SAQIB AZIM

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Education

University of California San Diego Sep '21 - Ongoing
MS in *Electrical and Computer Engineering*
GPA : 3.91/4
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, Deep Learning, Reinforcement Learning, Learning in Robotics, Computer Vision

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)

Industry Experience

Hitachi R&D Japan Oct '19 - Sep '21
Assistant Researcher, Intelligent Vision Research Group *Tokyo, Japan*

- Developed a **Visual Navigation** system using **SLAM** and deep learning algorithms for dynamic environments.
- Implemented feature-based camera tracking, 3D mapping, trajectory optimization and loop closure in **C++**.
- Proposed a novel targeted inference semantic segmentation network to efficiently detect dynamic scenes which **reduces computation time by 5x** leading to patent submission in Japan.
- Achieved **47% reduction** in localization error in dynamic environments over real-time state-of-the-art methods.
- Developed an **android app** to deploy the localization system on smartphones leading to Hitachi product impact.
- Fine-tuned **detectron2** model for segmentation of human and dangerous objects. Developed a **3D positioning** system to detect hazardous activity using computer vision methods. Successfully demonstrated a prototype at a Railway Factory.
- Implemented an interactive game in **Unity3D** graphics engine to generate synthetic data for deep learning training.
- Trained an end-to-end **SSD-UNet CNN** network to semantically segment hands using egocentric images, perform gesture classification, and identify hand-pointed objects with **94%** test accuracy.

Samsung R&D Institute May '18 - Jul '18
Machine Learning Intern, Advanced Technology Lab *Bengaluru, India*

- Prototyped a **handwritten text recognition** system by estimating wrist movements using Samsung smartwatch sensors.
- Improved signal-to-noise ratio using adaptive filters and devised an automated data-collection framework.
- Trained a pipelined **SVM** and **attention-LSTM** model to learn the relation between hand movement and character patterns, and achieved **93%** text recognition accuracy.

Technical Skills

- **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

Selected Projects

Inverse Reinforcement Learning for Robot Manipulation Dec '22 - Ongoing
Graduate Student Researcher at Existential Robotics Lab *UC San Diego*

- Developing and improving **deep RL** models for manipulation tasks in MuJoCo physics simulator.
- Employed autoencoder-based **Soft Actor-Critic** algorithm and expert demonstrations to learn the latent state and action spaces from images for **Robosuite** and **DeepMind** tasks.
- Successfully transferred learned policies to a real-world Panda robot arm (Sim2Real).

6D Pose Estimation and Neural Radiance Field (NeRF) 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 **Iterative closest point** algorithm for point cloud alignment and to estimate the 6D pose of segmented objects, achieving a **93%** test accuracy.
- Implemented **NeRF** to fit and generate photorealistic views of a scene, described by images and their poses.

Autonomous Vehicle Localization and Mapping Winter '23
Advisor: Prof. Nikolay Atanasov *UC San Diego*

- Implemented a **Particle-filter SLAM** algorithm for robot localization 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 (EKF) and estimated 3D landmarks in the environment using stereo camera observations.

Speech Enhancement using Convolutional-RNN and Wavelets Fall '22

- Built an end-to-end data-driven convolutional-recurrent neural network for enhancing the quality of speech signals.
- Employed wavelet pooling instead of max-pooling and evaluated performance using SNR, PESQ, STOI metrics.
- Demonstrated improved performance with faster training convergence on real-world speech dataset.

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

- Explored neural network sensitivity to random input perturbations and assessed the efficacy of heuristic defense mechanisms in training robust models against powerful attacks.
- Empirically analyzed the resilience of the **CLIP model** to adversarial perturbations and developed an attack mechanism for generating adversarial examples.
- Utilized these examples to train a robust classifier with certifiable guarantees against adversarial attacks.

Image Inpainting for Road-Scene Understanding Winter '22
Advisor: Prof. Pengtao Xie *UC San Diego*

- Implemented a unified framework to enhance **road-scene understanding** by combining state-of-the-art semantic segmentation (**DeepLabV3**) for removing undesired objects with a generative network for inpainting missing regions.
- Trained and evaluated the model on the **CityScapes** dataset, generating superior image quality.

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 optimal agent trajectories under diverse initial conditions.
- Trained an **attention-LSTM** network to learn the optimal trajectories using generated data.

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

- Worked on developing vision and navigation algorithms for a driverless car.
- Proposed a compute-efficient algorithm to mitigate the effect 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.

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

- Proposed a semi-supervised VGG16 autoencoder model to learn visual-semantic mapping using Word2Vec features.
- Improved ZSL unseen class performance from 58.7% to 65.3% on Animals with Attributes dataset.

TV Audience Measurement Challenge Winter '18
7^{th} *Inter-IIT Tech Meet* *IIT Bombay*

- Proposed robust solutions for various challenges put forward by BARC India such as automated TV channel and content recognition, viewers' age and gender recognition, hardware free solution to capture TV viewership data.
- Awarded **Bronze Medal ($3^{rd}/23$ teams)** which helped IIT Bombay achieve Runner-up ($2^{nd}/23$ IITs) at the event.

Achievements & Extra-Curriculars

- Ranked among **top 0.075%** *(out of 1.5 million candidates)* in JEE Advanced '15 (India's toughest entrance exam).
- **Teaching Assistant** at UC San Diego -
  - *Probabilistic Modeling and Machine Learning* in Spring '23 under Prof. Berk Ustun
  - *Image Processing* in Winter '23 under Prof. Ben Ochoa
  - *Probability and Statistics for Data Science* in Fall '22 and Spring '22 under Prof. Alon Orlitsky
  - *Linear Signals and Systems* in Winter '22 under Prof. Saharnaz Baghdadchi
- Volunteered to teach underprivileged kids at **LCCWA NGO** under IIT Bombay's Education Outreach program.
- **Mentor** at Summer of Science '19 & '20, IIT Bombay (guided 4 undergraduates, 2 Masters students)
- **Mentored** two student teams at *Institute Technical Summer Project '17*, IIT Bombay.
- Actively contributed to **Open Source** platforms such as Kivy and KivEnt.
- Contributed to Mood Indigo '16 website development, IIT Bombay.