SAQIB AZIM

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Research Interests: Robot Perception and Learning, Reinforcement Learning, Representation Learning, Generative AI, Computer Vision

EDUCATION

University of California San Diego — Sep '21 - Sep '23
Master of Science (MS) in *Electrical Engineering*, GPA : 3.918 / 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]

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)
Indian Patent #467255, Granted Nov '23

WORK EXPERIENCE

San Diego Supercomputer Center, UC San Diego — Nov '23 - Present
AI Research Engineer, WIFIRE Lab

· Developing an AI system for building damage assessment from wildfires using real-time IR aerial imagery data to prevent emerging disaster incidents in California.
· Developing **Physics-Guided ML** models for SDG&E power outage prediction using real-time weather and vegetation data.

HITACHI, LTD. R&D GROUP — Oct '19 - Sep '21
Assistant Researcher, Intelligent Vision Research Department — *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 and presented findings at *Hitachi Research Symposium 2019*
· 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.

Leadership Experience

· **Graduate Teaching Assistant**, UC San Diego
  - *Probabilistic Modeling and Machine Learning* - taught by Prof. Berk Ustun — Spring '23
  - *Image Processing* - taught by Prof. Ben Ochoa — Winter '23
  - *Probability and Statistics for Data Science* - taught by Prof. Alon Orlitsky — Fall '22
  - *Engineering Probability and Statistics* - taught by Prof. Alon Orlitsky — Spring '22
  - *Linear Signals and Systems* - taught by Prof. Saharnaz Baghdadchi — Winter '22

· **Teaching Assistant**, 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 students at LCCWA NGO under IIT Bombay's Education Outreach program. — 2015 - 16

Selected Courses

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

Selected Projects

Robotic Manipulation using Deep Reinforcement Learning — Dec '22 - Present
Graduate Student Researcher at Existential Robotics Lab — UC San Diego

· Developing deep RL and imitation learning methods 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.
· Enhanced agent performance through integrated multi-camera views, object shapes, and poses across four manipulation tasks.
· 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
3D Deep Learning by 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
Sensing & Estimation in Robotics by 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 Learning 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.

Robot Path Planning and Optimization — Nov '21 - Dec '21
Maths for Robotics by Prof. Henrik Christensen — UC San Diego

· Generated and visualized **configuration space** for a differential-drive robot in a 2D obstructed environment.

- Implemented and optimized path planning algorithms - greedy search, probabilistic roadmaps (**PRM**), rapid exploring random trees (**RRT**) - to estimate shortest and safest paths.
- Performed comparative analysis by contrasting PRM and RRT for efficient robot path planning.

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 [thesis]   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
Deep Generative Models by 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.

Technical Skills

- **Programming** - Python, C & C++, MATLAB, Bash, HTML, CSS
- **Algorithms** - Online RL: SAC, TD3, PPO. Unsupervised RL: DIAYN, CSD. Data-based / Offline RL: AWAC, DAPG, GAIL/AIRL
- **Frameworks** - TensorFlow, PyTorch, Scikit-Learn, NumPy, Matplotlib, Scipy, Pandas, CUDA, OpenCV, MuJoCo
- **Tools** - Git, Github, Docker, Android Studio, Unity, Linux, ROS, Arduino

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 (3rd/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.

References

Prof. Subhasis Chaudhuri
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Prof. Nikolay Atanasov
Director of Existential Robotics Lab
Assistant Professor @ UC San Diego
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