SAQIB AZIM

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Education

University of California San Diego Sep '21 - Ongoing
MS in Electrical and Computer Engineering
Advisor: Prof. Nikolay Atanasov

Indian Institute of Technology Bombay Jul '15 - Jun '19
B.Tech in Electrical Engineering with minor in Computer Science
Award: Undergraduate Research Award *(for excellent research contribution)* [2019]

Research Interests

Machine Learning, Reinforcement Learning, Planning and Learning in Robotics, Computer Vision, Optimization

Industry Experience

Hitachi, Ltd. Research and Development Group Oct '19 - Sep '21
Assistant Researcher, Intelligent Vision Research Group *Tokyo, Japan*
Advisors: Dr. Katsuyuki Nakamura

· Worked on a breadth of problems such as visual navigation, hazardous activity detection, synthetic training video generation, etc. aimed towards human work automation resulting in patent submission and Hitachi product impact.

Samsung R&D Institute May '18 - Jul '18
Research Intern, Advanced Technology Lab *Bengaluru, India*
Advisor: Dr. Shankar Venkatesan

· Prototyped a handwritten text recognition system by estimating precise wrist movements using Samsung smartwatch sensors. Devised an automated data-collection framework, trained a pipelined SVM and LSTM network to learn the relation between hand movement and character patterns, and achieved ∼87% text recognition accuracy.

Patent & Publication

. **Localization in Dynamic Environments with Targeted-Inference based SLAM** [report]
Saqib Azim, Takumi Nito and Katsuyuki Nakamura
Japan Patent Application, filed Aug '21 (pending)

. **Indoor Distance Estimation using LSTMs over WLAN Network** [arXiv/paper]
Pranav Sankhe, **Saqib Azim**, Sachin Goyal, Tanya Choudhary, Kumar Appaiah and Sukumar Srikant
In IEEE Workshop on Positioning, Navigation and Communications (WPNC 2019)
India Patent Application, filed Dec '18 (pending)

Selected Projects

Human Navigation Assistance using Visual-Inertial SLAM Feb '20 - Mar '21
Advisor: Dr. Katsuyuki Nakamura *Hitachi, Ltd.*

· Developed a visual-inertial localization system using SLAM and deep learning for navigation in dynamic environments.
· Implemented feature-based camera tracking, keyframe-based mapping, path optimization and loop closure.
· Proposed a time-efficient algorithm to detect dynamic objects using a targeted inference network with a heuristic-based decision module to identify frames with moving objects and a custom-trained dynamic segmentation network.
· Achieved ∼47% localization error reduction in dynamic environments compared to existing state-of-the-art system.
· Developed a user-friendly Android app for seamless localization and navigation experience, overcoming the challenge of deploying such systems on handheld devices.

Hazardous Activity Detection in Work Environments Oct '19 - Jan '20
Advisor: Dr. Katsuyuki Nakamura *Hitachi, Ltd.*

· Developed a vision-based system for detecting hazardous activities and quantitative risk estimation to humans in the workplace by estimating the positional relationship between individuals and dangerous objects or areas.
· Demonstrated working prototype at a Japanese Railway Factory and presented findings at Hitachi Research Symposium.
· Implemented a hand detection and gesture classification system to accurately identify hand-pointed objects aimed at reducing work-errors in industrial settings. Demonstrated real-time functionality through a prototype iPhone app.

Learning Latent Spaces in Inverse Reinforcement Learning Oct '22 - Ongoing
Advisor: Prof. Nikolay Atanasov *UC San Diego*

- Working to improve imitation learning algorithms used to perform robot manipulation tasks by learning latent action and state spaces from expert demonstrations.
- Conducted experiments in benchmark environments including Mujoco and Robosuite on a nautilus server.
- Evaluated and compared our approach with RL/IRL baselines and successfully applied it to a real robot arm.

Neural Radiance Field (NeRF) for Scene Representation Fall '22
Advisor: Prof. Hao Su *UC San Diego*

- Developed a 6D pose estimation pipeline to predict poses of objects in a scene using RGBD images.
- Utilized UNet for object segmentation, followed by 3D point cloud formation, and ICP algorithm for point cloud alignment and to estimate the 6D pose of each segmented object, achieving a 93% test accuracy.
- Implemented NeRF to fit a scene described by images and their poses, generating photo-realistic novel views of scene.

Simultaneous Localization and Mapping (SLAM) Winter '23
Advisor: Prof. Nikolay Atanasov *UC San Diego*

- Implemented a particle-filter SLAM algorithm for accurate localization of a robot in an unknown environment using encoder and IMU odometry data, and generated a 2D occupancy-grid map using LIDAR measurements.
- Implemented a visual-inertial SLAM system for precise pose estimation of an IMU sensor attached to a car using an extended kalman filter and estimated 3D landmarks in the environment using stereo camera observations.

Adversarial Robustness Analysis Apr '22 - Aug '22
Advisor: Prof. Lily Weng *UC San Diego*

- Investigated the sensitivity of neural networks to small random input perturbations and evaluated the effectiveness of heuristic defenses in training robust models against powerful attacks.
- Conducted an empirical analysis of the CLIP model's resilience to adversarial perturbations and devised an attack mechanism to generate adversarial examples.
- Employed these examples to train a robust classifier with strong certifiable guarantees against adversarial attacks.

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

- Formulated the pursuer-evader shepherding problem for estimating an optimal control algorithm to drive multi-evader agents to a destination using novel inter-agent interactions as a constrained optimization task.
- Utilized iterative search algorithms to find locally optimal trajectories of agents under diverse initial conditions. Generated a training dataset based on these trajectories and trained an attention-based LSTM network to learn a generalized function for approximating optimal trajectories.

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

- Developed vision and navigation algorithms for a driverless car, including a compute-efficient image processing algorithm to mitigate the effects of shadows and varying lighting conditions on roads.
- Managed the collection and annotation of a road dataset used to train DL framework for road and obstacle detection.

Achievements & Skills

- Ranked among **top 0.75%** *(out of 1,50,000)* candidates in JEE Advanced '15
- **Teaching Assistant** - *Probabilistic Modeling and Machine Learning* (Spring '23), *Image Processing* (Winter '23), *Probability and Statistics for Data Science* (Fall '22, Spring '22), *Linear Systems* (Winter '22)
- **Mentor** @ Summer of Science '19 & '20, IIT Bombay (guided 4 undergraduates, 2 Masters students)
- Actively contributed to **Open Source** platforms such as Kivy and Kivent [2016-17]
- **Programming** - Python, C & C++, MATLAB, Java (Android), Bash, HTML/CSS, Assembly, LaTeX
- **Frameworks & Tools** - Tensorflow, Pytorch, OpenCV, Scikit-Learn, Numpy, Scipy, Git, Docker, Unity, Kubernetes

Selected Courses

- Deep Generative Models
- Deep Learning for 3D data
- Advanced Machine Learning
- Deep Reinforcement Learning
- Sensing & Estimation in Robotics
- Maths for Robotics
- Statistical Learning
- Advanced Computer Vision
- Convex Optimization
- Advanced Image Processing
- Statistical Signal Processing
- Data Structures and Algorithms