SAQIB AZIM

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Education

Indian Institute of Technology Bombay, *Mumbai, India* Jul '15 - Jun '19
B.Tech in Electrical Engineering, Minor in Computer Science

- **Award :** Undergraduate Research Award (URA 01) *(for excellent research contribution)* [2019]

Research Interests

Theoretical and Applied aspects of Machine Learning, Deep Learning, Optimization, Statistics, Computer Vision, Robotics, Signal and Image Processing

Patent & Publication

- **Indoor Distance Estimation using LSTMs over WLAN Network** **[Paper]**
  IEEE Workshop on Positioning, Navigation and Communications (WPNC), 2019
  P. Sankhe, **S. Azim**, S. Goyal, T. Choudhary, K. Appaiah and S. Srikant
- **Indoor Positioning System for position estimation in an indoor environment**
  Indian Patent Application - 201821047043, filed Dec '18. Patent Pending
  P. Sankhe, **S. Azim** and S. Goyal

Work Experience

Human Navigation Support using Visual-Inertial SLAM Feb '20 - Ongoing
Advisor: Dr. Katsuyuki Nakamura ***Hitachi Research**, Tokyo*

· Developed a robust and reliable human navigation support system in unfamiliar dynamic real-world environments by combining visual-inertial SLAM with deep-learning methods
· Implemented feature-based SLAM with photometric optimization, performing device tracking, 3D mapping, and used pruning methods to improve speed and robustness
· Integrated dynamic object detection module with the visual-SLAM pipeline to mitigate inaccuracies in dynamic scenes, and demonstrated performance improvement on public datasets
· Built a smartphone application for real-time localization in a pre-built 3D map

Risky Activity Detection Oct '19 - Jan '20
Artificial Intelligence Lab ***Hitachi Research**, Tokyo*

· Developed method for quantitative risk estimation of human workers in factory environment based on positional relationship between a person and dangerous heavy objects
· Implemented camera-based system to estimate position of human and dangerous objects in factories
· Established proof-of-concept for the successful working of this technology at a Japanese Factory
· Presented this research technology at Hitachi Research Symposium '20

Handwritten Character Recognition using Smartwatch Summer Internship '18
Advisor: Dr. Shankar Venkatesan ***Samsung Research Institute***

· Prototyped a handwritten text recognizer by estimating wrist movements using smartwatch IMU sensors
· Employed learned frequency filters followed by adaptive thresholding to improve raw signal SNR
· Learned the relationship between hand movements (IMU signals) and character pattern using an SVM classifier (detecting valid IMU signal segments), and an LSTM (for character recognition)
· Trained the end-to-end system on a custom-created dataset and achieved 87% recognition accuracy

Finger-Pointing Direction Estimation Oct '20 - Dec '20
Advisor: Dr. Katsuyuki Nakamura ***Hitachi Research**, Tokyo*

- Designed a CNN-based hand gesture classifier trained using custom-dataset for classification of detected hand into multiple pointing gestures and achieved 95% accuracy in gesture classification
- Deployed the system on a smartphone for real-time finger-pointing direction estimation

Research Experience

Indoor Positioning System over WLAN Network [Paper] Jan '17 - Dec '18
Advisors: Prof. Kumar Appaiah & Prof. Sukumar Srikant *IIT Bombay*

- QuarterFinalist of India Innovation Challenge conducted by DST & Texas Instruments
- Developed a self-adaptive system to locate a wireless device in indoor areas using wireless networks
- Proposed a stationary wireless device setup to model the multipath fading and shadowing effects
- Used windowed-LSTM for time-series modeling of wireless received signal strengths recorded throughout device's trajectory to estimate the distance of target device from reference point
- Achieved state of the art accuracy of 5 cms on a range of 10 m with a confidence interval of 93% significantly advancing the previous state of art accuracy which was 40 cms
- Filed a patent at the Indian Patent Office and submitted a publication at the IEEE WPNC 2019

Optimal Pursuer-Evader Shepherding Problem [Thesis] Aug '18 - Apr '19
Advisor: Prof. Debraj Chakraborty *IIT Bombay*

- Defined a novel pursuer-evader problem of estimating optimal pursuer strategy for driving a multi-evader system to destination using inter-agent interactions, and formulated as a constrained optimization task
- Proposed to learn the optimal trajectory patterns (generated with optimization solvers) using time-series based LSTM module, producing promising results for various initial conditions

Zero-Shot Learning (ZSL) for Object Recognition May '17 - Nov '17
Advisor: Prof. Subhasis Chaudhuri *VIP Lab, IIT Bombay*

- Proposed a semi-supervised VGG16-based encoder-decoder network to learn visual-to-semantic space mapping using novel combination of margin-based hinge-rank loss and Word2Vec embeddings
- Explored multiple networks for better visual feature representations. Achieved improvement in recognition performance from 58.7% to 65.3% on the Animals with Attributes dataset over existing methods

Image Registration using FFT (*Selected in Top 5/40 projects*) Jan '18 - Apr '18
Advisor: Prof. Vikram Gadre *EE, IIT Bombay*

- Built a FFT based tool for registering and mosaicing images captured from different view-points and scales. Used phase correlation and impulse location for rotational and translational alignment resp. Achieved better results than SIFT based alignment in case of aerial images. Presented at MHRD-TEQIP-KITE Resource Creation Workshop under the initiative of MHRD, Govt. of India

TV Audience Measurement Winter '18
***Bronze Medal (3rd/23 teams)**, Inter-IIT Technical Meet* *IIT Bombay*

- Proposed scalable and robust solutions for various challenges put forward by BARC India such as channel identification, advertisement and content classification and recognition, age and gender recognition of viewers and providing hardware free solution in order to capture TV viewership data of the country

Simultaneous sensing & sparsifying dictionary optimization Feb '18 - Apr '18
Advisor: Prof. Ajit Rajwade *CSE, IIT Bombay*

· Implemented a framework for joint design and optimization of sensing matrix and non-parametric dictionary. Improved reconstruction accuracy on image patches using coupled K-SVD and OMP Algorithm compared to using gaussian sensing matrix and overcomplete dictionary learned using KSVD

Photoplethysmogram (PPG) Signal Acquisition Module [Report] Jan '18 - Apr '18
Advisor: Prof. Prem C Pandey *EE, IIT Bombay*

· Developed a hardware module for faithful PPG signal acquisition with low noise and minimal filtering. Implemented baseline restoration and auto-LED intensity control for varying skin color & shape. Provided bluetooth connectivity to display the acquired PPG signal on mobile devices

Music Information Retrieval from EEG signals Sep '17 - Nov '17
Advisor: Prof. Gaurav Kasbekar *EE, IIT Bombay*

· Applied onset detection techniques on EEG recordings to extract tempo of the corresponding stimulus. Implemented tempogram estimation using autocorrelation technique assuming EEG as the novelty curve. Achieved a difference of 1 bpm in actual tempo and calculated tempo from the EEG data

Pipelined Reduced Instruction Set Computer Aug '17 - Nov '17
Advisor: Prof. Virendra Singh *EE, IIT Bombay*

· Designed and implemented a 6-stage pipelined multicycle RISC processor in VHDL, with arithmetic, logical and branching instructions, and tested on DE0-Nano FPGA board. Implemented fully associative cache, flushing, data-forwarding, etc. to maximize the theoretical throughput of the processor.

Autonomous Self-Driving Car Sep '17 - Mar '18
Mahindra Rise Driverless Car Challenge ***Innovation Cell**, IIT Bombay*

· Studied the effects of shadows and varying lighting conditions for road, lane and zebra-crossing detection. Provided solution using image processing techniques. Developed proof-of-concept with YOLO network trained on our own custom-created Indian Road Dataset for detection of roads, obstacles, person, etc.

Achievements and Extra-Curricular

- Among top 0.75% *(out of 150000)* candidates in JEE Advanced '15
- Ranked among top 0.15% *(out of 1.5 million)* candidates in JEE Main '15
- **Undergraduate Teaching Assistant** at IIT Bombay in *Signals and Systems* Spring '19
- **Teaching Volunteer**, *National Service Scheme, IITB* [2015-16]
  - Completed one year teaching Maths and Science to underprivileged secondary school students
- **Mentored** four UGs, two Masters' IITB students on their *Summer of Science* projects (Summer '19 & '20), and guided two freshmen group in *Institute Technical Summer Project* (Summer '17)
- **Open Source** - Actively contributed to Kivy, Kivent in 2016-17
- **Web Coordinator** for Mood Indigo '16 at IIT Bombay
- Received **academic excellence** award from Humayun Kabir Institute in 2012

Relevant Courses & Skills

- **Computer Science** - Advanced Machine Learning, Computer Vision, Advanced Image Processing, Data Structures & Algorithms, Operating Systems, Computer Networks, Optimization Techniques

- **Electrical Engineering** - Estimation and Identification, Probability and Random Processes, Data Analysis, Control Systems, Signal Processing, Digital & Analog Communication, Microprocessors
- **Programming** - Python, C++, MATLAB, Java (Android), HTML/CSS, Assembly, LaTeX
- **Softwares Tools** - OpenCV, Tensorflow, Pytorch, Numpy, Git, Docker, Scilab, VHDL, Wireshark, GNU Radio, Quartus, Arduino