Sandeep Kumar Singh

CONTACT DETAILS & INFO

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RESEARCH INTEREST

Quantum networking, datacenter networking, optical switching, resource allocation, application of machine learning in communication networks.

EDUCATION

PhD in Computer and Network Engineering 2014-2019
Technical University (TU) of Braunschweig, Germany

- Thesis title: "Stochastic Analysis and Learning-based Algorithms for Resource Provisioning in Optical Networks" [online] **[Grade: Summa Cum Laude, highest]**
- PhD Advisor: Prof. Admela Jukan, TU Braunschweig, Germany
  Committee: Prof. Vincent Chan, MIT, USA; Prof. Krishna Sivalingam, IIT Madras, India
- Developed the first exact theoretical model and efficient machine learning-assisted algorithms for routing, spectrum allocation and defragmentation in elastic optical networks. Proposed an energy-efficient and intelligent fiber-wireless architecture for edge-cloud networks.

Master of Science by Research (M. S.) in Electrical Engineering 2010-2014
Indian Institute of Technology (IIT) Madras, India

- Thesis title: "Virtual Optical Bus: A New Paradigm for Optical Transport Networks" [**Grade: 8.9/10**]
- Developed an algorithm for the optimization of the number of virtual connections per fiber link with the objective of minimizing packet collision in optical burst-switched networks.

Bachelor of Technology (B. Tech.) in Electronics and Communication Engineering 2006-2010
SASTRA University, Thanjavur, India

- Thesis title: "High-Speed Serial Communication with FPGA" [**Grade: 8.35/10**]
- Implemented an interface for a high speed serial data transmission with a PCI Express protocol through a transceiver block of FPGA. This work was supported by a SUKHOI-30 project at DRDO, Bangalore, India.

WORK AND TEACHING EXPERIENCE

Postdoctoral Scholar-Employee 2021-present
University of California, Davis, USA

- Research: Working towards theoretical models and demonstration of distribution of entangled photons over quantum-classical channels. Developing a software defined networking-enabled datacenter testbed for intelligent routing and switching.
- Teaching: High-capacity optical data systems and networks. Primary instructor: Prof. S. J. Ben Yoo, EEC 239B, WQ 2022.
- Projects: i) Quantum wrapper networking, ii) Data center switching and interconnects
- Supervision: Two Master's theses in optical datacenter networks (ongoing)

Research Scientist 2019-2021

German Aerospace Center (DLR), IKN, Neustrelitz, Germany

- Research: Developed an anomaly detection software in Python for maritime traffic situation assessment, and a hybrid learning solution for vehicle tracking using prediction and uncertainty estimation by Evidential deep learning and Kalman filtering.
- Projects: IntelliMar & EMS III. The projects dealt with maritime security. My role was to investigate, and develop a software solution for real-time security assessment in maritime navigation using machine learning techniques.

Research Staff & PhD Student 2014-2019

Technical University of Braunschweig, Germany

- Research: Developed analytical models and algorithms for resource allocation in fiber optical networks with least spectrum fragmentation. Developed machine learning (ML) framework for allocating resources efficiently under time-varying traffic scenario, detecting power jamming attacks, and reducing energy consumption in Edge-Cloud fiber-wireless networks with sensors, ZigBee and Raspberry-Pi (R-Pi).
- Teaching: Broadband Communication (Optical transceiver and network components, OTN, WDM), Advance Topics in Telecommunication, Network Lab (OSPF, TCP/IP, BGP)
- Projects: Contributed in project proposal writing*, and worked on research projects. *EU project: mF2C- Fog-to-Cloud Management Ecosystem, *DFG project: Metrology for THz Communications. Animal Welfare project with Edge-Cloud fiber-wireless networks. DFG project: New Horizons in Optical Networking (see publications)
- Supervision: Three Master's theses in optical networks, fiber-wireless networks, and IoT

Teaching Assistant, and Internship

- Teaching Assistant: Optical networks, and Digital design lab, *Indian Institute of Technology Madras, India, 2012-2013.*
- Master's Project: Developed an algorithm for reducing packet collision in virtual optical networks, *Technical University of Berlin, Germany, 2011-2012..*
- Bachelor's Project: Implemented a high-speed serial communication interface over PCI express protocol in FPGA, *Defense Research and Development Organization (DRDO)*, Bangalore, India, 2009-2010.

PUBLICATIONS

All publications: https://scholar.google.com/citations?user=Xv2O8dgAAAAJ&hl=en

Major Journals:

- **S. K. Singh**, J. S. Fowdur, J. Gawlikowski, D. Medina, "Leveraging Graph and Deep Learning Uncertainties to Detect Anomalous Trajectories, arXiv:2107v1, 2021.
- **S. K. Singh** and A. Jukan, "Machine Learning-based Prediction for Resource (Re)allocation in Optical Data Center Networks," *IEEE/OSA Journal of Optical Communications and Networking (JOCN)*, vol. 10, issue 10, pp. D12-D28, 2018.

- **S. K. Singh**, F. Carpio, and A. Jukan, "Improving Animal-Human Cohabitation with Machine Learning in Fiber-Wireless Networks," *MDPI Journal of Sensor and Actuator Networks*, vol. 7, no. 3, 2018.
- **S. K. Singh** and A. Jukan, "Efficient Spectrum Defragmentation with Holding Time Awareness in EONs," *IEEE/OSA JOCN*, vol. 9, no. 3, pp. B78-B89, 2017.

Major Conferences:

- **S. K. Singh**, Roberto Proietti, C. Y. Liu, and S. J. Ben Yoo, "Multi-Cluster Reconfiguration with Traffic Prediction in Hyper-Flex-LION Architecture," *Optical Fiber Communication Conference (**OFC**)*, San Diego, CA, USA, March 2022.
- **S. K. Singh** and F. Heymann, "On the Effectiveness of AI-Assisted Anomaly Detection Methods in Maritime Navigation," *23rd International Conference on Information **Fusion***, virtual, July 2020.
- **S. K. Singh** and A. Jukan, "Computing Blocking Probabilities in Elastic Optical Networks with Spectrum Defragmentation," in proc. of *IEEE Conference on Computer Communications (**INFOCOM**)*, Paris, April 2019.
- **S. K. Singh**, W. Bziuk, and A. Jukan, "A Combined Optical Spectrum Scrambling and Defragmentation in Multi-Core Fiber Networks," *IEEE International Conference on Communications (**ICC**)*, USA, 2017.

AWARDS, ACHIEVEMENTS AND SERVICES

IEEE Member and Reviewer 2016-present
Optical society of America (OSA) recognition for quality peer-reviews, 2020
Invited Talks 2019-20
Resource Allocation in Optical Networks, IIT Indore, India
Application of Machine Learning in Communication Networks, VIT, India
Summer School and Workshop Participation 2018-20
Subsea fiber optical communication school by Google, 2019 and 2020
Cloud and edge computing workshop by SixSq, Switzerland, 2018
Outstanding Paper Award 2016
S. K. Singh, W. Bziuk and A. Jukan, "Balancing Security and Blocking Performance with Reconfiguration of the Elastic Optical Spectrum," MIPRO*, Croatia, 2016.*
Recipient of German Govt. Scholarship DAAD, Germany 2011-2012
Won robotics prizes and Science quizzes; Designed electronic circuits for displaying images and a Microcontroller-programmed cartoon 2007-2009

REFERENCES

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Dr. Frank Heymann
German Aerospace Center, Germany
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