SAQIB AZIM

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Education

University of California San Diego Sep '21 - Sep '23
Master of Science (MS) in *Electrical and Computer Engineering*, GPA : 3.92 / 4.0
Advisor : Prof. Nikolay Atanasov

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

Research Interests

AI, Machine Learning, Computer Vision, Robotics, Reinforcement Learning

Patent & Publication

- **Visual Localization in Dynamic Environments with Targeted-Inference 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, LTD. R&D GROUP Oct '19 - Sep '21
Assistant Researcher, Intelligent Vision Research Group *Tokyo, Japan*

- Developed a **Visual Localization and Navigation** system using **SLAM** and deep learning for dynamic environments.
- Implemented ORB-keypoint based camera pose estimation, keyframe-based 3D mapping, trajectory optimization and loop detection and closure in **C++**.
- Engineered a novel time-efficient 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** (in **Java** and **C++**) to deploy the **deep-learning localization** system on smartphones leading to significant product impact.
- Created visual hazardous activity detection system using **Mask RCNN segmentation** and depth estimation. 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 **MobileNet SSD** and **UNet** model to semantically segment hands using egocentric images, perform gesture classification, and identify hand-pointed objects with **94%** 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 raw IMU 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, Bash, Java, HTML, CSS
- **Frameworks** - TensorFlow, PyTorch, Scikit-Learn, NumPy, Matplotlib, Scipy, Pandas, CUDA, OpenCV, MLOps
- **Tools** - Git, Github, Docker, Android Studio, Google Colab, Jupyter, Kubernetes, Unity, Linux, ROS, Arduino
- **DL Models** - MLP, CNN, RNN, LSTM, Transformer, VAE, GAN, Diffusion models, ResNets, LLMs

Selected Courses

- Deep Generative Models
- Deep Learning for 3D Data
- Advanced Machine Learning
- Deep Reinforcement Learning
- Statistical Learning
- Computer Vision
- Advanced Computer Vision
- Sensing and Estimation in Robotics
- Maths for Robotics
- Convex Optimization and Applications
- Parameter Estimation
- Advanced Image Processing
- Statistical Signal Processing
- Linear Algebra and Applications
- Control Systems and Lab

Selected Projects

Robot Manipulation using Deep Reinforcement Learning Dec '22 - Aug '23
Graduate Student Researcher at Existential Robotics Lab *UC San Diego*

- Developing and improving deep RL models for wide-range of dexterous manipulation tasks.
- Employed **Soft Actor-Critic** and **Adversarial Imitation learning** algorithms (GAIL, AIRL, VMAIL) to learn optimal task-policy in **Robosuite** and **DeepMind** environments.
- Successfully transferred learned policies to a real-world Panda robot arm (**Sim2Real**) using computer vision algorithms.

Object 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 **PointNet** 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 **85%** 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.

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

- Utilized attack mechanisms, including FGSM, PGD, Auto-Attack, to generate adversarial examples.
- Developed robust **CLIP**-based classifier against l_2-norm perturbations using adversarial training and randomized smoothing. Evaluated on CIFAR10 and ImageNet datasets.
- Evaluated the effectiveness of heuristic defense mechanisms in training robust models against powerful attacks.

Team Member - Autonomous Self-Driving Car Aug '17 - Jul '18
Mahindra Rise Driverless Car Challenge *Innovation Cell*

- Contributed to developing deep learning algorithms for vision and navigation pipeline of an autonomous driverless car.
- Used path planning algorithms (such as A*, RRT, PRM) with **ROS** for path planning and navigation.
- Proposed a compute-efficient image processing algorithm to mitigate shadows and varying lighting conditions on roads.
- Managed collection and annotation of a road dataset used to train **YOLO** framework for road and obstacle detection.

Pursuer-Evader Optimal Trajectory Estimation Aug '18 - Jul '19
Advisor: Prof. Debraj Chakraborty *IIT Bombay*

- Developed an optimal control algorithm to drive multi-evader agents to destination using novel inter-agent interactions.
- Utilized global iterative solvers to estimate optimal agent trajectories under diverse constrained conditions.
- Learned to accurately predict pursuer-evader trajectories using an LSTM model.

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

- Combined state-of-the-art semantic segmentation (**DeepLabV3**) model for removing undesired objects along with a Fourier-Convolution inpainting network for missing region completion.
- Trained and evaluated the model on the **CityScapes** dataset, generating superior image quality.

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.

Achievements & Extra-Curriculars

- Secured rank of 1133 *(out of 1.5 million candidates)* in IIT-JEE Advanced '15 (India's toughest entrance exam).
- Awarded **Bronze Medal (3^{rd}/23 teams)** by BARC India for proposing innovative solutions to TV Audience Measurement Challenge at the 7th Inter-IIT Technical Meet 2018.
- Actively contributed to **Open Source** platforms such as Kivy and KivEnt.
- Contributed to the development of Mood Indigo '16 website using HTML, CSS, Javascript at IIT Bombay.

Teaching & Mentorship

- Served as a **Teaching Assistant** for the following five undergraduate and graduate courses at UC San Diego.
  - Probabilistic Modeling and Machine Learning Spring '23
  - Image Processing Winter '23
  - Probability and Statistics for Data Science Fall '22
  - Engineering Probability and Statistics Spring '22
  - Linear Signals and Systems Winter '22
- **Teaching Assistant** at IIT Bombay - Signals and Systems Spring '19
- **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.
- Taught underprivileged kids at LCCWA NGO under IIT Bombay's Education Outreach program. 2015 - 16

References

Prof. Subhasis Chaudhuri
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Director of IIT Bombay
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Prof. Nikolay Atanasov
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