.

McCarthy et al. [1] used disjoint analysis in order to regulate boarding times dynamically across hospitals. Their main objective determines time-dependent effects of crowding on waiting room and treatment in ECUs. The demonstrations achieved more timeliness effect on patients with high acuity. Lin et al. [2] focused on unusual diseases observed in Taiwan. The data was gathered using wards method and k-means method. The study used seven various correlation laws based on simple statistics. They identified patients with pneumonia and septicemia were most likely to have unusual diagnosis. Peck et al. [3] evaluated expert opinion, naive Bayes, and linear regression models using four different hospitals data located in USA to predict admissions into the hospital IU. Among these methods, LR performed best with ROC-AUC of 0.887 and naive Bayesian having an ROC-AUC of 0.841. The results were used to improve patient flow, bed management, and discharge processes.

Cameron et al. [4] conducted a research on Northern Glasgow unscheduled attendances using a six-variable score in order to predict ECU admission at triage. The source of patients likely or unlikely to attend ECU was responsible for making predictions which could help in decision support and hospital bed management. The data consisted of clinical variables to certify linear regression model with receiver operating cure (ROC) 0.8774. Peck et al. [5] developed four predictive models such as Baysian network, support vector machines, naive Bayes, and LR to prioritize discharge and treatment of patients. They showed that exchange of admission prediction and current state information among ECU and inpatient unit (IU) could have chances of making patient flow better and longer delays.

Cameron et al. [6] compared the probability evaluated by nurses using visual analog scale and probability generated automatically by prediction score. They found nurses perform better when patient admissions are certain and perform less when patient admissions are uncertain. Graham et al. [7] developed three DM models namely LR, DT, and gradient boosted machines (GBM), where the models were trained by accumulating administrative data from hospitals of Northern Ireland. The dataset included parameters such as arrival mode, patient's age, triage category, and other. According to them, GBM was most accurate compared to LR and DT in predicting admissions and improving patient flow at ECU.

Table 1 Literature works

Paper author	Datasets	Technique/algorithm	Results
McCarthy et al. [1]	ECUs of tertiary care hospitals with Level I trauma centers, the USA	Poisson regression	Climatic factors are not high cause of patient arrivals at ECU. More arrivals were overserved on the day after holiday
Lin et al. [2]	ECU of a Taiwan Medical Center	Ward's method, k-means, and DT analysis	The seven various correlation rules identified that unusual diagnosis is expected more in pneumonia and cirrhosis diseases
Peck et al. [3]	VA Medical Centers present in Boston region	Expert opinion, naive Bayes, and LRs	The linear regression model performed best to satisfy bed demands and staff decisions
Cameron et al. [4]	Hospitals of North Glasgow from 2010 to 2012	Multivariate LR using six-variable score	The results gave excellent admission/discharge of patients from triage using with ROC 0.8774
Peck et al. [5]	ECU at the Veterans Health Administration (VHA) Boston Healthcare System (BHS)	Discrete event simulation	Sharing of prediction and state information among ED and IU has resulted in improved patient flow and boarding times
Cameron et al. [6]	Glasgow Royal Infirmary, Glasgow, UK in 2014	Triage nurses and Glasgow admission prediction score	Glasgow admission prediction score performed better than triage nurses
Graham et al. [7]	Hospitals of Northern Ireland, the UK during the year 2015	LR, DT, and GBM	GBM was more efficient in terms of accuracy compared to other algorithms

3 Methodology to Manage Patient Flow

As soon as a patient arrives to the ECU department, a triage process is met for sorting patients. If a patient is in critical stage, emergency medicine is given directly to get cure else taken to treatment area where patient undergoes treatment or surgery depending upon the patient's condition. In mean time, the relatives of the patient fill the causality papers at registration desk which provide admission number to the patient indicating his/her successful admittance in the ECU. The increase in waiting times at triage causes overcrowding at ECU resulting in long delays for the treatment and patient suffers high illness or even death sometimes. Thus, data mining models can be build based on past historical data collected from hospital administrative systems for predicting hospital admissions at ECU to manage and plan resources in prior to the patient's admission. The data may consists of parameters such as time of the day, age of patient, ways of arrival into the hospital, and others. These models can be evaluated using accuracy, precision, and recall measure.

3.1 Proposed Architecture

Step 1. **Data Collection and Data Preprocessing**: The first step comprises of gathering of data from various ECU hospitals followed by data extraction with required parameters. These data records are used for preprocessing so as to clean the data and eliminate null or missing values. However, Fig. 2 exhibits all three steps for building DM models which demonstrates complete view of the current study.

Step 2. **Development and Validation of Models**: To meet the validation process of forecasting models, the collected data records should be segregated into training and testing sets in the scale of 80:20. The classification algorithms of DM such as decision tree, GBM, and light GBM can be used to build models for forecasting future admission rates. The predictive models provide a better way to control flow of patients at ECU.

Step 3. **Choosing Best Model to Plan Resources**: The performance of DM models was evaluated using definite measures. The final model with accurate predictions is chosen to figure out future admissions of patients at ECUs, reduce long length delays and avoid overcrowding. In this paper, proposed model light GBM may tend to perform more efficiently compared to other models. This gives hospital management an advance planning to accumulate resources before arrival of the patient and increase patient's satisfaction.

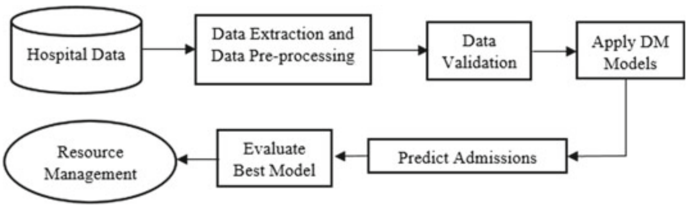


Fig. 2 Proposed architecture for building DM models

3.2 Pseudo Code for Proposed Model

The pseudo code presented below gives an implementation overview of light GBM (LGBM) that predicts the future admissions using training and testing data. Initially, in step 1, an array list is created to store all the data records and also initializes hashMap function in order to grow a vertically (leaf-wise order). In step 2, the data is added to array list by eliminating the records having missing values which is known as preprocessing. Here, variable '*a*' represents the training count and variable '*b*' represents the testing count which are incremented sequentially after preprocessing. The parameters of data are given by key and their number of admissions is given by value. Further, the model is used for future predictions by considering all the variables of step 1 and step 2. Once the model predicts the output, it can be used in real-time scenarios. The code evaluates the performance of LGBM using precision, recall, F1 and accuracy measures in step 5. Also, suitable intermediate results are calculated in step 4 in terms of truly positive, truly negative, falsely positive and falsely negative where expected values are compared with predicted values.

```
Input: a: train_count, b: test_count, d: max_depth
  Step 1: ArrayList[] = new List[]
  HashMap() t = new test_data // hashMap function
  HashMap() tr = new train_data
  Step 2: if space != 0 then // pre-processing
    for a = 0 to d do
      a += 1 add to List[]
    for b = 0 to d do
      b += 1 add to List[];
  s = count(tr) // total count of training data
  q <- value, r <- key // assign parameter and its
  value
  Step 3: predict = (t(r)/b) + boosting values
  (((q/a)*100) - (s/tr.size())) //predict admissions
  Step 4: exp = (t(r)/b)+ boosting value (((q/a)*100) -
  (s/tr.size()))- (q/a)*100 // expected admissions
  //predicted values compared to expected values
  if exp > 0 & predict > 0 then tp++
  if exp > 0 & predict < 0 then tn++
  if exp < 0 & predict > 0 then fp++
  if exp < 0 & predict < 0 then fn++
  Step 5: //performance evaluation measures
  R1 = tp/(tp+fp)
  R2 = tp/(tp+fn)
  R3 = 2*((R1*R2)/(R1+R2))
  R4 = (tp+fp)/(tp+tn+fp+fn)
Output: predict, R1, R2, R3, R4.
```

4 Conclusion and Future Scope

The research was conducted on various DM methodologies to develop and access three DM techniques to forecast the rate of admissions and advanced planning at ECU. Overall, light GBM could achieve best performance in terms of both accuracy and speed compared to GBM and DT. The pseudo code for the proposed model presented in this paper can also be helpful in future to develop predictive models in real-time scenarios such as to increase clinical performance and improve hospital management systems. Subsequent studies can focus on examining the accuracy of the proposed models with fire and traffic emergency units by using techniques of deep learning or artificial intelligence. It would be fascinating for future works to observe variation in accuracy over various population datasets based on choice of algorithm.

References

1. McCarthy ML, Zeger SL, Ding R, Levin SR, Desmond JS, Lee J, Aronsky D (2009) Crowding delays treatment and lengthens emergency department length of stay, even among high-acuity patients. Ann Emerg Med 54:9–13
2. Lin WT, Wang ST, Chiang TC, Shi Y, Chen W, Chen H (2010) Abnormal diagnosis of emergency department triage explored with data mining technology: an emergency department at a medical center in taiwan taken as an example. Expert Syst Appl 37:2733–2741
3. Peck JS, Benneyan JC, Nightingale DJ, Gaehde SA (2012) Predicting emergency department inpatient admissions to improve same-day patient flow. Acad Emerg Med 19:1045–1054
4. Cameron A, Rodgers K, Ireland A, Jamdar R, McKay GA (2013) A simple tool to predict admission at the time of triage. Emerg Med J 32:174–179
5. Peck JS, Benneyan JC, Nightingale DJ, Gaehde SA (2014) Characterizing the value of predictive analytics in facilitating hospital patient flow. IIE Trans Healthc Syst Eng 4:135–143
6. Cameron A, Ireland AJ, McKay GA, Stark A, Lowe DJ (2017) Predicting admission at triage: are nurses better than a simple objective score? Emerg Med J 34:2–7
7. Graham B, Bond R, Quinn M, Mulvenna M (2018) Using data mining to predict hospital admissions from the emergency department. IEEE Access Queen's University Belfast - Research Portal, pp 10458–10469

A Path-Based Model for Link Prediction in Location-Based Social Networks

Ch. Mounica and P. Srilatha

Abstract In recent years, link prediction is considered as one of the prominent task in studying the social networks. Link prediction problem also has applicability in other domains like health care, information retrieval, e-commerce, and bioinformatics. With the development and comprehensive utilization of the compact devices, location-based social network (LBSN) has grown a critical stand for several novel applications since location data will help to derive many potential relationships in various domains. Friendship prognostication in standard interfaces is beneficial for many applications, such as friend or place recommendation and security administration. For loss of standard friendship prognostication algorithms, in this paper, three new methods were proposed for friendship prognostication by considering social and mobility patterns of users in LBSNs. Studies conducted on real-world datasets demonstrate that our propositions obtain a contentious performance with schemes from the research and, in a most maximum of the circumstances, exceed them.

Keywords Link prediction · Location-based social networks · Path-based metrics

1 Introduction

Currently, with the rapid development, the online social community has been part of people's lifestyles. Many systems of sociology, biology, and facts can use the network to describe, where nodes form men or women and the edges represent relationships between individuals or interaction between people. Therefore, the study of complex networks was a critical task in many areas. Like for example in hyperlink

Ch. Mounica · P. Srilatha (✉)
Department of Computer Science and Engineering, Anurag Group of Institutions, Hyderabad, Telangana 500038, India
e-mail: srilathacse@cvsr.ac.in
URL: http://www.anurag.edu.in/

Ch. Mounica
e-mail: mounikachilukamari6395@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_29

extraction problem, predicting links can be considered as a task of finding the links between two nodes that are entirely based on distinct statistics and existing hyperlink information detected. Prediction links that are no longer effective can be used within the social network area. However, it can also be implemented in exclusive areas. As in bioinformatics, link prediction can be used to find interactions between proteins [7]. Link prediction can also help to locate hidden terrorist criminal gangs. Therefore, in current years, there are a number of correlation algorithms proposed to solve the hassles of predicting links. Neighborhood-based online social networks have seen an increasing reputation, which attracts hundreds of thousands of researchers. In literature, many online social networking programs based mainly in the region, along with Foursquare, Mingle, Gowalla, etc. Superb, novel, and fun offerings to users consider sharing neighborhood records by registering on Websites. LBSN offers a new social media platform to make friends, share information, search for content with location tags, and connect with close friends [4]. Unlike regular online social networks, LBSN no longer communicates within the digital community, but it also supports live oral exchanges around the world, providing valuable information to researchers. It has attracted a great variety of users and created a great problem for researchers. Community mining, privacy security, the expectation of friends, and advice on places are often research topics. Recently, LBSNs have attracted many and hundreds of researchers because of the truth, in addition to the possibility of making new friends, they can also determine the proportion of their locations with friends, as well as send different messages, indicators or data related to the places visited. LBSN's main Foursquare is one such network, which has over forty-five million users, over sixty-five million sites, and over eight billion hits. The consumer proximity link is promoted collectively by actors, which allows geographic mobility to be used as an additional statistical source of facts to investigate user behavior. Two years ago, Facebook launched a link prediction contest on Kaggle, with the aim of recommending that there are no limits in a social drawing. Recognize social networks specifically to build social family members among users who share common interests, historical past, real lifestyle connections, and many others. People may or may not need to maximize their social love. For instance, the holder of an Instagram business page needs to influence as many people as possible for its industrial benefits [12]. However, the community evolves over time, joining new clients, including friends, new connections between old customers, etc. Based on the current community we need, we will wait for imminent changes within the community and give evidence as a result. This paper is subdivided as follows. Sect. 2 describes related work. Sect. 3 describes the methodology. Sect. 4 describes the experimental results, and the conclusion is included in the final section.

2 Related Work

Friendship prediction can be considered as one of the important studies on LBSN. In general, community communications between LBSN users and their online behaviors reflect, to some extent, their real-life behaviors. In other words, people who have equal and geographically similar hobbies, or have the same social circle, often easily become friends. In [8], the author presented a model of multilayered friendship prediction and defined the relationship between a user's friendship with his kinetic characteristics, social graphics houses, and user profiles. In [6], the author recommends a targeted hyperlinked social network prediction technology-based entirely on the issue version, which analyzes the semantic facts of the nodes, aggregates the network node attributes and the structural properties of the hyperlink prediction. In [13], the author took personal elements, global factors, and time component as the most important functions to predict friendship. They noted that if it was more useful to take into account personal or international factors, some adverse conclusions might also emerge. For example, tourists are more likely to travel through Times Square in New York than locals. In [3], the author mentions the way in which temporal and spatial clashes between humans help to establish social bonds between them which has been validated. Liben-Nowell et al. [9], the authors determine how the opportunity for friendship can be linked to the geographical distance between two people. In [10], the author used the betweenness for friendship prediction in OSNs, and it is beneficial for various applications, such as friends/region advice and privacy control. In [9], authors recommend using a method to predict friendship by integrating topology and geographic functionality into entire area-based social networks. The proposed methods examine the functionality of online and offline dating users and evaluate the contributions of specific capabilities through the data acquisition scale. In [1], the author mentioned how online social networks have gained popularity recently. The problem of increasing the impact on online social networks has been studied considerably. However, in the previous work, the spread of influence within the physical world, which is also an integral part, is not taken into account. Location-based social networks (LBSNs) are a special type of online social networking where humans can have a percentage of events embedded in the region. In [2], the author uses crowd sourcing records from site-based social media offerings primarily to influence LBSN maximization. It is proposed to produce a new community and model for energy diffusion that takes into account the spread of impact on both online and worldwide social networks. In [5, 11] mentions recent advances in an era in the location have taken a large step in social networking offerings, allowing customers to appreciate the Internet site and content material related to the Website, as well as pictures and geo-tagged notes. In addition to huge geographical statistics sets, studies into new consulting structures are endorsed which seeks to facilitate the tour and social interaction among the persons.

3 Methodology

The proposed work focuses on the strength of the connections that exist between visitors that has integrated social approaches with social institutions. or communities patterns.

3.1 Basic Idea of the Algorithm

Given a social network of graph $G = (V, E)$ the link prediction problem is formulated in such a way that the algorithm has to predict the likelihood of affiliation between link nodes V_i, V_j. The link prediction challenge can be solved by considering two types of links, namely missed links and the non-existing links. The best framework for the correlation prediction set depends primarily on the similarity of the policy group. The similarity scores are calculated between the all pairs of non-existing links .Then, when connected pairs are ordered according to property values, from largest to lowest, the greater the value of the similarity property, the greater the chance of forming the link [8].

3.2 Proposed Friendship Prediction Metrics

In this paper, three methods were proposed by considering the social and mobility patterns. They are known as WOCP, TPOP, and CNP, and their range may be as follows:

1. *Within and Outside of Common Places (WOCP)*: This metric redefines a range of unusual acquaintances for persons.

$$\delta_{x,y} = \delta_{x,y}^{\text{wcp}} \cup \delta_{x,y}^{\text{ocp}} \tag{1}$$

$$\delta_{x,y}^{\text{wcp}} = \{z \in \delta_{x,y} \big| \phi_L(x, y) \cap \phi_L(z)\} \tag{2}$$

$$\delta_{x,y}^{\text{ocp}} = \{\delta_{x,y} - \delta_{x,y}^{\text{wcp}}\} \tag{3}$$

   where Eq. 1 is a collection of acquaintances shared within the places visited which is not unusual, and Eq. 2 is a group of extraordinary friends outdoors, not extraordinary places visited. From the above sets, the WOCP metric can be defined as

$$s_{x,y}^{\text{wocp}} = \frac{\delta_{x,y}^{\text{wcp}}}{\delta_{x,y}^{\text{ocp}}} \tag{4}$$

   WOCP measures the relationship between extraordinary friends traveling in common places.For example, the two marketing experts are much more likely to be friendly if they have extra common friends going to the shared destinations, and if they do meet, they have high quality friends who go to non-public places.
2. *Common Neighboring Places (CNP)*: This metric describes a set of unexpected partners in similar visiting areas.The size of this set defines the CNP is calculated as follows:

$$\delta^{L}_{x,y} = \{z \in \delta_{x,y} \big| \phi_L(x) \cap \phi_L(y) \neq \phi \vee \phi_L(y) \cap \phi_L(z) \neq \phi\} \tag{5}$$

$$s^{\text{cnp}}_{x,y} = \delta^{L}_{x,y} \tag{6}$$

CNP shows that users are more likely to be friends if they have friends who travel to common places.

3. *Total and Partial Overlapping of Places (TPOP)*: This metric considers re-important of an unusual group of friends on the area like

$$\delta^{L}_{x,y} = \delta^{\text{top}}_{x,y} \cup \delta^{\text{pop}}_{x,y} \tag{7}$$

$$\delta^{\text{top}}_{x,y} = \{z \in \delta_{x,y} \big| \phi_L(x) \cap \phi_L(y) \neq \phi \wedge \phi_L(y) \cap \phi_L(z) \neq \phi\} \tag{8}$$

$$\delta^{\text{pop}}_{x,y} = \delta^{L}_{x,y} - \delta^{\text{top}}_{x,y} \tag{9}$$

$$S^{\text{tpop}}_{x,y} = \frac{\delta^{\text{top}}_{x,y}}{\delta^{\text{pop}}_{x,y}} \tag{10}$$

where Eq. 8 is an unusual neighboring organization with a preferred overlay of places, and Eq. 9 is a group of co-partners with partial overlap. Using these values, TPOP can be given by Eq. 10. TPOP indicates that humans become friends if there are additional friends traveling to places visited in addition using x and y, rather than places visited correctly with the help of x or more useful with y.

4 Experimental Results

Table 1 gives the statistics of various data sets.Among the given datasets, Gowalla dataset is the largest dataset. By setting specific thresholds, real good rate and a false positive rate, respectively, were calculated, and the corresponding ROC curve was drawn. First, we present the CNP, WOCP, and TPOP on the basis of ROC curves

Table 1 Statistics of various datasets

Datasets	Gowalla	Brightkite	Hamsterster
Edges	827,036	215,079	12,635
Nodes	63,825	55,228	1959
Maximal degree	1099	273	273
Average path length	2.8	2.7	3.4
Average degree	25.653	7.3	3.5

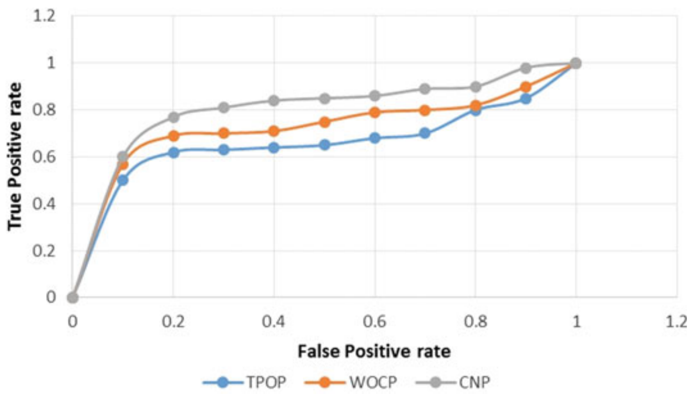


Fig. 1 The ROC curves of TPOP, WOCP, and CNP

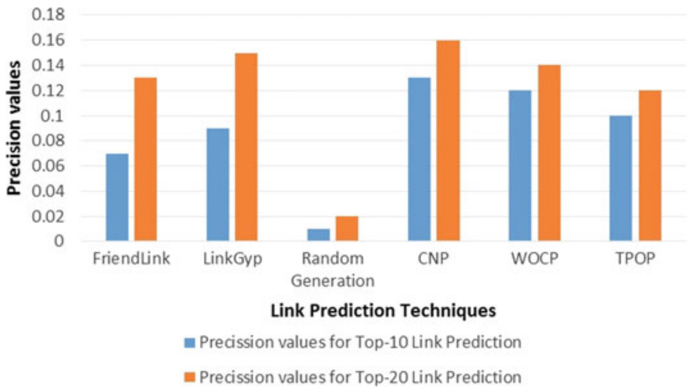


Fig. 2 Precision values of various link prediction techniques for the brightkite dataset

as shown in Fig. 1. These techniques have the general function of the universal first class. Although CNP is 0.33, WOCP and TPOP are linked to the fifth position, but they have proven aggressive due to the right social strategy. Precision values of various link prediction techniques for the brightkite dataset (Fig. 2).

5 Conclusions

The link prediction is an essential analysis domain in data mining. It has an extensive range of situations. Various data mining responsibilities include the association among the things. Link prediction can be practiced for recommendation methods, social networks, IR, and various other areas. In this paper, three distinct link prediction structures for friendship prediction in LBSNs were recommended which are divided into CNP, WOCP, and TPOP. Our proposed research work that a group of controversial users is viable enough to be friends if multiple close friends of each are in the same location, so as to enhance the accuracy of the link predictions movable patterns can be strengthened. Comparative results on a couple of real datasets determined that the prediction ability of proposed work independently outperforms when compared with other algorithms in friendship prediction in LBSNs. With the results it is inferred that CNP is provide high friendship prediction accuracy associated with various existing methods.

References

1. Bao J, Zheng Y, Wilkie D, Mokbel M (2015) Recommendations in location-based social networks: a survey. GeoInformatica 19(3):525–565
2. Cai JLZ, Yan M, Li Y (2016) Using crowdsourced data in location-based social networks to explore influence maximization. In: IEEE INFOCOM 2016—The 35th annual IEEE international conference on computer communications. IEEE, pp 1–9
3. Crandall DJ, Backstrom L, Cosley D, Suri S, Huttenlocher D, Kleinberg J (2010) Inferring social ties from geographic coincidences. Proc Natl Acad Sci 107(52):22436–22441
4. Fusco SJ, Michael K, Michael M, Abbas R (2010) Exploring the social implications of location based social networking: an inquiry into the perceived positive and negative impacts of using LSBN between friends. In: 2010 Ninth international conference on mobile business and 2010 ninth global mobility roundtable (ICMB-GMR). IEEE, pp 230–237
5. Jie L (2015) Analysis of link prediction method in mobile social network. In: 2015 Seventh international conference on measuring technology and mechatronics automation. IEEE, pp 145–148
6. Kabbur S, Han EH, Karypis G (2010) Content-based methods for predicting web-site demographic attributes. In: 2010 IEEE international conference on data mining. IEEE, pp 863–868
7. Lei C, Ruan J (2012) A novel link prediction algorithm for reconstructing protein-protein interaction networks by topological similarity. Bioinformatics 29(3):355–364
8. Li N, Chen G (2009) Multi-layered friendship modeling for location-based mobile social networks. In: 2009 6th annual international mobile and ubiquitous systems: networking & services, MobiQuitous. IEEE, pp 1–10
9. Liben-Nowell D, Novak J, Kumar R, Raghavan P, Tomkins A (2005) Geographic routing in social networks. Proc Natl Acad Sci 102(33):11623–11628
10. Liu Q, Li J, Xie Z, Zhang P (2015) An improvement of link prediction by combining local information and betweenness. In: 2015 11th International conference on natural computation (ICNC). IEEE, pp 456–461
11. Ma J, Xu H, Chen H (2013) Friendship prediction in recommender system. J Natl Univ Defense Technol 35(1):163–168
12. Quercia D, Askham H, Crowcroft J (2012) Tweetlda: supervised topic classification and link prediction in twitter. In: Proceedings of the 4th annual ACM web science conference. ACM, pp 247–250
13. Wang H, Li Z, Lee WC (2014) PGT: measuring mobility relationship using personal, global and temporal factors. In: 2014 IEEE international conference on data mining. IEEE, pp 570–579

Predicting the Cost of Pre-owned Cars Using Classification Techniques in Machine Learning

B. Lakshmi Sucharitha, Ch. V. Raghavendran and B. Venkataramana

Abstract Modern requirements present many challenging applications in the field of artificial intelligence (AI). Machine learning (ML) is concerned with how to construct a computer program that can increase its presentation on an assignment through understanding the input. An assignment can be a task to be learned. The functions responsibility is to produce output based on the input parameters. In this paper, we discuss on predicting the cost of pre-owned cars by using linear regression algorithms. The linear regression and random forest algorithms are applied on the dataset for future predictions. These methods are compared using R square and root mean square error methods. The results exhibited that random forest outperforms in the prediction of price of pre-owned cars comparing with linear regression.

Keywords Machine learning · Linear regression · Random forest · Categorical variables · Seaborne

1 Introduction

A study about the artificial intelligence (AI) has led the creation of algorithms that will be alternative to the statistical techniques in recent years. The names of these algorithms are machine learning (ML), and instead of relying on mathematical theory,

B. Lakshmi Sucharitha (✉)
JNTUH, Hyderabad, Telangana, India
e-mail: sucharithabitra7@gmail.com

Ch. V. Raghavendran
Department of IT, Aditya College of Engineering & Technology, Surampalem, EGDt, Andhra Pradesh, India
e-mail: raghuchv@yahoo.com

B. Venkataramana
Department of CSE, HITS, Hyderabad, Telangana, India
e-mail: bandaruramana1@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_30

their aim is to imitate the human intelligence abilities by benefit from computers. Development in central processing unit (CPU) technologies is increasing the interest to these algorithms.

AI and ML terms have been used interchangeable because boundaries of these terms are not clear. Artificial intelligence is rather broad and upper term that imitates human intelligence's all abilities. So, there is no any application that meets one-to-one artificial intelligence term. With the usage of artificial intelligence, we can analyze deeply huge amount of information in a short time. Machine learning algorithms present particular ability of human intelligence in a too limited field. Machine learning is a subfield of artificial intelligence.

Due to stastical techniques developed for studying with few data; they are incapable to solve a large amount of data and complicated relations. Increasing performance and showing developments in time by using new data are the most significant features that distinguish machine learning algorithms from the traditional computer algorithms. It was seen that very successful practices have been developed by using these algorithms in the literature. With the development of social media, a large amount of data about the human behaviors have been collected. Machine learning methods are used in analyzing these types of data.

Machine learning algorithms can be divided into subgroups according to intended use such as classification, clustering, pattern recognition and correlation analysis. To predict the financial failure, classification algorithms are used in this study.

Algorithms in ML are categorized as supervised or unsupervised. In supervised learning, the method takes a dataset with different parameter values and results/classification paired with their corresponding outputs called target as input and from which it concludes a mathematical function, which maps an input parameters to an output value. Training is a phase of constructing a model from the training set. After this, the model can give new output for new inputs, even though for inputs not existing in the training set.

Ahn and Kim [1] offered a hybrid model in bankruptcy prediction. Case-based reasoning and genetic algorithm were used in their studies. The study results showed that prediction accuracy of conventional case-based reasoning may be improved significantly by using genetic algorithm [1].

Kotsiantis et al. [2] compared machine learning algorithms. They applied naive Bayes, ocal decision stump, RIPPER, decision tree (C4.5), sequential minimal optimization and neural network (RBF algorithm). It was found that learning algorithms can predict bankruptcy with satisfying accuracy [2].

Barboza et al. [3] compared the performances of the machine learning algorithms with neural network and statistical techniques. SVM, boosting, bagging and random forest were used as a machine learning algorithms. Their study result showed that bagging, boosting and random forest outperform to others [3].

Wang [4] used SVM, neural network with dropout and autoencoder machine learning algorithms in bankruptcy prediction. Researcher also compared the performances of these algorithms with logit, genetic algorithm and inductive learning. As a result of the study SVM, neural network with dropout and autoencoder accuracies outperforms to other models [4].

The rest of the paper is planned in four sections. Section 2 introduces types of linear regression. Sect. 3 is preprocessing of data, in which we identify the continuous and categorical variables. This section also identifies the variables that are not relevant or not contributing more to the analysis. Section 4 presents the results of linear regression and random forest algorithms on the processed data. Section 5 is a conclusion on the results presented in previous section and future scope.

2 Classification Techniques

Linear regression is a supervised machine learning algorithm which is intended to predict the value of a continuous variable [5]. This method is used to predict values from a continuous range, like cost of a product, income of a customer.

2.1 Simple Regression

A simple linear regression is a statistical regression technique that shows the relationship between an independent and a dependent variable. The equation denoted for this regression is [6]

$$y = mx + c \tag{1}$$

where y and x are dependent and independent variables, and m and c act as the slope of the line and y-intercept.

2.2 Multiple Linear Regression

This is a statistical technique used to describe the connection among more than one independent variables to a response variable predict its value. The equation for multiple regression is [7]

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_1 x_{i2} + \cdots + \beta_p x_{ip} + \in \tag{2}$$

where y_i and x_i are dependent and explanatory variables, β_0 and β_p are y-intercept and slope coefficients for each explanatory variable, and $\in$ is model's error term.

2.3 Random Forest Improve Control

Random forest is an improved form of decision tree algorithm and is presented by Breiman [8]. The random forest method is an estimator to fit a number of classifying decision trees on several sub-samples of the dataset. This method uses an averaging technique to increase the predictive accuracy and also to regulate over fitting. Mean squared error (MSE) and root mean squared error (RMSE) are used to access the quality of this regression [9].

3 Data Preprocessing

3.1 Preparing the Data

The quality of the output of the regression depends on how quality the input is. The quality can be increased by using the following heuristics [10]

1. Linear assumption
2. Removing noise
3. Remove correlated variables
4. Gaussian distributions
5. Normalizing the input variables.

3.2 Dataset Source and Contents

The dataset used for analysis is about the pre-owned cars. The dataset consists of several variables that describe the car—price, condition of the car, seller details, specification details, registration, Web advertisement details, make, model, fuel type, etc. Several constraints were placed on the selection of these instances from a larger database. The problem is to predict the cost of the cars by considering various attributes associated with the car. The following are the statistics about the dataset.

No. of variables: 19
No. of instances: 50001

Before going to analyze the dataset, it has to undergo an important preprocessing stage. This phase is to identify the variables with missing data, variables that does not contribute in the analysis, fill the gaps with relevant data, etc. The preprocessing stage is to study and understand the data. Following are the Python libraries to be imported to interact with the data.

Let us start by reading in the pre_owned_cars_data.csv file into a data frame using pandas.

```
cars_data=pd.read_csv("pre_owned_cars_data.csv", header=0)
cars_data.info()
print (cars_data.head())
```

Among the 19 variables of the dataset, six are of integer type—continuous variables and the remaining 11 are of object type—categorical variables.

The categorical variables—“name”, “postalCode”, “dateCrawled”, “dateCreated”, “lastSeen” are unwanted variables for the analysis and will be dropped for the next steps.

3.3 Data Analysis and Visualization of Continuous Variables

In this section, the variables are analyzed and cleaned.

1. Remove any duplicate records.
2. Identify outliers in the continuous variables.
3. Reduce the range.

From the observation, it is found that following variables are having outliers and so the range is to be rearranged as

yearOfRegistration	1950 – 2018
price	100 – 150000
powerPS	10 – 500

This command removes approximately 6700 rows from the dataset. Further, the variable “yearOfRegistration” and “monthOfRegistration” are combined by adding a new variable “age” and dropping these two variables. This variable is created by the following command

```
cars_copy [‘age’]   = (2018-cars_copy[’yearOfRegistration’])+
                      cars_copy[‘monthOfRegistration’]/12
cars_copy [‘age’]   = round (cars_copy[’age’],2)
```

Figure 1 shows the visualization of the variables—age, price and powerPS using distribution and box plot after narrowing the data. Because of narrowing the data, the outliers in these variables are removed. Before this stage, these variables are having more outliers and due to that the box plots are not even visible with the box. Even the distribution plots are widespread due the outliers.

Figures 2 and 3 show the regression plot for age vs price and powerPS versus price. These plots clearly indicate that the price value increases with age and also with powerPS variables. This indicates that these variables influence the price and

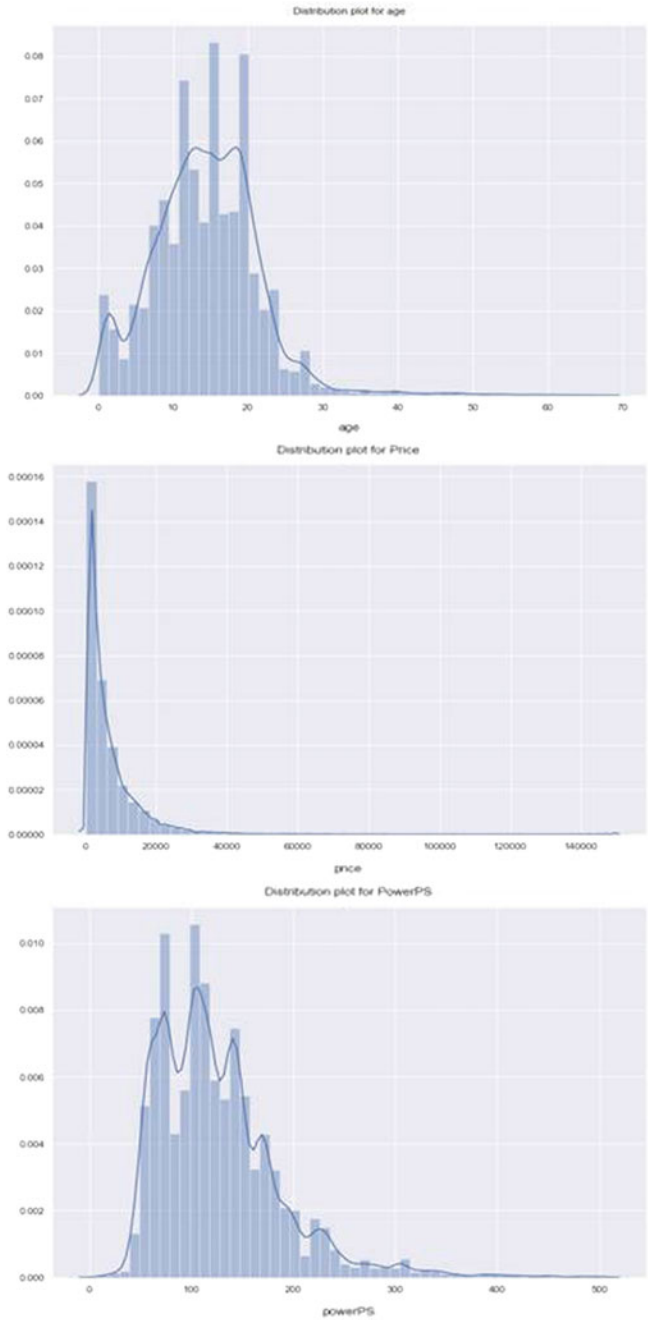


Fig. 1 Visualization of variables—age, price, powerPS

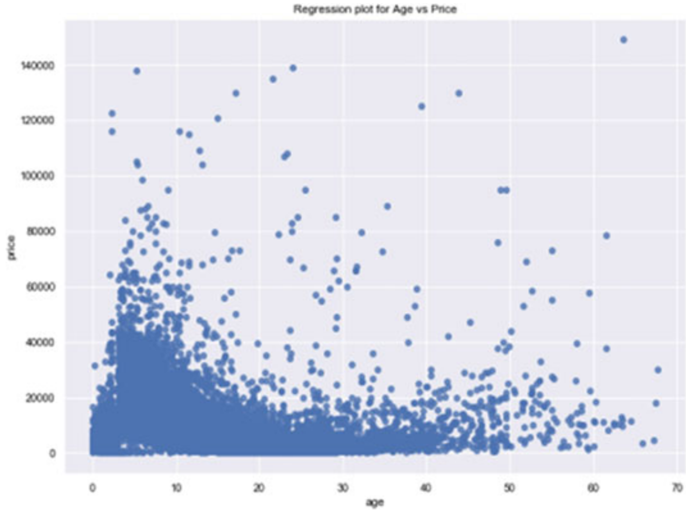


Fig. 2 Regression plots—age versus price

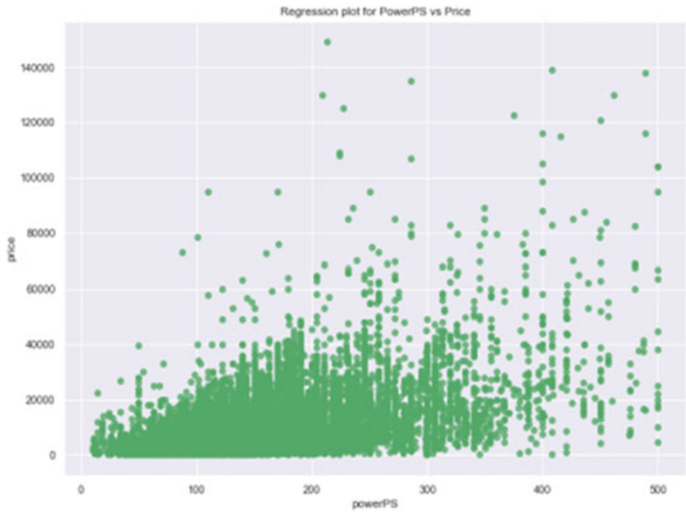


Fig. 3 Regression plots—powerPS versus price

these are to be retained in the analysis. Even though the price and powerPS variables are narrowed, they still have some outliers. Based on the quality of analysis result, again we can come back to this stage to check the possibility for further limiting the range of these variables.

It is clear that the cars priced higher are newer and with increase in age, the price decreases. Similarly, the cars price also increases with powerPS.

3.4 Data Analysis and Visualization of Categorical Variables

The dataset consists of several categorical variables, in which some are contributing more and some are contributing less for the analysis. This section is to study these variables and identify those are to be ignored for further analysis. The variables seller, offerType and abtest are influencing less on the deciding variable price and are decided to drop these variables for further analysis.

remove_cols = [“seller’, ‘offerType’, ‘abtest’]
cars_copy=cars_copy.drop (columns = remove_cols, axis=1)

From the study, it was observed that the categorical variables vehicleType, gearbox, model, fuelType, brand, notRepairedDamage are influencing more on the deciding variable price. The following plots in Fig. 4 show how these categorical variables influence the price. Commands used to plot these using seaborne

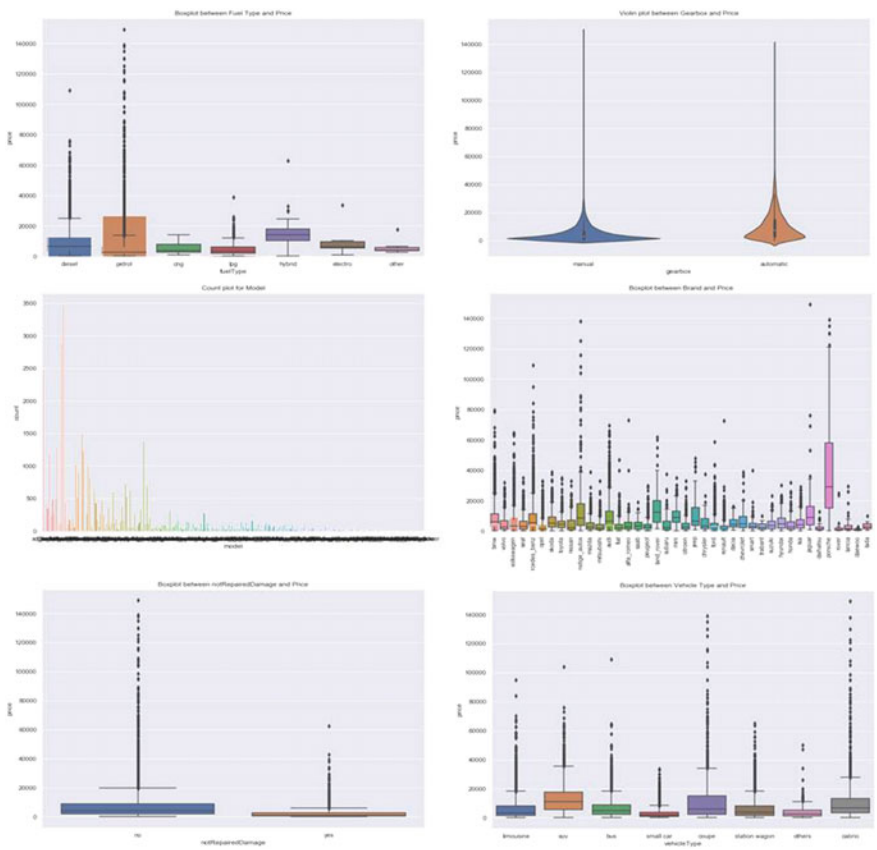


Fig. 4 Categorical variables versus price

```
Temp=sns.boxplot (x='vehicleType', y='price', data=cars_copy)
temp.set_title ("Boxplot between Vehicle Type and Price")
temp=sns.violinplot (x='gearbox', y='price', data=cars_copy)
temp.set_title ("Violin plot between Gearbox and Price")
temp=sns.countplot (x='model', data=cars_copy)
temp.set_title ("Count plot for Model")
temp=sns.boxplot (x='fuelType', y='price', data=cars_copy)
temp.set_title ("Boxplot between Fuel Type and Price")
temp=sns.boxplot (x='brand', y='price', data=cars_copy)
temp.set_title ("Boxplot between Brand and Price")
temp=sns.boxplot (x='notRepairedDamage', y='price', data=cars_copy)
temp.set_title ("Boxplot between notRepairedDamage and Price")
```

4 Classification Models

This section is to implement two classification models—linear regression and random forest on the data. Before applying these models, we need to study the correlation between the price and continuous variables. The importance of this study is to identify any positive correlations between any variables, so that they can be ignored for further study. The correlation of price with other variables is

powerPS	0.575
kilometer	0.440
age	0.338

This shows that these are not much correlated, and they can be considered for further study. Drop the rows having missing values and convert the categorical variables to dummy variables. As the rage of the deciding variable price is high (100–149,500), it is better to convert into logarithmic value (4.60517–11.9117).

The data is split into train data, test data in 70:30 ratio using the *train_test_split* command with random_state set to 3.

The base root mean square error (RMSE) is calculated, and 1.1274483657478247 is set as benchmark, and the models performance is evaluated based on this value.

4.1 Linear Regression

The linear regression model is useful to the data with the following commands.

```
Lgr = LinearRegression (fit_intercept=True)
model_lin1 = lgr.fit (x_train, y_train)
```

cars_predictions_lin1 =
lgr.predict(x_test)random_state=3)

The result generated is

Mean Square Error is: 0.29649809164246754
Root Mean Square Error is: 0.5445163832635962
Test data R Squared value: 0.7667462795378981
Train data R Squared value: 0.780728326697251.

The regression plot clearly indicates that the price values lie around 0 with some outliers.

4.2 Random Forest

Random forest model is applied with the following commands

rf = RandomForestRegressor (n_estimators=100, max_features=‘auto’,
max_depth=100, min_samples_split=10, min_samples_leaf=4, random_state=1)
model_rf1 = rf.fit (x_train,y_train)

The results are,

Mean square error is 0.18854487163991981
Root mean square error is 0.4342175395351042
Test data R squared value is 0.8516725941120302
Train data R squared value is 0.9201854511589997.

The regression plot clearly indicates that the price values lie around 0 with some outliers.

5 Conclusion

The objective of this paper is to design a classification model to predict the price of pre-owned cars using decision variables which include continuous and categorical variables. In preprocessing, some of the variables are eliminated from the dataset which were not contributing to the classification. In this paper, the dataset is predicted over two classification methods—linear regression and random forest. In these two methods, random forest method fits more to the test data comparing to the linear regression. This can be extended by replacing the missing values with some imputed values.

References

1. Kim K, Ahn H (2009) Bankruptcy prediction modeling with HCB reasoning and GA approach. ASC 599–607
2. Tampakas V, Tzelepis D, Kotsiantis S (2005) Efficiency of ML techniques in bankruptcy prediction. ICESA
3. Barboza F, Altman E, Kimura H (2017) ML models and bankruptcy prediction. ES Appl 83;405–417
4. Wang N (2017) Bankruptcy prediction using ML. JMF 908–918
5. Satish GN, Raghavendran Ch et al (2019) House price prediction using ML. IJITEE 8:717–722
6. https://medium.com/datadriveninvestor/machine-learning-algorithms-linear-regression-f89ab64ac490
7. https://medium.com/simple-ai/linear-regression-intro-to-machine-learning-6-6e320dbdaf06
8. Breiman L (2001) Random forests. ML 45(1):5–32
9. https://acadgild.com/blog/random-forest-algorithm-regression
10. https://machinelearningmastery.com/linear-regression-for-machine-learning

Bio-inspired High-Utility Item Framework based Particle Swarm Optimization Tree Algorithms for Mining High Utility Itemset

V. Jeevika Tharini and S. Vijayarani

Abstract Interestingness measures play a significant part in data mining and intended for selecting or ranking patterns relevant to the latent interest of users. Utility mining is a method of finding a high utility itemset (HUIs) from a database. Recently, bio-inspired algorithms had attracted considerable attention in many areas which led the evaluations of the new algorithm, and it has shown excellent performance. In this work, high-utility itemset framework-based particle swarm optimization (HUIF-PSO) is improved using the frequent pattern tree structure to retrieve HUIs effectively. Improved HUIF-PSO is compared with HUIF-PSO, high-utility itemset framework-based genetic algorithm (HUIF-GA) and high-utility itemset framework-based bat algorithm (HUIF-BA). The HUI's count, memory and time usage are tested, and the outcome displays that the HUIF-PSO tree algorithm performs better than existing algorithms.

Keywords Utility mining · High-utility itemset · Bio-inspired algorithm · Particle swarm optimization · Frequent pattern tree structure

1 Introduction

In data mining [1], frequent itemset mining (FIM) is a indispensable task in most of the applications. FIM spots the itemsets that repeatedly occur in a transactions [2]. FIM excludes the least occurrence item but have high significant value. To tackle shortcomings of FIM, the problem of FIM has been redefined as high-utility itemset mining (HUIM). In utility mining, every item has its profit and can occur multiple times in one transaction. HUIs utility is not lower when compared with the user-specified threshold. Many variances of the mining algorithm have been projected for the revelation of HUIs. The methods of HUIM compress the volume of the

V. Jeevika Tharini (✉) · S. Vijayarani
Department of Computer Science, Bharathiar University, Coimbatore, India
e-mail: jeevi153gv@gmail.com

S. Vijayarani
e-mail: vijimohan_2000@yahoo.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_31

database, and the quantity of a distinct item is increased. HUIM considers each item's utility (e.g., unit profit, quantity) and retrieves such itemsets [3–5]. HUIM is a prevalent data mining task for determining beneficial patterns in the customer purchase database and consists of discovering itemset that earns a high utility that is high utility itemset [5, 6]. HUIM has applications in other domains also, namely biomedicine and clickstream analysis [7–9].

2 The Proposed Frame Work

Let $I = \{m_1, m_2, m_3 \ldots m_n\}$ is a group of n individual items with a transaction $T = \{t_1, t_2, t_3 \ldots t_n\}$ where every transaction lies within $T_r \in$ DB. In this, T_r is a subunit of I and r is the identity of transaction. Count of the purchased items is represented as an internal utility in Table 1, and the profit of the item is represented as an external utility value that is given in Table 2. In accordance with a user preference, the least utility rate α is assigned. Elucidated an illustration in this article which is stated with 10 transactions and 5 items AA to EE.

Definition 1 The utility of m_j in the transaction T_r is signified as uti(m_j, T_r) and denoted as

$$\mathrm{uti}\left(m_j, T_r\right) = r\left(m_j, T_r\right) \times \mathrm{pr}\left(m_j\right)$$

Example Utility rate of AA in the transaction A_1 is estimated as

$$\mathrm{uti}(\mathrm{AA}, \mathrm{A2}) = r(\mathrm{AA}, \mathrm{A}_2) \times \mathrm{pr}(\mathrm{AA})\, r(6 \times 9) = 54$$

Definition 2 The utility of m_j in the data store DB is signified as uti(m_j) and denoted as

$$\mathrm{uti}\left(m_j\right) = \mathrm{uti}\left(m_j, A_p\right) + \cdots + \mathrm{uti}(m_n, A_n)$$

Example Utility rate of AA in the data store DB is estimated as

$$\begin{aligned}\mathrm{uti}(\mathrm{AA}) &= \mathrm{uti}(\mathrm{AA}, \mathrm{A}_2) + \mathrm{uti}(\mathrm{AA}, \mathrm{A}_6) + \mathrm{uti}(\mathrm{AA}, \mathrm{A}_7)\\ &\quad + \mathrm{uti}(\mathrm{AA}, \mathrm{A}_9) + \mathrm{uti}(\mathrm{AA}, \mathrm{A}_{10})\\ &= 54 + 9 + 90 + 9 + 54 = 216\end{aligned}$$

Definition 3 The utility of L in the transaction T_r is signified as uti(L, $\mathrm{T_r}$) and denoted as

$$\mathrm{uti}(L, T_r) = \sum_{m_j L \nu L \subseteq T_r} \mathrm{uti}\left(m_j, T_r\right)$$

Table 1 Quantitative data store

Tid	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
I-AA	0	6	0	0	0	1	10	0	1	6
I-BB	0	1	0	1	0	0	1	3	0	0
I-CC	0	1	0	0	0	0	0	0	3	4
I-DD	1	0	2	0	0	0	0	3	1	0
I-EE	1	1	1	1	2	0	1	1	0	2
I-FF	18	0	1	0	4	0	0	25	0	2

Table 2 Profit values

Item	Profit
AA	9
BB	5
CC	1
DD	3
EE	6
FF	1

Example Utility rate of AA in the transaction A_2 is estimated as

$$\text{uti}(\text{AABB, A2}) = \text{uti}(\text{AA}, \text{A}_1) + \text{uti}(\text{BB}, \text{A}_1) = 54 + 5 = 59$$

Definition 4 The utility of L in the data store DB is signified as uti(L) and denoted as

$$\text{uti}(L) = \sum_{L \subseteq T_r \nu T_r \subseteq \text{DB}} \text{uti}(L, T_r)$$

Example Utility rate of AABB in the data store DB is estimated as

$$\text{uti}(\text{AABB}) = \text{uti}(\text{AABB, A2}) + \text{uti}(\text{AABB, A7}) = 54 + 95 = 149$$

Definition 5 The transaction utility T_r is signified as tu and denoted as

$$\text{tu}(T_r) = \sum_{L \subseteq T_r} \text{uti}(L, T_r)$$

Example Utility value of tu in the transaction T_r is estimated as

$$\text{tu}(\text{A1}) = \text{tu}(\text{D}, \text{A}_1) + \text{tu}(\text{E}, \text{A}_1) + \text{tu}(\text{G}, \text{A}_1) = 4 + 12 + 5 = 21$$

Definition 6 The total tu (tltu) of a transaction T_r is signified as tu and denoted as

$$\text{tltu} = \sum_{T_r \in \text{DB}} \text{tu}(T_r)$$

Example Utility value of tu in the data store DB is estimated as

$$\text{tu} = 216 + 30 + 9 + 21 + 60 = 336$$

The process of HUI's and the relative utility value is retrieved from the transactional database with the incorporation of optimization algorithms. The chief feature of HUIM-PSO-tree from DB is to identify the set of HUIs.

Table 3 HTWUIs

Item	AA	BB	CC	DD	EE	FF
TWU	264	233	162	110	361	183
HTWUIs	Yes	Yes	Yes	No	Yes	Yes

Pre-processing phase: HUIF-PSO-tree is the exploration behavior of the fish or birds. Every particle in the solution space passes to the optimal value. With the help of the TWU model, unpromising items are removed and the threshold valued is also calculated.

$$\text{Minimum threshold value } (\alpha) = 385 \times 0.3 = 115.5$$
$$\alpha = 115.5$$

HTWUIs are evaluated using the TWU model. Every item poses the individual utility rate and added in every transaction that gives tu. Identified HTWUIs value is shown in Table 3. By the estimation of initial population, particles are generated in the solution space of L_i, DB.

$$\begin{aligned}\text{HTWUI(DD)} &= \text{DD}[(\text{A1}) + (\text{A2}) + (\text{A3}) + (\text{A6}) + (\text{A7})] \\ &= 21 + 22 + 46 + 16 + 31 = 136\end{aligned}$$

Based on the identification of HTWUIs in accordance with the minimum threshold, the population of the particles is dispersed in the data store of DB. HTWUIs are further used for the construction of tree and candidate item generation.

Particle generation phase: The process of candidate generation is accomplished using the frequent pattern tree (FP-tree). It is an effective method of candidate generation with high scalability. The FP-tree is a pattern of fragment growth, and it stores the most need information. The FP-tree reads the entire data only twice to construct a tree which is the foremost advantage. The utilization of memory is also compact and hence, efficiency is achieved in FP-tree. The item satisfying the minimum support count is used in the tree construction. From the tree, candidate items are generated. EEFF, EEFFBB, EEBB, EEAA, EEAABB, AA, FFBB, AABB and AAFF are the generated items through FP-tree. The following Figs. 1 and 2 show the tree construction procedure.

Evaluation phase: The fitness function is evaluated with each particle (items) in the evaluation phase. Particles in the population are tested with fitness value, and the particle having a value greater than fitness value is called as HUI.

$$\text{Fitness}\big(\text{Prt}_j\big) = U(L)$$

Updation phase: After the evaluation phase, traditional PSO approach is initiated to revise the velocity. Every particle in the solution space passes to the optimal value in accordance with the following equation:

Items with transaction

Tid	Items
1	EE,FF
2	AA,BB,CC,EE
3	EE,FF
4	BB,EE
5	EE,FF
6	AA,CC
7	AA,BB,EE
8	BB,EE,FF
9	AA,CC
10	AA,CC,EE,FF

Item	Support
AA	5
BB	4
CC	3
EE	8
FF	5

Min_Sup = 4

Ordered Item

Item	Support
EE	8
AA	5
FF	5
CC	3

Tid	Items
1	EE,FF
2	EE,AA,BB
3	EE,FF
4	EE,BB
5	EE,FF
6	AA
7	EE,AA,BB
8	EE,FF, BB
9	AA
10	EE,AA,FF

Fig. 1 Ordering of transaction item

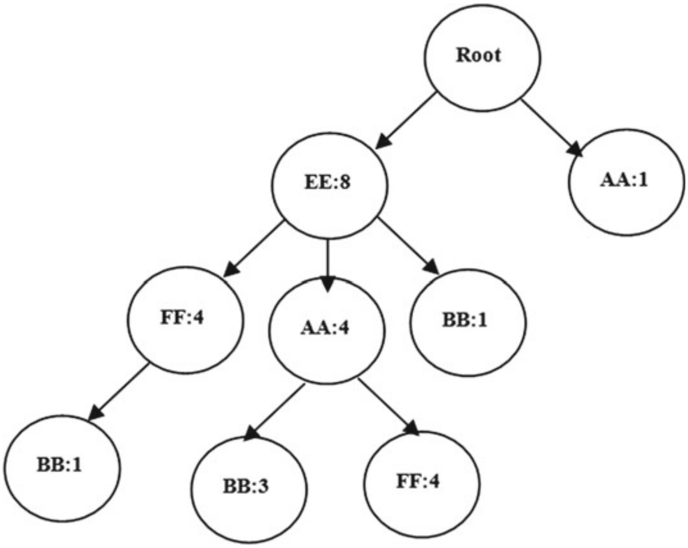


Fig. 2 Tree construction

$$v_i^{t+1} = wv_i^t + c_1 rd_1\left(\text{pbest}_i - x_i^t\right) + c_2 rd_2\left(\text{gbest} - x_i^t\right)$$
$$x_i^{t+1} = x_i^t + v_i^{t+1}$$

where v_i^t and v_i^{t+1} are velocities of the items in the data store to the corresponding iterations of t and $t+1$, w is considered as a social factor, c_1 and c_2 are constant values, rd_1 and rd_2 are random numbers that range from 0 to 1. From the HUIF-PSO-tree, particles in the data store are updated repeatedly and the condition is truncated once the particle attains the minimum satisfying criterion.

Algorithm 1. HUIF-PSO-tree

```
Input: Transaction Database DB, minimum utility mini_utility, iteration count maxi_ite;
Output: HUI's
Initi();
Count = 1 &&gbest =  0
build FP-tree to set particle dimension
while count < maxi_ite do
for I = 1 to n then
   if (count == 1) then
     pbest_i = P_i
   end if
Itemset = P_i
if (u(itemset)≥mini_utility) then
        a.    Initialize particle relevant to FP-tree
        b.    Itemset → HUI;
end if
if (u(itemset)>u(pbest_i)) then
        a.    Initialize particle relevant to FP-tree
        b.    pbest_i = P_i
end if
end for
Time ++
end while
Output HUIs
```

Pseudocode for HUIF-PSO-Tree

3 Performance Evaluation

HUIF-PSO-tree is compared with existing algorithm HUIF-PSO, HUIF-GA and HUIF-BA algorithms. Two benchmark datasets retail and chess are used in this experiment. Execution time, memory usage and HUI count are analyzed. Table 4 shows the dataset characteristics, and Tables 5, 6 and 7 show the experimental results (Figs. 3, 4 and 5).

Table 4 Dataset information

S. no.	Dataset	Item occurence	Occurence of item in transaction
1	Chess	3196	37
2	Retail	88,162	10

Table 5 Time usage of retail and chess dataset

Algorithm	Retail dataset				Chess dataset			
Threshold	HUIF-BA	HUIF-GA	HUIF-PSO	PSO-tree	HUIF-BA	HUIF-GA	HUIF-PSO	PSO-tree
50	327,695	228,982	70,953	67,825	57,823	366,404	160,484	87,655
45	331,015	324,445	63,229	65,498	58,284	475,899	69,115	67,535
40	230,591	332,987	50,357	65,771	62,331	619,708	158,401	77,656
35	338,885	345,129	63,687	55,412	68,123	654,080	91,208	75,785
30	302,617	338,972	58,673	51,766	71,231	571,938	118,491	87,654

Table 6 Memory usage of retail dataset and chess dataset

Dataset	Retail dataset				Chess dataset			
Algorithm	HUIF-BA	HUIF-GA	HUIF-PSO	PSO-tree	HUIF-BA	HUIF-GA	HUIF-PSO	HUIF- PSO-tree
T-50	18.67	15.87	10.87	11.67	36.08	47.39	35	31.99
T-45	18.98	15.88	15.16	11.09	38.69	48.96	36.77	30
T-40	21.14	15.34	14.75	10.87	39.56	49.9	39.82	32.76
T-35	22.14	14.89	14.26	10.65	45.34	40.11	50.67	29.46
T-30	19.36	13.11	10.47	10.01	46.34	51.93	52.49	27.54

Table 7 High utility item count of retail dataset

Algorithm	Retail dataset				Chess dataset			
Threshold	HUIF-BA	HUIF-GA	HUIF-PSO	PSO-tree	HUIF-BA	HUIF-GA	HUIF-PSO	PSO-tree
50	5829	6487	6381	6543	8821	8998	8771	8857
45	6055	6554	6151	6654	8919	8982	8812	8919
40	5967	6561	6101	6239	7798	7670	7512	7604
35	6123	6785	6876	6801	7629	7883	7874	7575
30	6258	6109	6469	6198	7592	7486	7375	7493

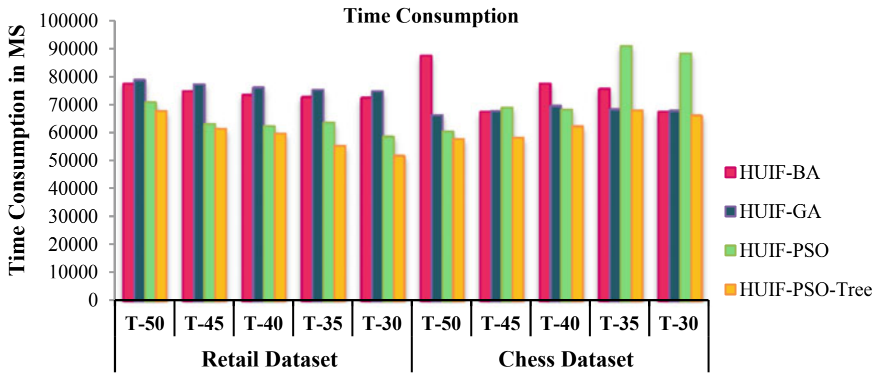


Fig. 3 Displays the time consumption (milliseconds) and HUIF-PSO generated the HUI's in a minimal time and outperforms the existing algorithms

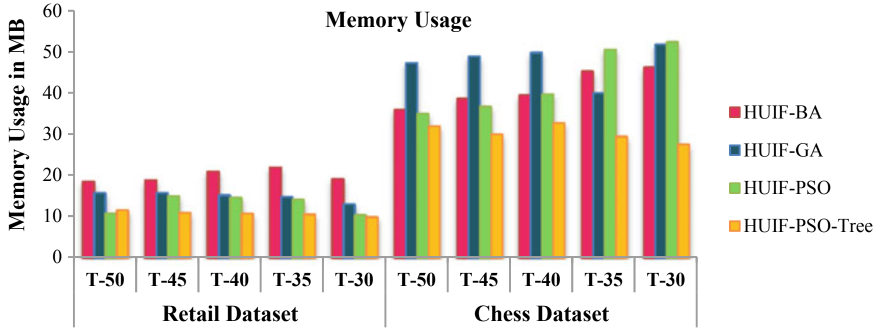


Fig. 4 Displays the memory usage (megabyte) and HUIF-PSO generated the HUIs by minimum memory utilization and outperforms the existing algorithms

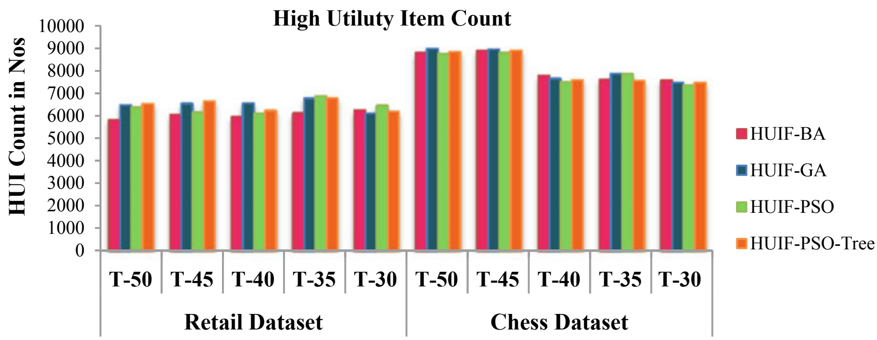


Fig. 5 Display the HUI count (nos) and HUIF-PSO generates same numbers of HUIs as in the existing and outperforms the existing algorithm

4 Conclusion

Retrieving HUIs from a transaction data store is utilized to identify the most profitable itemsets in retail or supermarkets. Utility mining is incorporated in identifying the itemset with huge profit. It includes the earnings and count of each item. HUIF-PSO algorithm is developed using FP-tree that extracts the HUIs efficiently. HUIF-PSO-tree is tested with the available algorithm. Test results display that the HUIF-PSO-tree performs well than the existing HUIF-PSO, HUIF-GA and HUIF-BA algorithms.

References

1. Shie B-E, Cheng J-H, Chuang K-T, Tseng VS (2012) A one-phase method for mining high utility mobile sequential patterns in mobile commerce environments. In Proceedings of 25th international conference on industrial, engineering and other applications of applied intelligent systems, pp 616–626
2. Agrawal R, Srikant R (1994) Fast algorithms for mining association rules in large databases. In: Proceedings of International Conference on Very Large Databases, pp 487–499
3. Ahmed CF, Tanbeer SK, Jeong B-S, Lee Y-K (2009) Efficient tree structures for high-utility pattern mining in incremental databases. IEEE Trans Knowl Data Eng 21(12):1708–1721
4. Yun U, Ryang H, Ryu KH (2014) High utility itemset mining with techniques for reducing overestimated utilities and pruning candidates. Expert Syst Appl 41(8):3861–3878
5. Fournier-Viger P, Wu C-W, Zida S, Tseng VS (2014) Faster high-utility itemset mining using estimated utility co-occurrence pruning. In: Proceedings of 21st international symposium on methodologies for intelligent systems. Springer, Berlin, pp 83–92
6. Lan G-C, Hong T-P, Tseng VS (2011) Discovery of high utility itemsets from on-shelf time periods of products. Expert Syst Appl 38:5851–5857
7. Yun U, Kim J (2015) A fast perturbation algorithm using tree structure for privacy preserving utility mining. Expert Syst Appl 42(3):1149–1165
8. Lan G-C, Hong T-P, Tseng VS (2014) An efficient projection-based indexing approach for mining high utility itemsets. Knowl Inf Syst 38(1):85–107
9. Lin C, Hong T, Lan G, Wong J, Lin W (2015) Efficient updating of discovered high-utility itemsets for transaction deletion in dynamic databases. Adv Eng Informat 16–27

On Atom–Bond Connectivity Invariant of Graphs

K. Pattabiraman

Abstract Molecular graph is frequently known through molecules and their compounds. By means of graph theory, the molecular graph is a representation of the structural formula of a chemical compound, whose vertices correspond to the atoms of the compound and connected with a graph which characterize the properties of a graph. Molecular descriptors play a significant role in mathematical chemistry, in particularly QSPR/QSAR studies. Among them, a special place is received for so-called topological invariants. The atom–bond connectivity invariant is a great significant topological invariant applied to estimate the chemical properties for compounds, drugs, and nanomaterials. This is devoted to find article of the formulae for fourth atom–bond connectivity invariant of bridge graph and few types of carbon nanocones.

Keywords Topological invariant · ABC invariant · Bridge graph · Nanocone

1 Introduction

Graph theory brings many types of tools to investigate the structures and properties of molecule. Molecular graph is frequently known through molecules and their compounds. In view of graph theory, the molecular graph is a representation of the structural formula of a chemical compound, whose vertices correspond to the atoms of the compound and connected with a graph which characterize the properties of a graph. There are several types of topological invariants based on distance and degree of the graphs and counting-related polynomials of graphs; among them, degree-based topological invariants are mainly treated in chemistry. Wiener [9] first introduced the concept of topological invariant while he was working on boiling point of paraffin. The Wiener invariant is the most prominent distance-based topological invariant, from both theoretical and application points of view.

K. Pattabiraman (✉)
Department of Mathematics, Government Arts College (A), Kumbakonam 612002, India
e-mail: pramank@gmail.com

Department of Mathematics, Annamalai University, Annamalai Nagar 608002, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_32

Atom–bond connectivity invariant is one of the widely known topological invariants based on degree studied by Estrada et al. [3], and it is defined for a connected graph $\Re$ as $ABC(\Re) = \sum_{ab\in E(\Re)} \frac{\delta_{\Re}(a)+\delta_{\Re}(b)-2}{\delta_{\Re}(a)\delta_{\Re}(b)}$, where $\delta_{\Re}(a)$ denotes the degree of a in $\Re$, that is, total number of edges incident to a in $\Re$. In [10], variant upper bounds for the ABC invariant of graphs with other graph parameters were given. The ABC invariant can be used for modeling thermodynamic properties and structures of organic chemical compounds which are given in [2, 3, 5]. Trees and their properties of ABC invariant were studied in [7, 8].

Lately, Ghorbani et al. [4] investigated a new type of invariant called fourth atom–bond connectivity invariant which is defined for a connected graph $\Re$ as $ABC_4(\Re) = \sum_{ab\in E(\Re)} \frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}$, where $\Gamma(a)$ is the sum of degrees of all vertices join to the vertex a, that is, $\Gamma(a) = \sum_{b\in N_{\Re}(a)} \delta_{\Re}(b)$, where $N_{\Re}(a)$ is the set of all neighbors of a, that is, $N_{\Re}(a) = \{b \in V(\Re) | ab \in E(\Re)\}$. In [1, 6], the ABC_4 invariant for various classes of chemical graphs such as silicate, chain silicate, fullerene network, oxide, carbon nanotube, honeycomb, and hexagonal networks was discussed. Pertaining to this matter, we have obtained the formulae for fourth atom–bond connectivity invariant of bridge graph and some types of carbon nanocone $CNC_t(s)$.

2 Bridge Graph

In this section, we find the several results for ABC_4 invariant of bridge graphs. Let $R = \{r^1, r^2, \ldots, r^k\}$ be a subset of $V(G)$. We know that

$$ABC_4^{\{r_1,r_2,\ldots r_k\}}(\Re) = ABC_4(\Re) = \sum_{ab\in E(\Re), x,y\notin R} \frac{\Gamma(x)+\Gamma(y)-2}{\Gamma(x)\Gamma(y)}.$$

One can see that if R is empty, then $ABC_4^R(\Re) = ABC_4(G)$.

Let $\Re_i, i \in \{1, 2, \ldots, t\}$ be some graphs and $a_i \in V(\Re_i)$. The bridge graph $B = \Re(\Re_1, \Re_2, \ldots, \Re_t, a_1, a_2, \ldots, a_n)$ which can be obtained as the union of the graphs $\Re_i, i \in \{1, 2, \ldots, t\}$ via connected edges $a_i a_{i+1}, i \in \{1, 2, \ldots, t-1\}$. Further, the bridge graph $B = \Re(\Re_1, \Re_2, \ldots, \Re_t, x_1, x_2, \ldots, x_n)$ is connected if and only if $\Re_i, i \in \{1, 2, \ldots, t\}$ are connected. One can observe that the number of vertices and edges of the bridge graph B is $\sum_{i=1}^t |V(\Re_i)|$ and $\sum_{i=1}^t |E(\Re_i)| + (t-1)$, respectively. From the construction of the bridge graph, we have the following;

- If $a \in V(\Re_i)$ and $a \neq a_i$, then $\delta_{\Re}(a) = \delta_{\Re_i}(a)$.
- If $a = a_i$ and $i \in \{1, n\}$, then $\delta_{\Re}(a) = \delta_{\Re_i}(a) + 1$.
- If $a = a_i$ and $i \in \{2, \ldots, t-1\}$, then $\delta_{\Re}(a) = \delta_{\Re_i}(a) + 2$.

The following lemma is easily obtained from the construction of the bridge graph.

Lemma 1 *Let $B = \Re(\Re_1, \Re_2, \ldots, \Re_t, a_1, a_2, \ldots, a_t)$ be a bridge graph and $N_{\Re}[a] = N_{\Re}(a) \cup \{a\}$ for each $a \in V(\Re)a$. If $a_i \in V(\Re_i)$ and $a_i \notin N_{\Re_i}[a]$, then $\Gamma_{\Re}(a) = \Gamma(a)$ and $S\Gamma_{\Re_i}(a) = \sum_{b\in N_{\Re_i}(a)} \delta_{\Re_i}(b)$.*

Theorem 2 *Let* $R = \{r_1, r_2, \ldots, r_k\} \subseteq \mathrm{V}(\Re)$ *and suppose* $r_1, r_2, \ldots, r_k \notin R$. *For bridge graph* $B = \Re(\Re_1, \Re_2, \ldots, \Re_t, a_1, a_2, \ldots, a_t)$*, we have*

$$
\begin{aligned}
ABC_4^{\{r_1,r_2,\ldots,r_k\}}(\Re) &= \sum_{i=1}^{t} ABC_4^{R\cup N_{\Re_i}[a_i]}(\Re_i)\\
&+ \sum_{i=1}^{t} \sum_{ab\in E(\Re_i),\ ab\notin R, a\in N_{\Re_i}[a_i]} \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}}\\
&+ \sum_{i=1}^{t-1} \frac{\Gamma(a)+\Gamma(a_{i+1})-2}{\Gamma(a_i)\Gamma(a_{i+1})}.
\end{aligned}
$$

Proof By using the definition of fourth ABC invariant, we have

$$
\begin{aligned}
ABC_4^{\{r_1,r_2,\ldots,r_k\}}(\Re) &= s \sum^{t}_{ab\in E(\Re),\ ab\notin R} \sum \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}}\\
&+ \sum_{i=1}^{t} \sum_{ab\in E(\Re),\ ab\notin R} \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}}\\
&+ \sum_{i=1}^{t-1} \frac{\Gamma(a)+\Gamma(a_{i+1})-2}{\Gamma(a_i)\Gamma(a_{i+1})}.\\
&= \sum_{i=1}^{t} \sum_{ab\in E(\Re),\ ab\notin R\cup N_{\Re_i}[b_i]} \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}}\\
&+ \sum_{i=1}^{t} \sum_{ab\in E(\Re),\ ab\notin R, a\in N_{\Re_i}[b_i]} \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}}\\
&+ \sum_{i=1}^{t-1} \frac{\Gamma(a)+\Gamma(a_{i+1})-2}{\Gamma(a_i)\Gamma(a_{i+1})}.\\
&= \sum_{i=1}^{t} ABC_4^{R\cup N_{\Re_i}[b_i]}(\Re_i)\\
&+ \sum_{i=1}^{t} \sum_{ab\in E(\Re_i),\ ab\notin R, a\in N_{\Re_i}[b_i]} \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}}\\
&+ \sum_{i=1}^{t-1} \frac{\Gamma(a)+\Gamma(a_{i+1})-2}{\Gamma(a_i)\Gamma(a_{i+1})}.
\end{aligned}
$$

By setting $n = 2$ in above theorem, we obtain the following corollary.

Corollary 3 *For*

$$B = \Re(\Re_1, \Re_2, v_1, v_2)(R = \{r_1, r_2, \ldots, r_k\} \subseteq V(\Re), a_1, a_2 \notin R),$$

we have

$$\begin{aligned} ABC_4^{\{r_1,r_2,\ldots,r_t\}}(\Re) &= \sum_{i=1}^{2} ABC_4^{R\cup N_{\Re_i}[b_i]}(\Re_i) \\ &+ \sum_{i=1}^{2} \sum_{ab\in E(\Re_i),\ ab\notin R, a\in N_{\Re_i}[b_i]} \sqrt{\frac{\Gamma(a)+\Gamma(b)-2}{\Gamma(a)\Gamma(b)}} \\ &+ \sqrt{\frac{(\Gamma_{\Re_1}(a_1)+\delta_{\Re_2}(a_2)+1)+(\Gamma_{\Re_2}(a_2)+\delta_{\Re_1}(a_1)+1)-2}{(\Gamma_{\Re_1}(a_1)+\delta_{\Re_2}(a_2)+1)(\Gamma_{\Re_2}(a_2)+\delta_{\Re_1}(a_1)+1)}} \end{aligned}$$

Using above corollary, we obtain the ABC_4 of some important molecular graphs.

Example 4 Let D be the nanostar shown in Fig. 1. One can check that

$$\begin{aligned} ABC_4(D) &= 6\sqrt{\frac{4+4-2}{4(4)}} + 3\sqrt{\frac{7+9-2}{7(9)}} + 6\sqrt{\frac{4+5-2}{4(5)}} + 6\sqrt{\frac{5+7-2}{5(7)}} \\ &= \frac{3}{2}\sqrt{6} + \sqrt{2} + 3\sqrt{\frac{7}{5}} + 6\sqrt{\frac{2}{7}}. \end{aligned}$$

Further,

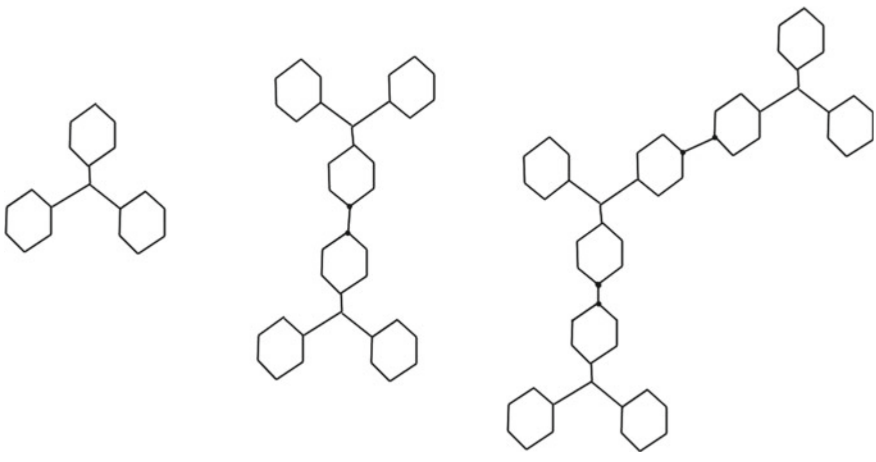


Fig. 1. Nanostar dendrimers D_1, D_2, and D_3

$$ABC_4^{N_D[a_1]}(D) = ABC_4^{N_D[a_2]}(D) = ABC_4^{N_D[a_3]}(D) = \sqrt{6} + \sqrt{2} + 2\sqrt{\frac{7}{5}} + 6\sqrt{\frac{2}{7}}.$$

For $1 \leq i, j \leq 3$ and $i \neq j$, we have

$$ABC_4^{N_D[a_i] \cup N_D[a_j]}(D) = \frac{\sqrt{6}}{2} + \sqrt{2} + 2 + 2\sqrt{\frac{7}{5}} + 6\sqrt{\frac{2}{7}}.$$

Now consider the bridge graph $\Re = \Re(\Re_{t-1}, H_1, a_1, r_1)$ given in Fig. 1. Observe that $H_i \cong \Re_1$ for $i \in \{1, 2, \ldots, t-1\}$ and

$$\begin{aligned}\Re_t &= \Re(\Re_{t-1}, H_1, a_1, r_1), \Re_{t-1} = \Re(\Re_{t-2}, H_2, a_2, r_2), \ldots \Re_{t-1} \\ &= \Re(\Re_{t-i-1}, H_{i+1}, a_{i+1}, r_{i+1}), \ldots \Re_2 = \Re(\Re_1, H_{t-1}, a_{t-1}, r_{t-1}).\end{aligned}$$

Hence by using Corollary 3, we get the following

$$\begin{aligned}
&ABC_4(\Re_t) = ABC_4^{N_{\Re_{t-1}}[a_1]}(\Re_{t-1}) + ABC_4^{N_{H_{t-1}}[r_1]}(H_1) + r,\\
&ABC_4^{N_{\Re_{t-1}}[a_1]}(\Re_{t-1}) = ABC_4^{N_{\Re_{t-2}}[a_2]}(\Re_{t-2}) + ABC_4^{N_{H_2}[a_1] \cup N_{H_2}[r_2]}(H_2) + r,\\
&\ldots\\
&ABC_4^{N_{\Re_{t-i}}[a_i]}(\Re_{t-i}) = ABC_4^{N_{\Re_{t-i-1}}[a_{i+1}]}(\Re_{t-i-1}) + ABC_4^{N_{H_{i+1}}[a_i] \cup N_{H_{i+1}}[r_i+1]}(H_{i+1}) + r,\\
&\ldots\\
&ABC_4^{N_{\Re_2}[a_{t-2}]}(\Re_2) = ABC_4^{N_{\Re_1}[a_{t-1}]}(\Re_1) + ABC_4^{N_{H_{t-1}}[a_{t-2}] \cup N_{H_{t-1}}[r_{t-1}]}(H_{t-1}) + r,
\end{aligned}$$

where $r = \sqrt{\frac{7+7-2}{7(7)}} + 4\sqrt{\frac{5+5-2}{5(5)}} + 4\sqrt{\frac{5+7-2}{5(7)}} = \frac{66}{35}\sqrt{2} + 4\sqrt{\frac{2}{7}}$.

Combining those relationships given above, we have

$$\begin{aligned}ABC_4(\Re_t) &= ABC_4^{N_{\Re_1}[a_{t-1}]}(\Re_1) + ABC_4^{N_{H_1}[r_1]}(H_1)\\ &\quad + \sum_{i=2}^{n-1} ABC_4^{N_{Hi}[a_{t-2}] \cup N_{H_t}[r_i]}(H_i) + (t-1)r.\end{aligned}$$

Therefore, $ABC_4(\Re_t) = 2ABC_4^{N_{\Re_1}[a_1]}(\Re_1) + (t-2)ABC_4^{\Re_1[a_1] \cup N_{\Re_1}[a_2]}(\Re_1) + (t-1)r$

$$\left(\frac{t+2}{2}\right)\sqrt{6} + \left(\frac{101t - 66}{35}\right)\sqrt{2} + (t+2)\sqrt{\frac{7}{5}} + (10t-4)\sqrt{\frac{2}{7}}.$$

Theorem 5 *If the bridge graph* $\Re_t = \Re(\Re_{t-1}, H_1, a_1, r_1)$ *is given in* Fig. 1*, then*

$$ABC_4(\Re_t) = \left(\frac{t+2}{2}\right)\sqrt{6} + \left(\frac{101t - 66}{35}\right)\sqrt{2} + (t+2)\sqrt{\frac{7}{5}} + (10t-4)\sqrt{\frac{2}{7}}.$$

Theorem 6 *For the nanostar dendrimer D_t,*

$$ABC_4(D_t) = \left(\frac{t+2}{2}\right)\sqrt{6} + \left(\frac{101t-66}{35}\right)\sqrt{2} + (t+2)\sqrt{\frac{7}{5}} + (10t-4)\sqrt{\frac{2}{7}}.$$

3 Carbon Nanocones

In this section, we provide the formulae for ABC_4 invariant of important type of carbon nanocones $\mathrm{CNC}_t(s)$. One can see that the cardinality of $V(\mathrm{CNC}_t(s))$ is $t(s+1)^2$ and cardinality of $E(\mathrm{CNC}_t(s))$ is $\frac{t(s+1)(3t+2)}{2}$.

Example 7 Let $\mathrm{CNC}_3(1)$ be the carbon nanocone given in Fig. 2. Note that the graph $\mathrm{CNC}_3(1)$ contains 15 edges; among these three of the edges of type $\Gamma(a) = \Gamma(b) = 5$, six of the edges of type $\Gamma(x) = 7$ and $\Gamma(y) = 5$, three of the edges of type $\Gamma(a) = 7$ and $\Gamma(b) = 9$, and three of the edges of type $\Gamma(x) = \Gamma(y) = 9$.

From the definition of ABC_4 invariant, we have

$$\begin{aligned} ABC(\mathrm{CNC}_3(1)) &= 3\sqrt{\frac{5+5-2}{5(5)}} + 6\sqrt{\frac{5+7-2}{5(7)}} + 3\sqrt{\frac{7+9-2}{7(9)}} + 3\sqrt{\frac{9+9-2}{9(9)}} \\ &= \frac{4}{3} + \frac{11}{5}\sqrt{2} + 6\sqrt{\frac{2}{7}}. \end{aligned}$$

Example 8 Let $\mathrm{CNC}_4(2)$ be the carbon nanocone given in Fig. 2. Note that the graph $\mathrm{CNC}_4(2)$ contains 48 edges in which four of the edges of type $\Gamma(a) = \Gamma(b) = 5$, eight of edges of type $\Gamma(a) = 7$ and $\Gamma(b) = 5$, eight of the edges of type $\Gamma(a) = 7$ and $\Gamma(b) = 9$, eight of the edges of type $\Gamma(a) = 7$ and $\Gamma(b) = 6$, and twenty of the edges of type $\Gamma(a) = \Gamma(b) = 9$. Then

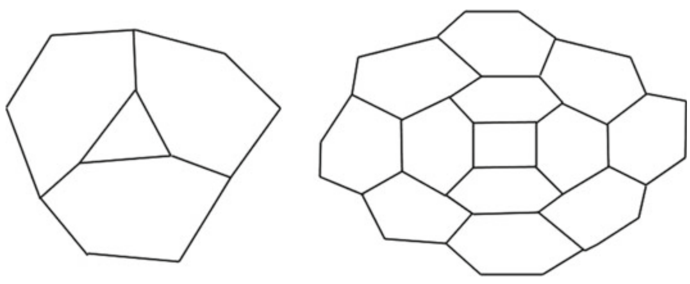


Fig. 2. Carbon nanocones $\mathrm{CNC}_3(1)$ and $\mathrm{CNC}_4(2)$

$$\begin{aligned}ABC_4(\mathrm{CNC}_4(2)) &= 4\sqrt{\frac{5+5-2}{5(5)}} + 8\sqrt{\frac{5+7-2}{5(7)}} + 8\sqrt{\frac{7+9-2}{7(9)}}\\ &\quad + 20\sqrt{\frac{9+9-2}{9(9)}} + 8\sqrt{\frac{7+6-2}{7(6)}}\\ &= \frac{80}{9} + \frac{64}{15}\sqrt{2} + 8\sqrt{\frac{2}{7}} + 8\sqrt{\frac{11}{42}}.\end{aligned}$$

Now we obtain the exact value of ABC_4 for general nanocone $\mathrm{CNC}_t(s)$.

Theorem 9 *For two positive integers* $t \geq 2$ and $s \geq 1$,

$$ABC_4(\mathrm{CNC}_t(s)) = \frac{4ts(3s-1)}{9} + \frac{t(5s+6)}{15}\sqrt{2} + 2t\sqrt{\frac{2}{7}} + 2t(s-1)\sqrt{\frac{11}{42}}.$$

Proof

$$\begin{aligned}ABC_4(\mathrm{CNC}_t(s)) &= t\sqrt{\frac{5+5-2}{5(5)}} + 2t\sqrt{\frac{5+7-2}{5(7)}} + ts\sqrt{\frac{7+9-2}{7(9)}}\\ &\quad + 2(s-1)t\sqrt{\frac{7+6-2}{7(6)}} + \frac{ts(3s-1)}{2}\sqrt{\frac{9+9-2}{9(9)}}\\ &= \frac{4ts(3s-1)}{9} + \frac{t(5s+6)}{15}\sqrt{2} + 2t\sqrt{\frac{2}{7}} + 2t(s-1)\sqrt{\frac{11}{42}}.\end{aligned}$$

4 Conclusion

The usage of topological invariants is established particularly in testing the chemical or physical materials. In this article, we concentrate on some bridge graphs and give the formulae of the ABC_4 invariant of these bridge graphs. The results of this article also offer promising prospects in the application for chemical and material engineering in chemical industry research.

References

1. Baca M, Horvathova J, Mokrisova M, Suhanyiova A (2015) On topological indices of fullerences. Appl Math Comput 251:154–161
2. Estrada E (2008) Atom-bond connectivity and the energetic of branched alkanes. Chem Phys Lett 463:422–425

3. Estrada E, Torres L, Rodriguez L, Gutman I (1998) An atom-bond connectivity index: modelling the enthalpy of formation of alkanes. Indian J Chem 37A:849–855
4. Ghorbani M, Hosseinzadeh MA (2010) Computing ABC_4 index of nanostar Dendrimers. Optoelectron Adv Mater Rapid Commun 4:1419–1422
5. Gutman I, Tosović J, Radenković S, Marković S (2012) On atom-bond connectivity index and its chemical applicability. Indian J Chem 51A:690–694
6. Hayat S, Imran M (2014) Computation of topological indices of certain networks. Appl Math Comput 240:213–228
7. Hosseini SA, Ahmadi MB, Gutman I (2014) Kragujevac trees with minimal atom bond connectivity index. MATCH Commun Math Comput Chem 71:5–20
8. Lin W, Chen J, Chen Q, Gao T, Lin X, Cai B (2014) Fast computer search for trees with minimal ABC index based on tree degree sequences. MATCH Commun Math Comput Chem 72:699–708
9. Wiener H (1947) Structural determination of paraffin boiling points. J Am Chem Soc 69:17–20
10. Zhou B, Xing R (2011) On atom bond connectivity index. Z. Naturforsch 66a:61–66

Theoretical Design and Experimental Study for Urban Data Management Using Energy-Saved IoT Big Data

M. Jayanthi and Ch. Pravallika Reddy

Abstract In this study, an experimental study (ESIF) is presented for urban data management and smart city application using energy-saved IoT big data analytics. This study is also used to manage the energy consumption in urban planning and smart city applications. The previous researchers demonstrate that the big data analysis process is more complex. We use different kinds of sensors such as traffic congestion, weather, smart home, water, and vehicular sensor to collect the resource data. The framework is divided into three phases. The first phase is responsible for collecting the data using IoT devices and interconnects with elasticity (energy-saving) manager. The second phase is data handling operation using MapReduce framework. Third phase deals with decision-making which is an important step to classify the events and produce the decisions accurately. To do this, machine learning concept of deep learning algorithms is used and it produces the decisions more effectively. The Hadoop is to provide offline service as well as online services with the help of spark. Therefore, the effectiveness of the model is illustrated in the case of processing time and throughput.

Keywords Smart city · Urban area · IoT · Energy-saving · Hadoop and machine learning

1 Introduction

Generally, the migration of suburban and rural in cities is made the basic problem in city superintendent and urban existence. Therefore, the few complicated issues are listed as control of crime, power, health management, house, irrigation system, no job, studies, traffic, and garbage gathering. Around the total population with eighty percentage of peoples are living in cities, and their requirements are randomly

M. Jayanthi (✉) · Ch. Pravallika Reddy
Mahatma Gandhi University Nalgonda, Nalgonda, India
e-mail: jayanthimgu@gmail.com

Ch. Pravallika Reddy
e-mail: pravallikaou@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_33

increased day by day [1]. So the government also planned to make smart cities but it is more expensive. Nevertheless, it effectively handles the challenging problem in urban cities. The observation of real-time application, expansion of urban area, and pre-planned process play a major part of smart city development [2]. Based on the requirement of user, real-time application such as storage, computing performance, and electrical regions is handled effectively. Moreover, the analysis of big data is more complex in current technology and this information is collected from media records, audios, sensor, query processing, smart phones, and social media. The energy-saved smart city creation is the major issue. In this paper, we effectively analyze the big data based on the energy-saving (elasticity) resource using machine learning algorithm.

The author [3] introduced the framework of context-aware information, and the data were collected from smart phones. The energy consumption is accepted using sensors or cameras, and there is no other recharge required. Then the process is much useful to smart city organization but it requires an additional energy source. Cloistral et al. [4] analyzed the housing expansion model with enlarger datasets. The smart city-based valuable outcomes are obtained with the usage of the prototype with multi-functionality. The sensor is used to gather the biometrical information, and it is not much suitable for healthcare detection and management; also, few safety issues are aroused because of the connectivity of neighbor. Nguyen et al. [5] suggested the Oliot-OpenCity platform which undertakes smart city issues. The GSI can approve global principles of building. The key management harmonization is controlled using arbitration gateways. The open-source interfacing with vehicular information separation contains lot of challenging issues. Hayar et al. [6] established a collaboration of frugal sustainable social concept. It based on the cost efficiency of the inducement method. The approach is based on cloud environment with possible to American countries due to larger expense. Kumar et al. [7] suggested aforementioned together with the user background and reduction in power consumption. The enhancement quality and making decision are not accurate but the system is connected by means of cloud environment. The scalability and sustainability are minimized using multi-level elasticity. Chen et al. [8] debated about the analysis of big data in smart city and PM2.5 model. The smart city populations are checked using various processes, and the implementations are handled with cloud-based workout environment. The paper is organized as follows: In Sect. 2, the study model is discussed. The implementation results are illustrated in Sect. 3, and the paper is concluded in Sect. 4.

2 Methodology

The aim of the study is to develop an experimental study to address the issues of big data analytics. The application of energy-saved IoT-based framework (ESIF) is urban data management and smart city. Therefore, the energy resource data such as traffic, water, weather, health, and parking are collected from the urban area. The resource data are collected with the help of IOT devices such as camera and different kinds of

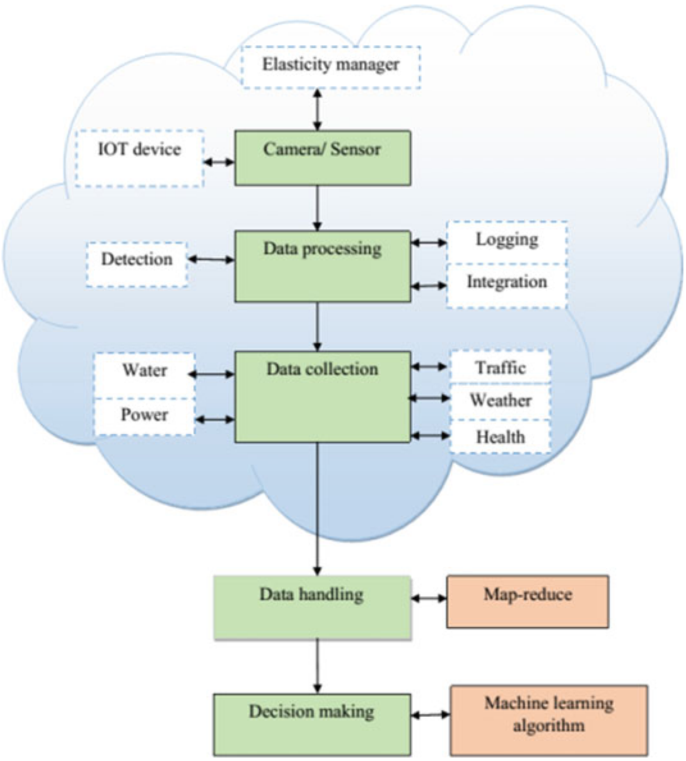


Fig. 1 Architecture of machine learning-based urban data management design

sensor. The basic architecture of energy-saving IoT-based framework is illustrated in Fig. 1; also, the operations are discussed as below.

2.1 Data Collection and Storing

In this section, the resource data are collected from the urban area using IOT devices. Hence, the data acquisition process such as data detection, integration, and logging is performed via Bluetooth, zigbee, WIFI, 3G, and 4G network. Commonly, the energy-saving IoT-based framework contains a larger amount of resources that are heterogeneous and its computational ranges are high. Because of unavoidability, every smart city implementation anxiety is based on data computation. Thus, the endeavor of smart city energy management process is to deliver efficient resources such as environmental issues, healthcare facilities, forecasting decision, traffic congestion, and water and power management. The samplers signals are performed using data acquisition as well as the digital computer machines are used to operate the digital values from transform and real-time measurement. The structure of transform data is analog to digitalize, and the operation is carried out with various data acquisition systems. Let us consider, the data were collected from the development section of the worried smart city, and the obtained data are subjected to the heterogeneous sensor. The collected data were associated with a cloud environment. The dataset is represented as $S_1,\ S_2, \ldots S_m$ with constant K statistical nodes which are denoted as $N_1\ ,\ N_2, \ldots N_{mk}$.

$$D = \sum_{j=1}^{m} S_j \tag{1}$$

Therefore, the dataset value is expressed as $S = \sum_{j=1}^{k} NM_j$.

2.2 Elasticity (Energy-Saving) Manager

The energy-saving IoT devices such as sensor and camera in smart cities are used to collect the resource data and interconnect with elasticity (energy-saving) manager. Here, the different kinds of sensors such as traffic congestion, weather, smart home, water, and vehicular sensor are employed. Similarly, the devices are used to collect the sensor message and location. Mainly, the sensor is connected to smart phones to monitor the energy-saving process. Everyday, the resource data like environmental issues, healthcare facilities, forecasting decision, traffic congestion, water, and power management are collected and monitored by elasticity manager. The activation of sensors time is set with the usage of logical mobility tree [9]. The upper and lower load thresholds are to create the reactive elasticity as well as the resource management is worked beyond these limits. The triggering of scaling in and out operation is directed by CPU. Thus, the smart phone with elasticity manager is used for the implementation process. The battery life of the smart phone is maximized because it always connected to the power source using cloud. The smart phone sensor with 3G or 4G antennas and global positioning system is used to identify the user location. All the nodes provide resource data directly, and better accuracy is obtained by the allocation of virtual machines.

In this work, the energy-saving model is done in data collection stage in the following ways. The main goal of elastic multilevel energy-saving scheme is to generate energy-saving plans depending upon each resource demand. But this saving scheme has not neglected the quality-of-service (QoS) provided by the resources of each energy source levels. Thereby, the IoT sensor device's usage pattern is followed to turn ON and OFF automatically of each level. During data collection, if we found the unnecessary usage of IoT sensor device, then the energy can be saved through controlling the working (turned OFF) of that particular device.

2.3 Data Handling

The collected energy-saved dataset is subjected to data handling operation using MapReduce framework. The Hadoop is used to divide the input data into small equivalent pieces. The Hadoop distributed file system (HDFS) is used to store larger data into tiny blocks of data. During division operation, the mapping functionality is used as evidence of block splitting. The pair of key value evidence is created using evidence reader. For the purpose of optimal performance in data division, the Hadoop of map task is performed in the specific node. The data obtained from IOT with offline services are performed by using Hadoop; also, the real-time or online services are provided by means of spark. The representation of map reduction is introduced over energy contamination dataset, and the various energy values are collected. Therefore, the map function emits the stamp time based on the requirement of association value. All the stamp time values against the required association values are decreased with the help of group function, and the threshold value limits are used widely for value comparison. The limitations in the conventional MapReduce problems are carried out using yet one more resource negotiator, and it is used to enhance the performance.

2.4 Decision-Making Process Using Deep Learning Algorithms

In this part, the classifications of resource event and decision creation are performed using decision-making process. The decision-making process is introduced to classify the events, and it produces the correct decisions. Hence, the decision-making process is carried out by means of machine learning algorithm such as deep learning algorithm [10]. The high event stages are stored by the departmental level, and there is no other lower stage event transformation. The independent outcome of splitting unit can post the decision of relevant smart city growth sections like smart cure and traffic congestion management section. Due to the correct analysis, decisions are properly analyzed by means of deep learning algorithm and the accurate notifications are collected. Based on the creation, any event with correct recipient is detected with the help of these notifications. In this work, deep recurrent neural network (DRNN) is used for decision-making process. To do this, the input data is divided into training and testing. Based on the training DRNN structure, the test data is classified into the events.

3 Result and Discussion

Experimentally, the evaluation performance is checked in this section using various criteria. The implementation of smart city energy management is simulated using Hadoop with *JAVA* platform. The datasets are attained from a valid and reliable source

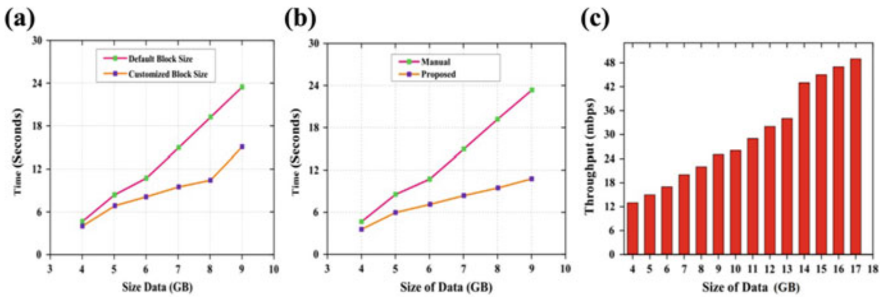


Fig. 2 **a** Customized instrument, **b** block size threshold, **c** throughput performance of proposed concept

[11] that is accessible and authenticated and verified as per our energy-saving elasticity model. It consists of pollution dataset that includes information about diverse toxic gases like ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, and so on. The data loading time of the threshold is initialized by 4 GB. Figure 2(a) illustrates the threshold for a customized block size of HDFS which is 4 GB. The structure of throughput is sketched in Fig. 2(b). From this Fig. 2(c), if the size increases, the speed reduced automatically. Therefore, our method efficiency is higher when compared to other existing methods.

Therefore, Fig. 3(a, b) represents the direct threshold of affection in the entire consumption of energy. The virtual machine allocation (VM) triggering is involved using the upper threshold limit of 70%. Thus, the energy consumption is increased but the execution time is minimized. The cloud elasticity performance is estimated and not validates the artificial workload [12]. The execution time and energy consumption are taken by the threshold of upper and lower limits; also, two to six virtual machines are chosen for the detection of time and energy. The variation of upper and lower limits with smart city energy-saving application is illustrated in Fig. 3(c). The entire application of energy consumption with extreme and drop values is shown in Fig. 3(c). The new virtual machine oscillation, host distribution, and redistributions are observed. The elasticity representation by the applications is listed out; also, the energy consumption managing is the part of information dispensation. Thus, the performance of energy-saving is better and efficient when compared to other existing methods.

4 Conclusion

In this work, a theoretical design and experimental study were developed to manage urban data and smart city application. A huge amount of resource data from the urban area is handled to evaluate the smart city architecture. The objective has been set smart urban city so that the big city data analytics would be analyzed effectively. The

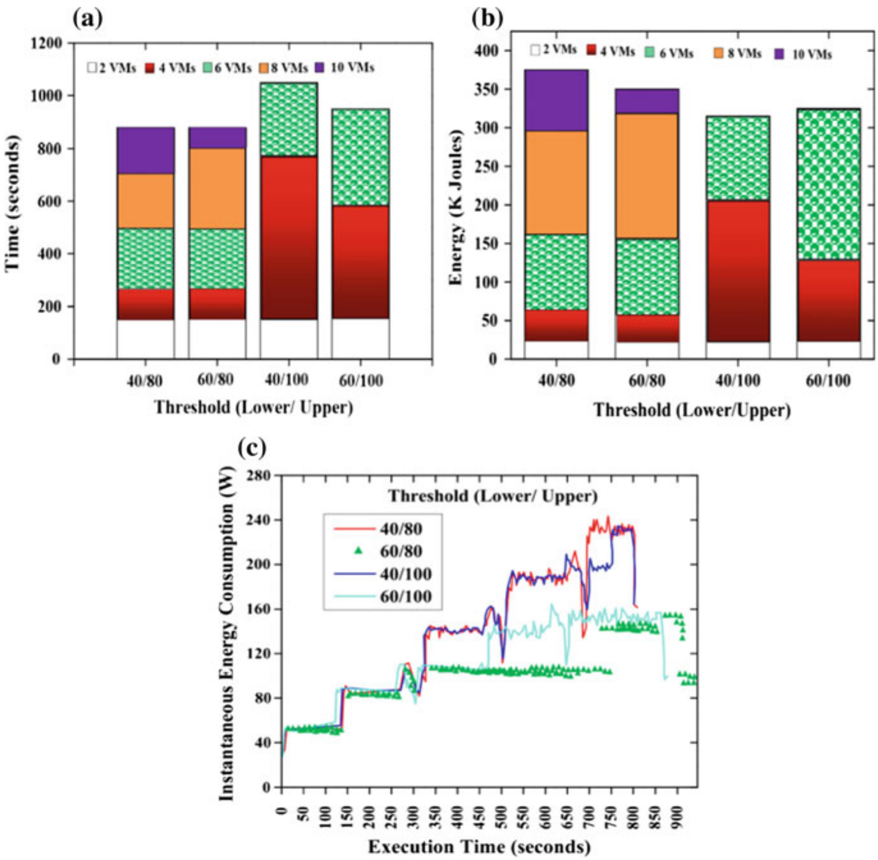


Fig. 3 **a** Execution time, **b** energy consumption, **c** upper and lower threshold energy-saving smart city using cloud

Hadoop is used to make offline service; similarly, the real-time or online service in ESIF is performed via spark. Therefore, the framework was implemented using *JAVA* platform, and the datasets are collected from different energy-saving resources such as vehicular, surveillance, traffic, pollution, and water in the city. The performance analysis of ESIF model is performed with the basis of processing time and throughput. Experimentally, six virtual machines are selected to analyze the performance of the energy consumption and execution time in energy-saving IoT-based framework successfully. In the future, we plan to propose optimization mechanisms to find the optimal distribution and configuration of node by considering the computational resources and capability of processing the needed data from many homes.

References

1. Pieroni A, Scarpato N, Nunzio L, Fallucchi F, Raso M (2018) Smart city: smart energy grid based on block chain technology. Int J Adv Sci Eng 8(1):298–306
2. Vogler M, Schleicher J, Inzinger C, Ranjan R (2016) Migrating smart city applications to the cloud. IEEE Cloud Comput 3(2):72–79
3. Perez-Torres R, Torres-Huitzil C, Galeana-Zapién H (2019) A cognitive inspired event based control for power aware human mobility analysis in IOT devices. Sensors 19(4):832
4. Cloistral J, Michael (2018) The evolving architecture of smart cities. IEEE Cloud Comput 34(2)
5. Nguyen HM, Byun J, Kwon K, Han J, Yoon W, Lee N, Kim H, Pham N, Kim D (2018) Oliot-Open City: open standard interoperable smart city platform. IEEE Int J Smart Cities Manage, 1–8
6. Hayar A, Betis G (2017) Frugal social sustainable collaborative smart city Casablanca paving the way towards building new concept for future smart cities by and for all. IEEE Sens Netw Smart Emerg Technol 2:1–4
7. Kumar N, Vasilakos AV, Rodriguez JJPC (2017) A multi-tenant cloud-based DC nano grid for self-sustained smart buildings in smart cities. IEEE Commun Mag 55(3):14–21
8. Chen L-J, Ho Y-H, Lee H-C, Wu H-C, Liu H-M, Hsieh H-H, Huang Y-T, Candice Lung S-C (2017) An open framework for participatory PM2 monitoring in smart cities. IEEE Access 5:14441–14454
9. Goyal T, Kaushal S, Sangaiah AK (2018) Fuzzy logic-based optimized algorithm for mobility robustness and load-balancing in LTE/4G networks. Int J Netw Virtual Organizations 18(4):323–337
10. Babar M, Arid F, Jan MA, Tan Z, Khan F (2019) Urban data management system: towards big data analytics for Internet of Things based smart urban environment using customized Hadoop. Future Gener Comput Syst 96:398–409
11. P. Dataset: Dataset collection. http://iot.ee.surrey.ac.uk:8080/datasets.html#pollution. Last accessed on 7 April 2018
12. da Rosa Righi R, Andrioli L, Rodriguez VF, da Costa C, Alberti AM, Singh D (2019) Elastic-RAN: an adaptable multi-level elasticity model for Cloud Radio Access Networks. Comput Commun 142:34–47

An Effective Approach for Security Attacks Based on Machine Learning Algorithms

Aerpula Swetha and K. Shailaja

Abstract The regular utilization of wireless network as well as mobile hot spot gives a remote network condition, recognition as well as hazard through Wi-Fi; security is relentlessly expanding, whereas the user utilizing authorized and unauthorized APs (Access Points) in organization, cabinet, and armed forces offices, huge disadvantages are being subjected to different malicious codes and hacking assaults; it is important to notice illegal APs based on security of data. Here, user utilizes round-trip time (RTP) value dataset to identify legitimate and illegitimate access points over connected/remote networks. User also analyzes the performance of data utilizing the ML models, such as support vector machine, Classification 4.5, k-nearest neighbor (K-NN), multi-layer perceptron, and decision tree algorithms. This analysis determines the attacks on data in wired and remote networks.

Keywords Detection · Unauthorized access point · Protection · Machine learning · SVM · C4.5 · MLP · Decision tree

1 Introduction

Wi-Fi is utilized by several anonymous end users and its huge complex to verify everyone in the network. Even if you are connected to the hot spot, accessing legal Wi-Fi recognition is tough until we examine straight on AP records as well as glance by the context deeply [1, 2]. Because of much smart devices usage in the present world, the presence of unauthorized access points has become inevitable and there is no restriction on the access points used by different users in the network. And there are no protocols of unauthorized APs like hot spots and public institutions. This comes up with a flaw in remote network. The network could be damaged by sneaking the

A. Swetha (✉) · K. Shailaja
Department of Computer Science & Engineering, Anurag Group of Institutions, Ghatkesar (M), Ranga Reddy (Dist.), Venkatapur, Hyderabad, Telangana 501301, India
e-mail: swethayadav501@gmail.com

K. Shailaja
e-mail: kshailajacse@cvsr.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_34

data of different users whoever approaches to unapproved APs and also PC's might be steeled. Researchers have detected access point records, and its threats have been scrutinized recently. Many researchers [3, 4] are working on this problem, and there is continuous progress in analyzing different aspects of problems. Algorithms have been experimented [5, 6] in order to identify the failure along with huge efficiency. With the effective advancement technology, remote network conditions are rapidly establishing as well as a huge challenges being subjected. So, there is a need for identifying unauthorized APs, and it is a very essential work of the remote Internet intrusion detection system.

In this paper, the author considered systematic approach for handling security attacks based on ML procedure. Reaming part of the journal is organized into four parts. Part 2 gives a literature review. The next part represents the advanced method. Parts 4 and 5 give the implementation and the experimentation results of advanced method. Finally, the conclusion is given in Sect. 6.

2 Literature Review

Jana and Kasera [1] explained the need about clock skew of remote AP so as to identify fingerprints of illegal access points rapidly as well as efficiently. As effective major limitation of the existing system is the ineffectiveness to detect MAC address spoofing. So to overcome effective situation, the synchronous digital circuit system has been introduced.

Han et al. [2] explored the rogue APs which they act as legitimate APs in order to connect fake users. They determined an appropriate timing-based technique; this approach confesses the end user avoid connecting to the fake APs. A client-centric approach has been introduced.

Awad and AI-Refai [7] addressed this issue with well-organized method to identify a fraud AP over utilizing appropriate particle swarm optimization (PSO).

Liu et al. [8] presented a method that determines the threat behavior of third parties. They determined that open-free wireless access point hacks strongly through the fraud AP, compromised AP, and spider AP. In order to ensure secure and trusted access, a new access method for AP in OSA is analyzed and improved to secure the AP's. An access point in OSA acts as a secure access point.

Agarwal et al. [9] pointed on harmful threats which are rogue AP setup by duplicating the media access control location [10, 11]. An attacker monitors the communication to takeover client connection and clients' switch to destructive Web sites. This method identifies the evil twin data which contain managing white lists, a lot of AP/client, modifies the timing based solutions, and so on. This method is used to identify individual unrelated data.

Modi and Parekh [12] planned a result toward detect the unrelated data hacker depending on the different MAC address, same MAC address, also the same external IP address, and different external IP addresses of access points [13, 14]. It does not depend on the network administration's action, whereas it identifies the fraud access point and also it gives warning to the clients to disconnect from an evil twin AP or it sends alert messages about the presence of concerned unrelated data APs if they act shown in the network [15, 16].

3 The Proposed Method

Nowadays, Wi-Fi is tremendously used by many users, and it is difficult to detect unauthorized users behaving, like using authorized Wi-Fi Identification of such activity in the network is tough unless we see directly on router history. It means user needs to see directly on AP setup within close range. So, there is a need to detect AP which is legal or illegal. The proposed method determines where the attack is going to occur in the network. To perform the experimentation, the author utilized the Knowledge Discovery CUP dataset available on the Internet where network administrator has control over the data. The proposed method uses normalization as well as preprocessing steps to remove unwanted and null values from existing knowledge and also gives specific numbers to each attribute such as prototypes, services, and flags for easy processing. In the training phase, once the user associates with the system, the attribute values are calculated, and whatever the values we are predicted are compared with training data. In this way, we are determining valid or invalid access points and also the type of attack possibility.

4 Implementation

The proposed method is implemented using KDD CUP 1999 dataset, and it is analyzed using machine learning algorithms based on round-trip time values in order to verify the system performance. The accuracy the obtained by proposed method is compared with existing research. An intelligent wireless AP detection system is used for the prediction of unauthorized AP. The information which is gathered from the authorized APs and unauthorized APs is used to construct datasets. The proposed method is implemented using the following machine learning algorithms.

SVM: Depending on specific dataset, user makes a non-probabilistic binary linear classification design. This mainly works on classifications of latest information and makes use of boundaries within the extent in which data is mapped. The support vector machine algorithm acts as procedure which identifies the boundaries along the highest width.

C4.5: This procedure is based on classifying as well as predicting the information by creating a decision tree. In this process, showing actual Iterative Dichotomiser 3 procedure is considered. The Classification 4.5 mainly makes use of the idea of the data entropy in order to make decision criterion along with classification of sample set for better accuracy.

MLP: Multilayer perceptron acts as a feed-forward artificial neural network; this produces a number of outputs from a number of inputs; in this, the hidden group acts as calculating on the predicted values based on existing knowledge. The back-propagation algorithm is performed by using supervisory learning; thus, information could not be unrelated that could be categorized according to information.

Decision Tree: It is also known as classification tree procedure which acts as a systematic arrangement in categories according to the established criteria classification built on ML procedures. It is a data mining technique. It makes a decision tree based on attribute values and calculating the entropy of each attribute by utilizing dataset for protection of information to increase the user performance and identifying the attacks for future protection.

5 Experimental Results

The experimentation has been done on Knowledge Discovery in Database (KDD) CUP 1999 dataset. We are identifying the attacks and also verifying how effectively it is working on the Internet using different kinds of attribute. Table 1 shows the sample structure of KDD CUP dataset.

The data record consists of attributes such as source bytes, duration, protocol type, service, flag, destination bytes, attack type, number of failed log-ins, number of file creation, and number of hot indicators, where few of them are described below:

Duration refers to the length (no. of seconds) of the connection.

Protocol-type refers to the type of the protocol, e.g., transmission control protocol, user data gram protocol.

Service refers to the application running at the network such as hypertext transfer protocol and telnet.

Flag refers to the value that acts as signal for a function or process.

The experimental results for each classification algorithms are shown in Table 2.

It is observed that MLP and decision tree are the most accurate as they got encouraging results on KDD CUP 1999 dataset. The results of these algorithms are shown

Table 1 Structure of KDD dataset

Duration	Protocol type	Service	Flag	Attack type
0	Tcp	Http	Sf	Normal
0	Icmp	Ecr-I	Sf	Smurf
0	Udp	Private	Sf	Teardrop
1	Tcp	Private	Rstr	Portsweep
0	Tcp	Finger	So	Land
31[a]	Tcp	telnet	Sf	Buffer-overflow

[a]Polynomial time

Table 2 Exploratory outcomes on various machine learning algorithms

Performance accuracy	SVM	C4.5	MLP	Decision tree
True positive	38	4	98	98
False positive	62	96	2	1.9
Total correctness	61.29	4.166	98	98.01

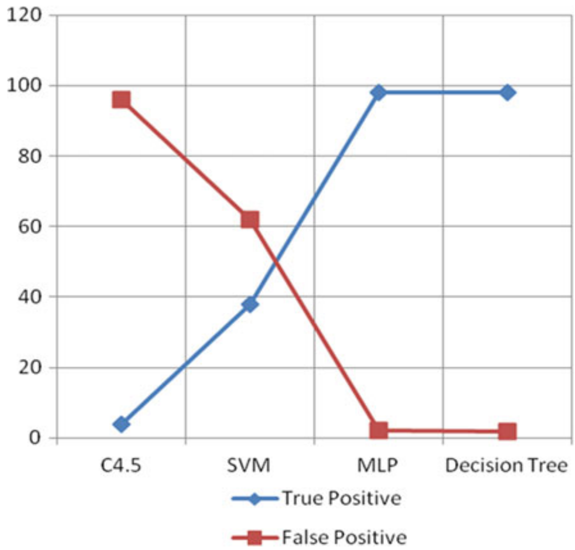


Fig. 1 Detection of authorized and unauthorized APs

graphically in Fig. 1. The blue line in the figure shows correct detection of authorized and unauthorized APs. The false positive shows the misclassification of these APs.

The performance accuracies of C4.5, MLP, SVM, and decision tree are 4%, 98%, 61.29%, and 98.01%, respectively. And decision tree achieved highest percentage among all the algorithms. Figure 2 shows the detection accuracy of different algorithms.

6 Conclusions

A legitimate as well as illegitimate access points could be arranged over ML models. The main aim is to developing the models to predict the future attacks by the administrator. In case the administrator identifies the assaults at particular process of illegitimate access point, the administrator can remove the connection of fake AP so as to preserve the system. The sensitive data threat occurs on the basis of rogue AP and wireless router at which a system might associate itself, thereby exposing its

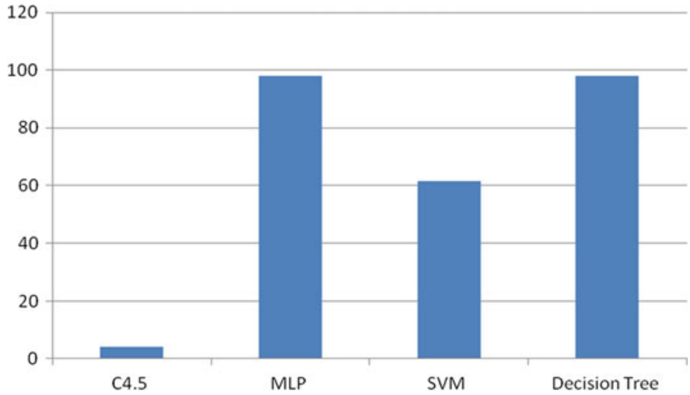


Fig. 2 Accuracy levels of various ML models

data to unauthorized users. Finally, a technique is presented by which rogue APs are identified in a Wi-Fi based on ML algorithms. The multilayer perceptron and decision tree algorithms achieved good accuracy compared to existing methods. Future works may include designing of these models for the protection of personal data in smart phones, tablets, and other devices that use artificial intelligence.

References

1. Jana S, Kasera SK (2010) On fast and accurate detection of unauthorized wireless access points using clock skews. IEEE Trans Mob Comput 9(3):449–462
2. Han H et al (2011) A timing-based scheme for rogue AP detection. IEEE Trans Parallel Distrib Syst 22(11):1912–1925
3. Awad F, Al-Refai M, Al-Qerem A (2017) Rogue access point localization using particle swarm optimization. In: 8th international conference on information and communication systems (ICICS), Irbid, Jordan, May 2017. https://doi.org/10.1109/iacs.2017.7921985
4. Pradeepkumar B et al Predicting external rogue access point in IEEE 802.11 b/g WLAN using RF signal strength. In: 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI), Udupi, India, Sept 2017. https://doi.org/10.1109/icacci.2017.8126135
5. Este A, Gringoli F, Salgarelli L (2009) On the stability of the information carried by traffic flow features at the packet level. ACM SIGCOMM Comput Commun Rev 39(3):13–18
6. Peng, L et al (2016) Early stage internet traffic identification using data gravitation based classification. In: 2016 IEEE 14th international conference on dependable, autonomic and secure computing, 14th international conference on pervasive intelligence and computing, 2nd international conference on Big Data Intelligence and Computing and Cyber Science and Technology Congress (DASC/PiCom/DataCom/CyberSciTech), Auckland, New Zealand, Aug. 2016. https://doi.org/10.1109/DASC-PICom-DataCom-CyberSciTec.2016.98
7. Awad F et al (2017) Access point localization using autonomous mobile robot. In: 2017 IEEE Jordan conference on applied electrical engineering and computing technologies (AEECT), Aqaba, Jordan, July 2017. https://doi.org/10.1109/iwcmc.2017.7986377
8. Liu S, Liu Y, Jin Z (2017) Attack behavioural analysis and secure access for wireless access point (AP) in open system authentication. In: 13th international wireless communications and

mobile computing conference (IWCMC), Valencia, Spain, June 2017. https://doi.org/10.1109/IWCMC.2017.7986377
9. Agarwal M, Biswas S, Nandi S (2018) An efficient scheme to detect evil twin rogue access point attack in 802.11 Wi-Fi networks. Int J Wireless Inf Networks 25(3):120–135
10. Watkins L, Beyah R, Corbett C (2007) A passive approach to rogue access point detection. In: IEEE global telecommunications conference 2007, Washington, DC, USA, Nov 2007, pp 355–360
11. Yang C, Song Y, Gu G (2012) Active user-side evil twin access point detection using statistical techniques. IEEE Trans Inf Forensics Secur 7(5):1638–1651
12. Modi V, Parekh C (2017) Detection & analysis of evil twin attack in wireless network. Int J Adv Res Comput Sci 8(5):774–777
13. Altman NS (1992) An introduction to kernel and nearest-neighbor nonparametric regression. Am Stat 46(3):175–185
14. Rumelhart DE, Hinton GE, Williams RJ (1986) Learning internal representations by error propagation. In: Parallel distributed processing: explorations in the microstructure of cognition, vol 1. MIT Press, Cambridge, pp 218–362
15. Vapnik V (2013) Support vector machine. In: The nature of statistical learning theory. Springer Science & Business Media, Berlin
16. Quinlan JR (1993) C4.5: programs for machine learning. Morgan Kaufmann Publishers Inc., Burlington

Class-Based Associative Classification Using Super Subsets to Predict the By-diseases in Thyroid Disorders

Shahebaz Ahmed Khan and Santosh Kumar Yadav

Abstract Data Mining in healthcare domain can provide the unknown information in the form of knowledge for decision support systems. Data mining can be used for effective diagnosis of diseases to recommend the healthcare world. Thyroid disorders are found in common all over the world, and these disorders are the causes for many other health issues. The need to discover the hidden patterns from the thyroid data always arises in such contexts to reduce the thyroid side effects. Associative classification techniques in Data Mining can provide better outcomes in terms of accuracy and prediction of data and here co-diseases. This research paper discusses the results and experiments carried out using Associative Classification. This work proposes the improved form of Associative Classification algorithm called CBACSS for better accuracy.

Keywords CBACSS · Associative Classification · Co-disease · Hidden patterns

1 Introduction

Data Mining is a powerful idea to extract the useful information and meaningful patterns for knowledge discovery. The outcomes of Data Mining are probably result-oriented; those then can be used to take correct decisions at right time. In data mining, Classification is a supervised method that can classify the large amounts data using efficient algorithms like Naïve Bayes, Multilayer Perceptron Decision Trees, Support Vector Machines, etc. At the same time, Association Analysis is another technique in data mining that involves the exploration of relationships and associations among the data items. There is also another powerful technique in data mining called Associative Classification that can provide better outcomes [1] with good accuracy rate. Today,

S. A. Khan (✉) · S. K. Yadav
Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu, Rajasthan, India
e-mail: sakklkyr@gmail.com

S. K. Yadav
e-mail: drskyadav@hotmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_35

healthcare data and medicinal data is increasing data by day and data mining can be used to solve issues with such data, and it can extract the knowledge from medical data with less efforts and more reliable results. Here, thyroid disorders are analyzed to predict the future issues using Associative Classification.

2 Existing Work and System

Data Mining provides the flexible options to meet the user objectives in the context of data analysis in medical domain. It is used for decision making in many fields like marketing business, education, health care, crime investigation, political science, finance, etc. Many algorithmic approaches of Data Mining are used for analyzing the electronic medical records and patient data that is available in computerized format. Jacquilin Margret et al. [2] have used the decision tree approach to diagnose the thyroid disorders. In this, attribute selection was used for splitting decision rule. Data Mining also helps to design the cost-effective treatments for patients in less span of time. Huge data related to many health issues like diabetes, cholera, AIDS, thyroid, kidney issues, heart attacks, skin diseases, etc., have been used to feed with Data Mining algorithms to analyze the records so that the useful knowledge can be extracted for the human benefits.

The use of artificial neural networks by Prerana et al. [3] has improved the accuracy in predicting the thyroid diseases and making a case study. Techniques like Clustering and Classification can make use of the medical data to give the pure knowledge in the context of disease diagnosis and prognosis. Chen et al. [4] have used the fuzzy set approach to derive the rules based on support vector machines to design an expert system that can easily diagnose the thyroid disorders in humans. The numbers of tests that are to be taken were reduced, and also, the factors that can contribute more for the heart disease and cardiac problems were diagnosed with genetic algorithms by deploying more than thirteen attributes for genetic search by Long et al. [5] in their work.

The rule extraction algorithms and other optimization algorithms have been extending help to the medical data to extract the valuable patterns for decision making. Turanoglu-Bekar et al. [6] have used the Data Mining models in their work to classify the thyroid disease data into different classes based on the symptoms and signs. The accuracy for the techniques of data mining has been improved for the purpose of mining the really useful patterns by using ensemble methods in diabetic disease prediction by Khan et al. [7] in their research work. Various data Classifications and Clustering methods are in use in medical sector for the construction of robust classifiers related to the medical data.

3 Associative Classification

Associative Classification is another improved technique of data mining which integrates the techniques of Classification and Association Analysis. This method of combining these two techniques can be an efficient mining technique that can give highly accurate results when compared to the previous methods.

Associative Classification can be used as a three-step approach. In the first step, by taking support and confidence measures, a set of association rules is produced from the training data. In the second step, the rules-generated are pruned, and at last, to predict the test data, Classification is applied in order to test the accuracy of the classifier. Some of the major and commonly used associative classification algorithms are CBA which means Class-Based Association rule, HMAC which means Hierarchical Multi-label Associative Classification, CMAR which means Classification based on Multiple Association Rules, CARGBA, CPAR, ACCF, GARC, etc. [8]. Here, we make use of CAR that is Class Association Rule which has greater accuracy and efficiency when compared to other techniques. A Class Association Rule is a subgroup of any given association rule.

Class-Based Association rule is an iterative method which can identify the frequent patterns by undergoing many phases. The longest rule generated using CBA is always equal to the number of the passes done. The rules with lowest confidence and support are included for the classification of the data sets. CMAR uses FP-Growth algorithm and rule pruning technique to find the necessary rules with Associative Classification. The algorithms like CBA and CMAR use the frequent item set generation approach. Thabtah et al. [9] proposed a new classification algorithm based on association analysis approaches with improved accuracy rate in analysis.

4 Proposed Work and Experimental Results

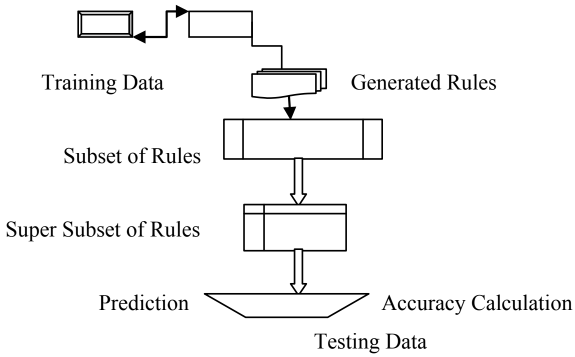
The work was intended to design a Decision Support System using Associative Classification for the prediction of co-diseases in thyroid patients. Co-disease is also called by-disease. These are the diseases which occur along with any given disease more frequently in patients. It may be due to side effects of the original diseases or due to other health issues, those which contribute favorable conditions for its occurrence of some other diseases under the presence of the actual diseases.

The proposed work uses a new approach called Class-Based Association using Super Subsets for Classification. This approach works in four steps.

1. Generation of Rules
2. Deriving Subset from the Data Set
3. Deriving Super Subset from the Subset
4. Comparison and Match for accuracy.

The data set is used for Association Analysis to find and generate the associated rules, and to do so, we have selected Predictive Apriori algorithm to generate the rules.

Fig. 1 CBACSS model



Then, obtained rules are partitioned into a subset for cross-checking the decision anticipated. From the present subset, again a new super subset with strongest rules is derived for the comparison of rules, and this comparison is made randomly by matching the instances of super subset with parent subset. This gives more accurate results than old techniques of Associative Classification.

The data sets are classified using various algorithms like ID3, Multilayer Perceptron, and Naïve Bayes for disease prediction, and the results are compared with the new approach that has been proposed in our work. Later, to find the frequent data objects, Predictive Apriori was applied and rules were generated. The algorithm and algorithmic flow for the proposed method is shown in Fig. 1. The experiments were conducted using Weka tool; due to its flexibility, Weka has all the data mining techniques which can be easily implemented with fast and accurate results. The data set selected for experiment consisted of 200 raw data instances of thyroid patients. The attributes defined for the data set were age, gender, T3, T4, TSH, diabetic, and based on these attributes, the target class label was decided into numeric type of 'yes' or 'no' for occurrence of psychological problems in thyroid patients. The data was trained using various algorithms like Naïve Bayes, ID3, and Multilayer Perceptron. For each algorithmic technique in the context of Associative Classification, the data was preprocessed using discretization filter to make it ready for classification to obtain the easy evaluation.

Algorithm

Input: Data Set
Step-1: Generate 'n' Rules of R = {n1, n2, n3,……nn}
Step-2: Derive a Subset RS from R, where RS $\subset$ R.
Step-3: Derive the Super Subset RSS from Subset RS, where RSS $\subset$ RS.
Step-4: Compare and Match RSS $\approx$ RS.
Step-5: Repeat 4 $\forall$ 'ni' values in M(RSS)$\approx$M(RS)..
Step-6: Calculate the Accuracy as
A = Correct Match(RSS) /Total Match(RS)
Step-7: Stop
Output: Classification.

There were two predefined constraints in this work, and they are as follows.

Condition 1:

If
(T3 and T4 = High) && (TSH = Normal|Low)
Then
Disease = 'yes'
Else disease = 'no'

Condition 2:

If
TSH = (Very High) && (T3 and T4 = Normal| Low)
Then
Disease = 'yes'
Else disease = 'no'
Conclude and Take Decision

The classification with association gave the rules which showed the maximum probability of occurrence of psychological problems in thyroid disorder patients with a probability distribution of 0.37 percentage. Also, there was less probability of occurrence of diabetes and thyroid at a time in a single person. Almost all the instances were correctly classified with improved accuracy rate than earlier predictions in this case of thyroid data diagnosis. Negligible difference was found in the accuracy levels of the three algorithms which were used for associative classification of the data set to predict the most probable occurrence of health problems in thyroid disorder patients. The below given are some rules generated.

R1: gender = female T3 = normal T4 = high 15 $\Longrightarrow$ disease = no 15 acc:(0.99399)
R2: diabetic = yes T3 = normal T4 = high 6 $\Longrightarrow$ disease = no 6 acc:(0.98473)
R3: gender = male T3 = low 5 $\Longrightarrow$ disease = yes 5 acc:(0.98086)
R4: T3 = high T4 = high 5 $\Longrightarrow$ disease = yes 5 acc:(0.98086)
R5: T3 = normal T4 = high 16 $\Longrightarrow$ disease = no 15 acc:(0.96149)
R6: gender = male diabetic = yes 7 $\Longrightarrow$ disease = yes 6 acc:(0.81233).

The results with three techniques are shown. To cross-check the accuracy of classification, first nominal to binary preprocessing was used and then discretization. Based on the results of classification, discretization feature was opted for all the three techniques. Results with nominal to binary for Naïve Bayes are given below in Table 1.

It divided seven attributes into fourteen attributes and gave the class 'yes' with 0.37 probability and class 'no' with 0.63 probability of co-disease. Without nominal to binary preprocessing, the simple discretized data set provided the following results located in Table 2. It treated seven as seven attributes.

Detailed accuracy of classification is given below in Table 2 in columns and rows format.

Accuracy details for Naïve Bayes

Table 1 **a** Nominal to Binary results using Naive Bayes **b** instance classification NB **c** instance classification ID3, **d** instance classification MLP

a		
Correctly classified instances	96	96.9697%
Incorrectly classified instances	3	3.0303%
b		
Correctly classified instances	97	97.9798%
Incorrectly classified instances	2	2.0202%
c		
Correctly classified instances	97	97.9798%
Incorrectly classified instances	2	2.0202%
d		
Correctly classified instances	97	97.9798%
Incorrectly classified instances	2	2.0202%

Table 2 Instance classification NB

TP rate	0.984	0.972	Weighted Avg
FP rate	0.028	0.016	0.98
Precision	0.984	0.972	0.023
Recall	0.984	0.972	0.98
F-Measure	0.984	0.972	0.98
ROC Area	0.999	0.999	0.98
Class	No	Yes	0.999

The accuracy of 98.24% was obtained for the Associative Classification using the proposed algorithm on data set by calculating the rule generation and accuracy measure. The sample rules of 19 were taken from total rules generated, and accuracy was calculated by deriving random rules of 8 in number from the subset of rules taken out.

Using ID3 algorithm, the following results were recorded in terms of accuracy and classification of instances. The instance classification was same even with ID3 classification as given below in Table 3.

The accuracy details with ID3 are listed below in columns and rows format in Table 3 which was different from Naïve Bayes algorithm's results.

Table 3 Instance classification ID3

TP rate	1	0.944	Weighted Avg
FP rate	0.056	0	0.98
Precision	0.969	1	0.035
Recall	1	0.944	0.98
F-Measure	0.984	0.971	0.98
ROC area	0.985	0.985	0.98
Class	No	Yes	0.985

Table 4 Instance classification with MLP

TP rate	0.984	0.972	Weighted Avg
FP rate	0.028	0.016	0.98
Precision	0.984	0.972	0.023
Recall	0.984	0.972	0.98
F-Measure	0.984	0.972	0.98
ROC area	0.998	0.998	0.98
Class	No	Yes	0.998

Accuracy Details with ID3
The accuracy of 98.8% was obtained for the Associative Classification using the proposed algorithm on data set by calculating the rule generation and accuracy measure. The sample rules of 35 were taken from total rules generated, and accuracy was calculated by deriving random rules of 10 in number from the subset of rules taken aside.

Multilayer Perceptron was used for classification, and it delivered the instance classification in the following as given in Table 4.

The accuracy details with MLP are listed below in columns and rows format in Table 4 which were different from both cases of results.
Accuracy details with MLP
The accuracy obtained with Associative Classification with the proposed algorithm was 98.09%, and here, the rules extracted from the actual rules were 26, and these were tested with comparison in other 8 rules of the subset rules. All the algorithms showed the improvement in accuracy of the classifiers using Associative Classification. Here, accuracy was calculated on the basis of total selected instances and correctly matched instances.

Accuracy = Number of comparisons matched correctly in ‘RS’/total comparisons in ‘RSS’

5 Conclusion

Form the results, it was shown that Associative Classification technique can perform better classification of data, and at the same, it was predicted that the co-disease or the mostly occurring problems in thyroid disorder were psychological issues. The same can also be used for designing highly favorable Decision Support System for such cases in the future to make the task of thyroid disease analysis easier. Anyhow, this algorithmic model is limited only to large data sets for prediction, and also, it makes the classification process greedy sometimes.

References

1. Milovic B (2011) Usage of data mining in making business decision. pp 153–157 (YU Info 2012 & ICIST 2012)
2. Margret JJ, Lakshmipathi B, Kumar AS (2012) Diagnosis of thyroid disorders using decision tree splitting rules. Int. J. Comput. Appl. 44(8): 43–46
3. Prerana PS, Taneja K (2015) Predictive data mining for diagnosis of thyroid disease using neural network
4. Chen HL (2012) A three stage experiment system based on support vector machine for thyroid disease diagnosis. J Med Syst 36(3):1953–1963
5. Long WJ et al (1997) Reasoning requirements for diagnosis of heart disease. Artif Intell Med 10(1):5–24
6. Turanoglu-Bekar E, Ulutagay G, Kantarcı-Savas S (2016) Classification of thyroid disease by using data mining models: a comparison of decision tree algorithms OJIDS. In: International Conference on Modern Trends in Engineering, Science and Technology (ICMTEST-17) vol 2016, issue 2
7. Khan SA, Jabbar MA (2019) Prediction of by-diseases in diabetic patients using associative classification with improved classifier accuracy for decision support system. IJEAT 8(6). ISSN: 2249-8958. https://doi.org/10.35940/ijeat.f8654.088619 Aug 2019
8. Yin X, Jiawei H (2003) CPAR: classification based on predictive association rule. In: Proceeding of the SDM, pp 369–376
9. Thabtah F, Mahmood Q, McCluskey L, Abdel-jaber H (2010) A new classification based on association algorithm. J Inf Knowl Manage 9(1):55–64 (World Scientific)

Recommendation of Diet Using Hybrid Collaborative Filtering Learning Methods

Vaishali S. Vairale and Samikshal Shukla

Abstract These days, various recommender systems exist for online advertisement services which recommend the products considering users' interests. Similarly, health recommendation systems are becoming most important component in individual's life. Due to the modernization and busy schedule, people give less concern to their eating patterns. This leads to various health issues like obesity, thyroid disorder, diabetes and others. Every individual has different health issues and food habits. Therefore, diet recommendations should be suggested by considering their personal health profile and food preferences. So, it becomes essential to analyze individuals' health concerns before recommending the diet with required nutrient values. Thus, it helps people to minimize the further risks associated with the current health conditions. The proposed diet and exercise recommender framework suggests a balanced diet for thyroid patients. It takes care of the food intake with necessary nutrients requirement based on thyroid disorders. This paper applies K-nearest neighbor collaborative filtering models using various similarity measures. The paper assessed two-hybrid learning methods, KNN with alternating least squares: KNN-ALS and KNN with stochastic gradient decent: KNN-SGD. The experimental setup analyzed and evaluated the performances of all algorithms using mean absolute error (MAE) and root mean squared error (RMSE) values.

Keywords Collaborative filtering · Recommender system · K-nearest neighbor · Matrix factorization · Thyroid disorder

V. S. Vairale (✉)
CHRIST (Deemed to be University), Kengeri Campus, Bangalore, Karnataka, India
e-mail: vairale.sheshrao@res.christuniversity.in

S. Shukla
CHRIST (Deemed to be University), Lavasa, Pune, India
e-mail: samiksha.shukla@christuniversity.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_36

1 Introduction

In recent years, recommender system becomes a new and interesting trend in e-commerce. It applies modern techniques like machine learning methods and artificial intelligence. Personalized recommendation systems mainly designed to fulfill consumers' needs [1]. Healthcare recommendation system is becoming an important research area. These systems recommend healthy diet [2], food taste [3] and balanced nutrition [4, 5]. Some diet recommendation frameworks are developed for special users who are suffering from specific diseases. A system was implemented to suggest food items considering user's health issues and personal information [6]. The system used consumers' dietary records to recommend a balanced nutrition [7]. A recipe recommender framework was analyzed for users to get their fitness targets [8]. Therefore, development of an intelligent diet recommendation framework for patients is an important and challenging task.

Eight out of ten women are suffering from thyroid issues mainly hypothyroidism worldwide. It is an underactive thyroid which produces less hormones. The vital signs of hypothyroidism are gaining weight, tiredness, feeling cold, etc. However, eating right amount of nutrients and prescribed medications may improve thyroid functions. It may help to reduce the disease symptoms. Eating nutrients like zinc, iodine and selenium is more beneficial to regulate the thyroid hormones. Eating foods with gluten may affect the regular function of thyroid gland. Therefore, patients should follow a thyroid-friendly diet. These diet plans can minimize the thyroid disorder symptoms and maintain a healthy lifestyle. The thyroid diet plan should contain whole, lean protein and unprocessed foods.

This research work is focused on above theme and develops a recommender system for thyroid patients by considering their food preferences. A proposed recommendation system can identify a patient's food choices and searches for other similar patients who may match with his/her preferences. We have presented a recommendation system for thyroid patients to predict similar user's ratings by using collaborative filtering learning algorithms.

Following sections describe the remaining paper. Section 2 narrates the previous research work of this research field. Section 3 proposes the design part of the system. Section 4 provides the implementation details and evaluation of hybrid recommender system. Finally, conclusion is provided in Sect. 5.

2 Related Work

Healthcare domain is a prominent application area of machine learning techniques. This technology helps to improve diagnosis as well as prevention of various diseases. Personalized recommendations are growing nowadays to improve health-related issues using various machine learning methods [9].

Mobile applications like mySugr [10] and RapidCalc Diabetes Manager [11] helped users to record their daily activities, food intake and glucose levels. These models were trained using machine learning approaches and can provide the adjustments for insulin dosage for diabetic patients. A health effective recommender system using big data was investigated by Archana et al. [12]. The proposed system used Bayesian network for multi-structured lifestyle healthcare data, physical and mental factors and user's social network activities. Recommendations were suggested as per their lifestyle data using classification methods. A mobile application developed by Preuveneers and Berbers [13] assisted diabetic patients. It kept the track of daily food intake, level of glucose, physical exercise and dosage of insulin. Hidden Markov model was used to monitor the location of users and their activities. The proposed model then suggested the medicine dosage to maintain the levels of blood glucose.

Researchers investigated collaborative filtering methods to recommend health data which matches with the people having similar health-related issues. Recommender frameworks can generate the health recommendations using user's medical history and personal profile. Kim et al. [14] designed a system using a context-aware collaborative technique. The proposed work used context data for filling up the missing values. This collaborative filtering process could suggest menu for the u-healthcare service domain. Hors-Fraile et al. [15] proposed hybrid recommender system which helped users to quit smoking. The proposed framework integrated content-based, demographic and utility-based filtering to generated health recommendations. Kulev et al. [16] proposed a recommender framework to provide recommendations for physical exercise. The model used collaborative filtering for identifying users with similar interests. The system analyzed the physical activity patterns of similar users and suggested the activities to improve user's health condition.

Many researchers have implemented recommender systems using rule-based techniques [17, 18]. The rules are generated by using domain knowledge. Lee et al. [19] designed fuzzy ontological expert system for diabetic patients of Taiwan. This food recommender model used fuzzy inference system to generate fuzzy factors for each type of food. It combined the personal profile and food ontology to generate food recommendations. Sivilai et al. [20] designed rule-based recommender model for old-aged Thai people. The system suggested meal plans as per their food choices and nutrition requirements. Skillen et al. [17] proposed rule-based framework using profile-based ontology. The system helped dementia patients to complete their daily routine work, like shopping, etc.

Above-mentioned all approaches are having their own drawbacks. Machine learning and collaborative filtering algorithms suffer from data scarcity (cold start) problem. Pre-defined rules are not always available in the health context. So, this becomes a major issue with the rule-based approaches. Tremendous research work is carried out in food and exercise recommendation domain, but still most of the recommender systems are focusing on diabetes disease. Thyroid is a growing and most prominent disease found among women. So, there is a need of diet and exercise recommender systems which helps thyroid patients to maintain healthy lifestyle.

3 Methodology

3.1 System Design

The diet recommender system has the following three phases: personal and medical data storage, finding similar users and prediction of ratings and recommendation of top three diet plans using hybrid method. The design of the system is as depicted in Fig. 1.

The framework stores patients' personal, medical and food databases. These knowledge bases contain basic information. The food database contains nutritional values like fat, protein, carbohydrates, iodine, zinc, sodium, total calories about the food items. We have applied KNN to the user-food matrix to find similar food and similar user. Users are having their own health goals and food preferences. So, we develop a hybrid KNN-SGD recommendation system to generate food list as. The interaction module displays the top three diet plan recommendations which are suitable for thyroid patients.

The proposed system predicts all users' rating given for each food items using training dataset. Prediction of ratings is an easy task for new users when the food ratings are available in food dataset. The aim is to reduce RMSE and MAE of the predicted results of testing dataset which contains unknown food ratings.

The recommendation process generates a health score. It compares user's food preferences and needed basic food nutrition based on their health condition. The generated health score lies in the range of 1–10. The food rating list is predicted and

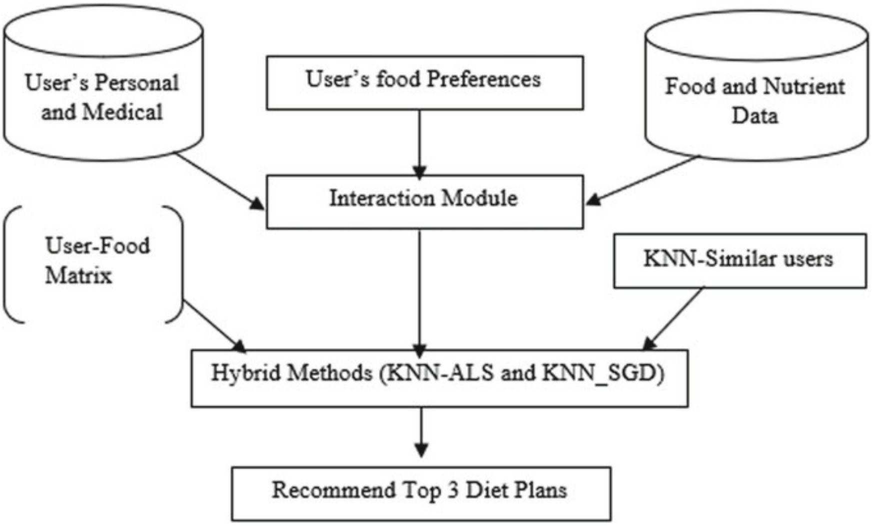


Fig. 1 System design

then sorted to obtain top three diet plan recommendations. The recommended diet plans are the average score of user's food preferences and predicted food list.

3.2 Dataset

For experimental study, Indian food data is used with a wide variety of vegetarian (veg) and non-vegan (non-veg) categories. The price range of selected food is moderate or low. We have collected 300 dishes in veg (200) and non-veg (100) categories together. The food dataset beneficial for thyroid patients is not available for public use. So, we collected the food list from nutritionist. We have interacted with 52 people (37 female and 15 male) who visited to the nutritionist to get their diet plans. We received the list of diet plans along with ratings for each food items/meal set. We assigned the range of 1–5 to the ratings. The food with higher rating is considered as more beneficial for thyroid patients.

3.3 Algorithms Used

K-Nearest Neighbors with its similarity measures
The unavailability of the users' rating for some food items may affect for the calculation of the similarity measures. Due to this, calculating similarities with shared ratings may likely lead to underestimations. So, we prepared the groupings of patients with different thyroid disorder using learning algorithms. Using user preferences of food, we formed general categories of food items like "vegetarian food and non-vegetarian food." KNN basic is a recommender algorithm used for collaborative filtering method. It considers mean ratings of every user. The predicted rating is calculated using below equation:

$$\widehat{\mathrm{R}}_{\mathrm{uf}} = \mu_{\mathrm{u}} + \frac{\sum_{v \in N_i^k(u)} S_{uv} \cdot \left(R_{vf} - \mu_v\right)}{\sum_{v \in N_i^k(u)} S_{uv}} \tag{1}$$

where $\widehat{R}_{\mathrm{uf}}$—predicted rating, μ_{u}—mean rating for user u, S_{uv}—Similarity measure among user u and user v, $N_i^k(u)$—sets which include neighbors for those similarity measure is +ve. We executed KNN method with five-split cross-validation using different combinations of similarity measures defined in Sect. 4.

Hybrid Approach
Matrix factorization method decomposes user/food matrix into smaller dimensional user and food factors. We estimated user ratings using their food preferences and thyroid disease level by multiplying user and food factors with the following equation:

$$\widehat{R}_{\mathrm{uf}} = X_u^T Y_f \tag{2}$$

where $\widehat{R}_{\mathrm{uf}}$ is the predicted rating using vector of each user X_u and food item Y_f.

The Eq. 3 produces the loss function to reduce the error of the recommendation method. This function is squared of the difference among the all ratings of our dataset and the predicted results.

$$\min_{Y,X} \sum_{u,i} \left(R_{\mathrm{uf}} - \widehat{R}_{\mathrm{uf}} \right)^2 \tag{3}$$

where R_{uf} is the available rating and $\widehat{R}_{\mathrm{uf}}$ is the predicted result (predicted rating calculated as per Eq. 2). Biases and regularization were not considered in Eqs. 2 and 3, respectively.

Alternating least squares is a collaborative filtering method which uses matrix factorization algorithm. It optimized the non-convex loss function given in Eq. 3 into simple quadratic problem. ALS fixed either X_u or Y_f alternatively. X_u is computed when Y_f is fixed and vice versa.

Stochastic gradient descent is used for factorization of sparse matrix into two—low-level rank matrices. This algorithm computed the error $\left(R_{\mathrm{uf}} - \widehat{R}_{\mathrm{uf}} \right)$ for each instance of dataset. The method updated the features by user and food item latent factors in the reverse way of gradient.

The hybrid approach KNN-ALS and KNN-SGD calculated the user's rating by averaging predicted ratings generated using Eq. 1 (with KNN) and Eq. 2 (ALS and SGD for each sample). The method is evaluated with four similarities measures defined in Sect. 4.

4 Results and Discussions

The experimental work is carried out in Python on Jupyter Notebook5 with surprise RecSys package. KNN and hybrid learning methods KNN-ALS and KNN-SGD are analyzed and implemented using our dataset. The evaluation results of these methods are discussed here. We used K-split cross-validation (k = 5) for evaluation of errors in terms of RMSE and MAE. The performance metric precision is evaluated for KNN and hybrid methods. Figure 2 shows the RSME and MAE values for KNN with its four similarity measures namely as follows:

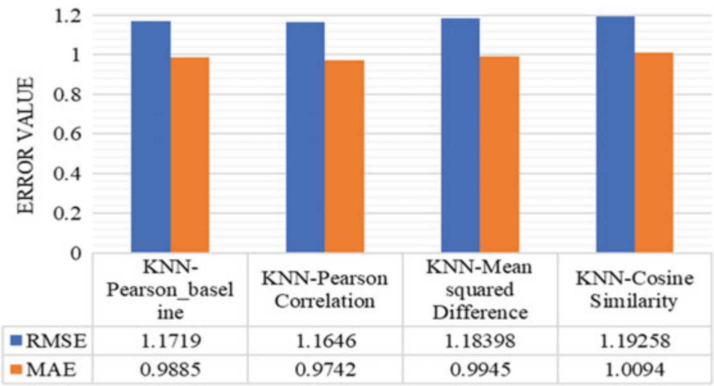


Fig. 2 RSME and MAE values of KNN basic with different similarity measures

Pearson baseline—"Pearson correlation coefficient (PCC)" is calculated among all pairs of food items or users. Instead of means, it uses baselines for centering.

Pearson Correlation—It considers only common items or users to compute PCC among all pairs of food items or users. PCC is applied as mean-centered cosine similarity.

Mean Squared Difference—It considers only common items or users. It uses "mean squared difference" to calculate the similarity among all combinations of food items or users.

Cosine Similarity—It uses cosine similarity to calculate the similarity among all the combinations of food items or users. It considers only common items or users.

Out of four similarity measures, KNN with Pearson correlation showed the less RMSE and MAE values. To improve the performance of KNN, we have applied alternative least squares with four similarity measures. The results are shown in Fig. 3.

Hybrid KNN-ALS showed better results for prediction of rating and recommendations of food items. The RSME and MAE values of KNN-ALS are less as compared to KNN basic alone. The performance of KNN-SGD is better than earlier methods. The evaluated RSME and MAE values for KNN-SGD are displayed in Fig. 4.

KNN-SGD performed well among KNN basic, KNN-ALS and KNN-SGD in terms of minimization of RSME and MAE values. We achieved good precision performance score for KNN-SGD hybrid approach. Figure 5 compares the precision score of implemented algorithms for prediction of the unknown rating of new user and recommends the food list.

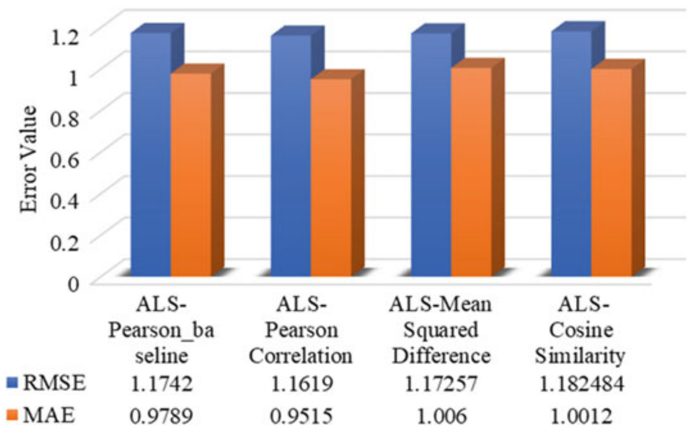


Fig. 3 RSME and MAE values of KNN-ALS with different similarity measures

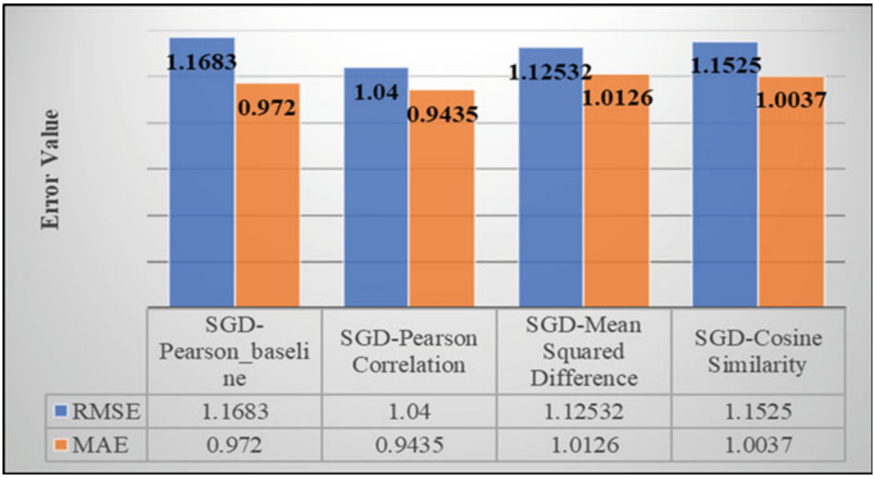


Fig. 4 RSME and MAE values of KNN-SGD with different similarity measures

5 Conclusion

The personalized approach of recommender system in food domain contains different features. A diet recommender system by using hybrid machine learning techniques is presented in this paper. It mainly designed to recommend diet plans for thyroid patients. The hybrid learning method with KNN enhances the precision of recommender system. This research work presents a hybrid methodology which evaluates KNN with matrix factorization-based ALS and SGD methods for creation of robust recommendation system. The experiments are executed with these hybrid methods based on patients' food preferences. It aggregates the features of food items and

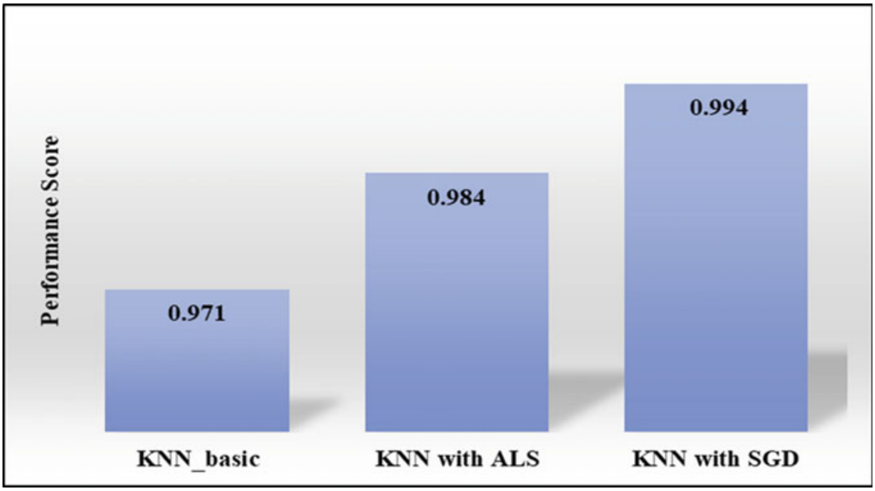


Fig. 5 Precision score of KNN and hybrid learning methods

applied factorization methods to obtain latent low-rank matrix. The obtained features rank matrix is utilized to generate accurate recommendations. Future research will focus on other hybrid or deep learning methods to capture more features and to enhance the recommendation performance results.

References

1. Tan TS, Chang C, Chen Y (2012) Developing an intelligent e-restaurant with menu recommender for customer-centric service. IEEE Trans Sys Man Cybern 42(5):775–787. https://doi.org/10.1109/tsmcc.2011.2168560
2. Ge M, Ricci F, Massimo D (2015) Health-aware food recommender system. In: 9th ACM conference on RecSys, Vienna, Austria, 16–20 Sept 2015, pp 333–334
3. Longqi Y, Cheng-Kang H, Yang H, Pollak J et al (2017) Yum-me: personalized nutrient-based meal recommender system. ACM Trans Inf Sys (TOIS) 36(1):7–31. https://doi.org/10.1145/3072614
4. Mouzhi G, Mehdi E, Ignacio F-T, Francesco R, David M (2015) Using tags and latent factors in food recommender system. In: ACM 5th international conference on digital health, Italy, 18–20 May 2015, pp 105–112
5. Saeed H, Shouman A, Elfar M, Shabka M, et al (2016) Near-field communication sensors and cloud-based smart restaurant management system. In: IEEE 3rd World Forum on Internet of Things (WF-IOT), Reston, VA, USA, pp 686–691
6. Kim J, Lee J, Park J, Lee Y, Rim K (2009) Design of diet recommendation system for healthcare service based on user information. In: IEEE 4th international conference on computer sciences and convergence information technology, pp 516–518, Seoul, 24–26 Nov 2009
7. Li X, Liu X, Zhang Z, Xia Y, Qian S (2010) Design of health eating system based on web data mining. In: IEEE WASE international conference on information engineering Beidaihe, Hebei, China, 14–15 Aug 2010, pp 346–349

8. Mino Y, Kobayashi I (2009) Recipe recommendation for a diet considering a user's schedule and the balance of nourishment. In: IEEE international conference on intelligent computing and intelligent systems, Shanghai, China, 20–22 Nov 2009, p 38
9. Fadhil A, Wang Y (2018) Towards automatic & personalized mobile health interventions: an interactive machine learning perspective. https://arxiv.org/abs/1803.01842
10. mySugr Bolus Calculator (2018) https://mysugr.com/mysugr-boluscalculator/
11. GlucoMen (2018) https://www.glucomen.co.uk/rapidcalc/
12. Archenaa J, Anita EAM (2017) Health recommender system using big data analytics. J Manage Sci Bus Intell 2(2):17–24
13. Preuveneers D, Berbers Y (2008) Mobile phones assisting with health self-care: a diabetes case study. In: 10th ACM international conference on human computer interaction with mobile devices and services (MobileHCI'08), Amsterdam, The Netherlands, 02–05 Sept 2008, pp 177–186
14. Kim J, Lee D, Chung K (2014) Item recommendation based on context aware model for personalized u-healthcare service. J Multimedia Tools Appl 71(2):855–872
15. Hors-Fraile S, Benjumea FJN, Hernández LC, Ruiz FO, Fernandez-Luque L (2016) Design of two combined health recommender systems for tailoring messages in a smoking cessation app. In: International workshop on engendering health with RecSys co-located with ACM RecSys, Boston, MA, USA
16. Kulev I, Vlahu-Gjorgievska E, Trajkovik V, Koceski S (2013) Recommendation algorithms based on collaborative filtering and their application in health care. In: 10th conference for informatics and information technology, pp 34–38
17. Skillen K-L, Chen L, Nugent CD, Donnelly MP et al (2014) Ontological user modelling and semantic rule-based reasoning for personalization of help-on-demand services in pervasive environments. J Future Gener Comput Syst 34:97–109
18. Al-Nazer A, Helmy T, Al-Mulhem M (2014) User's profile ontology based semantic framework for personalized food and nutrition recommendation. Procedia Comput Sci 32:101–108
19. Lee CS, Wang M-H, Li HC, Chen WH (2008) Intelligent ontological agent for diabetic food recommendation. In: IEEE international conference on fuzzy systems, Hong Kong, China, 1–6 June 2008, pp 1803–1810
20. Sivilai S, Snae C, Brueckner M (2012) Ontology-driven personalized food and nutrition planning system for the elderly. In: 2nd international conference in business management and information sciences, Phitsanulok, Thailand, 19-20 Jan 2012, pp 1–6

Classification of Natural Images Using Machine Learning Classifiers on Graph-Based Approaches

B. Kishore, V. Vijaya Kumar and J. Sasi Kiran

Abstract Local descriptors have become more and more popular and are gaining a high recognition in recent years in texture analysis and other domains of image processing and computer vision due to their capability in identifying unique and distinct features which are robust to various conditions. Most of the local descriptors like local binary pattern (LBP), textons and Peano scan motif considered the neighborhood as a simple window and extracted the features. This paper derives a graph structure on a local grid. The local features are derived based on transitions between adjacent vertices. This paper derives a dual graph function using the neighborhood property that exists between a vertex V and two of its neighbors V_1 and V_2 which are connected with vertex V. This paper initially divides the texture image into 2×2 non-overlapped grids and derives dual transition function and derives a dual graph unit (DGU) and replaces the 2×2 grid with DGU. The co-occurrence matrix derived on DGU indexed image represents dual graph texture matrix (DGTM). The gray level co-occurrence matrix (GLCM) features are derived on DGTM, and these feature vectors are given as inputs to the machine learning classifiers for classification. The proposed local DGTM is compared with state-of-the art local-based approaches, and the results on five popular databases exhibit the efficacy of the proposed DGTM over the existing local-based methods.

Keywords Dual graph · Transitions · Peano scan · Motif

B. Kishore (✉)
PhD Scholar, Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya University, Kanchipuram, India
e-mail: kishore.gmr@gmail.com

Professor of Practice, EECS, Oregon State University, Corvallis, USA

V. Vijaya Kumar
Professor & Dean, Department of CSE & IT, Aurag Group of Institutions, Hyderabad, Telangana, India
e-mail: drvvk144@gmail.com

J. Sasi Kiran
Farah Institute of Technology, Chevella, India
e-mail: sasikiranjangala@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_37

1 Introduction

Extraction of significant features which are more distinctive is one of the primary and active issues in computer vision, and it has got wide range of applications, e.g., texture classification [1–3], face recognition [4–6], content-based image retrieval (CBIR) [7–9], age classification [10, 11], 3D reconstruction and many others. The high quality and low computational cost are the most important and crucial issues of any feature descriptor. One of the crucial aspects in the design of a feature descriptor is to be discriminative, robust and invariant to various rotations. The local binary features have aroused an extensive attention in computer vision field over the past decade mainly due to their efficiency, robustness, discriminative power, low computational cost. The robust invariant scalable key point (BRISK) [12], robust independent elementary feature (RIEF) [13], fast retina key point [14], local binary pattern (LBP) and its variants [15–21] are the popular descriptors that derive binary features for various applications of computer vision. The advantages of binary features are (i) they deliver strong robustness toward local changes, (ii) easy to compute and understand and (iii) exhibits high computational efficiency by substituting the Euclidian distance with hamming distance. However, the above methods are treated as handcrafted methods. To address the limitations of local binary descriptors, learning-based local binary descriptors [22–26] were proposed in the literature; however, they have not become popular due to the following disadvantages like (i) sensitive to rotations and (ii) data addictiveness. Further, these descriptors are not suitable for real-time applications when data rotation is a common factor.

In the literature, co-occurrence features are widely used in computer vision. The co-occurrence features derive relationship between the related features and thus provide higher order statistical information compared to individual occurrence of features. The co-occurrence features can be grouped into two classes, namely holistic co-occurrence features [27, 28] and local co-occurrence features [29–32]. The relationship between visual sematic concepts such as scenes and objects is derived by holistic co-occurrence approaches. The local co-occurrence features are extracted from the adjacent local patches.

The remaining of the paper is organized as follows: Sect. 2 describes about proposed methodology, and Sects. 3 and 4 describe about results and discussions and conclusions, respectively.

2 Derivation of Proposed Dual Graph Texture Matrix (DGTM)

A graph "G" is denoted by $G = (V, E)$ where V and E respresents a path from finite set. The edge represents a path form finite set of pairs of vertices. An example of non-directed graph is shown below in Fig. 1.

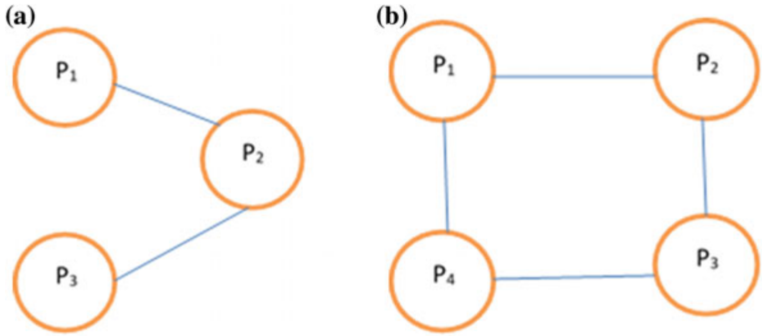


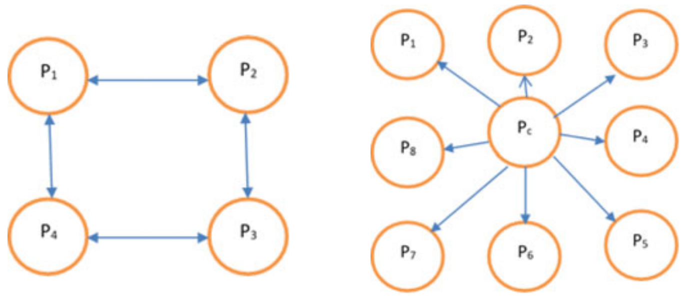
Fig. 1 Example of graphs

Figure 1 a consists of three vertices, i.e., $V = \{P_1, P_2, P_3\}$, and edges are denoted as $E = \{\text{P1}\rightarrow\text{P2, P2}\rightarrow\text{P3}\}$.

In a non-directed graph, if there is an edge from vertex P_i to P_k then vice versa is also true. Figure 1b represents a cyclic graph, since it contains a cycle. Figure 1a is an acyclic graph, and it can also be treated as a tree. The major difference between a tree and a graph is all trees are graphs, however, vice versa are not true. A graph can be called as a tree if it is an acyclic graph. A vertex P_j is considered to be a neighbor of Pi if and only if there exists a direct edge between P_i and P_j.

The path in a graph consists of sequence of vertices $P_1, P_2, P_3 \ldots P_k$, $k \geq 1$, such that there is an edge (V_i, V_{i+1}) for each i, $1 \leq i \leq k$. The length of the path is $k - 1$. The above graph structure can be associated with a local neighborhood of an image. The representation of a 2×2 and the relationship of LBP on a 3×3 neighborhood in the form of a graph are shown below.

The graph G_2 (V_2, E_2) of Fig. 2a is defined as: $V_2 = \{P_1, P_2, P_3, P_4\}$, with a maximum path length of 4. The graph G_2 represents a 2×2 grid of an image, and the vertices $\{P_1, P_2, P_3, P_4\}$ represents the pixel locations, and the function $f(P_i)$ represents the gray value associated with pixel vertex P_i. Fig. 2a is an example of



(a): Graph G2: representation. (b): Graph G3.

Fig. 2 Simple representation of a directed graph on a local neighborhood

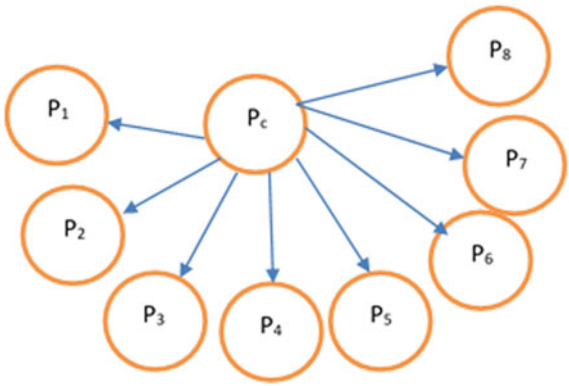


Fig. 3 Representation of Fig. 2b: Graph G_3 in the form of a tree

cyclic and directed graph, and each vertex or the pixel location P_i will have two immediate neighbors, and one can reach any vertex P_j from any other vertex P_i and vice versa. Figure 2a is cyclic graph, so it does not derive any tree. Figure 2b represents an acyclic and directed graph G_3. The maximum length of any path is 1. The graph G_3 (V_3, E_3) where $V_3 = \{P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_c\}$ represents the nine vertices, and the graph G_3 can derive a relationship between $f(P_c)$ and $f(P_i)$ where $i = 1$ to 8. This is similar to the relationship derived in LBP framework, i.e., between central pixel Pc and its 8-neighboring pixels P_i where $i = 1$ to 8. In the graph G_3, we can only reach any vertex P_i where $i = 1, 2\ldots8$, from the vertex P_c only with a path length of 1. The graph G_3 represents a local binary pattern (LBP) framework, since it derives a relationship in the form of an edge from P_c to P_i, where P_c and P_i represent the center and sampling points of the 3×3 grid.

The LBP relationship framework between the vertex or pixel Pc and the sampling or neighboring vertices or pixels of a 3×3 neighborhood can be represented in the form of a tree as given Fig. 3. In Fig. 3, the vertex P_c represents the root node and the other vertices or sampling points $P_1, P_2 \ldots P_8$ represent the terminal or leaf or child nodes. This paper derived a transition function (tf) for a vertex P_i of a graph with respect to the other vertex P_j in the graph as follows, and it is denoted as tf (P_i). The tf (P_i) can be defined if and only if there is an edge from P_i to P_j. The tf (P_i) derives a value based on the relationship between $f(P_i)$ and $f(P_j)$, and it is represented as follows.

$$\mathrm{tf}(P_i) = R(f(P_i) f(P_j)) \tag{1}$$

where $R\big(f(P_i)\ f\big(P_j\big)\big)$ derives the relationship between the values associated with P_i and P_j. The tf (P_i) derives a unique value for P_i based on the values associated with P_i and P_j and replaces the $f(P_i)$ with $\mathrm{tf}(P_i)$. For example in LBP framework, $\mathrm{tf}(P_i)$ is generated with respect to P_c, and it derives binary values, i.e., 0 and, 1 as explained above

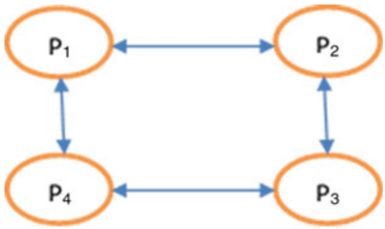


Fig. 4 A 2 × 2 image microgrid represented in the form of a directed graph

$$\mathrm{tf}(P_i) = \begin{cases} 0 \text{ if } f(P_i) \geq f(P_c) \\ 1 \text{ if } f(P_i) < f(P_c) \end{cases} \text{ for } i = 0 \text{ to } 7 \tag{2}$$

This paper also derived a dual transition function (dtf) for a vertex P_i with respect to its two of its adjacent vertices P_j and P_k, and this is only possible if and only if there is a direct edge between P_i and P_j and P_i and P_k. The dtf for the vertex P_i is denoted as dtf(P_i). That means, dtf(P_i) is based on the relationship between P_j and P_k with P_i. This paper derived a ternary relationship on dtf(P_i), and it is given in equation.

$$\mathrm{dtf}(P_i) = \begin{cases} 0 \text{ if } f(P_i) \geq f(P_j) \text{ and } f(P_i) \geq f\left(P_j\right) \\ 1\ f(P_i) < f(P_j) \text{ and } f(P_i) < f\left(P_j\right) \\ 2 \qquad \text{Otherwise} \end{cases} \tag{3}$$

This paper derived dtf (P_i) on a 2 × 2 image microgrid with pixels P_1, P_2, P_3 and P_4 as follows. This paper considered the 2 × 2 grid as a graph as shown in Fig. 4. Figure 4 represents a graph G_4 with four vertices $\{P_1, P_2, P_3$ and $P_4\}$, and the relationship between the vertices are displayed in Fig. 4. The direct graph G_4 with four vertices is similar to a 2 × 2 grid of an image with four pixels $\{P_1, P_2, P_3, P_4\}$.

In the above graph of 2 × 2 image microgrid, the vertex P_1 is having two neighbors P_2 and P_4, and in the similar way, the remaining vertices or pixel locations are also having two adjacent vertices (P_2: P_1 and P_3; P_3: P_2 and P_4; P_4: P_3 and P_1). This paper initially divides the texture image into microgrid of size 2 × 2. The microgrid is assumed as a graph G_4 of Fig. 4, where each pixel or vertex is having two adjacent vertices. This paper derives dtf(P_1), dtf(P_2), dtf(P_3), dtf (P_4) and replaces each P_i with a ternary value using Eq. 3. Thus, the 2 × 2 grid with four pixels are replaced with ternary values. This paper derives dual graph unit (DGU) of a 2 × 2 grid using the four dtf(P_i) derived on the four vertices or pixels and by multiplying ternary pattern with ternary weights as given in Eq. 4.

$$\mathrm{DGU} = \sum_{i=1}^{4} \mathrm{dtf}(P_i) * 3^{i-1} \tag{4}$$

172	90
140	100

(a) sample 2x2 grid

0	1
2	2

(b) Derivation of dtf at each pixel (dtf(pi))

30	31
33	32

(c) Correspond ternary wright

75

(d) DGU

Fig. 5 Framework of generation of DGU on a 2 × 2 grid

This paper replaces the 2 × 2 grid with DGU, and DGU ranges from 0 to 80. Thus, this paper transforms the 2 × 2 grid with a single value, i.e., DGU; thus, this paper quantizes the image of dimension $N \times M$ by $N/2*M/2$ with code levels ranging from 0 to 80. The process of generating DGU for a given 2 × 2 grid is shown below in Fig. 5.

This paper initially converts the given image into DGU indexed image. On DGU indexed image, this research derived co-occurrence matrix, and this derives DG texture matrix (DGTM). The GLCM features are applied with three distance factors $d = 1, 2, 3$ on DGTM. One of the oldest and still popular and benchmark statistical models of texture analysis is GLCM proposed by Haralick, and it is widely used and integrated with many other models due to its high classification rate. The GLCM is a second-order statistical model. The spatial relationships between gray level tones are well established by GLCM, and this is an important and very useful relationship for characterizing texture information more efficiently. The GLCM computation is given below: Let the image gray level ranges from 0 to $g - 1$. Then, GLCM is computed from the DTU coded image by scanning the DTU of each 2 × 2 grid and its neighbors, defined by displacement d and angle ϕ. The displacement d could take a value of 1, 2, 3…n, whereas an angle ϕ is limited 0°, 45°, 90° and 135°.

The GLCM features, i.e., contrast correlation, entropy, angular second moment, local homogeneity-inverse difference moment and prominence feature, are derived under four rotation angles, i.e., 0°, 45°, 90° and 135°, for each d value on the proposed DGTM. The average feature value on 0°, 45°, 90° and 135° for each "d" value is computed on proposed DGTM and considered for the classification purpose on four machine learning classifiers.

The major contribution of this paper

1. Derivation of local features of an image using graph models and property.
2. The representation of a 2 × 2 grid in a graph model with four vertices and edges
3. Derivation of unary and dual transition functions (tf and dtf) based on the relationship between a vertex and its neighbor and vertex with its two of its neighbors, respectively.
4. The derivation of a unique DGU for each 2 × 2 grid. The DGU represents the complete structural and texture information of a 2 × 2 grid.
5. Derivation of DGTM by deriving co-occurrence matrix on DGU texture image.

The proposed DGTM describes the spatial correlation of structural, texture and statistical relationship using graph properties.

3 Results and Discussions

The proposed descriptor DGTM is tested using the five popular databases, namely colored Brodatz texture (CBT) [33], Outex [34], UIUC [35], KTH-TIPS [36] and ALOT [37]. This paper computed initially the proposed dual graph texture matrix (DGTM) with distance values 1, 2 and 3. And on each distance value, this paper computed six GLCM features with four varying rotations. This derives a total of 24 features on each distance value. That is the feature vector of each distance value consists of 30 features. The feature vector of each distance value, i.e., 1,2, and 3, is computed on the proposed descriptor DGTM from the above database and given as inputs to the four machine learning classifiers, i.e., using multilayer perceptron (MLP), naive Bayes, Ibk and J48. The DGTM exhibited high classification rate for d value = 1, and the classification results for the four classifiers for "*d*" value 1 are shown in Table 1 and Comparison of proposed method and state-of-the art methods are seen in Fig. 6.

The last row of Table 2 gives the average classification rate of the proposed descriptor on all databases using four different machine leaning classifiers. The multilayer perceptron and Ibk classifiers have shown comparatively better results than naive Bayes and J48. The two classifiers, i.e., multilayer and Ibk, exhibited more than 10% of high classification rate on all databases when compared to J48 and naive Bayes. Among two better classifiers, the multilayer perceptron has shown almost 2% of high classification rate than Ibk. The rest of the paper uses the multilayer perceptron classification results when comparison made with rest of the papers.

The proposed DGTM results are compared with the popular and widely used local descriptors of the literature lbp [38], ltp [39], CLBP-SMC [40], CS-LBP [41], MCM [42], MMCM [43], LMP-CM [44] and CDCETM [45], and the classification results on each database is listed in Table 4. The classification results on all six databases considered are also plotted in Fig. 7. The results clearly indicate the supremacy of the proposed descriptor over the other LBP-based methods and motif-based methods. The main reason for this is most of the LBP-based methods derives a binary relation based on a relationship between two pixels or two vertices of a graph as in our case.

Table 1. Classification rates of DGTM with different classifiers on $d = 1$

S.no	Database	Ibk	Naive Bayes	J48	Multilayer perceptron
1	A LOT	93.59	83.6	83.94	94.59
2	Outex-TC-10	95.88	84.86	85.58	98.62
2A	Outex-TC-12	93.59	85.5	86.89	98.82
3	Brodtaz	94.85	85.09	85.95	97.78
4	UIUC	96.22	86.13	86.89	98.54
5	KTH-TIPS	97.55	86.45	87.62	98.31
	Average classification rate	95.28	85.27	86.15	97.78

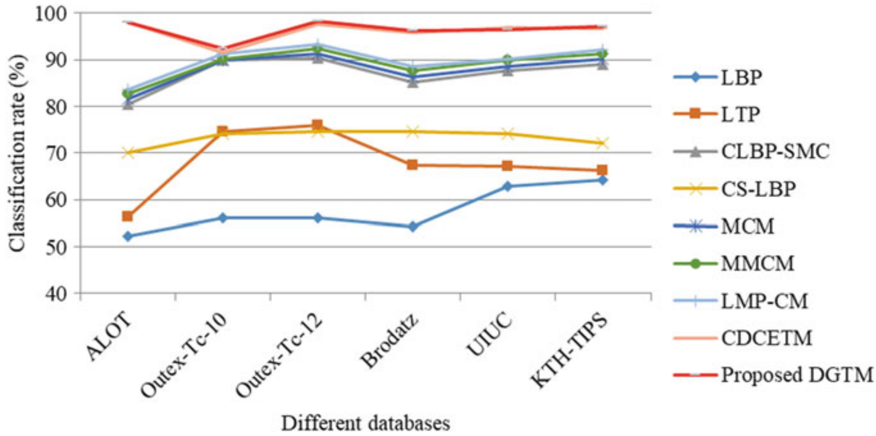


Fig. 6 Comparison of proposed method and state-of-the art methods

The advantage of the proposed method is it derives a ternary value of a vertex V or pixel based on its gray level relationship between two immediate adjacent vertices or pixels. This relationship forms a right angle relationship for a vertex or pixel P as shown in Fig. 7.

The advantage of this work is that this relationship is derived based on the dual transition. This relationship derives more significant and powerful information of a pixel, since it is derived basically from two adjacent vertices. This has made the proposed DGTM as a superior framework than the existing methods. The proposed DGTM attained high classification rate on all databases, and this indicates the efficacy of the proposed method in classifying the different types of natural texture images.

4 Conclusions

This paper derived a new framework in establishing neighborhood relationship of a pixel based on graph properties. For this, this paper considered the 2×2 window as a graph with vertices (representing the pixel locations) and edges. This paper derived a dual transition function by establishing the basic graph property, i.e., based on the relationship between adjacent vertices. The proposed DGTM computed a ternary relationship based on directional measures and represented the given 2×2 window with a unique value named as DGU which represents a directional unit. This paper combined the directional patterns or DGU with statistical features by deriving a co-occurrence matrix and computing GLCM features. This made the proposed dual graph texture matrix (DGTM) more precise and accurate. The replacement of distance measures with machine learning classifiers has given a high classification rate. The experimental result on five natural texture images and comparison of the

Table 2. Classification rate (%) of proposed method and existing classifiers

Database	LBP [38]	LTP [39]	CLBP-SMC [40]	CS-LBP [41]	MCM [42]	MMCM [43]	LMP-CM [44]	CDCETM [45]	Proposed DGTM
ALOT	52.26	56.24	80.46	70.14	81.52	82.68	83.54	98.02	98.11
Outex-Tc-10	56.11	74.56	89.88	74.11	89.92	90.21	91.25	91.42	92.32
Outex-Tc-12	56.19	75.88	90.30	74.64	91.25	92.35	93.36	97.52	98.21
Brodatz	54.28	67.50	85.23	74.56	86.32	87.68	88.56	95.81	96.23
UIUC	62.86	67.16	87.64	74.24	88.63	89.88	90.24	96.92	96.52
KTH-TIPS	64.16	66.18	89.14	72.14	90.21	91.23	92.31	96.72	97.21

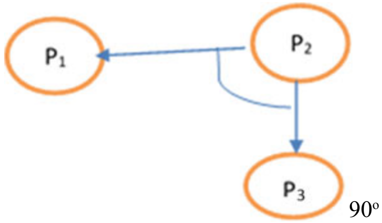


Fig. 7 Right angle relationship of P_2

proposed DGTM with other existing methods clearly indicates the supremacy of the proposed method over the existing ones.

References

1. Sowjanya Kumari Y, Vijaya Kumar V, Satyanarayana C (2017) Texture classification using complete texton matrix. Int J Image Graphics Signal Process 10:60–68
2. Kishore B, Vijaya Kumar V (2018) Local Texton Centre Symmetric Pattern Matrix (LTCSPM) on wavelet domain for texture classification. Int J Innov Technol Exploring Eng (IJITEE) 8(2S). ISSN: 2278-3075, December, 2018
3. Subba Reddy K, Vijaya Kumar V, Siva Kumar AP (2018) Texture classification based on first order circular and elliptical ternary direction pattern matrix. Int J Eng Technol 7(3.27):601–608
4. Vijaya Kumar V, Srinivasa Reddy K, Venkata Krishna V (2015) Face recognition using prominent LBP model. Int J Appl Eng Res 10(2):4373–4384. ISSN: 0973-4562
5. Srinivasa Reddy K, Vijaya Kumar V, Eshwarareddy B (2015) Face recognition based on texture features using local ternary patterns. Int J Image Graphics Signal Process (IJIGSP) 10:37–46. ISSN: 2074-9082
6. Vamsee Mohan B, Vijaya Kumar V (2018) Face recognition using robust fuzzy based fundamental texture matrix (RFFTM). J Adv Res Dyn Control Syst 10, 15-Special Issue
7. Obulesu A, Vijaya Kumar V, Sumalatha L, Niranjan SK (2017) Region based image retrieval using ranking concept of local binary pattern. IEEE-Int J Big Data Anal Comput Intell (ICBDACI-2017), 23–25 March 2017
8. Obulesu A, Vijay Kumar V, Sumalatha L (2018) Cross diagonal derivation direction matrix for efficient image retrieval. J Adv Res Dyn Control Syst 10(4):284–295
9. Vijaya Kumar V, Srinivasa Rao A, Sundara Krishna YK (2015) Dual transition uniform LBP matrix for efficient image retrieval. Int J Image Graphics Signal Process (IJIGSP) 8:50–57
10. Kumar PJS, Venkata Krishna V, Vijaya Kumar V (2016) A dynamic transform noise resistant uniform Local Binary Pattern (DTNR-ULBP) for age classification. Int J Appl Eng Res (IJAER) 11(1):55–60. ISSN 0973-4562
11. Vijaya Kumar V, Kumar PJS, Pullela S, Kumar VVSR (2015) Age classification of facial images using third order neighbourhood Local Binary Pattern. Int J Appl Eng Res (IJAER) 10(15):35704–35713. ISSN 0973-4562
12. Leutenegger S, Chli M, Siegwart RY (2011) BRISK: binary robust invariant scalable keypoints. In: Proceedings of ICCV, pp 2548–2555
13. Calonder M, Lepetit V, Strecha C, Fua P (2010) BRIEF: binary robust independent elementary features. In: Proceedings of ECCV, pp 778–792
14. Alahi A, Ortiz R, Vandergheynst P (2012) FREAK: fast retina keypoint. In: Proceedings of CVPR, pp 510–517

15. Lu J, Liong VE, Zhou X, Zhou J (2015) Learning compact binary face descriptor for face recognition. IEEE Trans Pattern Anal Mach Intell 37(10):2041–2056
16. Sun Y, Wang X, Tang X (2014) Deep learning face representation from predicting 10,000 classes. In: Proceedings of CVPR, pp 1891–1898
17. Sun Y, Chen Y, Wang X, Tang X (2014) Deep learning face representation by joint identification-verification. In: Proceedings of NIPS, pp 1988–1996
18. Sun Y, Wang X, Tang X (2015) Deeply learned face representations are sparse, selective, and robust. In: Proceedings of CVPR, pp 2892–2900
19. Qi X, Xiao R, Li C-C, Qiao Y, Guo J, Tang X (2014) Pairwise rotation invariant co-occurrence local binary pattern. IEEE Trans Pattern Anal Mach Intell 36(11):2199–2213
20. Zhao G, Ahonen T, Matas J, Pietikäinen M (2012) Rotation-invariant image and video description with local binary pattern features. IEEE Trans Image Process 21(4):1465–1477
21. Mehta R, Egiazarian KO (2013) Rotated local binary pattern (RLBP)—rotation invariant texture descriptor. In: Proceedings of ICPRAM, pp 497–502
22. Strecha C, Bronstein AM, Bronstein MM, Fua P (2012) LDAHash: improved matching with smaller descriptors. IEEE Trans Pattern Anal Mach Intell 34(1):66–78
23. Trzcinski T, Lepetit V (2012) Efficient discriminative projections for compact binary descriptors. In: Proceedings of ECCV, pp 228–242
24. Trzcinski T, Christoudias M, Fua P, Lepetit V (2013) Boosting binary keypoint descriptors. In: Proceedings of CVPR, pp 2874–2881
25. Zhang S, Tian Q, Huang Q, Gao W, Rui Y (2014) USB: ultrashort binary descriptor for fast visual matching and retrieval. IEEE Trans Image Process 23(8):3671–3683
26. Balntas V, Tang L, Mikolajczyk K (2015) BOLD—binary online learned descriptor for efficient image matching. In: Proceedings of CVPR, pp 2367–2375
27. Rasiwasia N, Vasconcelos N (2009) Holistic context modeling using semantic co-occurrences. In: Proceedings of CVPR, pp 1889–1895
28. Yuan J, Yang M, Wu Y (2011) Mining discriminative co-occurrence patterns for visual recognition. In: Proceedings of CVPR, pp 2777–2784
29. Ito S, Kubota S (2010) Object classification using heterogeneous co-occurrence features. In: Proceedings of ECCV, pp 701–714
30. Yang S, Chen M, Pomerleau D, Sukthankar R (2010) Food recognition using statistics of pairwise local features. In: Proceedings of CVPR, pp 2249–2256
31. Nosaka R, Ohkawa Y, Fukui K (2011) Feature extraction based on co-occurrence of adjacent local binary patterns. In: Proceedings of Adv Image Video Technol, pp 82–91
32. Qi X, Shen L, Zhao G, Li Q, Pietikäinen M (2015) Globally rotation invariant multi-scale co-occurrence local binary pattern. Image Vis Comput 43:16–26
33. Abdelmounaime S, Dong-Chen H (2013) New Brodatz-based image databases for gray scale color and multiband texture analysis. ISRN Mach Vis 2013. https://doi.org/10.1155/2013/876386
34. http://www.outex.oulu.fi/index.php?page=image_databases
35. Lazebnik S, Schmid C, Ponce J (2005) A sparse texture representation using local affine regions. IEEE Trans Pattern Anal Mach Intell 27(8):1265–1278
36. Hayman E, Caputo B, Fritz M, Eklundh J (2004) On the significance of real-world conditions for material classification. In: European Conference on Computer Vision (ECCV), pp 253–266
37. Burghouts GJ, Geusebroek J-M (2009) Material-specific adaptation of color invariant features. Pattern Recogn Lett 30(3):306–313
38. Ojala T, Pietikäinen M, Harwood D (1996) A comparative study of texture measures with classification based on featured distributions. Pattern Recognit 29(1):51–59
39. Tan X, Triggs B (2010) Enhanced local texture feature sets for face recognition under difficult lighting conditions. IEEE Trans Image Process 19:1635–1650
40. Guo Z, Zhang L, Zhang D (2010) A completed modeling of local binary pattern operator for texture classification. IEEE Trans Image Process 9(16):1657–1663
41. Heikkilä M, Pietikäinen M, Schmid C (2006) Description of interest regions with center-symmetric local binary patterns, ICVGIP 2006, LNCS 4338, pp 58–69

42. Jhanwar N, Chaudhuri S, Seetharaman G, Zavidovique B (2004) Content-based image retrieval using motif co-occurrence matrix. Image Vis Comput 22:1211–1220
43. Obulesu A, Vijay Kumar V, Sumalatha L (2018) Content based image retrieval using multi motif co-occurrence matrix. Int J Image Graphics Signal Process 4:59–72
44. Obulesu A, Vijay Kumar V, Sumalatha L (2018) Image retrieval based local motif patterns code. Int J Image Graphics Signal Process 6:68–78
45. Subba Reddy K, Vijaya Kumar V, Siva Kumar AP (2018) Cross diagonal circular and elliptical texture matrix for efficient texture classification. J Adv Res Dyn Control Syst 10(4)

Convolutional Neural Network-Based Diagnosis of Alzheimer's Disease Using Time–Frequency Features

Nilesh Kulkarni, Anuradha Salvi and Saurabh Parhad

Abstract Alzheimer's disease, commonly referred to as a form of dementia in early stage is one of the prominent cause of death all over the world. It is a neurodegenerative disorder in which electrical movements of brain becomes slow as compared to normal subjects. To detect these abnormalities, several biomarkers are discussed in literature. In present research work, electroencephalogram signals which record electrical activities of brain are emphasized. EEG signals are used for diagnosis of Alzheimer's disease by means of time–frequency images. Two-dimensional time–frequency scalograms are obtained using continuous wavelet transform (CWT) by applying it to EEG signals. Convolutional neural network algorithm was incorporated to learn images and obtained results were compared with those obtained in literature. The presented system provides 96.5% accuracy, 98% sensitivity, and 99% specificity on experimental database used in the study. Therefore, the application of deep learning algorithms in clinical assessment provides a benchmark for examining various neurological disorders such as epilepsy, brain tumors, Alzheimer's disease, and many more.

Keywords Alzheimer · Electroencephalogram · CNN · Deep learning · Wavelet transform

1 Introduction

Nowadays, Dementia can be considered as a major health issue over a globe, since it is predicted that population of people existing with dementia is nearly about 46.8 millions and it is likely to get double by 2030 [1, 2]. Alzheimer's disease (AD) is type of dementia in severe stage, and neurodegenerative disease. Alzheimer's disease is a growing issue to health of an individual and it accounts up to 75% of all dementia cases [3]. As per symptamatology, Alzheimer's disease is basically divided into three stages: pre-dementia, mild cognitive impairment (MCI) plus severe Alzheimer's.

N. Kulkarni (✉) · A. Salvi · S. Parhad
Department of EXTC Engineering, Sinhgad Institutes, Pune, India
e-mail: nileshkulkarni992@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_38

The concluding phase is further segmented to (a) mid-stage Alzheimer's and (b) severe or late-stage Alzheimer's disease. It is reported that physiological process of Alzheimer's disease up to 25 years ahead the clinical evidence can be detectable [3–5]. Rigorous diagnosis is a key threat, as pathophysiological process may start up to 20 years before its progression. Clarification of raw signals using supervision is not only tedious job but also time consuming since there exist hours or days worth of EEG recordings which are to be studied as well as reviewed manually [5]. There exists some automated software tools by which seizures can be detected in case of epilepsy diagnosis. But, these techniques have poor sensitivity and specificity and these techniques are rarely used in clinical practices. These results were tested in varying clinical interpretation depending on reader's proficiency levels. Therefore, the quality of study can be improved by analyzing the signal more specifically to identify the abnormalities more accurately. The aim of present research work was to classify the EEG signals into two categories, i.e. Alzheimer's infected and normal subjects. In general, Alzheimer's classification procedure is subdivided into two main steps: feature extraction and classification. In literature, a number of features are highlighted for distinguishing the EEG signals of normal and Alzheimer's subject. As the extracted features are based on pre-defined set and limited dataset, the computed EEG features vary among different patients and changes over time [6–8]. Therefore, it is essential to automatically extract and learn informative features for classification of EEG data.

The challenges discussed need to be solved by introducing new techniques for improving the performance of EEG-based diagnostic systems in case of Alzheimer's disease, epilepsy, schizophrenia, Brian Stroke's, and other such neurological disorders for making system more flexible [9, 10]. Advancements in the field of deep learning and its application in the field of detection and predictive data analysis, especially in medical and healthcare have attracted many researchers and scientists [11]. It enables the features to be learned automatically from previous data and, therefore, it is regarded as one of the powerful computational tools for data analysis.

In [12], Subasi et al. developed a composite model for optimizing the performance of SVM classifier. But, these algorithms did not reduce the goal of manual feature selection. Feature extraction plays a significant role in data classification and it depends on system accuracy as well. Therefore, to perform complex data classification with minimum error, deep learning algorithms play a significant role and has provided a new platform for data classification as well as prediction.

Deep learning can be regarded as subset of machine learning algorithms which predefines computational models. It reinforces the complex representations of different inputs using subsequent transformations which are non-linear in nature [13]. Most of the studies in literature are studied only in time and frequency domain signals, but there are also exist most of the hidden information in the frequency domain as well. Therefore, frequency-based features are extracted, studied, and performance of these techniques are then compared with the time-domain signals as well. The pre-processed EEG signals in time–frequency domain were given as an input to the convolutional neural networks (CNN) rather than giving each extracted feature. The experimentation was performed on the experimental database obtained from hospital. The results explored in this paper are compared with other classifiers obtained in literature.

2 Data Collection

2.1 Subjects Evidence

Multichannel EEG signals used in the present study were collected from Medicine Dept., Navale Hospital, Pune, under the observation of expert clinicians. Dataset consisted of both Alzheimer's disease patients as well as normal subjects. The study involved about 200 patient's database consisting of both subjects. Patients were selected from local community residing in urban as well as rural area with report of cognitive decline in their behavioral and cognitive functions. The age of patients ranged in between 65 and 80 years. Diagnosis of AD patients was done by expert clinicians as well as neuro-surgeons on the basis of Indian version of Mini Mental State Examination (MMSE) and Clinical Dementia Rating (CDR). MRI reports of AD patients were also examined. Patients from both the groups were also analyzed for sugar, kidney problems, thyroid disease, or vitamin B12 deficiency since it can also result into cognitive decline as per medical standards. The hospital ethical committee and participants approved the obtained EEG data for study.

2.2 Data Acquisition

Neurological data was registered using RMS (Recorders and Medicare Systems Pvt. Ltd.) EEG machine having resolution of 12-bits and sampling rate 1024 Hz. The electrodes were positioned as per recommendations of American EEG society using International 10/20 standards. Low-pass filters were used for eliminating power grid interference. EEG signal data was recorded from temporal, parietal, central, and occipital lobe for 5 min duration.

At EEG tests, patients were awake with their eyes closed. Muscle activities and eye-blinking artifacts were eliminated manually by expert clinicians on basis of visual inspection. The artifacts were removed based on visual inspection based on different criteria such as (a) increment in amplitude of signal, (b) change in shape of EEG signal, and many more. But, as these abnormalities in signal were removed manually, no computational method was used.

3 Methodology

To characterize signals for correctly classifying AD and normal subjects, several features are computed, analyzed, and discussed in literature. Electroencephalograms are basically non-stationary signals; therefore, they are difficult to analyze. Thanks to their erratic nature, brain disturbances can be seen in different frequency bands of EEG signals. Since enough information can be squeezed from EEG signals in terms of time–frequency transformations, continuous wavelet transform (CWT) is used. It also represents two-dimensional (2D) EEG signals. The basics steps involved in study are shown below (Fig. 1).

In the present study, EEG signals in time–frequency domain were given as input for CNN classifier. There exists a typical interconnection in between amplitude and frequency of EEG signal, when frequency plots are observed. Hence, they can be used for further analysis in diagnosis of different neurological disorders.

Due to the progression of technology and growth of large of huge public image repositories and high performance computing systems, convolutional neural networks (CNN) are been successful for video processing, image processing, and many such applications. In this work, CNN was applied for EEG signals for diagnosing the Alzheimer's disease by using spectral-based features. The CNN architecture comprises of input, output, and various hidden layers lying between them. Hidden layer of CNN architecture exhibits three internal layers such as pooling, convolutional, and fully connected layers. A convolution function is applied to the input of convolutional layer thereby transferring the result of previous layer to the next layer. To combine the output of various neurons into single neuron for transferring the input from one layer to next layer, local as well as global pooling layers can be incorporated.

The concept of CNN is almost same as that of multi-layer perceptron neural network. The images in time domain as well as frequency domain were obtained by application of wavelet transform to neuro signal of each subject. The dimension of the computed images was of size 662 × 536. The obtained images were reduced to dimension of 32 × 32 using cubic interpolation mechanism for giving the input to classifier. These images were finally used as input to classifier for prediction.

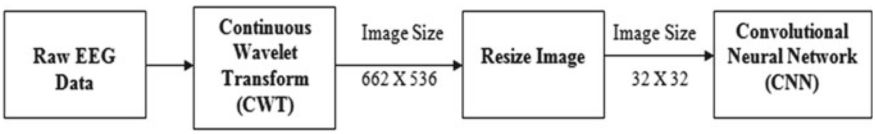


Fig. 1 Basic steps involved in current research work

3.1 Significance of Wavelets

In case of wavelets, the function window is scaled as well as shifted using the main wavelet during conversion process. Therefore, the signal can be analyzed for long-time interval as well as for short-time interval at low and high frequencies. On other hand, in case of STFT, size of window is constant and signal is analyzed at the same time–frequency resolutions. On contrary, wavelets are of effective tool for analyzing non-stationary signals such as EEG. For enhancing better resolution, smallscale can be used for high frequencies and vice-versa. Mathematically, the wavelet function is given by,

$$W_x(s, \tau) = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} x(t)\psi^*\left(\frac{t-\tau}{s}\right)\mathrm{d}t \tag{1}$$

where, $W_x(s, \tau)$ represents coefficient, $x(t)$ signifies original signal, $\psi(t)$ indicates ground wavelet function, scale is denoted by$s$, whereas position parameter is given by T. Since Morlet wavelet is most suitable for analysis of EEG signal, it was incorporated rather than using any other wavelet from wavelet family for spectral analysis of EEG signals [14]. The scalograms were obtained from EEG segment of 20 s durations. Total 200 images of scalograms were included in signal analysis.

3.2 Feature Extraction

The present research work was carried using Python environment with Keras deep learning library. Using cross-validation technique, computed scalogram images were separated into 10 different parts. About 70% database was adopted for training purpose and left out data for testing purpose. In the present CNN architecture, two convolutional as well as pooling layers were used. The basic CNN models inhibit three layers such as pooling, fully connected, and convolutional layer.

(a) Convolutional Layer: It represents product of weighted sum of its own values with neighboring pixels. Weighted matrix is also termed as convolutional kernel or filter. The applied filter implements windowing on given image and identifies the features. After convolution, activation function is used. In CNN and related deep learning networks, RELU is used. The mathematical function of RELU is given by,

$$f(x) = \begin{cases} 0, & \text{if } x < 0 \\ x, & \text{if } x \geq 0 \end{cases}$$

Table 1 Guidelines incorporated for training the CNN

Layer	Filter range	Number of filters	Total neurons	Stride
First convolution layer	5 × 5	16	–	1
Max pooling	–	–	–	2
Second convolution layer	5 × 5	64	–	1
Max pooling	–	–	–	2
Fully connected layer	–	–	–	–

(b) Pooling Layer: The aim of this layer is to minimize the extracted features and also to deduct the total parameters in the network. The poling concept in neural networks is one form of nonlinear downsampling process. Maximum and average pooling techniques are commonly used in pooling layers process. In the present study, maximum pooling was used as it provides better results.
(c) Fully Connected Layer: The data patterns features associated within this layer are converted into feature vectors of one dimension. These layers in short works like a conventional artificial neural networks. The computational load increases in this layer since it has several parameters for computation. The main parameters of the above discussed layers are listed below (Table 1).

Images are given as an input of size 32 × 32. The result of first convolution layer is obtained which consists of 16 feature maps and images are converted to 16@28 × 28. After passing through maxpooling layer, images are further compressed and reduced to 16@14 × 14. After computation of the second convolutional layer, image size is 64@10 × 10 and features maps obtained are around 64. The obtained size is then again minimized to 64@5 × 5 by use of maxpooling layer which is the final layer. After the computation of all processes, vectorization is carried out and data is transferred to final connected layer. For computing CNN algorithm, following values were considered for various parameters. Learning rate—0.001, momentum—0.9, optimizer—Adadelta, epoch number—50 and batch size—4.

3.3 Performance Evaluation

Cross-validation approach was used in the present research work for evaluation. Therefore, ten cross-validation concepts were used. It was basically used for ensuring the reliability of the algorithm and results obtained in the study. For assessing the performance of the system, accuracy, sensitivity, and specificity parameters were used to test the system. The parameters used for calculation are defined by following formula. These parameters are explored in [7, 15].

$$\text{Accuracy} = \frac{(\text{TP} + \text{TN})}{(\text{TP} + \text{TN} + \text{FP} + \text{FN})} \tag{2}$$

Table 2 Observation table

Original data		Predicted data		Accuracy (%)	Sensitivity (%)	Specificity (%)
		X	*Y*			
	X	99	1	96.5	98	99
	Y	2	98			

$$\text{Sesnsitivity} = \frac{\text{TP}}{(\text{TP} + \text{FN})} \tag{3}$$

$$\text{Specificity} = \frac{\text{TN}}{(\text{FP} + \text{TN})} \tag{4}$$

where, TP indicates True Positive, TN indicates True Negative, FP indicates False Positives, FN indicates False Negative [15].

4 Results

In the present research work, features in time–frequency domain were computed and scalogram images were obtained from raw electroencephalogram data of both normal and AD subjects. Morlet wavelet was used for obtaining time–frequency features as well as for plotting scalogram. The obtained scalograms images were considered as an input and diagnosis of same was computed using deep learning algorithm, i.e. CNN. The system performance was tested by creating confusion matrix and performance of algorithm was evaluated using various parameters such as accuracy, sensitivity, and specificity.

Based on the above concept, following results were obtained in the present research work. Accordingly, various parameters were computed as discussed in Sect. 3 (Table 2).

In the above observation table, *X* variable indicates correctly classified Alzheimer's subjects, whereas *Y* indicates misclassified Alzheimer's subjects. Considering the predicted data, performance parameters are computed.

5 Conclusion

From above results, it can be concluded that satisfactory results are obtained using deep learning algorithm. CNN was implemented using Python environment with Keras deep learning library. The obtained result highlights that deep learning algorithms can be used for improving the reliability of medical diagnostic systems. These deep learning networks play a significant role in achieving higher accuracy rate for

Table 3 Summary of obtained results with previous literature

Sr. No	Reference	Features	Classification algorithm	Accuracy (%)
1	[16]	Multi-modal imaging features	Linear discriminant analysis (LDA)	89.4
2	[17]	Time–frequency and synchrony-based features	Linear discriminant analysis (LDA)	83
3	[18]	Nonlinear-based features	Neural networks (NN)	82
4	[19]	Epoch entropy and bump modeling	Support vector machine (SVM)	91.2
5	[7]	Spectral, wavelet, and complexity	Support vector machine (SVM)	96
6	Proposed	Time–frequency features	Convolutional neural networks (CNN)	96.5

classifying the data into multiple classes. In the present research work, a methodology which assesses clinical decision for diagnosing Alzheimer's disease is proposed. The results obtained in the present research work are compared with those obtained in literature. Table 3 summarizes the contrast of presented results with previous literature.

From above comparison table, it can be concluded that the proposed method provides better results in terms of classification when compared with other such algorithms presented. Deep learning algorithm plays a significant role in image processing applications as well. In many literature studies, different features are computed using various techniques. In the present research work, unlike previous literature:

- No features such as synchrony features, complexity, and nonlinear features were obtained from EEG data. There was no presence of any feature reduction technique.
- Scalograms of filtered EEG signals in time–frequency domain were evaluated using CNN algorithm.

The work presented in current research thereby explores a new significant approach for dementia and Alzheimer's detection by means of EEG signal. Further research by analyzing EEG signals and analysis of different deep learning algorithms for clinical assessment can make phenomenal achievements in this field.

References

1. Mattson M (2004) Pathways towards and away from Alzheimer's disease. Nature 430:631–639
2. Alzheimer's Association (2018) Alzheimer's disease facts and figures. Alzheimers Dementia 14(1):367–429
3. Patterson C (2018) World Alzheimer report, The State of the Art of Dementia Research: NewFrontiers. London, UK
4. Alzheimer's Disease International: World Alzheimer Report. 2018

5. Miskovic V, MacDonald KJ, Rhodes LJ, Cote KA (2019) Changes in EEG multiscale entropy and power-law frequency scaling during the human sleep cycle. Human Brain Mapping 40(2):538–551 (Wiley)
6. Kulkarni NN, Bairagi VK (2015) Electroencephalogram based diagnosis of Alzheimer disease. In: Proceedings of the IEEE sponsored international conference on Intelligent Systems and Control (ISCO), Coimbatore, pp 1–5
7. Kulkarni NN, Bairagi VK (2017) Extracting Salient features for EEG based diagnosis of Alzheimer's disease using support vector machine classifier. IETE J Res 63(11):11–22 (Taylor and Francis)
8. Staudinger T, Polikar R (2011) Analysis of complexity based EEG features for diagnosis of Alzheimer disease. In: Proc Intl Conf IEEE-EMBC, Boston, USA, pp 2033–2036
9. Harpale V, Bairagi V (2018) An adaptive method for feature selection and extraction for classification of epileptic EEG signal insignificant states. J King Saud Univ Comput Inf Sci (Elsevier)
10. Zack D-A et al (2015) Schizophrenia detection and classification by advanced analysis of EEG recordings using a single electrode approach. PloS One 10(4):1–12
11. Subasi A, Gursoy MI (2010) EEG signal classification using PCA, ICA, LDA and support vector machines. Expert Syst Appl 7(12):8659–8666
12. Ullah I, Hussain M, Qazi E-U-H, Aboalsamh H (2018) An automated system for epilepsy detection using EEG brain signals based on deep learning approach. Expert Syst Appl 107:61–71
13. Oh SL, Hagiwara Y, Raghavendra U, Yuvaraj R, Arunkumar N, Murugappan M, Acharya UR (2018) A deep learning approach for Parkinson's disease diagnosis from EEG signals. Neural computing & applications. Springer, Heidelberg, pp 1–7
14. Unser M, Aldroubi A (1996) A review of wavelets in biomedical applications. Proc IEEE 84(4):626–638
15. Rueda A, Gonzalez FA (2014) Extracting salient brain patterns for imaging based classification of neurodegenerative diseases. IEEE Trans Med Imaging 33(6):1262–1274
16. Dai Z, Yan C (2012) Discriminative analysis of early Alzheimer disease using multi-modal imaging and multilevel characterization with multi-classifier (M3). J Neuroimage 59(3):2187–2195 (Elsevier)
17. Dauwels J, Srinivasan K, Ramasubba Reddy M, Musha T, Vialatte F-B, Latchoumane C, Jeong J, Cichocki A (2011) Slowing and loss of complexity in Alzheimer's EEG: two sides of the same coin? Hindawi Access of Research. Int J Alzheimer's Dis. Article ID 539621
18. De Bock T, Das S, Mohsin M (2010) Early detection of Alzheimer's disease using nonlinear analysis of EEG via Tsallis entropy. Published in IEEE Biomedical Sciences & Engineering Conference, pp 1–4, May 2010
19. Houmani N et al (2018) Diagnosis of Alzheimer's disease with Electroencephalography in a differential framework. PLoS ONE 13(3):1–19

Humanly Evolving Robotics with Angular Sensor Control (Herasc)

Avuku Obulesu, Thimmaraju Rishwi and Sirmoria Deepika

Abstract In artificial intelligence, identifying suspectable activities and people in public areas is a real-time challenging issue. This paper proposing robot framework which can act like human using natural language processing and self-learning-based deep reinforcement learning (DRL) for making human-related robots, which use finite human action sets as a form of walking and human to human conversations. In our approach, human conversions made sentence clustering and waking actions are recorded for future training. While recording walking styles, consider angle movements and calculate distances between foots and used as further incremental learning using DRL. We assume human conversation data as without labels manually and angular movements of walking style. Investigational results using robot reveal that (1) near human-like discussion rules can be encouraged, (2) classifying the suspecting human walking panaches (3) self-trained with instance conversations and angular movements show performance over using a single negotiator. In addition, rated dialogues in terms of fluency and judgment of suspecting events will be predicted.

Keywords Self-learning · Robot · Angular movements · Reinforcement · DRL

A. Obulesu · T. Rishwi (✉) · S. Deepika
Anurag Group of Institution, Hyderabad, India
e-mail: tsriram6@gmail.com; 16h61a0555@cvsr.ac.in

A. Obulesu
e-mail: avuku06@gmail.com

S. Deepika
e-mail: deepikajaiswal9963@gmail.com

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_39

1 Introduction

One of the interesting issues in computer vision is video analyzing due to many surveillance systems like cameras and social media in big cities collecting numerous video data. After analyzing video identifying recognition, abnormal actions that are suspicious are one of the difficult tasks [1]. Although there are multiple criminal actions, the present work focuses on suspicious activities useful for generating early notices. Many approaches like movement analysis by optical flow [2], energy distributions [3], texture based [4] and analysis of trajectory [5] are listed in literature. Some these methods considered human activities [6], in that few are on detecting criminal actions [7], semantic process to learn patterns in video scenes [8] and supervised methods to learn space-temporal relations among different activities [9]. Two contextual features are identified in literature [10, 11]: One is the recitation of the type of behaviors and another one is behaviors repetition frequency. These methods clustered long period of activities and then used for detecting irregular behaviors. The detection of activities and action in video involve clustered-type training stage, where we required sufficient number of available label data.

(1) A Tracking Module that locates the objects of interest in the image during all movements throughout the scene. The tracking system was implemented based on the algorithm proposed by Arroyo et al., in [12], which is suitable for surveillance applications and deals with common problems as occlusion and real-time operation.
(2) The Location and Kinematics Module which transforms the inputs provided by the surveillance tracking system to coordinates in the real world. It also calculates the velocity components of people at the scene. To transform the image information to coordinates in the real world was implemented the method presented by Hollander et al., which is described in [13].

This paper used the following concepts to find interesting event.

2 Related Concepts

This paper used the following concepts to find interesting events.

2.1 Context Model

Without initial large training data, designing of accurate suspicious activity detection is the main concern of this model.

2.2 Inference Model

This model uses incremental learning from newly coming online data.

Main contribution of the paper

1. Previous activities and actions are considered for suspicious individuals.
2. It requires few initial data.
3. New coming data training takes less time than previous data training.
4. Considered angle movement of persons and person to person communications.

3 Proposed Methodology

The algorithm description of proposed method is as follows:

1. The robot looks at humans and identifies angles between their "A" points.
2. Following are A points.
   (a) Two elbows
   (b) Two knees
   (c) Between two legs
   (d) Two shoulders.
3. Bone structure identification is used to identify angles and convolution neural networks to track activity.
4. Make exact angles at angular sensors.
5. We call them angular sensors or A sensors. All "A" sensors are interlinked.
6. Walking or running activity is tracked using CNNs.
7. Angle sensors are used to exactly imitate the posture of any person.
8. Continuous bone structure and angle shift tracking.

Now coming to the evolutionary idea:

- NLP for audio analysis. Robot listens to two persons and trains itself based on the type of outcome or reaction in a conversation between two people. Then, it imitates the same verbiage if it encounters the same situation.
- All the examples conversations are stored in cloud.
- Most frequent activities are stored locally, and activities which are required and not in the memory can be accessed using the cloud.
- Parallel processing helps us to perform multiple tasks simultaneously that is while walking we can think about other things. This is one of strong features of human brains. Similar kind of feature is adapting for current proposed and robot application. For example, if a thief stole your bag and he is running away, a human will run to catch him and while running he will think what to do after reaching him. Robots should also get parallel processing capability.
- The night is its training itself and job scheduling period.

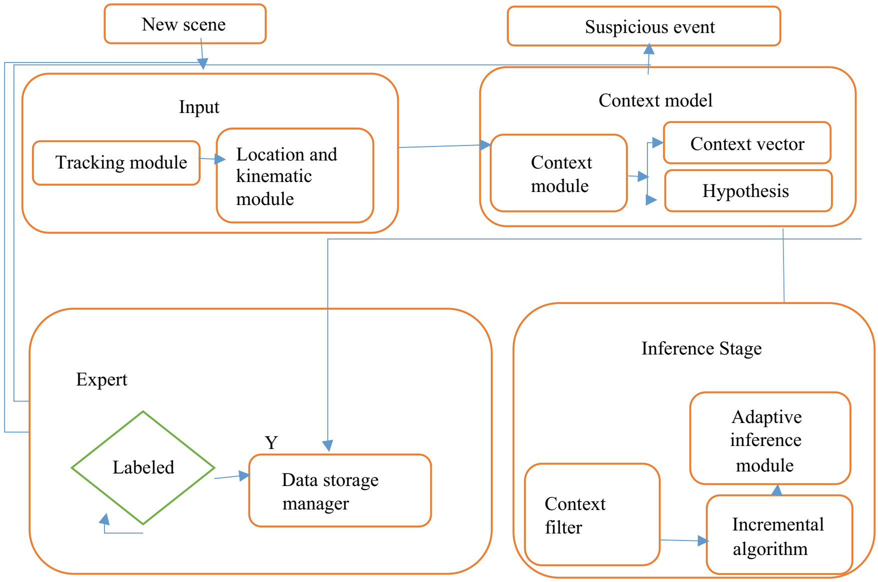


Fig. 1 Complete architecture of the proposed method

- We need to include something called motor neurons and a connected chain of a network which share every thought and connect the chain of processes.

We will train a robot based on the analysis of the skeletal structure of a person so that the robot will exactly imitate the person's angles formed at the angle points. This includes two steps. First, the robot analyzes the angles, and the second, it will calculate how much distance did the person walked and based on his or her length of the leg it will calculate the distance for one step and combine the data with angular data and implement it.

This can be used in robotics to identify context between two persons and implement incremental learning. You can see in Fig. 1. This can be used for walking and running.

Arroyo et al. [12] is suitable for real-time operation in surveillance applications.

3.1 Now for Conversation Learning

Given two people $P\,(i)$ and $P\,(j)$, the interaction time is $t\,(i, j)$. The robot will listen to the conversation of both persons. Then, it will identify the context of their discussion, train itself with particular situations and contexts, update the model with responses based on satisfaction and reward the $P(j)$ gets in the conversation.

3.2 Incremental Learning Algorithm

Modified incremental process proposed by Grbovic et al. in [14] is proposed using weak classifiers. Adaboost algorithm [14] iteratively optimizes the cost exponential function given in the following equation.

$$E_m = \sum_{i=1}^{N} e^{y_i F_m(x_i)} \tag{1}$$

where x_i is the feature vector, y_i is either $+1$ or -1 as label, $\mathrm{Fm} = \sum_{j=1}^{m} \alpha f_j(x_i)$ is classifier's base value with respect to m, and the output value of f_j (x_i) is in the list $\{-1, 0, +1\}$.

The confidence parameters and weight for each weak classifier are given in a_j. The x_i with expected output y_i has associated a weight value calculated by the following equation.

$$w_i^m = \mathrm{e}^{-y_i f_m(x_i)} \tag{2}$$

The confidence parameters are updated using the gradient descent method as shown in Eq. (2).

$$\alpha_j^{\text{new}} = \alpha_j^{\text{old}} - \aleph E_m \big/ \alpha_j \tag{3}$$

where g stands for the learning rate. For a sample (x_i, y_i), Eq. (3) is expressed as follows in Eq. (3):

$$\alpha_j^{\text{new}} = \alpha_j^{E} + \aleph y_i f_i(x_i) \mathrm{e}^{-y_i \sum\limits_{k=1}^{m} \alpha_k^{\text{old}} f_k(x_i)} \tag{4}$$

Now using the two-dimensional coordinate system and based on the distance between the A points, the angles need to be calculated. Now, these angles will be the input to the neural networks. In the feed -forward stage, test run with those angles will be initiated and continued with back propagation by adjusting the angles to achieve the exact results as looked and measured in the video of the subject. Parameters like distance covered or motion analysis will be used in the back propagation stage to correct the parameters of hidden layers (Figs. 2 and 3).

At position change of each limb point, the angular data is captured. In each frame, the angular and positional data is captured.

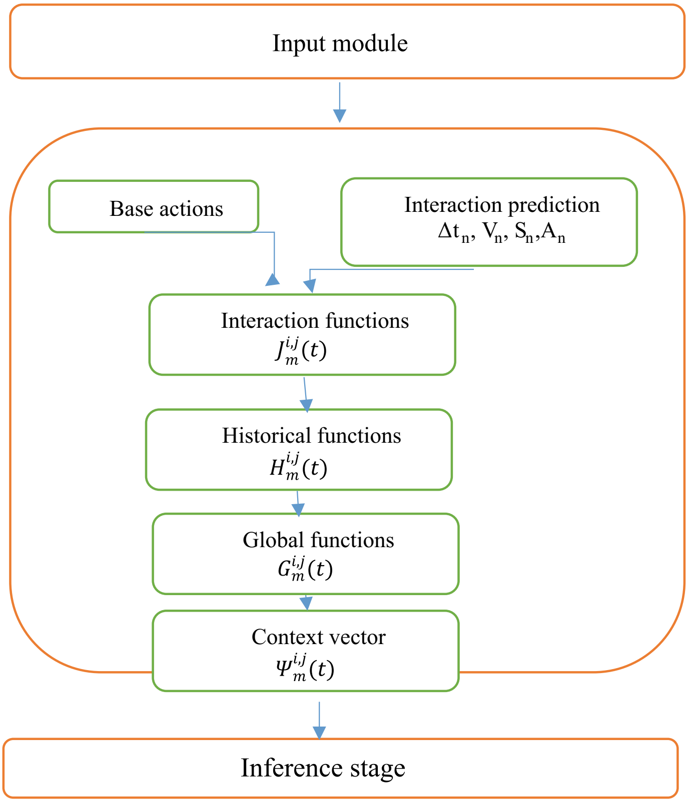


Fig. 2 Flow of events in the proposed approach

Fig. 3 Identification of key points of human to train waling style

```
import numpy as np;from PIL import Image
from pose_engine import PoseEngine
pil_image = Image.open('couple.jpg')
pil_image.resize((641, 481), Image.NEAREST)
engine =
PoseEngine('models/posenet_mobilenet_v1_075_481_641_quant_decoder_edgetpu.tf
lite')inference_time=engine.DetectPosesInImage(np.uint8(pil_image))
print('Inference time: %.fms'%inference_time)
for pose in poses:
if pose.score < 0.4: continue
print('\nPose Score: ', pose.score)
for label, keypoint in pose.keypoints.items():
print(' %-20s x=%-4d y=%-4d score=%.1f'%
(label, keypoint.yx[1],keypoint.yx[0], keypoint.score))
```

The above is the pose_engine_class code

And the data we get is in the below format

left shoulder	x=268	y=168	score=0.8
right shoulder	x=161	y=172	score=1.0
left elbow	x=282	y=255	score=0.6
right elbow	x=154	y=254	score=0.9
left wrist	x=236	y=333	score=0.7
right wrist	x=163	y=301	score=0.6
left hip	x=323	y=181	score=0.2
right hip	x=191	y=251	score=0.0
left knee	x=343	y=84	score=0.8
right knee	x=162	y=295	score=0.0
left ankle	x=318	y=174	score=0.1
right ankle	x=167	y=309	score=0.0

For the angle measurement and implementation, we have angular sensors that will mimic the angles using the magnetic orientation in them.

4 Conclusions

Many of video-based surveillance system automated tools are having enough previous training data for finding crime events. To resolve this drawback, this paper proposes instance training data which combines the context model and incremental mode to find the threat level at a given time using DRL. Main contribution of this paper is rather than pre-training of data, it introduces dynamic training with respect to human to human conversation and human style to walking. One more interesting thing is while training itself, it finds a solution of the current event. Unlike conventional algorithm, the proposed one not required huge volume of preliminary training data. Because of the incremental learning model, the proposed one has an adaption competence to every situation from instant information and new data learnt during the online operation. The system's ability to learn gradually by dynamic training. Moreover, the investigational results have confirmed the greater performance of the proposed approach for ferocity detection.

References

1. Subetha T, Chitrakala S (2016) A survey on human activity recognition from videos. Proc Int Conf Inf Commun Embed Syst (ICICES) 1–7
2. Gao Y, Liu H, Sun X, Wang C, Liu Y (2016) Violence detection using oriented violent flows. Image Vis Comput 48:37–41
3. Mohammadi S, Kiani H, Perina A, Murino V (2015) Violence detection in crowded scenes using substantial derivative. AVSS IEEE Comput Soc 1–6
4. Yeffet L, Wolf L (2009) Local trinary patterns for human action recognition. ICCV IEEE Comput Soc 492–497

5. Khokher MR, Bouzerdoum A, Phung SL (2015) Violent scene detection using super descriptor tensor decomposition. DICTA IEEE, pp 1–8
6. Zhao C, Wang J, Lu H (2016) Learning discriminative context models for concurrent collective activity recognition. Multimedia Tools Appl 1
7. Zhu Y, Nayak NM, Roy-Chowdhury AK (2015) Context-aware activity modeling using hierarchical conditional random fields. IEEE Trans Pattern Anal Mach Intell 37(7):1360–1372
8. Zhang T, Liu S, Xu C, Lu H (2013) Mining semantic context information for intelligent video surveillance of traffic scenes, IEEE Trans Ind Inf 9(1):149–160
9. Zhu Y, Nayak NM, Roy-Chowdhury AK (2013) Context-aware activity recognition and anomaly detection in video, IEEE J Sel Top Sign Proces 7(1):91–101
10. Wiliem A, Madasu V, Boles W, Yarlagadda P (2009) A context-based approach for detecting suspicious behaviours. DICTA IEEE Comput Soc 146–153
11. Wiliem A, Krishna V, Boles W, Yarlagadda P (2012) A suspicious behaviour detection using a context space model for smart surveillance systems. Comput Vis Image Underst 116(2):194–209
12. Arroyo R, Yebes JJ, Bergasa LM, Daza IG, Almazan J (2015) Expert video-surveillance system for real-time detection of suspicious behaviors in shopping malls. Expert Syst Appl 42(21):7991–8005
13. Hollander RJM, Bouma H, Baan J, Eendebak PT, van Rest JHC (2015) Automatic inference of geometric camera parameters and inter–camera topology in uncalibrated disjoint surveillance cameras. Proc SPIE 9652:96520D
14. Grbovic M, Vucetic S (2011) Tracking concept change with incremental boosting by minimization of the evolving exponential loss. Springer, Berlin, Heidelberg, pp 516–532

Post-occupancy Evaluation of Building Facilities in a University Community Using an Electronic Platform

Adedeji Afolabi, Ibukun Afolabi, Faith Akinbo, Sanjay Misra and Ravin Ahuja

Abstract The study examined the prospects of carrying out a post-occupancy evaluation of building facilities in a university community using an electronic platform. The SRS showed the user classes and characteristics, software architecture, functionality, the coding language used and external interfaces. The Web pages were designed using HTML, while the database management system was developed using MySQL. C-Sharp programming language was used to control the post-occupancy system. The three main users identified in this study; the building user, the maintenance manager/facility manager and the management team can access the system to evaluate the building facilities. In conclusion, the study developed a post-occupancy evaluation system for a university community to effectively manage the state of its building facilities. By using the proposed system, the study aims to increase the speed of maintenance works, improve the state of building facilities in schools of higher learning and ensure accountability in the building maintenance process.

Keywords Building facilities · Electronic platform · Higher institution · Post-occupancy · Web-based system

A. Afolabi · F. Akinbo
Department of Building Technology, Covenant University, Ota, Nigeria
e-mail: adedeji.afolabi@covenantuniversity.edu.ng

F. Akinbo
e-mail: tomisin.akinbo@covenantuniversity.edu.ng

I. Afolabi
Department of Computer and Information Sciences, Covenant University, Ota, Nigeria
e-mail: ibukun.fatudimu@covenantuniversity.edu.ng

S. Misra (✉)
Department of Computer Engineering, Covenant University, Ota, Nigeria
e-mail: sanjay.misra@covenantuniversity.edu.ng

R. Ahuja
Shri Vishwakarma Skill University, Gurgaon, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_40

1 Introduction

According to [1], buildings serve the purpose of providing occupants with an indoor environment that is conducive, safe, comfortable and healthy in order to carry out their different activities in terms of work, academics, family life and other social interactions. The article by [2] stated that building occupants or employees are mostly concerned about their health and well-being in relation to the environment where they work. Buildings have different standards that they should conform to; however, [3] argued that some do not meet the expectation and changing needs of building occupants. The opinion of [2] is that buildings that do not perform according to the satisfaction of building occupants can affect negatively the morale, productivity and performance of the occupants. The non-conformity of buildings to laid down standards and specification can be linked to several factors [1]. In the study by [1], the major causative factor for buildings performing poorly in meeting users' needs is attributed to the inadequate knowledge of occupants' changing needs by building professionals.

According to [4], facilities in higher education should be designed in a way that accommodates the various spatial functions required for faculty, staff and the students. In that, for office spaces for faculty and staff, there may be need to prioritize satisfactory designs that promote thermal comfort, efficient furniture layout, adequate storage space and ease of interaction. On the other hand, students may be more concerned about the lighting and acoustic conditions in their classrooms and libraries. Building facilities form one of the most important assets or investment within a university community. These assets are used to satisfy the needs of the customer which are the students and the workers within its walls or even attract potential employees and students. Evaluating the customers' needs is essential in ensuring sustainable growth of firms/organization. In [5], it was noted that using post-occupancy evaluation (POE) is quite important in today's world where the customers' need is paramount. Likewise, [6] suggested that this is a major way to improve the performance of buildings by constantly understanding users' experience and needs. In [7], it was recorded that building performance evaluation will help gain valuable insight and lessons from occupants which can be used to improve existing spaces. This study has selected an educational institution as an area of interest. Furthermore, [7] noted that the need for concentrating on learning environment evaluation stems from the need to take positive future decisions based on collected data. In addition, [8] stated that educational facilities bring together large number of users with different needs, making POE crucial to such environment. Therefore, the study examined the prospects of carrying out a post-occupancy evaluation of building facilities in a university community using an electronic platform.

According to [9], the use of post-occupancy evaluation (POE) was first introduced in 1960 with major concern aimed at engaging the building occupant's perspective. In POE, the difference between original design intended and the actual facility delivered is compared in order to reduce the discrepancies noticed [10]. While [11] noted that on the long run, designers can benefit from POE through feedback databases that can help inform better planning and design protocols. Past studies on POE have focused on residential buildings [12] and commercial buildings [2] rather than educational buildings [7, 13]. The study by Ibem et al. [1] noted that the physical characteristics of public buildings are crucial in determining users' satisfaction. There are different methods in carrying out POE in the built environment. The comprehensive study by [14] reported that there are over one hundred and fifty (150) POE methods used worldwide. Some common methods involve the use of walk-through in buildings, face-to-face observation, interviews and use of questionnaire instrument [15].

2 Design and Implementations

This study follows the methodology used in previous studies in [16, 17]. The software requirement specification (SRS) showed the functional and non-functional requirement in the electronic platform for post-occupancy evaluation of building facilities in a school of higher learning. The SRS showed the user classes and characteristics, software architecture, functionality, coding language used and external interfaces. The user classes and characteristics showed that there are three main users applicable to the post-occupancy evaluation system. The three main users include the building facility users, the maintenance officers/facility manager assigned to each building and the oversite management team. After signing up to the post-occupancy system, the building user is able to access four interfaces, the maintenance officers/facility manager can access five interface pages, and the management team can access four interface pages as shown in Fig. 1.

In order to design the interactive pages of the post-occupancy system, a software architecture was laid out to show the attributes of each page and the flow of the software. Figure 2 showed the software architecture of the post-occupancy system. In coding the post-occupancy evaluation software, Hypertext Markup Language (HTML), Cascading Style Sheet (CSS), Structured Query Language (MySQL) and C-Sharp (#) programming language were used. This helped to develop the Web pages which can be viewed on a browser. Since the post-occupancy evaluation software has input parameters, it needed a database system to store and process information. MySQL was used to design the database management system (DBMS). C-Sharp (#) programming language was used to maximize the performance of the post-occupancy evaluation software. The programming language was inputted into a Microsoft Visual Studio to develop the Web-based platform as shown in Fig. 3. The system implementation is presented via screenshot of the post-occupancy evaluation system as shown in Figs. 4, 5, 6, 7, 8, 9, 10 and 11. In Fig. 4, the URL of the Web-based system is inputted into a browser. Once the system loads, the home page for the post-occupancy evaluation system is displayed as shown in Fig. 5. As

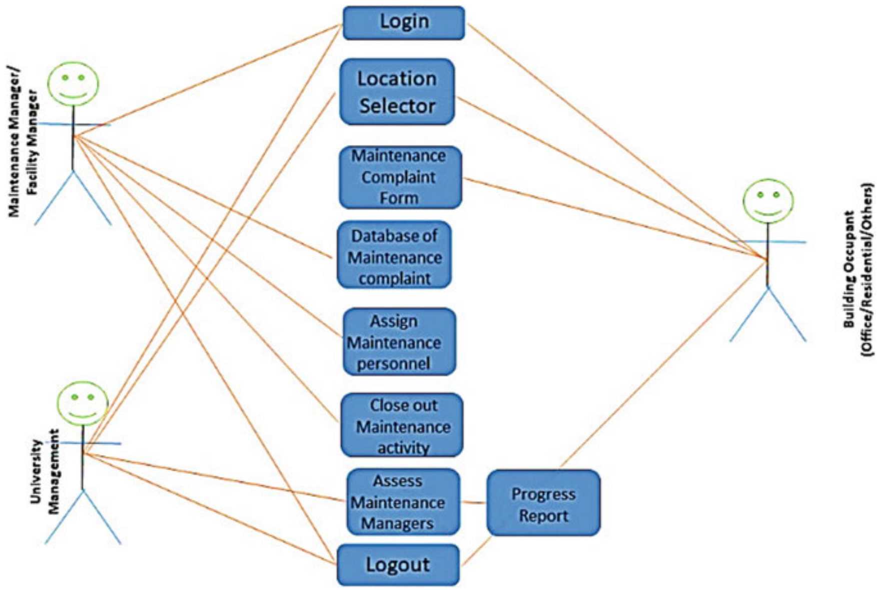


Fig. 1 User classification and characteristics in the electronic system

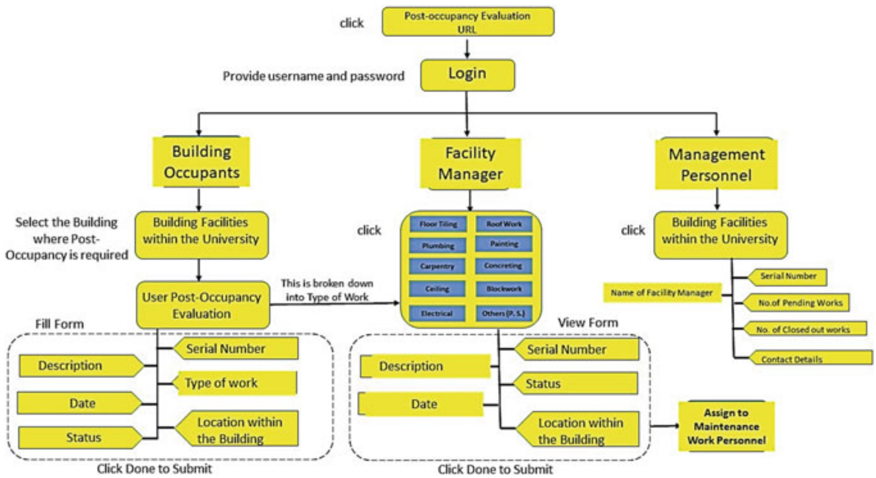


Fig. 2 Software architecture of the electronic system

mentioned earlier, there are three (3) main users applicable to the system. Users can access the post-occupancy evaluation system via a username and password which can be gotten through a signup interface on the home page. Figure 6 showed the signup page where users can obtain their username and password by supplying some personal information. Once the building occupant has signed-in, the building user is

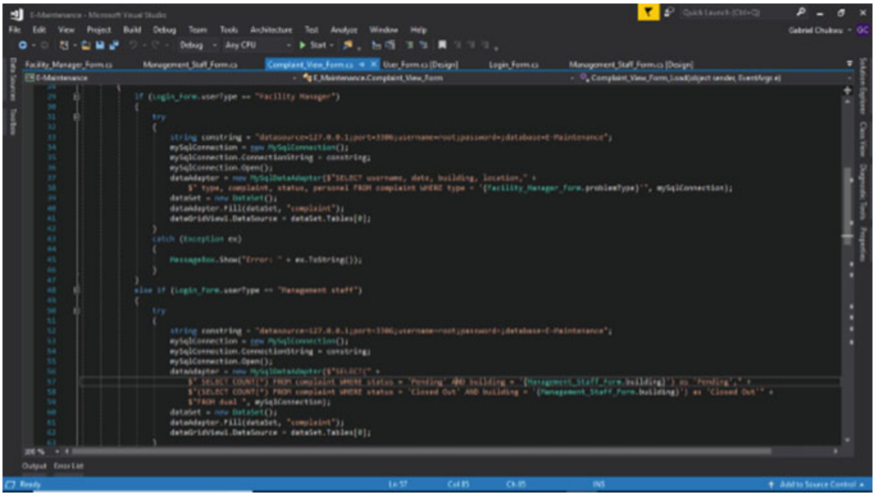


Fig. 3 Screenshot of the programming platform for the electronic system

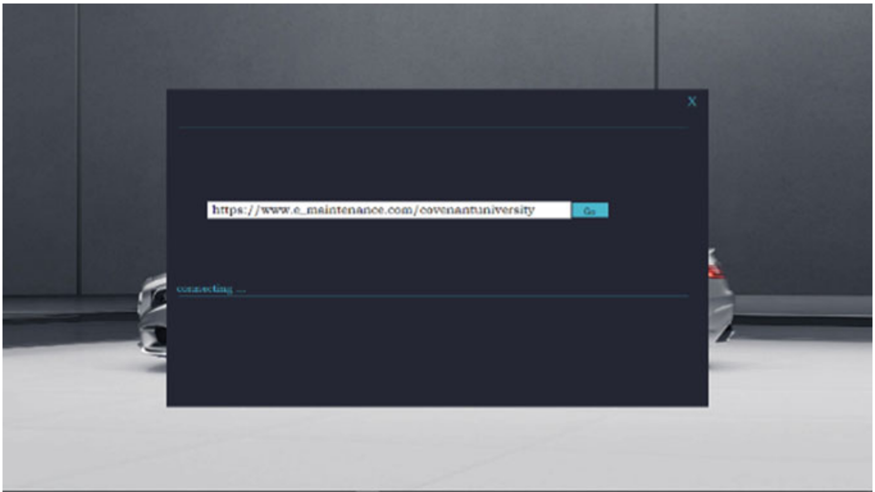


Fig. 4 Post-occupancy system link inputted into a browser

able to select the location where the post-occupancy evaluation is required. Building occupants are able to select the building facilities where they reside/work and give evaluation on the condition of each building component/element. Figure 7 showed the location selector within the electronic system. From this interface, the building occupant can proceed to the evaluation interface as shown in Fig. 8. In Fig. 8, the condition of the facility, the type of facility, the date, the status and the specific room/floor where the evaluation is intended is inputted. At this point, the building user can logout

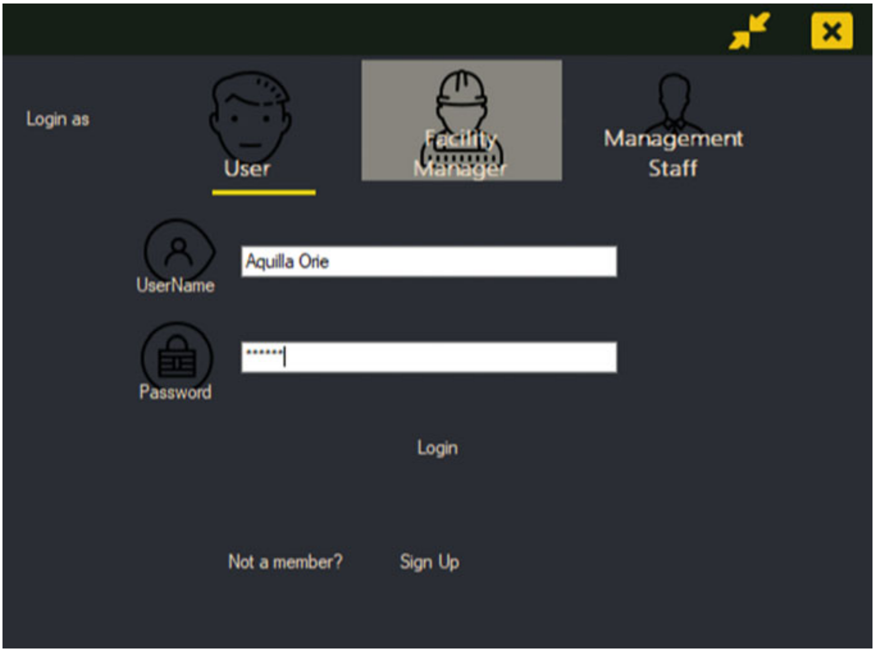


Fig. 5 Home page for the electronic system

of the system having completed the post-occupancy evaluation of the building facility within the school of higher learning. The maintenance manager/facility manager after logging into the post-occupancy evaluation system can access the evaluation for each building component/element as specified by the building user. Figure 9 showed the type of evaluation for each of the building component/elements. The post-occupancy evaluation filled by different building users is aggregated into type of trades for the maintenance manager/facility manager to easily assigned maintenance officers. Figure 10 showed the tabulation of the post-occupancy evaluation of the building facilities based on the type of building components/elements. For effective oversite of the post-occupancy evaluation, the management team responsible for monitoring the activities of the maintenance team can access the post-occupancy system. Figure 11 showed the status interface of the post-occupancy evaluation system. The management team can click on each of the building facility location to access the status of each evaluation done within the location.

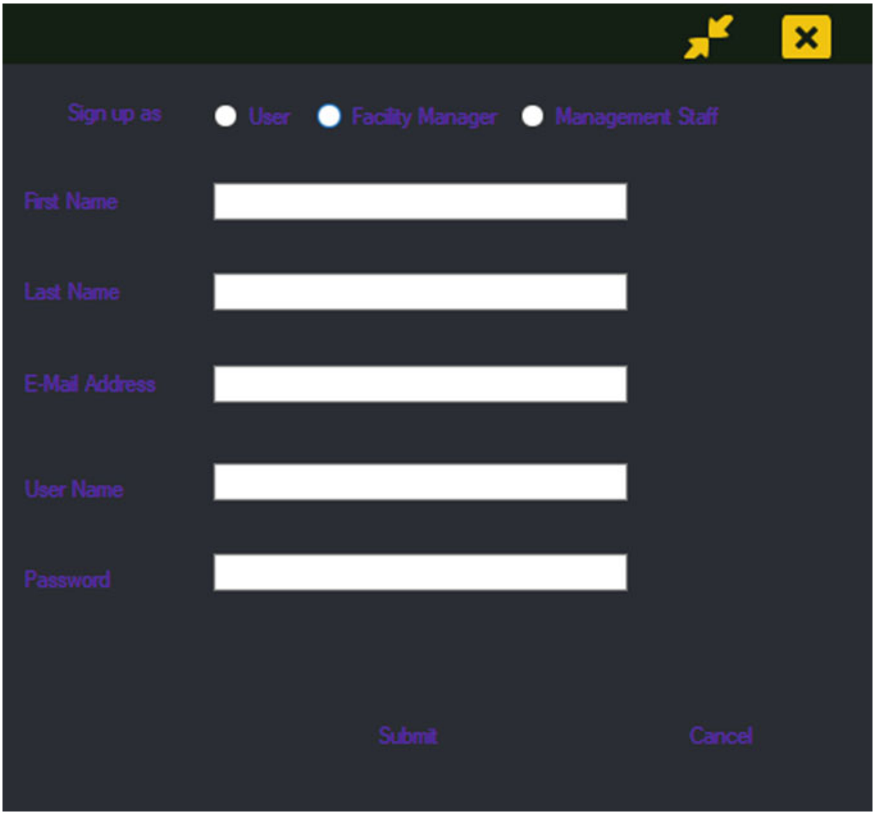


Fig. 6 Signup for the electronic system

3 Conclusion

In this study, the need for post-occupancy evaluation of building facilities was highlighted especially for schools of higher learning. The study examined the prospects of carrying out a post-occupancy evaluation of building facilities in a university community using an electronic platform. The SRS showed the user classes and characteristics, software architecture, functionality, coding language used and external interfaces. The Web pages were designed using HTML, while the database management system was developed using MySQL. C-Sharp programming language was used to control the post-occupancy system. The three main users identified in this study; the building user, the maintenance manager/facility manager and the management team can access the system to evaluate the building facilities. In conclusion, the study developed a post-occupancy evaluation system for a university community to effectively manage the state of its building facilities. By using the proposed system,

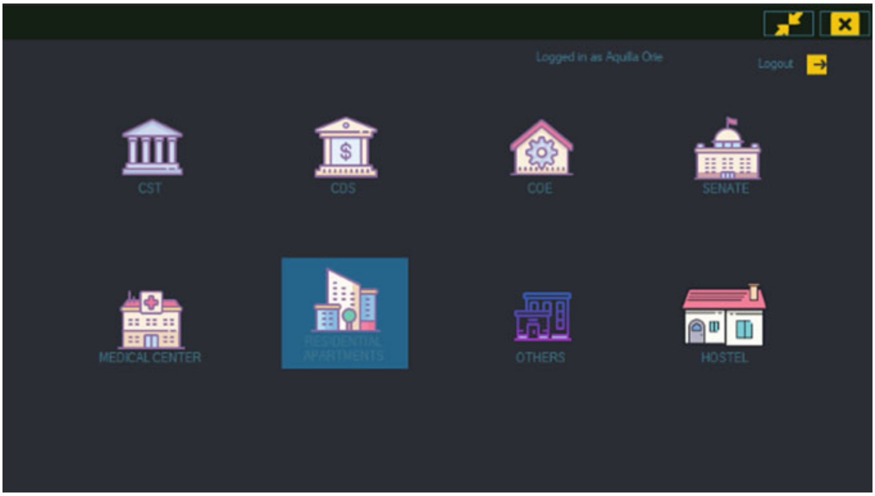


Fig. 7 Location selector within electronic system

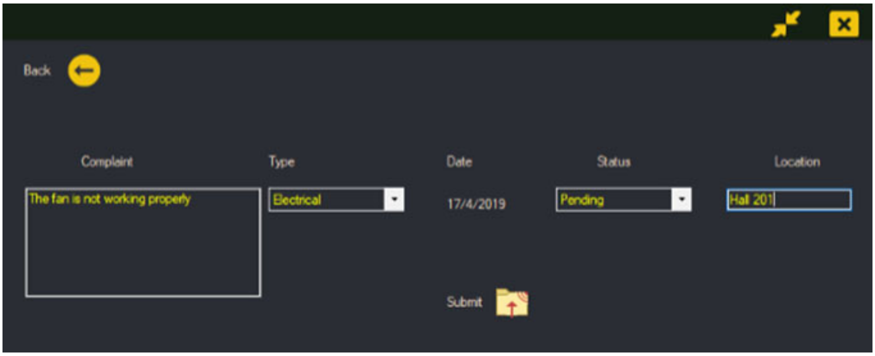


Fig. 8 Post-occupancy evaluation of building facilities within the electronic system

the study aims to increase speed of maintenance works, improve the state of building facilities in schools of higher learning and ensure accountability in the building maintenance process.

Acknowledgements The authors appreciate the financial support of Covenant University through its Centre for Research, Innovation and Discovery.

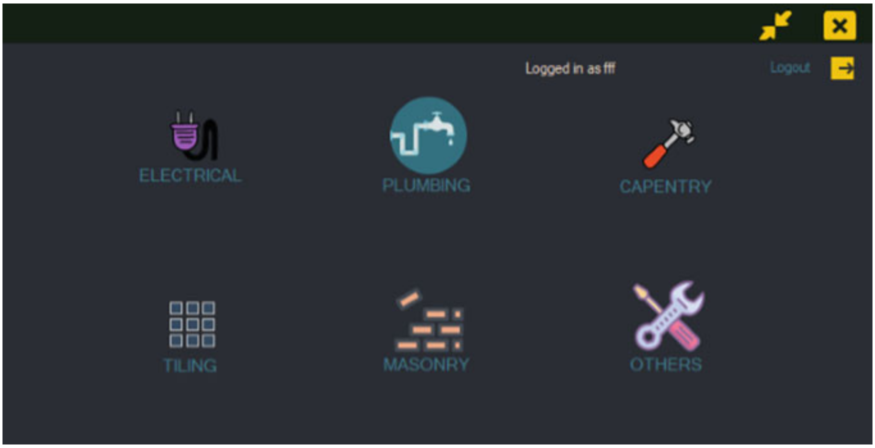


Fig. 9 Evaluated building components/elements within the electronic system

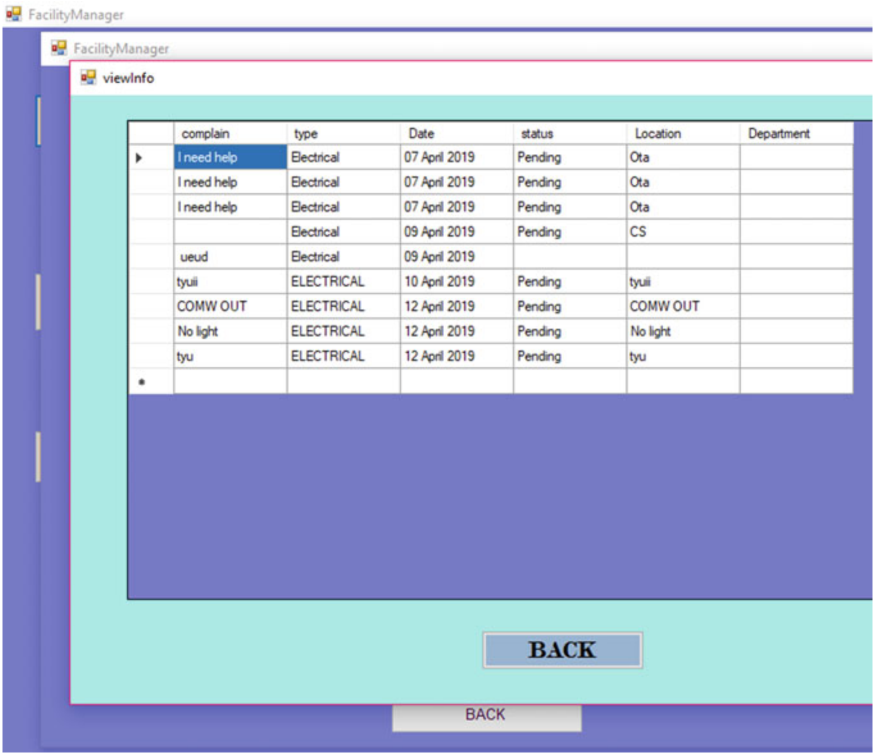


Fig. 10 Summarized post-occupancy evaluation in the electronic system

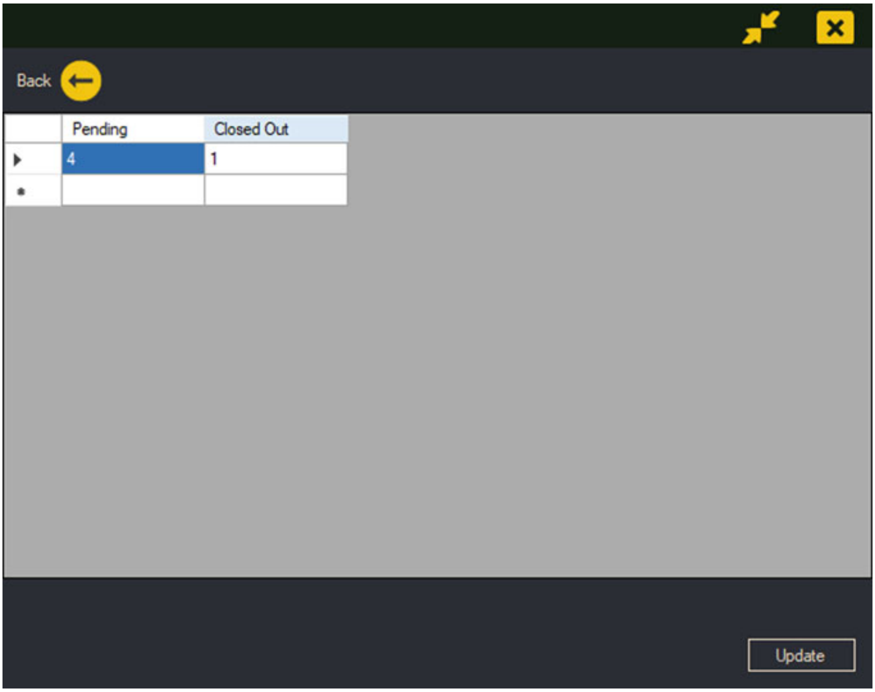


Fig. 11 Status interface of the post-occupancy evaluation system

References

1. Ibem EO, Opoko AP, Adeboye AB, Amole D (2013) Performance evaluation of residential buildings in public housing estates in Ogun State, Nigeria: users' satisfaction perspective. Front Architectural Res 2:178–190
2. Emuze F, Mashili H, Botha B (2013) Post-occupancy evaluation of office buildings in a Johannesburg country club estate. Acta Structilia 20(1):89–110
3. Meir IA, Garb Y, Jiao D, Cicelsky A (2009) Post-occupancy evaluation: an inevitable step toward sustainability. Adv Build Energy Res 3:189–220
4. Commission for Architecture and the Built Environment, CABE (2005) Design with distinction: the value of good buildings design in higher education. Available from www.cabe.org.uk
5. Preiser WF (2001) Feedback, feedforward and control: post-occupancy evaluation to the rescue. Build Res Inf 29(6):456–459
6. Fatoye EO, Odusami KT Occupants' satisfaction approach to housing performance evaluation: the case of Nigeria. In: Proceedings of the RICS COBRA research conference, University of Cape Town. Available from http://www.rics.org/cobra
7. Ahmadi RT, Saiki D, Ellis C (2016) Post occupancy evaluation an academic building: lessons to learn. J Appl Sci Arts 1(2):1–16 (2016) (Article 4)
8. Hassanain M, Mudhei A (2006) Post-occupancy evaluation of academic and research library facilities. Struct Surv 24(3):230–239
9. Preiser WFE (1995) Post-occupancy evaluation: how to make buildings work better. Facilities 13(11):19–28
10. Pati D, Pati S (2013) Methodological issues in conducting post-occupancy evaluations to support design decisions. Health Environ Res Des J 6:157–163

11. Preiser WFE, Vischer J (2005) Assessing building performance. Butterworth-Heinemann, Oxford
12. Ibem EO, Aduwo EB, Uwakonye O (2012) Adequacy of incremental construction strategy for housing low-income urban residents in Ogun State, Nigeria. Built Environ Proj Asset Manag 2(2):182–194
13. Leaman A (2003) Post-occupancy evaluation, prepared for gaia research CPD seminars on sustainable construction. Available from https://www.usablebuildings.co.uk/UsableBuildings/Unprotected/AdrianLeamanPost-OccupancyEvaluation.pdf
14. Göçer Ö, Hua Y, Göçer K (2015) Completing the missing link in building design process: enhancing post-occupancy evaluation method for effective feedback for building performance. Build Environ 89:14–27
15. Riley M, Kokkarinen N, Pitt M (2010) Assessing post occupancy evaluation in higher education facilities. J Facil Manag 8(3):202–213
16. Afolabi A, Afolabi I, Eshofonie E, Akinbo F (2019) e-maintenance framework for strategic asset management in tertiary institutions. In: Misra S et al (eds) ICCSA 2019, LNCS 11623, Chapter 22, Springer Nature, pp 1–12
17. Afolabi A, Afolabi I, Eshofonie E, Akinbo F (2019) Improving employability skills through a web-based work integrated learning database for construction students. In: Misra S et al (eds) ICCSA 2019, LNCS 11623, Chapter 31, Springer Nature, pp 1–11

Internet of Things: Demystifying Smart Cities and Communities

Modebola Olowu, Chika Yinka-Banjo, Sanjay Misra, Jonathan Oluranti and Ravin Ahuja

Abstract This paper presents a review on the use of IoT for demystifying smart cities and communities. The upward paradigm shift in the way standard of living has evolved, has pointed at the poor impact of service delivery in human homes and cities, owing to constrained amenities and resources. As such, the smart cities and homes concept has been adopted to boost the delivery of services in both suburban and urban areas. IoT's concept has been effective by facilitating right of entry and relations with an extensive range of devices, e.g. appliances, vehicles, security cameras, actuators, monitoring sensors, displays, etc. The increase in the development of a number of applications resulted from the existence of IoT, which allows the use of the big, rich and varied form of data generated by devices and objects to produce innovative services to individuals, organizations and government parastatals, who we identify as "users". The urban IoT is an infrastructural communications platform which gives economical, modest and good unified admittance to surfeit of the problem in public services, leading to the birth of prospective interactions. It aims towards revealing concepts and the general framework of the design for an urban IoT, the description of its service-based architecture, the protocols necessary for its implementation and some cutting-edge technologies utilized.

Keywords Internet of things (IoT) · Machine to machine (M2M) · Near-field communications (NFC) · Radio frequency (RFID)

M. Olowu · C. Yinka-Banjo
University of Lagos, Akoka, Lagos, Nigeria
e-mail: mdblanne20@gmail.com

C. Yinka-Banjo
e-mail: cyinkabanjo@unilag.edu.ng

S. Misra (✉) · J. Oluranti
Covenant University, Ota, Nigeria
e-mail: sanjay.misra@covenantuniversity.edu.ng

R. Ahuja
Shri Vishwakarma Skill University, Gurgaon, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_41

1 Introduction

IoT alters the original form of these mere devices from the boring norm to pervasive smart devices with embedded systems, budded up with security wares, multifactor applications with sensors and protocols [1]. Radio frequency (RFID) existed with necessity when IoT was birthed, but with the new progressive standard IoT has adopted, new technologies such as machine to machine (M2M) and near-field communications are relevant and effective for the application of IoT, we also have the vehicular to vehicular communications (V2V), which enables a seamless connection of IoT [2].

The impact of poor service delivery in human homes and cities, owing to constrained amenities and resources; such as poor, vulnerable security and health care systems. Thus, the era of IoT presents the transformation of a common city into a smart city, leaving homes, communities and cities that need seamless services in their day-to-day activities to overcome the normal struggles they have faced before the IoT smart city model was introduced. Section 2 discusses the literature review, with Sect. 3 showing the case study of the Padova Smart City and the remaining sections focuses of the future trends of IoT and summary with conclusions, respectively.

2 Literature Review

IoT Service Architecture: The service architecture for Internet of things is dispersed into diverse layers. The first layer is known as the perception layer which consists of sensors, gateways, actuators and various types of end systems and devices. The second layer called the network layer is the brain behind the backend systems connection to the devices [3]. Application layer which is responsible for the concrete UI of the service and intelligence is the last layer. The popular model which consists of four layers is not so different from the three-layer model that is made up of an additional supporting layer (also known as the data layer) taken apart from the application layer. The supporting layer is responsible for the entire computing capabilities and data management. Various models are also introduced with main layers been split into varied exhaustive pieces (Fig 1).

Most centralized service architecture models are used by the smart city services, where a solid and varied types of peripheral devices installed over the urban area produce various kinds of data delivered via the appropriate channels of technologies and communications then unto a control centre, where the processing and storage of data are effectively performed.

The Web Service Approach for IoT Service Architecture

Although in the IoT service architecture domain many different principles are still fraught in being the one referenced and the most approved, the Internet Engineering

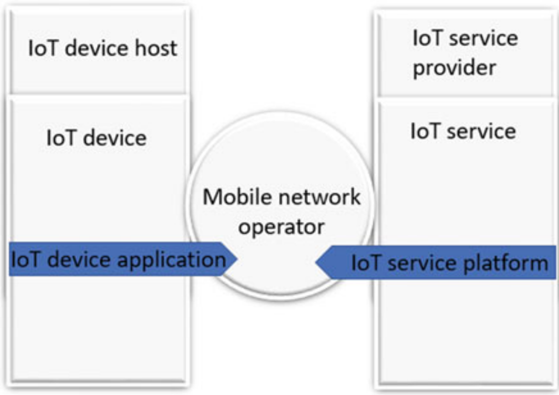


Fig. 1 Typical IoT service architecture model

Task Force (IETF) standards will be discussed in this section, as they are royalty-free and accessible, because they can cover an extensive community area and it denotes the best Internet standards. The Representational State Transfer (ReST) is a Web-based model that satisfies the IETF ideals for IoT in using a Web service architecture for IoT.

Figure 2 illustrates an architecture called the reference protocol for an urban IoT system that is made up of the protocol stacks known as the unconstrained and constrained. The protocols shown on the left (unconstrained) have low complex and are the fixed Internet hosts standard for Internet network and communications, the Constrained Application Protocol (CoAP), and 6LoWPAN are best for constrained devices.

Unconstrained Application Protocol (UAP): It shows how the low not so well power devices can still perform well in an IoT environment, so even machine to machine communications with low bandwidth and availability can still join the IoT train and work effectively, and it also acts as an enabler for sensors, actuators, etc.

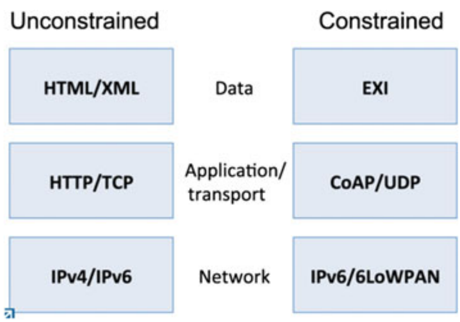


Fig. 2 Unconstrained and constrained protocol stacks

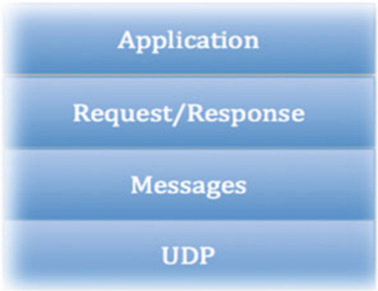


Fig. 3 Abstract layer of CoAP

Constrained Application Protocol: It is a lightweight protocol projected to be used and considered as a replacement of HTTP for being an IoT application layer protocol. CoAP interactive model is like HTTP's client/server model. Figure 3 shows that CoAP employs a four-abstract layer structure. The message layer which also happens to be the bottom layer has been designed to deal with UDP and asynchronous switching. The communication method utilizes the request/response layer and deals with request/response message [4].

The protocol architecture shown in Fig. 3 shows we can distinguish the three distinct and basic functional layers, explicitly into the data, application/transport and network layer, respectively, and the transcoding aspects may be required by committed holders to monitor the protocols and formats constrained and unconstrained. In order to guarantee interoperability, we will see in depth the layers mentioned above.

(i) **Data Format**: The schema-less and schema-informed are the two types of encoding under the EXI-Efficient XML. Schema-less encoding is produced directly from the XML data and can be decoded by any entity bound EXI without any prior knowledge about the data, even though the schema-informed encoding adopts that the two EXI processors share an XML Schema before actual encoding and decoding exist; numeric identifiers to the XML tags in the schema occur by sharing this schema and which in turn allow such coding to be built on the EXI.

(ii) **Network Layer**: The most widely Internet hosts supported addressing technology is known as The Internet Protocol Version 4 (IPv4). Conversely, IANA which happens to be the international organization that globally assigns IP addresses has recently announced the fatigue of IPv4 address blocks which includes billions of nodes in the IoT network, each of which shall be uniquely addressable. The IPv6 surfaced as a solution to this problem, which tends to provide a 128-bit address field, therefore allowing the allotment of a unique IPv6 address to nodes in the IoT network [5].

The mapping technique used in Universal Resource Identifier (URI) involves a particular type of HTTP-CoAP cross proxy, called the reverse cross proxy. This proxy works like a final Web server to the HTTP/IPv4 client and as the unique client to the CoAP/IPv6 Web server. IPv4/IPv6 conversion is securely determined within by the applied URI mapping function as the machine is seen located in a network space where IPv6 connectivity is existing to permit direct access to the final IoT nodes [5].

(iii) **Link Layer Technology**: Internet of things systems are sometimes urban adopted which requires a large placement area, requiring a group of link layer technologies that can certainly cover a wide landscape, also that can back a huge amount of traffic coming from an extremely aggregated major and large number of minor data flows. For the enablement of an efficient urban IoT, the link layer technologies can be categorized into unconstrained and constrained technologies. The group considered first are the common traditional networks such as the WAN, LAN, MAN, communication technologies, examples of which are the Ethernet, Wi-fi, fibre optic, cellular technologies like LTE, UMTS and broadband power line communication (PLC).

(iv) **Sensor Technology**: Smart sensors are a vital enabler of the Internet of things, they include the radio frequency identification (RFID) tags, in which (3) it satisfies three purposes which are the ones that classify items, discover them and lastly determines their environmental states, all of which have key inferences for the markets. Warehouses and plants used in manufacturing make good use of sensors [6] as it helps them to measure the rate of humidity and temperature, their management system logs, historical records and also for alarm signals or procurement and process management. For the purpose of this paper, we utilized the IoT service architecture model, wherein the Web-based service approach was fully used, the Web services permit to have a flexible and interoperable system that can be extended to IoT nodes, through the adoption of the Web-based paradigm known as Representational State Transfer (ReST), also the objective of this paper is to confer a broad position framework for a state of the art urban IoT design. The specific features of an urban IoT will be described, alongside the services that may drive the implementation of urban IoT by communities.

3 Case Study

To break bounds on this paper, an experimental wireless sensor network test bed, with more than 300 nodes, deployed at the University of Padova has been successfully used to realize proof-of-concept demonstrations of smart grid and health care services, but what is new is the practical implementation of an urban IoT, tagged "Padova Smart City", which involved the improvement of innovative IoT solutions, nodes and the control software, which has largely led to the promotion of a quick open data and ICT solutions in the public sector. As simple as it seems, it is an IoT concept that involves several various devices and link layer technologies, necessary for an urban design.

This implementation involves the use of wireless nodes and data gathering from the environment to create systems such as the one used for monitoring street lights, equipped with different kinds of sensors, the use of gateway units to connect to the Internet and many more. Its emergence in Padova brought about fast retrieval of eco-friendly factors like vibrations, pressure, temperature, moisture, distortions, element rations, etc., measuring all this factors and even monitoring the applications that also depend on them, from each posts light intensity for the street lights in the public or even temperature in the house with the use of the smart thermostats. [5].

3.1 Street Light

The streetlights are purposefully and intentionally geo-located on Padova's map, also directly in sync with the map of the city where the IoT nodes are physically and remotely attached to the street lights. This urban IoT nodes work with batteries (usually small) and sometimes may need the use of power grid boosters for the lowed which provide data concerning weather states. The sensor nodes are each coated with plastic looking transparent shield, keeping it safe from rain, heat, but doubling up in accuracy to circulate enough power and air in the right intensity and proportion for light and temperature [5].

3.2 Link Layer Technologies (Constrained)

The streetlight poles have IoT nodes mounted on them, which form a multichip cloud called 6LoWPAN that uses IEEE 802.15.4 constrained link layer technology. A gateway is therefore used as a bridge between the 6LoWPAN cloud connection and the Internet for all transcoding required to be completed [5].

3.3 The WSN Gateway

It does the job of communing with the technology used in the constrained link layer for the sensors cloud with traditional tools like WAN utilized to give the backend central servers connections.

3.4 HTTP-CoAP Proxy

This proxy facilitates communication transparency with CoAP devices. Its logic can then be stretched to applications monitoring and curbing the traffic issues in the peripheral network of the IoT.

3.5 Database Server

For the networks in the Padova Smart City, the WSN Gateway recognizes the database server, and then it denotes a plug-and-play section that delivers transparency within the peripheral nodes of its interface.

3.6 Operator Mobile Device

Mobile devices will easily locate and communicate with the street lamps or lights that need interventions as the public lighting operators are automatically connected with them through the mobile device. The use of the mobile devices in this urban IoT framework involves the extensive use of IoT nodes on the peripheral systems which enables independence in technology, with a standard and open interaction so far, each node supports an interface that is HTTP-based [7].

4 Future Trends

A lot of people will see a common streetlamp as a lamp that illuminates the street, just like any other, but a smart-city designer would see it as a prospect to construct a charter for enhancing major city processes and activities, from security to good living standard and education or health facilities [8]. Key issues in cities and communities range around safety, good standard of living, security, obsolete infrastructure revisits, issues around traffic jams and responses to events like climate change and disasters, have commonly been dealt with by unit-sized departments. Nonetheless, homes, cities and communities are stirring towards IoT solutions that ooze of smart city concepts and realization to a large extent [9]. For an urban IoT, the use of the street lighting networks can provide a good and affordable solution for smart city concepts. Seeing as after installing an LED, you add a control unit, therefore, saving electricity to a large percent because they can be automated to dim or brighten, thus lowering crime and traffic accidents. Sensor technology will also be implemented for most devices to help monitor patients heart rate, level and general conditions. Others will involve the use of robots to grant ease of locomotion for patients to promote safety also to reduce a caregiver's workload and many more [8].

5 Summary and Conclusion

Innovating with the use of technology and proactive strategy is a driving force for the development and creation of cities, and it brings in resourceful ways of managing funds and providing exceptional services for the public. Quite a lot of devices have been put in place to automate the normal manual process of energy, waste or even transportation distribution [10]. The public's safety is also being considered and their seamless access to new age technology that makes life better and general developments with serenity and intellects in areas such as data and information analytics, wireless communications, sensor technology and many more. We can also identify the use of smartphones and devices as a rising need for the creation of smart cities and communities, involving data from open platforms and taking ownerships of life-changing solutions.

For this research work, we reviewed the solutions currently put in place for the cities with the implementation of urban IoTs. Indeed, current technologies make the IoT concept feasible but do not fit well with the scalability and efficiency requirements they will face. The IoT systems design is vast with different types of protocols from being homogenous to being open and quite small. Therefore, the empowering technologies are matured enough to grant genuine recognition of IoT services and solutions. A proof of this implementation is seen with the deployed and fully functional smart city—Padova creation.

Acknowledgements The authors appreciate the kind efforts of Covenant University through its Centre for Research, Innovation and Discovery in paying for the article processing charge of this article.

References

1. Samuel V, Misra S, Nicholas O (2014, November) Internet of Things & its application to road navigation and usage problem. In: APWC on CSE engineering. IEEE, pp 1–5
2. Sajjad H, IIyas Y (2016) A survey: Internet of Things (IoT) Technologies, applications and challenges. In: 2016 the 4th IEEE international conference on smart energy grid engineering, pp 381–385
3. Jukka K (2017) IoT service platform architecture. In: 2017 Technology, communication and transport, vol 1, p 8
4. Shelby Z, Sensinode K (2013) Hartke Constrained Application Protocol (CoAP), draft-ietf-core-coap-18. http://tools.ietf.org/html/draft-ietf-core-coap-18
5. Andrea Z, Nicola B, Angelo C, Lorenzo V, Michele Z (2014) Internet of Things for smart cities. IEEE Internet Things J 1(1):22–32
6. Adenugba F, Misra S, Maskeliūnas R, Damaševičius R, Kazanavičius E (2019) Smart irrigation system for environmental sustainability in Africa: an internet of everything approach. Math Biosci Eng 5490–5503
7. Joao C, Juan C, Fabio N (2017) Trusting the Internet of Things. IT Professional 19(5):c1–c1

8. Nagayoshi N Predicts 2017: smart cities must create the right data orchestration for sustainable citizen and business services 1(19):23–54
9. Bettina T, Andrew K, Nagayoshi N (2016) Hype cycle for smart city technologies and solutions, 2016. Gartner research G00302841 7(19):56–83
10. Saber T, Miadreza S, Pierluigi S Catalão J (2017) A review of smart cities based on the Internet of Things concept. Energies 10:1–23. https://doi.org/10.3390/en10040421, (2017)

Comparative Analysis of Optimisations of Antecedents and Consequents of Fuzzy Inference System Rules Lists Using Genetic Algorithm Operations

Abraham Ayegba Alfa, Sanjay Misra, Achem Bumojo, Kharimah Bimbola Ahmed, Jonathan Oluranti and Ravin Ahuja

Abstract Researches have pointed to the fact that fuzzy logic controls (FLC) largely rely on the inputs, rules lists specifying logical notation and outputs for its inference applications. The accuracy of these inference systems outputs is directly influenced by the quantity of rules constituting the Rule Bases (RBs), which are often redundant, poorly mapped and inconsistent, arising from human experts' construction errors. This paper is investing the effectiveness of optimising antecedents and consequents of Rules Bases separately using genetic algorithms operations. The resultant rules lists realised from both genetic procedures are used to construct FLC. The training and evaluation of FLCs were carried out using DangoteCem PLC shares prices data set including opening, highest and closing prices. The paper found that the optimisation of RB-antecedents minimised the rules list redundancy to five (5) rules. Whereas, the optimisation of RB-consequents minimised the rules list to seven (7) rules when compared to nine (9) rules of initial human experts' rules. However, the FLC constructed with five rules produced better forecasting outcomes as against that with seven (7) rules using parameters such as MSE, RMSE, RAE and MAPE.

Keywords FLC · Consequents · Antecedents · Rules lists · Accuracy · Rule base · Genetic algorithms · Optimisation

A. Ayegba Alfa · K. Bimbola Ahmed
Kogi State College of Education, Ankpa, Nigeria
e-mail: abrahamsalfa@gmail.com

K. Bimbola Ahmed
e-mail: bimbola.k.ahmed@gmail.com

S. Misra (✉) · J. Oluranti
Covenant University, Otta, Nigeria
e-mail: sanjay.misra@covenantuniversity.edu.ng

A. Bumojo
University of Nigeria, Nsukka, Nigeria
e-mail: bumojoachem@yahoo.com

R. Ahuja
Shri Vishwakarma Skill University, Gurgaon, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_42

1 Introduction

The emergence of cognitive computation field is its capability to interact with humans in complex circumstances by imitating the process of human rationality in a self-regulated manner for the increased productivity [1]. The inability of humans to exhibit complete cognition gave rise to the concept of fuzzy logic controls (FLCs). In practice, evolutionary algorithms are realised from biological processes and methods which are combined with FLCs to serve as the foundation for soft computing [2–5].

Evolutionary algorithms are limited in the aspect of iterative solution searching technique and high large cost of computation such as the choice of fitness function and time inefficient during the training of large volumes data sets. Rule-based fuzzy systems shortfall can be resolved with the accuracy enhancements approaches including custom aggregation operators, adaptive fuzzy operators in the inference system (that is adaptive defuzzification) [5, 6], fine-tuning of rule lists or determining the best permutation for the membership functions [7].

In this paper, the genetic algorithm was used to refine the two FLCs rules list, which is FLC with antecedents' optimisation and FLC with consequents' optimisation. The comparative analysis of performances is to be carried out to ascertain the FLC with the most predictive capability for enormous data set (i.e., the stock prices) chosen for the study. The remaining parts of this paper are subdivided into sections as follows: section two is the literature review, section three is the methodology, section four is the results presentation, and the last section is the conclusion.

2 Literature Review

2.1 Fuzzy Logic Problem Modelling

Hisdal in [8] explained the accomplishments of fuzzy set theory including (a) the inclusion of linguistic values of variables and (b) the prospect of a fractional grade of a membership value of items in a class rather than bivariate membership values of 0 and 1 (in crisp sets). In the case of a classical set, the crisp limit is given to the set, with item membership value in a class given as 0 or 1. The membership or non-membership of an item y in the crisp set B is denoted by the characteristic function of B, defined by Eq. 1 [9].

$$\mu_B(y) = \begin{cases} 1 \text{ if } y \in B \\ 0 \text{ if } y \notin B \end{cases} \tag{1}$$

The fuzzy set B in terms of mathematical representation is given by Eq. 2.

$$A = \{y,\ \mu_B(y) | y \in U\}. \tag{2}$$

where U is the universe of discourse set for a particular problem, and $\mu_B(y)$ is the degree of membership of the item y, which can be expressed by Eq. 3.

$$\mu_B(y) \to [0, 1]. \tag{3}$$

The parameter fine-tuning remained the most tasking for fuzzy logic controllers (FLC). The operations of FLC fine-tuning are to attain the desired or optimal criteria of construction through the selection of appropriate combinations of different control parameters or gains. The aftermath of the fine-tuning approaches is to achieve optimal control objectives or desired step responses in which fuzziness of the membership functions for the inputs can be tuned or adjusted, especially input error and error degree [10, 11].

2.2 Genetic Algorithm

Genetic algorithm is a stochastic all-inclusive search technique simulating the characteristics of natural sciences evolution such as crossover, mutation and selection. GA concept of the artificial principal is Darwinian's survival of fittest theory, while the genetic task is abstracted from nature to build a strong tool useful for determining the best solutions to multifaceted real-life problems [12]. Genetic algorithms are simple and potent from the calculation standpoint, which reduce the hypotheses in search space rather than restraining it [13]. Genetic algorithm can operate on linear and nonlinear problems expressed in continuous and discrete research space. According to [14], the objective of GA is to continuously produce fitter offspring through successive generations of simple genetic procedures.

2.3 Related Studies

Genetic fuzzy system (GFS) was introduced in the building of an expert system for predicting stock price movements by Hadavandi et al. [15]. The outcomes of the GA-based FIS model gave better efficiency as against the ARIMA, ANN and HMM for the MAPE evaluation parameter due to fewer amount of input parameter using step-by-step regression. Genetic algorithm was used to optimise FLCs for the antecedents of the rules lists. The resultant rules lists were used to build and optimise FLCs which showed significant stock prediction outcomes with fewer quantity of rules in the rule base against FLCs built without rules lists optimisation [16].

The forecasting system was constructed using the human expertise or knowledge base and clinical experimentation data set to ascertain the severity levels [17]. This system supports similar operations conducted in clinics and hospitals with 97% reliability and accuracy. A comparison of the accuracy of human expert systems and computer expert system was carried out by Alfa et al. [18]. Fuzzy inference system expert system (FISES) and neural network expert system (NNES) were analysed. In the results, FISES outperformed twice as NNES because of the presence of optimised rule base in NNES. However, FISES requires optimisation of the rule base for increased accuracy and forecasting capability.

3 Methodology

The initial rules lists and membership function indices generated from human expert for FLC on the basis of DangoteCem Company's opening price (High = 3, Medium = 2, Low = 1), highest price (High = 3, Medium = 2, Low = 1) and closing price (Rise = 3, Stable = 2, Falls = 1) data set are presented in Table 1.

3.1 FLC Rules Lists Derivation

Encoding of chromosomes was achieved through a row-wise combination of each input fuzzy set which is given by [333231232221131211]. The initial population for the chromosomes ($N_{\text{POP}} = 30$) are constructed randomly for $N = 18$. The mean square error (MSE) fitness function is chosen for GA operation given by Eq. 4.

$$\text{MSE}\left(X_j\right) = \frac{1}{n}\sum_{i=1}^{n}\left(X_i - \hat{X}_i\right)^2. \tag{4}$$

where X_i = actual value of ith training data of RB coded in jth chromosome (X_j), $\hat{X}_i$ = adjusted or predicted value of ith training data of RB coded in jth chromosome (X_j), X_j = jth chromosome, and n = the training data set quantity. The operation of GA is required produce the best solution set with the smallest errors.

Table 1 Initial fuzzy rules lists

Rules list	Input 1	Input 2	Output
1	3	3	3
2	3	2	2
3	3	1	3
4	2	3	3
5	2	2	2
6	2	1	2
7	1	3	3
8	1	2	2
9	1	1	1

Table 2 FLC RB outcomes built with consequents and antecedents optimised

Parameter	Model			
	Consequents (New)	Per cent (%)	Antecedents [16]	Per cent (%)
MSE	0.001041135	70.37	0.000438377	29.63
RMSE	0.032266628	60.65	0.020937461	39.35
RAE	3.768072451	61.43	2.365752510	38.57
MAPE	0.091904206	61.43	0.057701281	38.57
Resultant rules	7	77.78	5	55.56
Chromosomes	9	33.33	18	66.67

4 Results

4.1 Optimised Antecedents and Consequents for the FLC Rule Base

The resultant rules lists for the FLC reduced to five after performing the genetic operation includes R1, R5, R6, R7 and R9. This was attained through the genetic operation on the antecedents of the rules base using the fitness function (MSE) [16]. Similarly, the final rules lists reduced to seven for the FLC after performing genetic operation includes R2, R3, R4, R5, R6, R7 and R8 after performing the genetic operation on the consequents of the rules base using the fitness function (MSE).

4.2 Comparisons of FLCs Performances

The forecasts for FLCs built with optimised antecedents and consequents of Rules Bases are carried out using share closing prices. The outcomes of the forecasts (observed values) and relative performances with respect to the target (expected values) are shown in Table 2.

5 Conclusion

This paper found that the outcomes of the FLC constructed with optimised rules list antecedents were better than the FLC constructed with optimised rules list consequents as proposed by this paper and [22], respectively. In fact, the performance of FLC with optimised antecedents is relatively lower in the fitness function (MSE) than that of consequents, which is 29.63–70.37%. Again, the quantity of rules lists decreased significantly from nine to five and seven for antecedents and consequents optimisations leading to the removal of redundancies and improved accuracies of forecasts. The paper established that the accuracy of FLCs mostly depends on the bigger sizes of chromosomes used in genetic algorithms operations and smaller rules lists constituting the FLCs Rule Bases.

Acknowledgements The authors appreciate the kind efforts of Covenant University through its Centre for Research, Innovation and Discovery in paying for the article processing charge of this article.

References

1. López S, Márquez AA, Márquez FA, Peregrín A (2019) Evolutionary design of linguistic fuzzy regression systems with adaptive defuzzification in big data environments. Cogn Comput 11(3):388–399
2. Zhang HY, Ji P, Wang JQ, Chen XH (2016) A neutrosophic normal cloud and its application in decision-making. Cogn Comput 8(4):649–669
3. Tao Z, Han B, Chen H (2018) On intuitionistic fuzzy copula aggregation operators in multiple-attribute decision making. Cogn Comput 10(4):610–624
4. Molina D, LaTorre A, Herrera F (2018) An insight into bio-inspired and evolutionary algorithms for global optimization: review, analysis, and lessons learnt over a decade of competitions. Cogn Comput 10(4):517–544
5. Pino A, Shin K, Velázquez-Rodríguez C (2018) Improving the genetic bee colony optimization algorithm for efficient gene selection in microarray data. Prog Artif Intell 7(4):399–410
6. Alcala-Fdez J, Herrera F, Márquez FA, Peregrín A (2007) Increasing fuzzy rules cooperation based on evolutionary adaptive inference systems. Int J Intell Syst 22(9):1035–1064
7. Márquez FA, Peregrín A, Herrera F (2007) Cooperative evolutionary learning of linguistic fuzzy rules and parametric aggregation connectors for Mamdani fuzzy system. IEEE Trans Fuzzy Syst 15(6):168–1178
8. Hisdal EL (1994) Interpretative versus prescriptive fuzzy set theory. IEEE Trans Fuzzy Syst 2:22–26
9. Xue X, Xiao M (2016) Application of adaptive neuro-fuzzy inference system for prediction of internal stability of soils. Eur J Environ Civ Eng 1–20 (Taylor & Francis)
10. Bai Y, Roth ZS (2019) Interval type-2 fuzzy logic controllers. In: Classical and modern controls with microcontrollers. Advances in industrial control, vol 9, Springer, Cham, pp 549–579 (2019)
11. Bai Y, Roth ZS (2019) Fuzzy logic control systems. In: Classical and modern controls with microcontrollers. Advances in industrial control, vol 7, Springer, Cham, pp 437– 507
12. Singh SP (2019) Economic load dispatch using fuzzy logic controlled genetic algorithm. Unpublished M. Eng Thesis, Department of Electrical and Instrumentation Engineering, Thapar University, Patiala, pp 1–68
13. Delnavaz B (2014) Forecasting of the stock price index by using fuzzy-neural network and genetic algorithms. J Appl Sci Agric 9(9):109–117
14. Yefimochkin O (2011) Fundamental: using macroeconomic indicators and genetic algorithms in stock market forecasting. Unpublished master's thesis, Department of Computer Engineering, The Technical University of Lisbon, Portugal, pp 1–120
15. Hadavandi E, Shavandi H, Ghanbari AA (2010) Genetic fuzzy expert system for stock price forecasting. In: Proceedings of 7th IEEE international conference on fuzzy systems and knowledge discovery, pp 41–44 (2010)
16. Alfa AA, Yusuf I, Misra S, Oluranti J (in press) Enhancing stock prices forecasting system outputs through genetic algorithms refinement of rules-lists. IC4S

17. Azeez NA, Towolawi T, Vyver CV, Misra S, Adewumi A, Damasevicius R, Ahuja R (2019) A fuzzy expert system for diagnosing and analyzing human diseases. In: A. Abraham et al (eds) IBICA 2018, AISC 939, pp 474–484
18. Alfa AA, Adewale OS, Ajagbe KD, Sanjay M (2016) Analysis of fuzzy and neural networks expert systems in forecasting stock prices. Int Adv J Nat Appl Sci 1(1):29–39

Uses and Impact of Social Media on Work Performance of Low Literate People

Naila Rafique, Adeed Ishaq, Muhammad Shoaib, Sanjay Misra, Jonathan Oluranti and Ravin Ahuja

Abstract Social media is a famous method for communication and entertainment not only among the younger generation but also older ones. The social media applications such as Facebook, YouTube, Twitter, WhatsApp and much more are used by the users of all age groups. However, the excessive use of social media can affect the work performance of the people. This paper presents a survey, which was conducted on the low literate adults of Pakistan, in regard to social media usage and their work performance. This survey also explored which social media application is more frequently used and what factors affect their work performance other than social media usage (SMU). This survey conducted on 111 illiterate participants then descriptive statistics were used to examine the average number of hours that they spent on social media applications. Also, the effects of these applications on the work performance of participants were measured. The results demonstrated that there is no linear relationship between social media usage and work performance. Furthermore, the study highlighted that health issues, workload and political talks have been major factors that affect their work performance other than SMU. In addition, future research directions and study limitations are discussed.

Keywords Social media · Low literate · Platform · Entertainment · Communication · Applications

N. Rafique · A. Ishaq · M. Shoaib
The University of Lahore, Lahore, Pakistan
e-mail: 90naila@gmail.com

A. Ishaq
e-mail: adeed.cs@gmail.com

M. Shoaib
e-mail: mshoaib.cs@gmail.com

S. Misra (✉) · J. Oluranti
Covenant University, Ota, Nigeria
e-mail: sanjay.misra@covenantuniversity.edu.ng

R. Ahuja
Shri Vishwakarma Skill University, Gurgaon, India

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_43

1 Introduction

Social media is the most important platform in this modern era for communication, entertainment, learning and so on. The social media usage (SMU) has a vast range of users including children, teenagers, adults and older adults [1]. For social interaction, social media (SM) is the main part of the social lives of adults. They commonly use SM to make new friends, make relationships and share their feelings with them [2, 3]. Giles et al. [4] focused upon the online first impression of a person by viewing their personal profiles including avatars and descriptions.

Adults mostly make friends on SM applications whom they find similar to their own self [5]. Social network sites (SNS) are the most common way of communication nowadays. Capra et al. [6] in 2013 revealed that 88% of the people have mostly two accounts, one for personal use and others for work [7]. Nouwens et al. in 2017 found that users of SM apps are very conscious about selecting the appropriate apps [8]. Some of the adults use these applications not only as a source of social interaction but entertainment also [9]. Many users take interest in news, and for this reason, they mainly focused upon such types of platforms on SM. The adolescents were concerned about the authentication and preciseness of news apps [10]. Chung et al. examine the interaction and influence of online news on media organizations and other readers [11]. The main purpose of the current study is to observe the usage of social media applications on low and illiterate Pakistani adults. A survey is conducted, and both qualitative and quantitative data are collected. Also, the questionnaire was made in English as well as with its translation into Urdu. This made it understandable to candidates of our survey. An instructor was provided to illiterate participants to fill up the questionnaire especially to get qualitative data. We also find out which most popular social media applications among them are and the other factors which affect the work performance of these adults.

In the remaining paper, Sect. 2 describes the related work, Sect. 3 explains the methodology and participants' demographic analysis, and Sect. 4 expresses the results and discussion on our findings. The rest of the paper presents the conclusion and direction for future work.

2 Related Work

According to the Global Digital Statistics (2014), 41% of the total population, i.e. 2.95 billion people are active Internet users. With 2.30 billion diffusions of active social media users among which the number of people who use social media applications through their mobile devices is 1.56 billion. People use social applications that are used by millions of people all over the world for multiple purposes regularly [12, 13]. In the academic area, the social media platform has its own impotence [14], and it is also thought to be the reason for disturbance and divergence from their studies [13]. In [15], Ali et al. surveyed the distractions and highlighted the factors that take the attention of the students away from the studies. They took interviews from students and concluded the factors that have major effects were social influences, psychological characteristics, information quality and usefulness of the system.

Alwagait et al. [12] conducted a study on the engineering students of Saudi Arabia University. They found that the Twitter SM application was the most popular, and there was no linear relationship between SMU and GPA score a week. The concept of social media multitasking has also been increased widespread [16]. The most frequent users are children; they excessively use electronic devices like tablets and smartphones. Most toddlers do extreme usage of social networking sites including YouTube. In [17], Nikken et al. investigate the usage of electronic screens ownership in relationship to media skills of the child. Ourdi et al. [18] in 2016 conducted a study regarding the adoption of technology and social media in employee's recruitment and selection in Central and Eastern Europe (CEE). Another study by Tajudeen et al. [19] provides an understanding of the benefits of SMU to organizations along with its financing justification by organizations. In 2015, the ethnographic study was conducted among the low literate adults in India by Krish Pushtak [20]. In this study, the researchers deployed a social network mobile application with audio-visual features for farmers in rural areas.

3 Methodology and Participants' Demographic Analysis

In this study, we have surveyed the low literate adults and their social media usage duration. The data were collected through a questionnaire comprising twenty-five questions (quantitative along with qualitative). The questions were according to the main objective of the study. All the participants were given a questionnaire to fill up with an instructor because most of them were illiterate and were not eligible to read and write the questionnaire. These participants were given maximum time and a relaxed environment to fill the questionnaire. They were free to ask any question to the instructor which they did not understand. The questionnaire was filled with 90 males and 21 females adults who were employed. For the users of social networking sites (SNSs), we have created a scale for motivational predictors of communication and information. A Likert scale used was between "strongly agreed = 5" and "strongly disagreed = 1". A total of 111 participants from different regions of Pakistan were selected for this survey. Most of the participants were illiterate to whom we provide an instructor. The main purpose of the instructor is to let them understand the questionnaire. They also filled the questionnaire on behalf of such participants. We divided the participants into three age groups 14–20, 21–30 and 31–35 years. Table 1 shows the complete details of the participants.

Table 1 Demographic information of participants

Demographic information	Variables	Frequency	Percentage (%)
Age	14–20 years	30	27.02
	21–30 years	59	53.15
	31–35 years	22	19.81
Gender	Male	90	81
	Female	21	19
Qualification	Middle	79	71.2
	Primary	30	27.0
	Less than primary	2	1.8
Occupation	Government employee	23	20.70
	Private employee	76	68.50
	Retired	2	1.8
	Business	10	9.0
Monthly income	Below 5000	22	19.81
	5000–10,000	16	14.4
	10,000–15,000	26	23.42
	15,000–20,000	26	23.42
	Above 20,000	21	18.91
Phone set	Smartphone	80	72.1
	Keypad phone	31	27.9

4 Results and Discussion

In this study, we use a Likert scale to measure the time consumed by social media applications based on the age factor of the participants. Mostly, the participants express that social media usage does not affect their work performance. Figure 1 shows the variation between Likert scale points, according to the participant's age factor.

The most frequently used social media application is Facebook with a percentage of 48.99% after that WhatsApp is used by 23.33% and YouTube by 13.27%. Only 2.78 and 3.26% of participants use Twitter and Instagram. Figure 2 results indicate

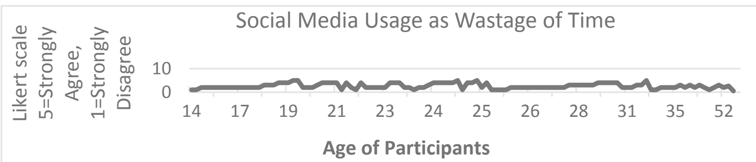


Fig. 1 Analysis of social media usage as wastage of time

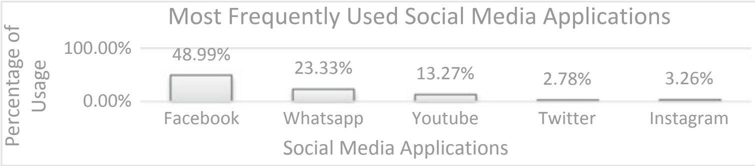


Fig. 2 Most frequently used social media applications

that the most popular social media applications among low and illiterate people are Facebook, WhatsApp and YouTube.

Most of the low literate people use social media applications for entertainment purposes, almost 37.89. 16.23% of them consider these applications as a good source for communication and 16.84% used for news updates. For social interaction, 6.22% of people use SM applications and only 2.30% use them for taking health tips and information. The main purpose of social media usage by low literate people is shown in Fig. 3.

Figure 4 shows the more time-consuming social media applications as Facebook 52%, YouTube 15%, WhatsApp 11%, Twitter 10.45% and Instagram 11.56%. The most time-consuming social media application is Facebook where the least time is Twitter.

A study was conducted which revealed the opinion of 98 participants that having strong self-control helps them to enhance their work performance. It is also found that 102 participants agreed on the argument that social media applications pay a vital role to distract them during working hours. The distraction factors other than

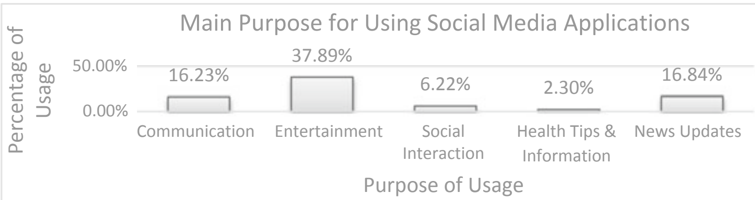


Fig. 3 Main purpose of using social media applications

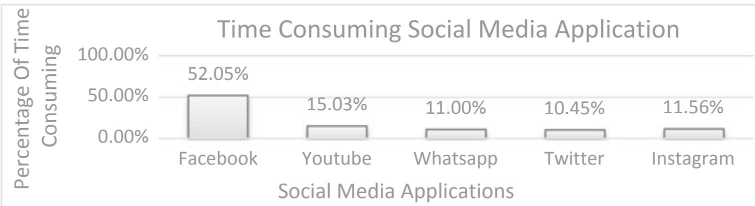


Fig. 4 Time-consuming social media applications

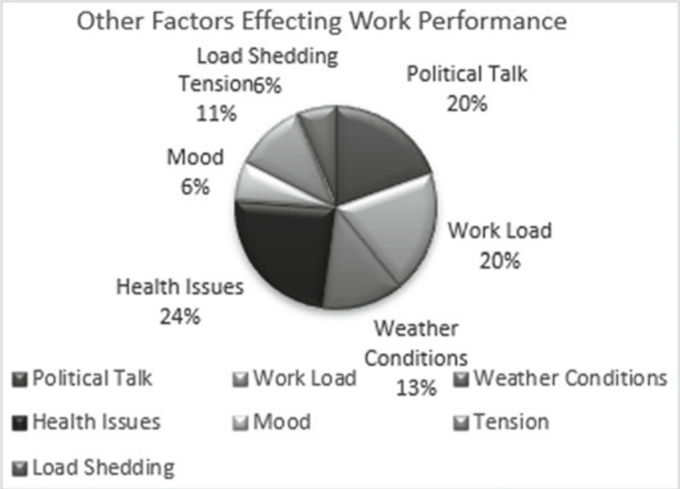


Fig. 5 Factors other than SM effect work performance

social media usage that affect the work performance of low literate adults are found in this study. Pie chart (Fig. 5) was plotted which revealed that most leading factors were health issues, workload and political talks with colleagues. Weather conditions, tension, load shedding and mood effect less than leading factors.

5 Conclusion and Future Work

This study emphasizes the social media usage and its effects on the work performance of the low and illiterate adults of Pakistan. Social media usage does not affect negatively the work performance of illiterate adults. There are various factors other than SMU such as health issues, workload and political talks that have a negative effect on participants' work performance. Furthermore, Facebook is a more time-consuming and more frequently used social media application. Also, many of the low literate people use social media applications for entertainment purposes only. Participants having strong self-control of not using the SM applications give better work performance than others.

References

1. Al-rahmi WM, Othman MS, Musa MA (2014) The improvement of students' academic performance by using social media through collaborative learning in Malaysian higher education. Asian Soc Sci 10(8):210

2. Kumar R, Kumar S, Misra S, Damaševičius R, Maskeliūnas R (2019) Distributed centrality analysis of social network data using MapReduce. Algorithms 12(8):161
3. Behera R, Rath S, Misra S, Damaševičius R, Maskeliūnas R (2017) Large scale community detection using a small world model. Appl Sci 7(11):1173
4. Bacev-Giles C, Haji R (2017) Online first impressions: person perception in social media profiles. Comput Hum Behav 75:50–57
5. Postmes T, Spears R, Lea M (1998) Breaching or building social boundaries? Side-effects of computer-mediated communication. Commun Res 25(6):689–715
6. Capra R, Khanova J, Ramdeen S (2013) Work and personal e-mail use by university employees: PIM practices across domain boundaries. J Am Soc Inform Sci Technol 64(5):1029–1044
7. Cecchinato ME, Sellen A, Shokouhi M, Smyth G (2016) Finding email in a multi-account, multi-device world. In: Proceedings of the 2016 CHI conference on human factors in computing systems. ACM, pp 1200–1210
8. Nouwens M, Griggio CF, Mackay WE (2017) WhatsApp is for family; Messenger is for friends: communication places in app ecosystems. In: Proceedings of the 2017 CHI conference on human factors in computing systems. ACM, pp 727–735
9. Chen B, Bryer T (2012) Investigating instructional strategies for using social media in formal and informal learning. Int Rev Res Open Distrib Learn 13(1):87–104
10. Sundar SS, Knobloch-Westerwick S, Hastall MR (2007) News cues: information scent and cognitive heuristics. J Soc Inf Sci Technol 58(3):366–378
11. Chung M (2017) Not just numbers: the role of social media metrics in online news evaluations. Comput Hum Behav 75:949–957
12. Alwagait E, Shahzad B, Alim S (2015) Impact of social media usage on students academic performance in Saudi Arabia. Comput Hum Behav 51:1092–1097
13. Giunchiglia F, Zeni M, Gobbi E, Bignotti E, Bison I (2017) Mobile social media and academic performance. In: International conference on social informatics, Springer pp 3–13
14. Al-Shdayfat NM (2018) Undergraduate student nurses' attitudes towards using social media websites: a study from Jordan. Nurse Educ Today 66:39–43
15. Ali M, Yaacob RAIBR, Endut MNAAB, Langove NU (2017) Strengthening the academic usage of social media: an exploratory study. J King Saud Univ-Comput Inf Sci 29(4):553–561
16. Lau WW (2017) Effects of social media usage and social media multitasking on the academic performance of university students. Comput Hum Behav 68:286–291
17. Nikken P, Schols M (2015) How and why parents guide the media use of young children. J Child Fam Stud 24(11):3423–3435
18. El Ouirdi M, El Ouirdi A, Segers J, Pais I (2016) Technology adoption in employee recruitment: The case of social media in central and Eastern Europe. Comput Hum Behav 57:240–249
19. Tajudeen FP, Jaafar NI, Ainin S (2018) Understanding the impact of social media usage among organizations. Inf Manag 55(3):308–321
20. Medhi-Thies I, Ferreira P, Gupta N, O'Neill J, Cutrell E (2015) KrishiPustak: a social networking system for low-literate farmers. In Proceeding of the 18th ACM conference on computer supported cooperative work & social computing. ACM, pp 1670–1681

A Comparative Analysis on Rumor Microblogs Detection from Social Network Sites

Abdul Rahiman and Syed Abdul Sattar

Abstract Social media platforms had emerged as a new trend of spreading of news and events, easy to access and relatively cheap. Subsequently, spreading of falsify information may lead to the emergence and spread of rumors that leads toward serious damage to government and private sector, adversely affecting the business market and society. To overcome, there is an immense necessity to build models for detecting rumors as early as possible before they extensively spread viral in the society. The earlier models which were developed till now detect predefined rumors and are not effective in predicting the new emerging rumors. This paper illustrates a brief literature review on rumor detection models that were proposed earlier for social networking sites. Further, the pros and consequences of each of the paper are thoroughly discussed, and suggestions were given for improving the existing rumor detection models. Many of the rumor detection models utilize data mining techniques, SVM technique, random graph theory models, RNN model, CRF classifier, semantic graph structures, propagation tree structures, propagation structures and others. It is suggested that rumor models can be improvised by embedding of predefined logical rumor rules and semantic ontology instead of lying on one specific technique. Recently, researchers put forth efforts to build models to effectively detect fake rumor messages in social communities.

Keywords Rumor detection · Social media · RNN model · Semantic web ontology · Predefined logical rumor rules

---

A. Rahiman (✉)
Research Scholar, Department of Computer Science, Rayalaseema University, Kurnool, Andhra Pradesh, India
e-mail: reachrahmist@gmail.com

S. A. Sattar
Department of Computer Science, Nawab Shah Alam Khan College of Engineering & Technology, Hyderabad, India
e-mail: principal@nsakcet.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_44

1 Introduction

Rumor dissemination becomes very common in the real world. In early days, the main source for the rumor spreading is "word of mouth." Rumors not only cause social panic but also may cause sudden incidents and affect social stability. So, finding the source of rumor and preventing it to propagate at the initial stage will help in preventing damages in society. The identification of rumor words in social networks is the basis for detecting the source of rumor. The existing works mainly detected rumor by analyzing only shallow features of messages. In many cases, it is not satisfactory in differentiating rumor message from normal message. Earlier, several methods are used with the combination of shallow features and implicit features of messages in order to identify the rumor message with efficiency. Most of the previous studies in social network sites to detect rumor words are unattended. In our research work, we would like to detect rumor words from the microblogs in social network sites. Many studies ignore the embedding of ontology to detect rumors from instant messages.

2 Rumor Description

Social media platform are increasingly used by people to follow newsworthy events because it is fast, easy to access and relatively cheap. The continuous increase in use of social media for sending the information in the form of news may leads towards the spread of rumors which may cause serious damage for the international peace. So, it is necessary to have an effective system for detecting rumors as early as possible before they widely are spread. To detect rumors from social media, first we need to study psychology of rumor. Then based on features and characteristics of rumor, we can make effective system that detects rumor as suggested in the literature [1–4].

Rumor:
Primarily rumor is a false story or message whose truth value is unverified at the time of posting. This unverified information may be true, or partially true or entirely false. Even, sometimes it may also remain undecided. Rumor is defined in different ways in the past literature. Broadly, rumors are classified as general rumors, objective rumors and subjective rumors.

General Rumor:
The information circulating in social networks, whose genuineness is not verified, is called as general rumors. General rumors are frequently used in monitoring public opinions toward controversial stories on social media.

Objective Rumor:
The unauthorized news which is circulated through social media is named as fake information; it is labeled as a rumor [5], called as objective rumor or false

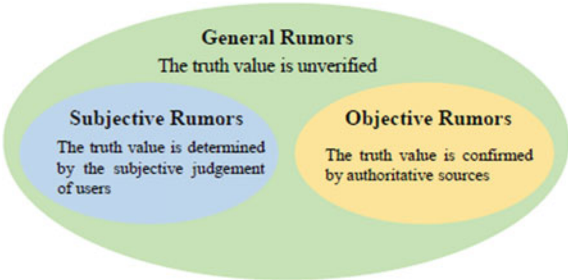


Fig. 1 Three definitions of rumors and their relationships

rumor. Rumors with objective confirmation are extensively used for automatic rumor detection.

Subjective Rumor:

The sentiment polarity of a statement in social networks is defined as rumor, based on people's subjective intentions [1], called as subjective rumor. This is used to understand user's behavior. The various definitions of rumors are depicted in Fig. 1.

Definition for Rumor Detection:

In general, the word "rumor" is defined as a particular news story **e** with its message set **M** and user set **U**; the rumor detection task will determine whether the story is true or false using the prediction function $F(e) \rightarrow \{0, 1\}$; here, if e is 1 (one), then the story **e** is a rumor, otherwise it is not a rumor.

Types of Rumors:

Many different factors are available for classifying rumors by types as based on its veracity value (true, false or unverified), and based on credibility (low or high). Knapp et al. (1994) had classified the rumors into three types: (1) "pipe-dream" rumors (2) "bogy" rumors (3) "wedge-driving" rumors. According to rumor classification system, rumor was classified as (1) priori rumor (2) new emerging rumor. Most existing methods detect a priori rumor, where rumors are well classified using predefined rumors; then, classifier can separate posts based on keywords of predefined rumors. In this section, we have elaborately discussed the classification of various types of rumors and its impact on society.

3 Literature Survey

Rumors have been a hot subject in many disciplines; research on identifying rumors from online social media through computational methods has begun recently. In the beginning rumor detection is carried out by defining classifiers. Developing model to determine rumors automatically becomes a more challenging problem than the priori rumor detection. Here, we present different existing rumor detection models in social media. Qazvinian et al. [6] have presented a general framework which expects whether a given statement belongs to rumor related or not. When such rumor related words are identified then such users are put under the rumor category. They mainly explored the effectiveness of three categories of features (1) content-based, (2) network-based and (3) twitter-specific memes for finding rumors. Their model is effective to priori rumors, and it is not effective for new emerging rumors. Takahashi et al. [7] defined a structure that finds rumor candidates from twitter. They have found two categories of rumors pertaining to earthquake disaster and found that "When people re-tweets a re-tweeted tweet, has higher likelihood of being a rumor comparing with their followings tweets". They presented that after correcting tweet posted about a rumor, the corrected post will spread faster than rumor. They proposed that the higher value of re-tweet ratio can be a clue to find rumor. The detailed survey of various techniques used for detection of rumors is discussed in Table 1.

4 Comparative Analysis

The modern social media evolved rapidly and attracted huge followers within a short period of time. The basic form of this is social networks, where the users are allowed to create their specific Web pages and can be connected with their friends to share content and interact with each other. The major problem of social media is spreading information irrespective to the credibility of the information, which causes the main challenge of information reliability assurance. Without verifying, the information would reach thousands of users immediately and cause serious damages. To tackle with problem of rumors detection in social media, many researches had been done.

The aim of rumor detection in social media is to categorize whether a message posted on social media sites is a rumor or not depending on its relevant information, such as text content, comments, repost patterns, user profile and so on. Based on the types of information and methods used, [16] divided into three categories (1) traditional classification methods using artificially designed feature (2) deep neural networks related methods (3) propagation mode-based methods. Castillo et al. [17] design various types of features to evaluate the credibility of a message on specific topics. Yang et al. [18] introduced additional client-based and location-based features to identify rumors in SinaWeibo. Kwon et al. [19] employed temporal, structural and linguistic features to improve the performance of rumor detection. Liu et al. [20] proposed verification features by treating the crowd's contradictory beliefs as their debates on veracity. Traditional classification methods are usually designed for specific scenarios, so they cannot be easily generalized for other applications. Some proposed deep neural network methods to detect rumors efficiently; Ma et al. [21] utilized various recurrent neural networks (RNN) to model the repost sequence. Yu et al. [22] employed convolutional neural networks (CNN) on the repost sequence to capture the interactions among high-level features. Ruchansky et al. [23] proposed a model that combines three characteristics: the text of an article, the user's response and the source user's information promoting. Song et al. [16] proposed a model to classify a microblog into rumors or facts according to its repost sequence. Ma et al. [24] proposed classification of propagation trees to calculate the similarities between

Table 1 Techniques used for detection of rumors

Sl. No.	Title	Objective	Strategy/technique	Remarks
1	Automatic rumor detection on microblogs: a survey [8]	Presented different rumor detection models in three paradigms	Survey paper on rumor detection methods	Suggested different methods for future work on rumors detection in microblogs
2	Detecting root of the rumor in S N GSSS [9]	Identifying root of the rumor that spread in the social network in wider range	Nodes monitoring to record the data and report it to the server. GSSS improve the efficiency for rumor detection	The experiment result shows that it can reduce 80–95% of the root of the rumor in social networks in dynamic time varying network topology
3	Exploiting context for rumor detection in social media [10]	Compared the novel approaches using CRF that learns from the sequential dynamics of social media posts with the current state-of-the-art rumor detection system	Exploits context learning during the event to detect the rumors	It needs to develop tools that can aid: (a) The detection of rumors (b) Determination of their likely veracity
4	Identifying influential rumor spreader in social network [11]	Identification of influential spreaders is a core issue of propagation and control on social networks	Based on the classical rumor model and combining one-to-many modes of propagation, it was investigated by Monte Carlo simulations when the spreading rate is small	Proposed model provide powerful theoretical support for controlling rumor propagation or enhancing information transmission

(continued)

the trees which will decide whether the message is rumor or non-rumor based on the structural, linguistic and temporal properties of the message. Zhao et al. [2] used the enquiring behavior of users from social media which tries to find whether the message is rumor or non-rumor. Wu et al. [25] proposed a model which uses the hybrid kernel SVM classification to detect rumors, which is the combination of CA—LPT and the random walk graph kernel. Zhanget al [26] presented the rumor detection as classification problem where features are extracted from different aspects using classifier. Here, they used implicit features of content and user to find the rumor

Table 1 (continued)

Sl. No.	Title	Objective	Strategy/technique	Remarks
5	Rumor analysis and visualization system [12]	The main four modules help to examine the three types of messages rumor, counter-rumor and uncertainty expressing messages in the wake of a rumor outbreak	Data crawling, data preprocessing, data analysis and visualization are the main functions of the proposed model	Future work can be done in the implementation of an integrated system in which the data stream can be interpreted, analyzed and visualized in real time
6	Detecting rumors in social media: a survey [13]	Survey paper on automatic identifying rumors from online social media Web sites especially in microblogging Web sites	Applied different rumor detection methods in three categories depending on the type of the machine learning they use	There is still an urgent need to expand the search to include many languages to improve the rumor detection process
7	Rumor detection from social media: a review [14]	Review paper on rumor detection	It consists of four things, rumor detection, rumor tracking, stance classification veracity classification	Existing rumor detection methods are not capable to process stream data efficiently
8	Rumors detection on social media during crisis management [15]	Proposed an approach for conflicting information and rumor detection on social media platforms	Used the semantic graph structures for information representation and graph matching algorithms for information fusion	The proposed approach will not work efficiently in the evaluation of large amounts of uncertain information

in the message. Nivetha et al. [9] implemented two-level framework to identify the rumors. The first level is injecting monitor nodes in the network to report the data they receive, and the second level is applying GSSS algorithm on it to identify the rumors.

5 Conclusion

Rumor spreading on social media could severely influence people's daily life. The research on automatic rumor detection attracts more and more attention. We have discussed different studies to improve the automatic detection of rumors. A main difficulty in collecting dataset is that rumor is that news which is debunked by authorities, the number of which is less than that of non-rumor samples. Few strategies make use of BuzzFeedNews, LIAR, BS Detector and CREDBANK are the datasets for detection of fake rumors using data mining techniques [27].

Apart from finding more efficient features, we have a main challenge which is the early detection of rumors. The life cycle of a story propagating on social networks is quite short; studies suggest that the life span of short posts is less than three days, and rumors become viral in seconds or minutes [28]. It is very important to detect rumors at their very early stage. The resource on the beginning of a rumor is such limited that it is very challenging to detect it at the early stage [29]. We plan to develop a rumor detection model named as RDM using predefined knowledge-based logical rules embedded with semantic Web ontology to overcome the flaws which were discussed in Sect. 3 [4].

References

1. Friggeri A, Adamic LA, Eckles D, Cheng J (2014) Rumor cascades. In: Proceedings of the eighth international AAAI conference on weblogs and social media
2. Zhao Z, Resnick P, Mei Q (2015) Enquiring minds: early detection of rumors in social media from enquiry posts. In: 24th international conference on WWW. ACM, pp 1395–1405
3. Jain A, Borkar V, Garg D (2016) Fast rumor source identification via random walks. Springer-Verlag Wien
4. Mahmood Ali M (2018) SDF: psychological stress detection framework from microblogs using predefined rules and ontologies. IJISAE 6(2):158–164
5. Wu K, Yang S, Zhu KQ (2015) False rumors detection on sina weibo by propagation structures. In: IEEE, ICDE
6. Qazvinian V, Rosengren E et al (2011) Rumor has it: identifying misinformation in microblogs. Edinburgh, Scotland, UK, pp 1589–1599
7. Takahashi T, Igata N (2012) Rumor detection on twitter. SCIS-ISIS, Kobe, Japan
8. Cao L, Guo J et al (2018) Automatic rumor detection on microblogs: a survey
9. Nivetha S, Priyadharshini R et al (2017) Detecting root of the rumor in social network using GSSS. Int Res J Eng Technol
10. Zubiaga A, Liakata M, Procter R (2017) Exploiting context for rumour detection in social media. Springer
11. Zhang R, Li D (2019) Identifying influential rumor spreader in social network
12. Pal A, Alton Y et al (2019) Rumor analysis & visualization system. In: Proceedings of the international multi conference of engineers and computer scientists
13. Samah M, Aqil AM (2018) Detecting rumors in social media: a survey. In: The 4th international conference on arabic computational linguistics
14. Lathiya S, Chaudhari MB (2018) Rumor detection from social media: a review. IJSR Comput Sci, Eng Inf Technol
15. Laudy C (2017) Rumors detection on social media during crisis management. In: Proceedings of the 14th ISCRAM Conference, Albi, France
16. Song C, Tu C et al (2015) CED: credible early detection of social media rumors. J Latex Cl Files 14(8)
17. Castillo C, Mendoza M, Poblete B (2011) Information credibility on twitter. In: Proceedings of WWW, pp 675–684

18. Yang F, Liu Y, Yu X, Yang M (2012) Automatic detection of rumor on sinaweibo. In: Proceedings of KDD
19. Kwon S, Cha M, Jung K, Chen W, Wang Y (2013) Prominent features of rumor propagation in online social media. In: Proceedings of ICDM, pp 1103–1108
20. Liu X, Nourbakhsh A, Li Q, Fang R, Shah S (2015) Real-time rumor debunking on twitter. In: Proceedings of CIKM, pp 1867–1870
21. Ma J, Gao W et al (2016) Detecting rumors from microblogs with neural networks. Twenty-fifth international joint conference on artificial intelligence (2016)
22. Yu F, Liu Q, Wu S, Wang L, Tan T (2017) A convolutional approach for misinformation identification. In: Proceedings of IJCAI
23. Ruchansky N, Seo S, Liu Y (2017) CSI: a hybrid deep model for fake news detection. In: Proceedings of 7 ACM on Conference on IKM, pp 797–806
24. Ma J, Gao W, Wong K (2017) Detect rumors in microblog posts using propagation structure via kernel learning. The ACL, pp 708–717
25. Cai G, Bi M, Liu J (2017) A novel rumor detection method based on labeled cascade propagation tree. In: 13th ICNC-FSKD
26. Zhang Q, Zhang S et al (2015) Automatic detection of rumor on social network. NLPCC, pp 113–122
27. Shu K, Sliva A et al (2016) Fake news detection on social media: a data mining perspective
28. Sahana VP et al (2015) Automatic detection of rumored tweets and finding its Origin. In: International conference on computing and network communications IEEE
29. Zubiaga A, Aker A et al (2018) Detection and resolution of rumors in social media: a survey. ACM Comput Surv 51(2), Article 32

Smart Sprint Methodology for Financial Management System Development

V. Dattatreya, K. V. Chalapati Rao and M. Raghava

Abstract Modern software development projects leverage the agile methodologies to deliver reliable and stable artifacts early. The project plan generation revolves around the complexity of use cases, technology stack, testbeds, and validations. In addition, the project plan under agile development strategies must help the sprint planner and developers to reduce iterations required to develop and deploy the product. However, the agile programming practices tend to translate into legacy waterfall model if the sprint planner is a novice on the project, technology stack and development plans leading to falling late in the pipeline. Hence, it is essential to draft a sprint plan in a futuristic and smart manner to reduce the risk of failure. This is possible, if the primitive code modules are raised to off-the-shelf projects. In this article, we propose two knowledge-driven plans to complement the agile strategy that avoids the necessity to freeze the fledgling user requirements, utilize the smart prototypes while generating sprints. We also propose a new capacity building strategy through cross-functional expertise and is demonstrated on reengineering of Financial Management Systems (FMS) maintained by Government of Andhra Pradesh.

Keywords Agile methodologies · Sprint · Project plan

1 Introduction

In the wake of disruptive technologies and automation, the software project planning is assuming new policies and methodology. For example, big data technologies are capable of dealing with volume, velocity, and veracity features of data, and a designer

V. Dattatreya (✉) · K. V. Chalapati Rao · M. Raghava
CVR College of Engineering, Ibrahimpatnam, Hyderabad, India
e-mail: v.dattatreya@cvr.ac.in

K. V. Chalapati Rao
e-mail: chalapatiraokv@gmail.com

M. Raghava
e-mail: raghava.m@cvr.ac.in

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_45

needs to master this technology to increase his potential. Similarly, the dashboard technologies, GUI with visual analytics, highly responsive and pervasive computing models, demanded to change the attention of programming aspects from server side to client side, profoundly in mobile applications. Given this scenario, there is an imperative need to restructure the existing software architectures using sophisticated API's and software packages. Tier-based application development projects can adopt conventional waterfall model, spiral model, and so on to develop large-scale applications. The project manager can write the requirements specifications, resolve dependencies, choose a suitable technology stack, design the modules and their interaction. And finally, the developers translate everything into functional code. Subsequently, code artifacts are thoroughly tested, based on the strategy evolved as decided by the nature of the project. Finally, the deployment models are planned and production maintenance is taken up. However, realization of all these principles takes a longer duration to complete individual phases and it is quite reasonable to follow the principle called Economy rule: "programmer time is expensive, conserve it in preference to machine time". The potential problem with this approach is maintainability. In a sense, if stakeholders add some new requirements to the existing project, then the manager becomes unable to add new requirements in production. These no-go scenarios lead to the evolution of agile development methodologies. The agile models are primarily designed to help a project to accept the request from the stakeholders and implement them quickly. In this strategy, the requirements are decomposed and added incrementally, facilitating faster project completion. Each iteration may take one or two weeks of time to complete the specified task along with a test case, verification, and validation steps, and together, we refer to them as scrum. Formally, scrum involves three phases mainly pregame, game, and postgame [1]. Pregame entails architecture and planning; game comprises sprints and scrum meeting. Postgame includes integration, testing, and release. By adopting this methodology, a team can deliver the working software in lesser time frames. Big companies generally deploy a large group of remote software developers. Agile methodologies involve contributing to the project development. If it is not so, it may lead to failure of the project due to lack of clarity in explaining the implementation details. Version survey results in 42 percent of the people [2] against agile core values. The highest proportion of developers feel that the expertise to change the organizational culture the main hurdle to promote agile adoption. Generally, in agile methodology, team member size is restricted to 10. An example of this is Amazon. This rule is called "Two-Pizza Team" [3]. Examples of failure agile projects are the UK government's welfare reform project by loosing £2.4bn revenue due to agile methods upon conducting a review by the National Audit Office (NAO). They indicate that this loss in revenue is mainly due to transparency and poor performance in solving the problems in the project. Another example of such failure is UK's Surrey Integrated Reporting Enterprise Network (SIREN) [4] which is a large-scale project and faces a loss of £15million. This is mainly due to requirements failure, clear demand, insufficient communication between the customer and technical persons in scrum methodology. Due to these issues, we propose two plans, viz. smart sprint plan and custom sprint plan to support the latest agile development methodologies.

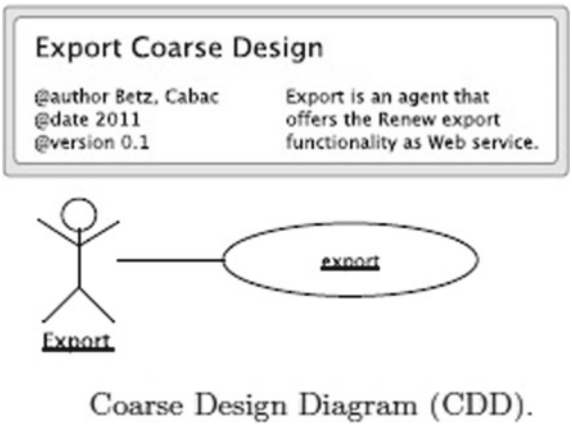
2 Petri Net-Based Agent-Oriented Software Engineering Approach (PAOSE) Approach

PAOSE uses Petri nets to represent multi-agent systems. Petri nets offer tools, methods, techniques, and built-in processes to execute the model. Multi-agent platform-based Petri net models use MULti-Agent Nets (MULAN) [5] framework to implement them. Mulan programs are executed in the reference net workshop integrated development environment (RENEW IDE). This IDE provides an essential set of tools for creating net instances, communication channels, and Java integration. PAOSE application uses coarse design diagrams (CDD). A CDD is typically utilized use case diagram but with distinct notations. Figure 1 shows the export service example. Figure 1 depicts one agent role (export). The CDD is used to generate a folder for the application containing templates.

3 Knowledge-Driven Sprint Plan

The user stories play an important role in project planning. Due to its basic nature, the user interactions suffer from semantic gaps and wrong interpretation of specifications. Many a time, the sprint planner who is generally a nontechnical guy, out of his freakish nature, tends to generate the project schedule in haste. Such a schedule if executed blindly, the development cycle suffers from many technical snags during the production phase. To mitigate the risk of low productivity, we propose the smart sprint planner (SSP) methodology, wherein a consultant, more often, utilizes the expertise of the project manager while generating sprints. And the deliverables of a sprint potentially become free from schedule slippage anomaly.

Fig. 1 Coarse design diagram [6]



3.1 SSP Specifications

We propose a Petri net-based modeling and code generation mechanism that run both the activities simultaneously and quickly. The following Petri net-based figure in Fig. 2 accommodates the designer in the pregame that improves the quality of the software architecture through utilizing the expertise of the designer on the process patterns. The subsequent game phase also gets simplified as the audit phase is driven by meaningful and quantifiable questions. This also helps in unfolding the latent design challenges and swiftly acting upon them through deliberations with a consensus. The game phase becomes a smooth and productive routine as confidence among the team members increases gradually through successful implementations of the design. This model has ideally suggested for startup companies, wherein the solution architect himself participates in user stories with the client. Such an interaction helps the sprint planner to generate effective sprints that reduce the iterations.

3.2 Custom Sprint Planner

In software industry, it is quite a common feature to designate professionals as consultants rather than the developers(e.g., Deloitte, MindTree, Accenture). These organizations interact with clients to implement a business model. However, the assigned consultant participating in the interaction is quite often a nontechnical person. His naive interpretations and evaluation of user requirements might lead to wrong tech-

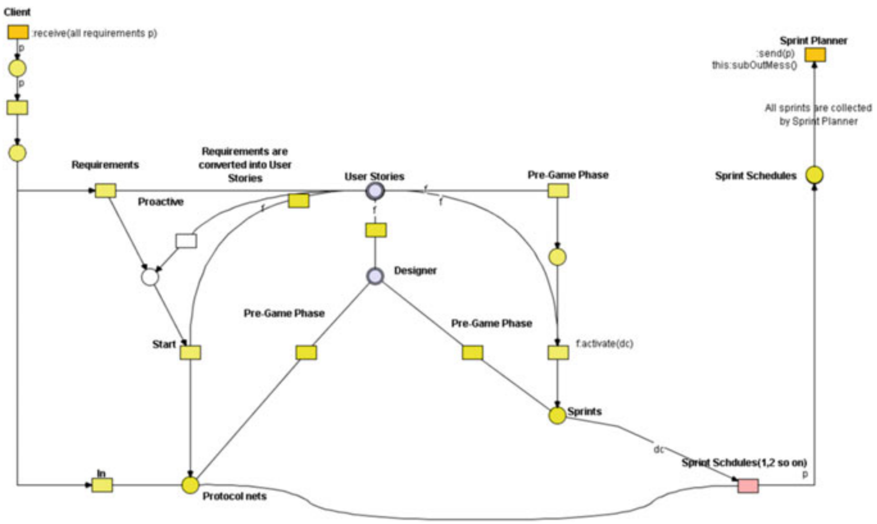


Fig. 2 Smart sprint planner

nology stack selection and improper sprint generations. If such an involuntary sprint is followed by the developer's team, the game phase of scrum model witnesses frequent team reorganizations, skill enhancement necessities, and even new design adaptations. Such a lengthy sequence of quality assurance steps redresses the poor design at the cost of schedule slippages which is undesirable and against the spirit of agile methodology. As a solution to mitigate that we propose custom sprint planner (CSP).

3.3 CSP Specifications

Nowadays, major software industries like Netflix, Amazon are implementing their projects through microservices. The microservices architecture is proposed by Martin Fowler [7] and Lewis in 2014. Microservices are autonomous, small, and defined clearly their purpose. Writing little programs for a large program is easy to debug and easy to integrate. The advantage of independent deployability leads to the continuous delivery of working software. In this architecture, all the tiny services will communicate with each other to implement a big system or service using URLs. We can create them using different programming languages and in different platforms. The microservices communicate with other microservice by using different URLs. Microservices enable rapid, frequent, and deliver large complex applications that are reliable. The output of one service is utilized by another service as an input in collaboration with other services. Because of their microsize, we can easily maintain and more fault-tolerant. Due to which the entire system will not breakdown. Microservices are an architectural pattern emerging out of service-oriented architecture (SOA), emphasizing self-management and its lightweight. Scalability, flexibility, and portability are key benefits of this architectural style. Microservices follow scalability; as each service is an independent component, we can scale up a single function or service without having to scale the entire application. By developing applications in smaller increments that are independently tested and deployable can be easily promoted in a quick manner. Microservices [8] use multipurpose teams and continuous delivery model to handle the complete life cycle of an application. The significant benefit of microservices is to design, develop, test, and subsequent release of service with great agility. Microservices are decentralized and decoupled into services that act as separate entities to implement an application. Microservice architecture [9] is a special design pattern of service-oriented architecture. The microservice architecture for FMS is shown in Fig. 3.

3.4 Refactoring Using Single-Page Application (SPA)

It is a Web application that collaborates with the user by rewriting the existing page rather than creating a new/modified Webpage from the server. In SPA, either the

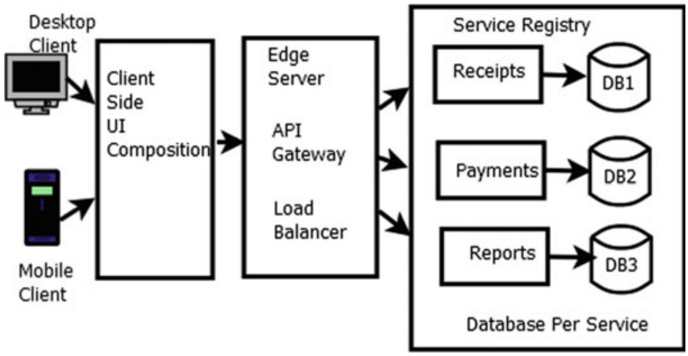


Fig. 3 FMS architecture using micro services

Webpage code is retrieved or the concerned resources are loaded. Interaction with the single-page application involves dynamic communication by using AngularJS and different databases.

4 Results

Implementation of Comprehensive Financial Management Systems (CFMS): Sprint-oriented CFMS is implemented using SPA. AngularJS performs as a client and Postgres as a database server. CFMS is designed to serve three modules: receipts, payments, and reports. First, we take into account receipts module, all the departments that take advantage of paying taxes to the government. SPA furnishes Webpage that no more transfer of data in multiple Webpages. On a single page, all appropriate data is filled by the department people. By doing this, the Web traffic is reduced substantially and system performance is increased. SPA in CFMS is a solution for both desktop and mobile by using bootstrap, Web services, and Ajax technologies. CFMS home page is shown in Fig. 4.

In receipt menu, item has department list. Each department is associated with service. The unique data item of head of account is based on department and service. Each unique DDO code is obtained by selecting the district, upon selecting district the drop-down box result district treasuries, upon selecting treasury code. After filling some credentials, the appearance of the screen is shown in Fig. 5.

The payment screen appearance after the user press SUBMIT Button contains remitter name field, address field, mobile field, amount field as shown in Fig. 6.

By clicking the payment button, the payment gateway of Andhra Pradesh Financial Services and Systems screen is displayed. This is shown in Fig. 7.

FMS payment module home page is shown in Fig. 8.

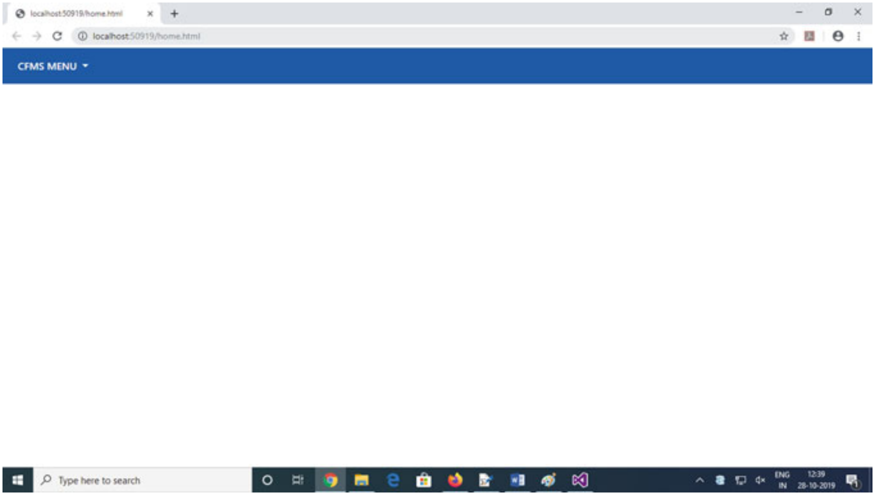


Fig. 4 FMS home screen

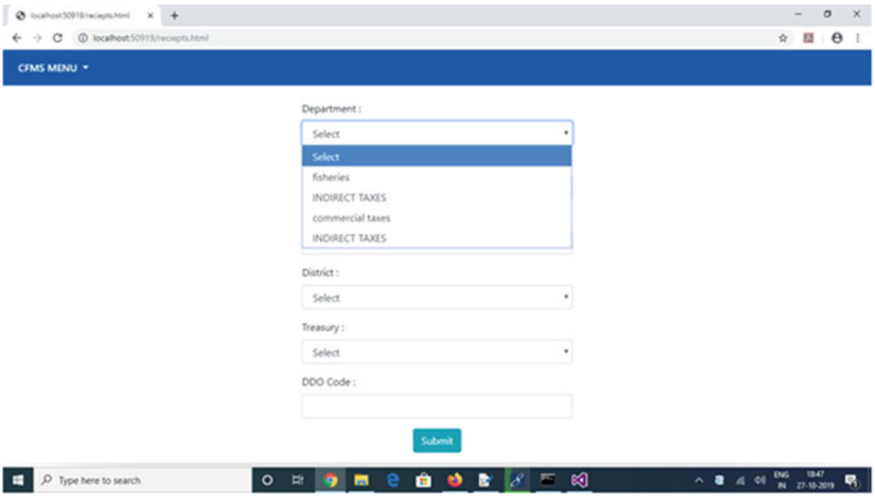


Fig. 5 CFMS receipts home page desktop version

People who are drawing scholarships/pensions should submit their credentials in the district treasury. In payments application of CFMS, we provide a search option for PPO number. In CFMS, we compare the PPO number in treasury with PPO number in the search box. If both match in all criteria, then the PFMS payment application will credit the amount to pension holders. If PPO Number is in a mismatch in any criteria, it will raise an error. This screen is shown in Fig. 9.

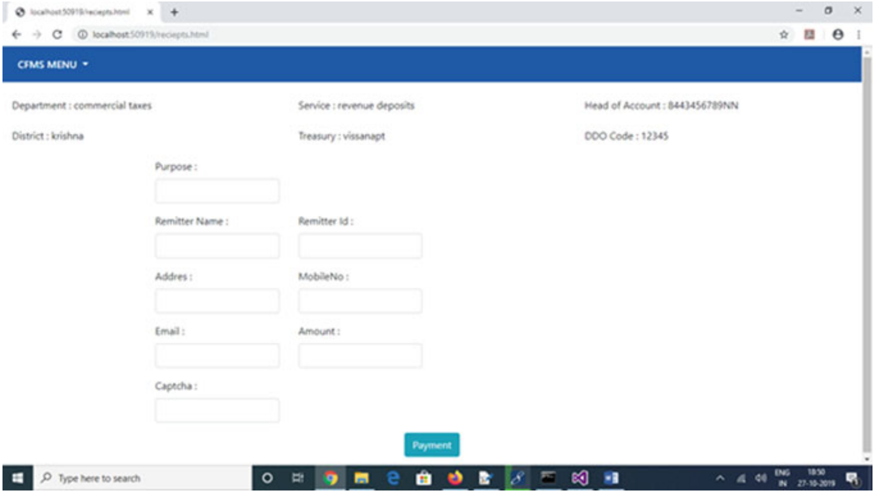


Fig. 6 CFMS receipts home page desktop version

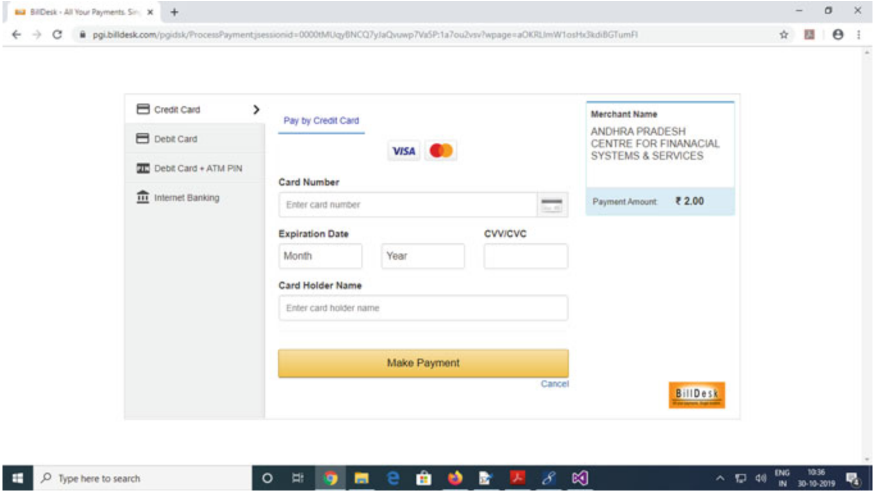


Fig. 7 CFMS receipts payment gateway desktop version

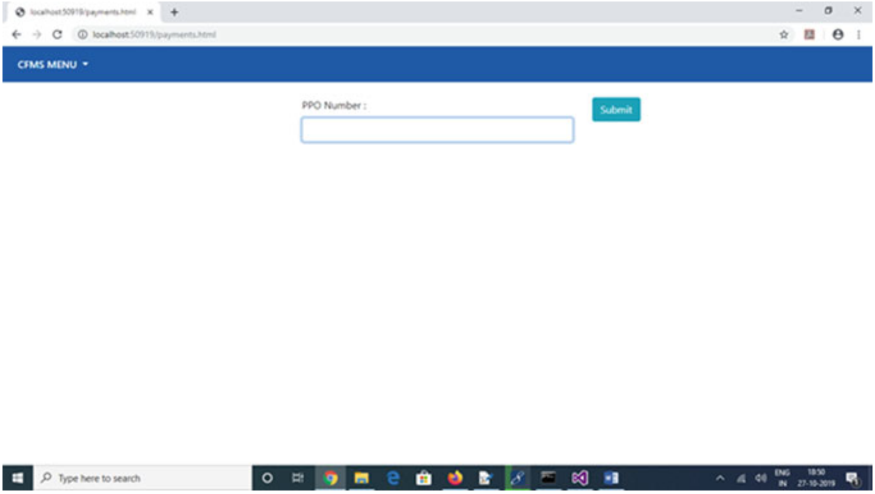


Fig. 8 CFMS payments home page desktop version

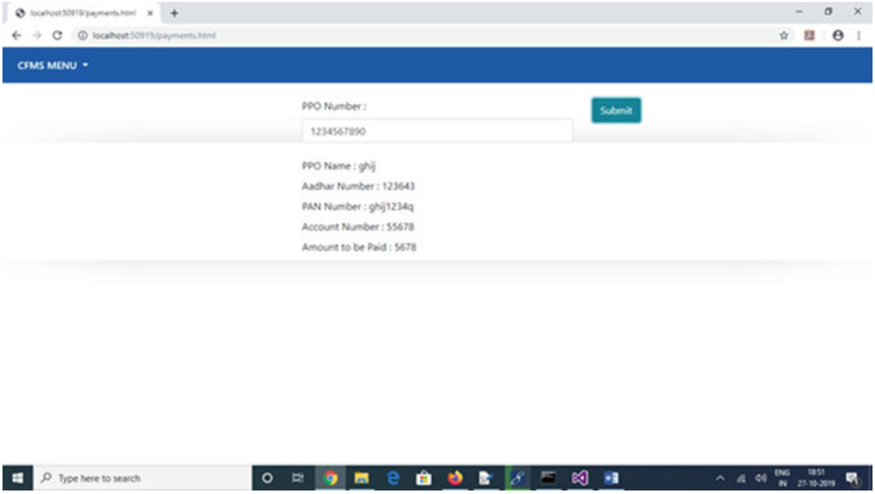


Fig. 9 CFMS PPO details screen

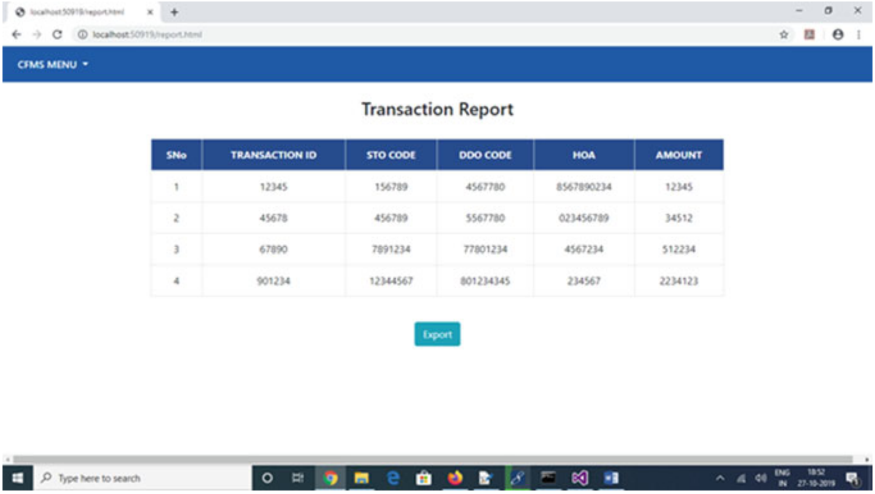


Fig. 10 Web view screen

4.1 Reports

In the reports module, we display three types of reports as given below.

WEB View
PDF View For all reports, we used SQL statement as input and the results from SQL query are stored in a tabular format and displayed in different formats. First is Web view; by executing SQL query, the database results are stored in HTML table and will be displayed in a Web browser. **Web View Scenario in** Fig. 10.

The results from SQL query are stored in PDF text cells and sent to a browser. PDF view and download of reports are shown in Fig. 11.

4.2 Receipts Mobile Version

In AngularJS, two types of display formats exist: one is desktop version and the other is mobile version. This feature is termed as responsive Web design. The desktop version to mobile version is by using responsive feature. Reports mobile version home page is shown in Fig. 12.

After filling receipt module credentials like department, service, head of account district, treasury code, etc, the appearance of the screen is shown in Fig. 13.

CFMS payments mobile version home page contains search option. We compare the PPO number in the district treasury database with PPO number in the search box. If both match in all criteria, then the PFMS payment application will credit

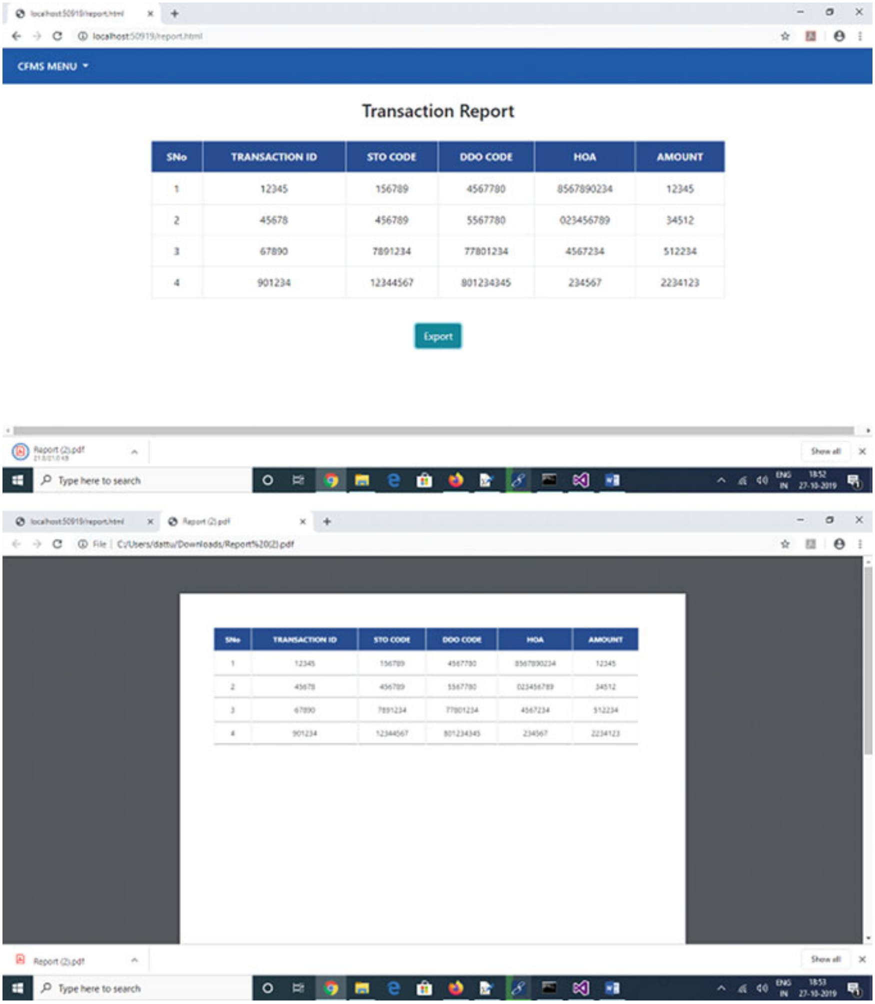


Fig. 11 PDF download and view screen

the amount to pension/scholarship holders. If PPO number is in a mismatch in any criteria, it will raise an error and is stored in a treasury log file. This is shown in Fig. 14.

In FMS reports module, the database query results are stored in newly created Excel file as columns data and the entire Excel Page with show/download options is shown in Fig. 15.

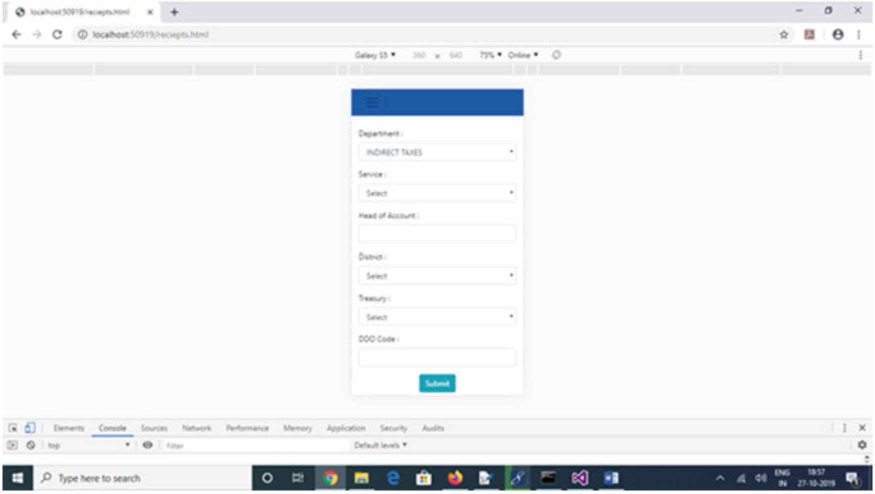


Fig. 12 CFMS receipts home page mobile version

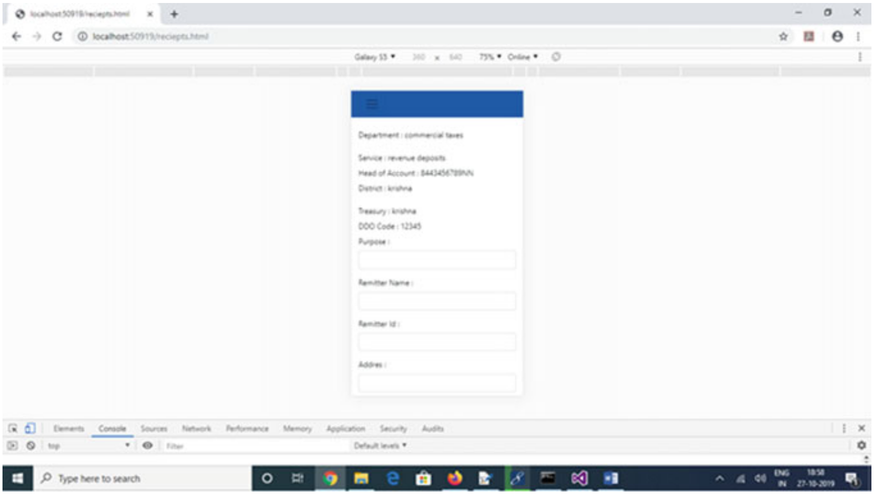


Fig. 13 FMS receipts payment screen

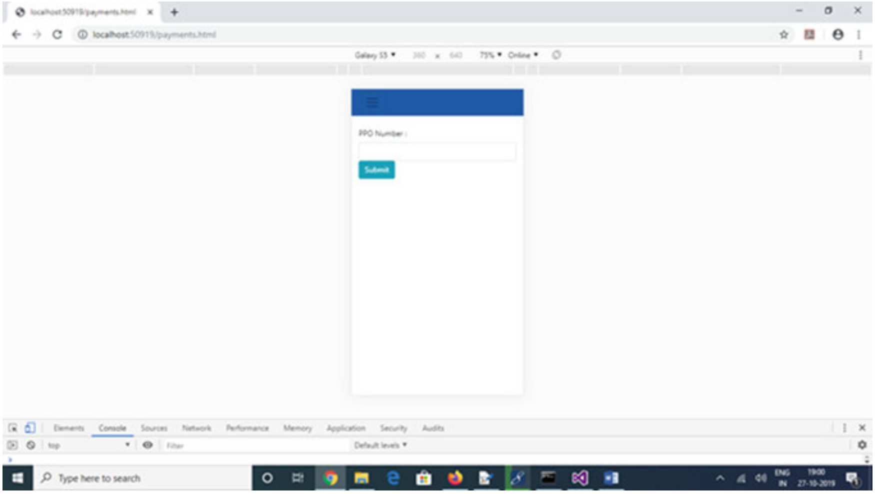


Fig. 14 CFMS payment mobile version screen

5 Conclusions

The paradigm shift in client–server implementation demanded reengineering of legacy systems. In this paper, we have adapted three enabling technologies catering to three layers of MVC architecture. The microservices, namely client-side UI composition, API gateway, and database per service, are successfully incorporated using smart sprint approach. The identified microservices stand as an example for customized sprints. In the future work, few more services such as shared databases and reliability features are planned.

Acknowledgements I would like to express my gratitude toward senior infrastructure manager V.M. Rayudu, APCFMS, for the encouragement which helped me in the completion of this paper. I am highly indebted to the management of CVR college of engineering, Hyderabad, for their support and guidance. I would like to express my special gratitude and thanks to my supervisor K. V. Chalapati Rao and Professor M. Raghava for imparting his knowledge and expertise in this study.

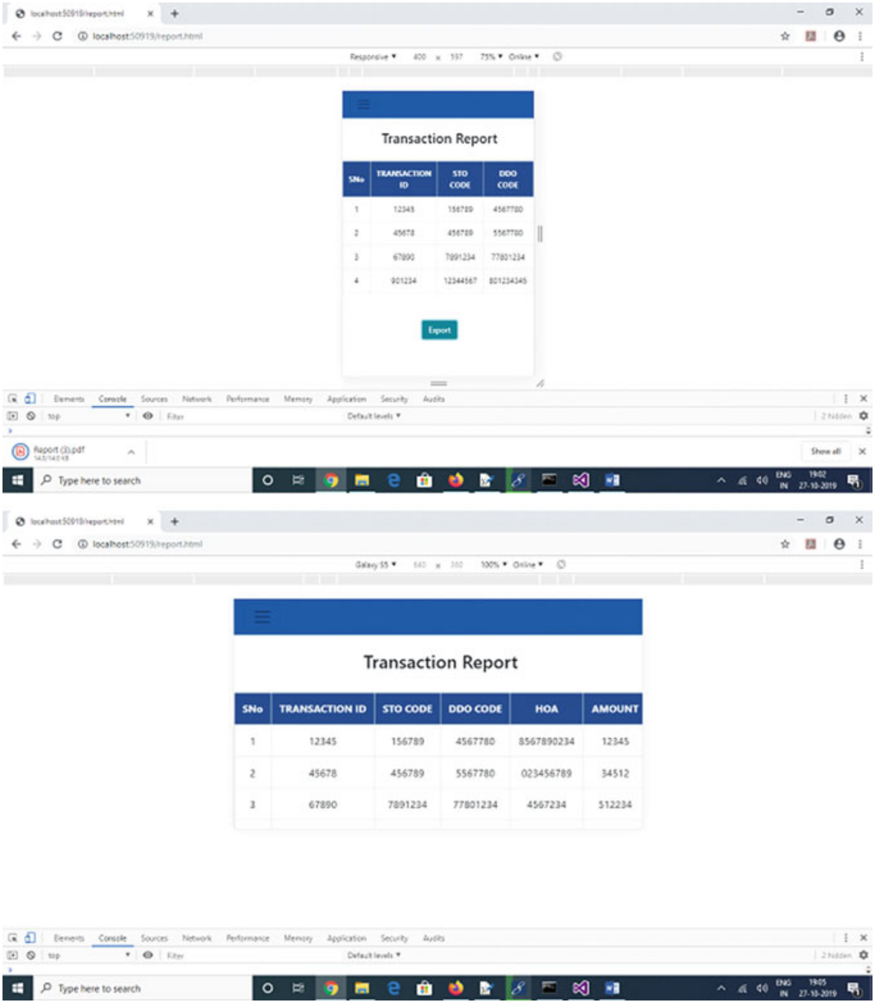


Fig. 15 CFMS mobile reports screen

References

1. Jenkins P (2019) Relax, it's a game: utilising gamification in learning agile scrum software development, pp 1–4. https://doi.org/10.1109/CIG.2019.8848104
2. https://www.watermarklearning.com/downloads/state-of-agile-development-survey.pdf
3. https://www.rd.com/food/fun/two-pizza-rule-work-hack/
4. https://www.cio.co.uk/opinion/digital-devolution/siren-call-of-unicorn-3648683/
5. Bendoukha S, Bendoukha H, Moldt D (2015) RenewGrass - a tool for building scientific workflows: application to the remote sensing domain. In: 2015 IEEE International Conference on Information Reuse and Integration, San Francisco, CA, pp 311–317

6. Cabac L et al (2018) Software development with Petri nets and agents: approach, frameworks and tool set. Sci Comput Program 157:56–70. https://doi.org/10.1016/j.scico.2017.12.003
7. Fowler M, Lewis J. Microservices architecture. Available Online: https://martinfowler.com/articles/microservices.html/
8. Viggiato et al (2018) Microservices in practice: a survey study
9. https://microservices.io/patterns/microservices.html

A Novel Infrared Image Segmentation Method for Identifying the Faults in the Systems

Manikanta Prahlad Manda, ChanSu Park, ByeongCheol Oh and Hi-Seok Kim

Abstract In recent years, infrared thermography can be used in detecting the failures or faults in the electrical and mechanical systems. Infrared image segmentation is one method for fault diagnosis of the electrical or mechanical systems. The authors propose an infrared image segmentation method for identifying the faults in the systems. The threshold value for the image segmentation has been calculated based on the concept of one-dimensional histogram approximation. The performance of the proposed method has been evaluated by testing the proposed method on the various infrared images, and we have obtained satisfactory results.

Keywords Infrared thermography · Faults in the electrical or mechanical systems · Image segmentation · Histogram approximation · Threshold value

1 Introduction

Image segmentation is a process of separating the foreground from the background of the image. Image thresholding is one of the techniques used for the image segmentation. The foreground and background of the image are separated based on the threshold value obtained in the image thresholding method [1]. Infrared (IR) imaging is useful in many applications such as military applications, industrial applications, and medical applications. Thermal infrared cameras are useful in detecting the infrared radiation emitted by the objects [2]. Thermal infrared cameras work based on the law of black body radiation. The thermal cameras observe the infrared radiation emitted by the objects and transform them into an electronic signal. The infrared images captured by the IR camera show abnormalities in the temperature of the objects [3]. Image segmentation is recognized as being the most important part of infrared image processing. This paper proposes a new image segmentation approach to detect the faults in the systems.

M. P. Manda · C. Park · B. Oh · H.-S. Kim (✉)
Department of Electronic Engineering, Cheongju University, Cheongju, South Korea
e-mail: khs8391@cju.ac.kr

R. R. Chillarige et al. (eds.), *Advances in Computational Intelligence and Informatics*, Lecture Notes in Networks and Systems 119,
https://doi.org/10.1007/978-981-15-3338-9_46

We propose an image thresholding method for infrared image segmentation. The threshold value is calculated by approximating the grayscale histogram of the image to the equation of a straight line. The proposed method is tested on various infrared images that include: faulty electrical systems damaged solar PV panel images and defective pipeline images. The experimental results of the proposed method are compared with the other thresholding methods such as the Otsu thresholding method [4], Li thresholding method [5], and Yen thresholding method [6]. Our method produced satisfactory image segmentation results. This paper is explained in the following sections. Section 2 gives a brief overview of the grayscale histogram of a digital image, intensity thresholding, and the concept of entropy. The proposed method for determining the threshold value for the image segmentation is explained in Sect. 3. Section 4 gives the experimental results of the proposed method. Conclusions are given in the final section.

2 Backgrounds

2.1 Histogram of an Image

The histogram of an image is a two-dimensional plot between the discrete gray levels and their corresponding pixel frequency [7]. The image in color domain is converted into grayscale image. Each gray value is represented with N bits (8 bits), and the image can be represented by L discrete gray levels (256 gray levels). The histogram of a digital image can be defined as,

$$h_i = n_i;\ i \in [0, L-1]$$

where n_i is pixel frequency associated with ith gray level [8].

2.2 Intensity Thresholding

The threshold value in image thresholding is a gray intensity value which converts the grayscale image into a binary image. Let $f(x, y)$ is a grayscale image where x and y represent the pixels position and $f(x, y)$ represents the grayscale value at the point (x, y) on the three dimensional plane of the image. Pixels in the image are represented by L gray levels in the grayscale image. The grayscale image is converted into the binary image based on the threshold value is defined as,

$$g(x, y) = \begin{cases} 0, & f(x, y) \le T \\ 1, & f(x, y) > T \end{cases} \quad (1)$$

Here, $f(x, y) \leq T$ represents background and $f(x, y) > T$ represents the foreground of the image for an image containing light objects on a dark background [2, 9].

2.3 Entropy

The unpredictable behavior of the histogram of a grayscale image is analyzed based on the concept of entropy [10]. The entropy of the grayscale image depends on the probability of the pixel frequency. The entropy H of the grayscale image is defined as,

$$H = \sum_{k=0}^{L-1} p_k \log_{\mathrm{e}}(1/p_k) \tag{2}$$

Here, p_k is the probability of the pixel frequency at gray level k.

3 Proposed Methodology for the Infrared Image Segmentation

In the proposed method, the threshold value for the image segmentation is determined by approximating some portion of the grayscale histogram of the image to a straight line. The straight-line equation can be plotted by using the maximum grayscale frequency $h_{\max}$ and the highest grayscale value $(L - 1)$. The original image has been converted to 8-bit grayscale image. This implies that the value of L is 256.

Let $i_{\max}$ is the grayscale value corresponding to the maximum grayscale frequency $h_{\max}$. Let h_{L-1} is the grayscale frequency corresponding to the grayscale value $L - 1$. The equation of the line between the points $(i_{\max}, h_{\max})$ and $(L - 1, h_{L-1})$ can be written as

$$h - h_{\max} = \left(\frac{h_{L-1} - h_{\max}}{(L-1) - i_{\max}}\right)(i - i_{\max}) \tag{3}$$

$$\frac{(h - h_{\max})((L-1) - i_{\max})}{h_{L-1} - h_{\max}} = (i - i_{\max}) \tag{4}$$

$$i = i_{\max} + \frac{(h - h_{\max})((L-1) - i_{\max})}{h_{L-1} - h_{\max}} \tag{5}$$

The threshold value T for the image segmentation is defined based on the entropy value as,

$$T = i_{\max} + \frac{(h - h_{\max})((L-1) - i_{\max})}{h_{L-1} - h_{\max}} \tag{6}$$

Equation 6 gives the expression of the threshold value for the image segmentation. The binary image based on the threshold value can be represented as,

$$g(x, y) = \begin{cases} 0, & f(x, y) < T \\ 1, & f(x, y) \geq T \end{cases} \tag{7}$$

In the proposed method, Eq. 7 has been used for the segmentation of the infrared images.

4 Experimental Analysis

The proposed method is tested on various thermal infrared images that are collected using the Google search engine. Infrared imaging can be used in identifying the faults and defects in the systems. EL1 and EL2 thermal infrared images show the faults in the electrical systems. The images SP1 and SP2 are thermal infrared images showing the leakage areas in the steam pipelines. The images PV1 and PV2 are example infrared images showing the solar photovoltaic (PV) panels containing failure areas.

4.1 Quantitative Analysis

The proposed method has been analyzed by comparing the image segmentation result with the ground truth image. For that, the threshold value for the ground truth image is selected manually. The results of the proposed method are analyzed via two quantitative measures: misclassification error (ME) [11] and peak signal-to-noise ratio (PSNR) [12].

The misclassification error (ME) is defined as

$$\mathrm{ME} = 1 - \frac{|B_G \cap B_R| + |F_G \cap F_R|}{|B_G| + |F_R|} \tag{8}$$

Here, B_G is the number of background pixels of the ground truth image, F_G is the number of foreground pixels of the ground truth image, B_R is the number of background pixels of the image segmentation result, and F_R is the number of foreground pixels of the image segmentation result, and the cardinality of the set is expressed using the symbol $|.|$.

The PSNR (in dB) is defined as

$$\mathrm{PSNR} = 10\log\left(\frac{(L-1)^2}{\mathrm{MSE}}\right) \tag{9}$$

Here, MSE is the mean squared error value of the image.

4.2 Results and Discussions

The image thresholding methods—Otsu method, Li method, and Yen method—have been considered in order to analyze the segmentation results of the proposed method. Figure 1 shows the segmentation results of the proposed method and the other image

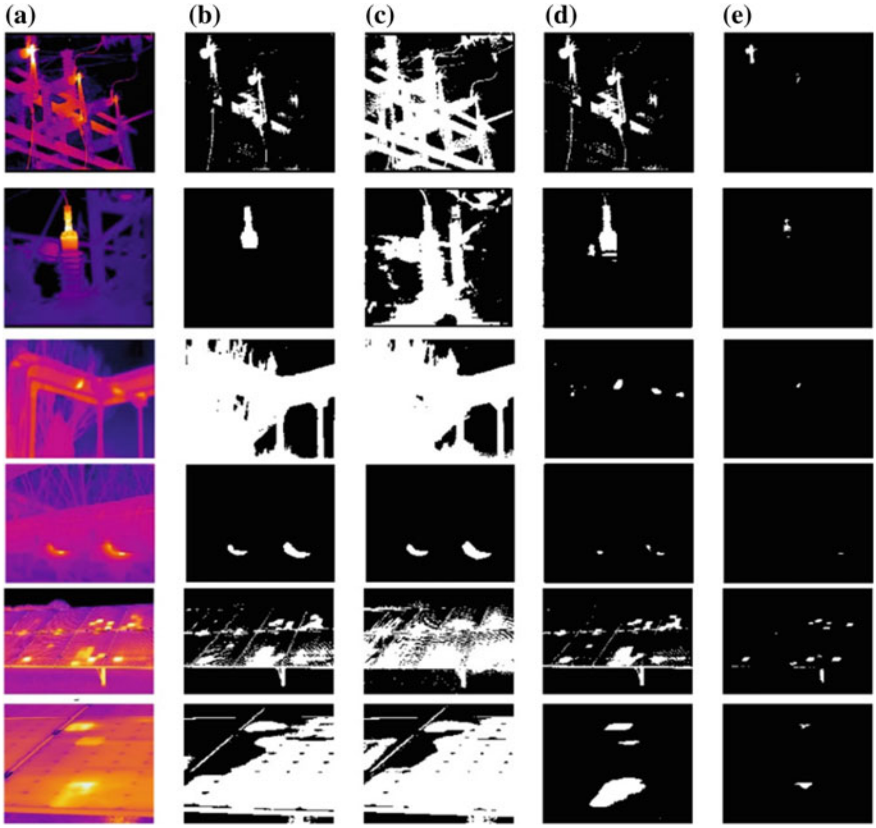


Fig. 1 **a** Original color image **b** results of Otsu method **c** results of Li method **d** results of Yen method **e** results of the proposed method

segmentation methods. The segmentation results of the Otsu method are shown in the second column, and the segmentation results of the Li method are shown in the third column of Fig. 1. For the most of the infrared images, both methods are failed to give authentic results. The segmentation results of the Yen method are shown in the fourth column of Fig. 1. As compared to Otsu method and Li method, Yen method produced valid infrared image segmentation results. The last column of Fig. 1 shows the segmentation results of the proposed method. Our method was successful in identifying the faults in the electrical system, in detecting the leakages in the steam pipeline, and in finding the defective areas in the solar PV panel. The performance measures of the different image thresholding methods are listed in Table 1. The best performances have been highlighted to emphasize the significant segmentation method.

Table 1 Performance evaluation

Image	Method				
	Ground truth	Otsu	Li	Yen	Proposed
EL1 *T* MSE PSNR	185	68 0.069 11.577	20 0.456 3.407	64 0.079 11.035	231.046 **0.004** **24.271**
EL2 *T* MSE PSNR	150	93 **0.008** **21.183**	20 0.323 4.903	47 0.018 17.374	238.427 0.011 19.550
SP1 *T* MSE PSNR	137	45 0.674 1.716	38 0.730 1.365	116 **0.004** **23.913**	230.5 0.007 21.31
SP2 *T* MSE PSNR	159	87 0.025 15.938	80 0.030 15.207	154 **0.000** **35.545**	232 0.002 27.551
PV1 *T* MSE PSNR	169	104 0.118 9.282	78 0.358 4.464	124 0.050 12.973	150 **0.035** **14.514**
PV2 *T* MSE PSNR	217	113 0.531 2.749	105 0.609 2.148	176 0.047 13.288	241 **0.013** **18.884**

5 Conclusion

We proposed a new and robust infrared image segmentation method for identifying the faults in the electrical and mechanical systems in this paper. The proposed algorithm is simple to implement, and we have obtained accurate quantitative results that show the significance of the proposed method for the segmentation of infrared images.

Acknowledgements The authors would like to thank the Ministry of Trade, Industry and Energy (MOTIE) and Korea Institute for Advancement of Technology (KIAT) for providing the financial support through the National Innovation Cluster R&D program (P0006704_Development of energy saving advanced parts).

References

1. Yu X, Zhou Z, Gao Q, Li D, Ríha K (2018) Infrared image segmentation using growing immune field and clone threshold. Infrared Phys Technol 88:184–193
2. Hristov NI, Betke M, Kunz TH (2008) Applications of thermal infrared imaging for research in aeroecology. Integr Comp Biol 48(1):50–59
3. International Energy Agency Photovoltaic Power Systems Programme (2018) Review on infrared and electroluminescence imaging for pv field applications International Energy Agency. Tech Rep IEA-PVPS T13-10:2018
4. Otsu N (1979) A threshold selection method from gray-level histograms. IEEE T Sys Man Cy SMC-9(1)
5. Li CH, Tam PKS (1998) An iterative algorithm for minimum cross entropy thresholding. Pattern Recognit Lett 19(8):771–776
6. Yen JC, Chang FJ, Chang S (1995) A criterion for automatic multilevel thresholding. IEEE Tran Image Proc 4(3):1–9
7. Ramesh N, Yoo JH, Sethi IK (1995) Thresholding based on histogram approximation. IEE Proc Vision Image Signal Process 142(5):271–279
8. Medina Caballero RD, Brizuela Pineda IA, Mello Román JC, Vázquez Noguera JL, Cáceres Silva JJ (2019) Quadri-histogram equalization for infrared images using cut-off limits based on the size of each histogram. Infrared Phys Technol 99:257–264
9. Umaa Mageswari S, Sridevi M, Mala C (2013) An experimental study and analysis of different image segmentation techniques. Procedia Eng 64:36–45
10. Naidu MSR, Rajesh Kumar P, Chiranjeevi K (2018) Shannon and Fuzzy entropy based evolutionary image thresholding for image segmentation. Alexandria Eng J 57(3):1643–1655
11. Parida P, Bhoi N (2017) Wavelet based transition region extraction for image segmentation. Future Comput Inf J 2(2):65–78
12. Elbayoumi Harb SM, Isa NAM, Salamah SA (2015) Improved image magnification algorithm based on Otsu thresholding. Comput Electr Eng 46:338–355