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RESEARCH INTERESTS

My current research projects focus on the applications of image processing, computer vision, machine learning, pattern recognition and mathematical modeling in biological and biomedical image analysis and informatics.

I have been developing algorithms for histological tissue images analysis for 11 years. My research includes developing automatic feature extraction and classification methods to solve object detection, object classification and image segmentation problems in histopathological tissue images.

PROJECTS' OVERVIEW

At [Computer Vision and Pattern Discovery \(CVPD\)](#) group of [BII](#), Singapore.

- Leading and co-developing projects (2021 onwards)
 - Automated histological tissue image based assessment for multiple cancers including Lung cancer (NSCLC) with Genome Institute of Singapore (GIS), Singapore General Hospital (SGH), and National Cancer Centre Singapore (NCCS).
 - AI Driven National Platform for CT Coronary Angiography for Clinical and Industrial Applications (APOLLO) with National Heart Centre Singapore, Institute for Infocomm Research (I2R), Institute of High Performance Computing (IHPC), Nanyang Technological University Singapore, National University of Health Sciences, and Tan Tock Seng Hospital (TTSH).
- Projects during PhD (2013-2017):
 - Automated nucleoli detection system for prostate/breast/kidney histopathological images with TTSH.
 - Automated gland segmentation system for prostate histopathological images with TTSH.
 - Automated grading system for kidney Histopathological images with Institute of Bioengineering and Nanotechnology (IBN, A*STAR), SGH, and NCCS for clear cell renal cell carcinoma (ccRCC).

At [Computational & Molecular Pathology Lab \(CMPL\)](#) of [IMCB](#), Singapore. (2018-2021)

- Developed an automated image processing pipeline to detect and quantify multiple immunophenotypes in histological prostate tissue samples with National University Hospital. Our pipeline integrates powerful image processing and machine learning methods to analyse histopathological tissue whole slide images (WSI) for tumor microenvironment quantification.

EDUCATION

Jan 2013 - Dec 2017	Ph.D. in Computer Science , School of Computing, National University of Singapore . Singapore. Thesis: Automated Image Based Tools For Digital Pathology. Research Area: Digital Pathology, Computer Vision, Machine Learning. Supervisors: Dr. Hwee Kuan LEE and Prof. Wing-Kin SUNG, Ken .
Jul 2008 - Jun 2012	B.Tech. in Information Technology (Hons.) , Indian Institute of Information Technology Allahabad . Prayagraj, India. Thesis: Speech Retrieval. Research Area: Speech Processing, Information Retrieval, Machine Learning. Supervisor: Prof. Uma Shanker TIWARY .

AREAS OF EXPERTISE

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- **Artificial Intelligence:**
Deep Learning, Machine Learning, Clustering, Pattern Recognition, *etc.*
 - **Computer Vision:**
Image Analysis, Image Segmentation.
 - **Software Engineering:**
Git, CI/CD development, Project Management and logistics.
 - **Medical Imaging:**
Digital Pathology problems of prominent nucleoli detection, gland segmentation, automated cancer assessment, multiplexed fluorescent immuno-phenotype quantification.

TECHNICAL STRENGTHS

Programming Languages	Python, Javascript, C, C++, R, Java.
Software Packages	MATLAB, \LaTeX , gnuplot, ImageJ, Oracle, iMovie, QuPath,
Libraries Explored	Docker OpenCV, TensorFlow, Keras, PyTorch, VTK, scipy, Pysim- pleGUI, Matplotlib, Pandas, Seaborn, Boost C++ library, Re- act.js, Node.js, Django.
Communication Languages	English (Advanced working proficiency), Hindi (native pro- ficiency).

WORK EXPERIENCE

Bioinformatics Institute (BII) , Singapore.	July 2023 - .
<i>Senior Scientist I</i> at the Computer Vision and Pattern Discovery (CVPD) group of BII , Singa- pore.	
Yong Yoo Lin School of Medicine, NUS , Singapore	January - April 2024.
<i>Invited Lecturer</i> for PHM5005 - AI and Machine Learning for Precision Medicine .	
Bioinformatics Institute (BII) , Singapore.	April 2022 -June 2023.
<i>Senior Post-doctoral Research Fellow</i> at the Computer Vision and Pattern Discovery (CVPD) group of BII , Singapore.	

Bioinformatics Institute (BII), Singapore.

May 2021 - March 2022.

Post-doctoral Research Fellow at the [Computer Vision and Pattern Discovery \(CVPD\)](#) group of [BII](#), Singapore.

[Institute of Molecular and Cell Biology \(IMCB\)](#), Singapore.

May 2018 - April 2021.

Research Fellow (Post-doctoral) at the [Computational & Molecular Pathology Lab \(CMPL\)](#) of [IMCB](#), Singapore.

[National University of Singapore](#), Singapore

August 2015 - December 2015.

Part Time Teaching Assistant at Department of Computer Science,

- Tutor for
 - CS3244 Machine Learning and
 - CS6205 Advanced Modelling and Simulation modulesat Department of Computer Science, National University of Singapore.
- **Lecturers:** [Prof. Chew Lim TAN](#) and [Dr. Hwee Kuan LEE](#).

[University of Alberta](#), Canada

May 2011 - July 2011.

Research Assistant in “Optimization of CO_2 Injectivity in Geological Carbon Storage” project with [Prof. J. Fraser Forbes](#) and [Prof. Vinay Prasad](#).

DISSERTATIONS

[National University of Singapore](#), Singapore

January 2013 - December 2017

Supervisors: [Dr. Hwee Kuan LEE](#) and [Prof. Wing-Kin SUNG](#), [Ken](#).

Weblink: [PDF@NUS Scholarbank](#)

- Developed an automated image based prominent nucleoli detection system for histopathological images.
- Developed a machine learning and image processing based automated system for gland segmentation in prostate histopathological images.
- Developed an automated image based grading system using nuclear patterns for renal histopathological images.

The above projects were implemented using C++, OpenCV, and Python.

[Indian Institute of Information Technology-Allahabad](#), India

January 2012 - July 2012

Supervisor: [Prof. Uma Shanker TIWARY](#)

- Development of software using CMUSphinx library, C++ and Java to transcribe a large amount of audio data into text format and facilitate search using audio queries.
- Use of multiple text document summarization based approach by incorporating human knowledge represented via fuzzy logic-based word-mesh and sentence-mesh.

PUBLICATIONS

Journal Publications

1. Narmada BC*, Khakpoor A*, Shirgaonkar N*, Narayanan S, Kim Aw PP, **Singh M**, Ong KH, Owino CO, Ting Ng JW, Yew HC, Binte Mohamed Nasir NS, Au VB, Sng R, Kaliaperumal N, Toe Wai Khine HH, Casuscelli di Tocco F, Masayuki O, Naikar S, Ng HX, Chia SL, Yi Seah CX, Alnawaz MH, Lee Yoon Wai C, Ling Tay AY, Singh MK, Chew V, Yu W, Connolly JE, Periyasamy G, Plissonnier ML, Levrero M, Lim SG, DasGupta R. **Single cell landscape of functionally cured chronic hepatitis B patients reveals activation of innate and altered CD4-CTL-driven adaptive immunity**. Journal of Hepatology (2024) [DOI](#). *Equal contribution.
2. Mustafa Umit Oner*, Mei Ying Ng*, Danilo Medina Giron, Cecilia Ee Chen Xi, Louis Ang Yuan Xiang, **Malay Singh**, Weimiao Yu, Wing-Kin Sung, Chin Fong Wong, and Hwee Kuan Lee. **An AI-assisted Tool For Efficient Prostate Cancer Diagnosis in Low-grade and Low- volume Cases**. Patterns 3 (12), 100642 (2022). [PDF](#). [Dataset](#) and [Code\(GitHub\)](#). *Equal contribution.
3. Bhav Harshad Parikh*, Zengping Liu*, Paul Blakeley, Qianyu Lin, **Malay Singh**, Jun Yi Ong, Kim Han Ho, Joel Weijia Lai, Hanumakumar Bogireddi, Kim Chi Tran, Jason Y. C. Lim, Kun Xue, Abdurrahmaan Al-Mubaarak, Binxia Yang, Sowmiya R, Kakkad Regha, Daniel Soo Lin Wong, Queenie Shu Woon Tan, Zhongxing Zhang, Anand D. Jeyasekharan, Veluchamy Amutha Barathi, Weimiao Yu, Kang Hao Cheong, Timothy A. Blenkinsop, Walter Hunziker, Gopal Lingam, Xian Jun Loh, and Xinyi Su. **A bio-functional polymer that prevents retinal scarring through modulation of NRF2 signalling pathway**. Nature Communications 13, 2796 (2022). *Equal contribution. [PDF](#).
4. Daniel Aitor Holdbrook*, **Malay Singh***, Yukti Choudhury, Emarene Mationg Kalaw, Valerie Koh, Hui Shan Tan, Ravindran Kaneshvaran, Puay Hoon Tan, John Yuen Shyi Peng, Min-Han Tan, and Hwee Kuan Lee. **Automated Renal Cancer Grading Using Nuclear Pleomorphic Patterns**. JCO Clinical Cancer Informatics 2018 :2, 1-12. *Equal contribution. [PDF](#).
5. Oleg V. Grinchuk, Surya Pavan Yenamandra, Ramakrishnan Iyer, **Malay Singh**, Hwee Kuan Lee, Igor V. Kurochkin, Kiat Hon Lim, Pierce K. H. Chow, and Vladimir A. Kuznetsov. **Tumor-adjacent tissue co-expression profile analysis reveals pro-oncogenic gene signature for prognosis of resectable hepatocellular carcinoma**. Molecular Oncology 12(1):89-113, 2018. [PDF](#).
6. **Malay Singh**, Emarene Mationg Kalaw, Danilo Medina Giron, Kian-Tai Chong, Chew Lim Tan, and Hwee Kuan Lee. **Gland Segmentation in Prostate Histopathological Images**. Journal of Medical Imaging: 4(2), 027501, 2017. [PDF](#).
7. Choon Kong Yap, Emarene M. Kalaw, **Malay Singh**, Kian-Tai Chong, Danilo M. Giron, Chao-Hui Huang, Li Cheng, Yan Nei Law, and Hwee Kuan Lee. **Automated Image Based Prominent Nucleoli Detection**. Journal of Pathology Informatics 6.1. 2015: 39. [PDF](#).

Conference Posters

1. Kok Haur ONG, Laurent Gole, Longjie LI, Xinmi HUO, Kah Weng LAU, David M. YOUNG, Susan Swee Shan HUE, Char Loo TAN, Gabriel Pik Liang MARINI, Hao HAN, **Malay Singh**, Haoda LU, Soo Yong TAN*, Weimiao YU*. **Digital pathology annotation & image quality assessment platform for developing and training various AI cancer models and realizing the intelligent clinical assessment**. Poster presentation at HPCAsia2023: International Conference on High Performance Computing in Asia Pacific Region (HPCAsia2023). 27 Feb -2 March 2023. [HPCAsia2023](#). *Corresponding Authors.
2. Nicholas Cheng, Eddy W. P. Tan, Shuang Leng, Lohendran Baskaran, Lynette Teo, Min Sen Yew, **Malay Singh**, Weimin Huang, Mark Yan-Yee Chan, Kee Yuan Ngiam, Roger Vaughan, Terrance Chua, Swee Yaw Tan, Hwee Kuan Lee, Liang Zhong. **Machine Learning Accurately Quantifies Epicardial Adipose Tissue from non-contrast CT images in**

- Coronary Artery Disease.** Poster presentation at ESC Asia 2022 with APSC & AFC Conference by European Society of Cardiology. Singapore. December 2022. [ESC2022](#).
3. **Malay Singh**, Laurent Gole, Kok Haur Ong, Longjie Li, Xinmi Huo, Hao Han, Kah Weng Lau, Li Mei Gan, Char Loo Tan, David M Young, Hwee Kuan Lee, Susan Swee Shan Hue, Weimiao Yu, and Soo Yong Tan. **Highly multiplexed immuno-fluorescence images data analysis for prostate cancer.** Poster at “Frontiers in Cancer Science 2021”. [FCS2021](#).
 4. **Malay Singh**, Laurent Gole, Kok Haur Ong, Hao Han, David M Young, Susan Swee Shan Hue, Soo Yong Tan, and Weimiao Yu. **Highly multiplexed immuno-fluorescence images data analysis for prostate cancer.** Poster at “Frontiers in Cancer Science 2020”. [FCS2020](#).
 5. Brandon Ryan Hong, **Malay Singh**, Jane Vin Chan, Matan Thangavelu, Giridharan Periyasamy, Hwee Kuan Lee, and Judice L. Y. Koh. **Predicting Drug Response in 3D Tumor Spheroids using Convolutional Neural Networks.** Poster at “EMBL Symposium: Seeing is Believing - Imaging the Process of Life”. EMBL Heidelberg, Germany. October 2017.

Conference Articles

1. **Malay Singh**, Zeng Zeng, Emarene Mationg Kalaw, Danilo Medina Giron, Kian-Tai Chong, and Hwee Kuan Lee. **A Study of Nuclei Classification Methods in Histopathological Images.** International Conference on Innovation in Medicine and Healthcare (KES-InMed-17). Springer, 2017. [PDF](#).
2. **Malay Singh**, Uma Shanker Tiwary, and Tanveer J. Siddiqui. **A Speech Retrieval System based on Fuzzy logic and Knowledge-base filtering.** In Proceedings of International Conference on Multimedia, Signal Processing and Communication Technologies (IMPACT), 2013 , pp. 46-50. IEEE, 2013. [PDF](#).
3. Anupam Srivastava, Divij Vaidya, **Malay Singh**, Pranjal Singh, and Uma Shanker Tiwary. **A Cognitive Interactive Framework for Multi-Document Summarizer.** Advances in Intelligent Systems and Computing, 1, Volume 179, Proceedings of the Third International Conference on Intelligent Human Computer Interaction (IHCI 2011), Prague, Czech Republic, August, 2011, Part 5, Pages 257-268. [PDF](#).

Seminars and Talks

1. Seminar in the AI DP Informatics Journal Club at SGH. **Using Deep Learning to Assist Pathologists in Prostate Cancer Grading.** Online. 20 June 2023.
2. Invited talk at [Digital Pathology Malaysia 2023](#) Conference. **Using Deep Learning to Assist Pathologists in Prostate Cancer Grading.** Kuala Lumpur, Malaysia. 27 June 2023.
3. Invited talk at [Unlocking the Power of Spatial Omics](#) Symposium. **Structure Based Immune Profiling Using Multiplex Immunofluorescence Images for Prostate Cancer.** Singapore. 5 October 2023.
4. Invited talk at Department of Pathology, Erasmus Medical Center (EMC), The Netherlands. **Using Deep Learning to Assist Pathologists in Prostate Cancer Grading.** Online. 17 November 2023.

Talks (1-2 and 4 above) were an abridged version of the Cell Patterns paper: [Oner et al. 2022 Patterns](#).

Preprints

1. **Malay Singh**, Emarene Mationg Kalaw, Wang Jie, Mundher Al-Shabi, Chin Fong Wong, Danilo Medina Giron, Kian-Tai Chong, Maxine Tan, Zeng Zeng, and Hwee Kuan Lee. **Crib-**

riform pattern detection in prostate histopathological images using deep learning models. arXiv pre-print, 1910.04030, 2019. [PDF](#).

DATE: August 3, 2024