

# Mustafa Shaikh

[mustafanshaikh@gmail.com](mailto:mustafanshaikh@gmail.com) | [linkedin/mustafa-shaikh-716ba8140](https://www.linkedin.com/in/mustafa-shaikh-716ba8140/) | [shaikh58.github.io/website](https://shaikh58.github.io/website)

Robotics and machine learning practitioner focusing on object tracking with experience in control, perception and motion planning. I have 5 years of industry experience working closely with business stakeholders. I can dive deep into the details, and I have also lead projects end to end, from identifying a problem and designing a solution, to implementation and delivery.

## EDUCATION

### M.S. Electrical and Computer Engineering

UNIVERSITY OF CALIFORNIA, SAN DIEGO

Specialization: Robotics and Intelligent Systems

San Diego, CA | 2022 - 2024

### B.A.Sc. Engineering Science

UNIVERSITY OF TORONTO

Toronto, ON | 2013 - 2017

## WORK EXPERIENCE

### RESEARCH ENGINEER | SALK INSTITUTE FOR BIOLOGICAL STUDIES

San Diego, CA | 2024 -

**Key Skills:** Multi-object tracking, deep learning, transformers, ResNet, rotary embeddings, segmentation, Kalman filters, Hungarian matching, camera distortion, video encoding, ffmpeg, fast video loading

**Summary:** Implement a deep learning based multiple object tracking system applied to animal and microscopy videos, to enable the study of the impact of neurodegenerative diseases on animal and cell movement

- Implemented features to boost learning capacity and usability of the model, including: **rotary embeddings**, support for **sparsely annotated** training data, mixed dataset training, customizable **feature extractor factory**
- Performed **ablations** and experiments to **identify model gaps** as: overreliance on visual signal vs. position for microscopy; use of limited in-house data with weak signal to noise ratio; high GPU memory usage during inference
- Created a **pretrained microscopy model** that **improves key metrics** ID switches and tracking accuracy by **>40%** vs. previous, and **>8%** vs. state of the art; acquired and processed public cell datasets **40x** larger than in-house datasets
- Optimized tracker code to reduce **GPU memory** usage by **50%** and reduce **runtime** by **30%** during inference
- **Created and implemented** robust **global tracking accuracy** metric to address gaps in multi-object tracking metrics for downstream biological analysis; this metric helped us address a key failure mode of the model

### GRADUATE RESEARCH ASSISTANT | EXISTENTIAL ROBOTICS LAB, UC SAN DIEGO San Diego, CA | 2023 - 2024

**Key Skills:** Model predictive control, control barrier functions (CBF), casADi, CVX, JAX, automatic differentiation, QP, Extended Kalman Filter, RRT\*, collision avoidance, ROS, Jackal robot, LiDAR, depth camera, HectorSLAM

**Summary:** Determine the optimal trajectory (online) for an autonomous robot with limited field-of-view to keep a target within view while avoiding collisions with obstacles

**Publication:** *"Control Strategies for Pursuit-Evasion Under Occlusion Using Visibility and Safety Barrier Functions"* accepted at the *IEEE International Conference on Robotics and Automation (ICRA) 2025*. Arxiv: <https://arxiv.org/abs/2411.01321>

- **Implemented** a **model predictive controller** with control barrier (CBF) constraints to compute the optimal trajectory of the 'seeking' robot in order to keep a target within the field of view
- Implemented features to improve the **stability, and reliability** of the controller: **smoothing** to reduce changes in direction; **adaptive tuning** of CBF to improve collision avoidance; **slack** to improve feasibility of solution
- Demonstrated **>95% tracking** in **real world experiments** with Jackal wheeled robot in a cluttered environment
- Operated lightweight controller at 50Hz onboard the robot; fused sensor data from 3D LiDAR and RGB camera for SLAM and target detection using Python ROS nodes
- Implemented **Extended Kalman Filter** to estimate target's position and velocity using camera detections

**Key Skills:** Natural Language Processing - Spacy, Named Entity Recognition, BERT, human-in-the-loop systems, AutoML, PySpark, SQL, MLOps, Python, Pandas, Numpy, Keras, Google Cloud Platform, Airflow

**Project lead - Automated Attribute Assignment** (Jul 2021 to Jun 2022). **Goal:** Extract product features from item descriptions to populate missing data for products on walmart.ca to improve search quality for customers

- Developed **named entity recognition pipeline** (Spacy, BERT) to learn **context-aware** features from product descriptions; led to **>\$1MM CAD revenue increase** annually by populating features for over 500,000 items
- Recognized need for **high quality custom annotated data**; pitched and integrated a **human-in-the-loop** annotation tool (Prodigy); setup **active labelling** loop with **least confident predictions** annotated
- **Coordinated Jr. Data Scientist**, and guided the implementation of an **asynchronous orchestration layer**
- Worked closely with business stakeholders to guide problem framing, roadmap, execution and production support

**Other Projects** (Apr. 2019 to Jun. 2021)

- Developed and deployed **hierarchical model factory** (xgboost) to categorize 3rd party vendor items on walmart.ca; increased **categorization rate from 90% to 97%** which increased product views for previously 'unfindable' items
- Lead developer for data-driven, rules based online **grocery substitutions recommendation** engine; **300bps improvement in customer satisfaction**
- Created and maintained **fulfillment centre forecast** (ARIMA, Prophet, AutoML) to optimize labour; >90% accuracy up from 75% previously, **>\$1MM annual labour savings** by achieving high accuracy during holiday period

## PROJECTS

### **ROBOTICS, DEEP LEARNING AND SOFTWARE**

UC SAN DIEGO, 2023-2024

**Key Skills:** Extended Kalman Filter (EKF), Particle Filter, IMU, LiDAR, encoder, stereo camera features, intrinsics, sensor fusion, odometry, disparity, occupancy grid, texture map, SIFT, point cloud registration, PyTorch, C++, RAI, smart pointers, design patterns, templates, variants, STL

- **Visual-Inertial SLAM** for a car moving in an urban environment with an Extended Kalman Filter using **IMU data** and **stereo camera features** to map landmarks and plot the trajectory of a car in an urban environment
- **Particle Filter SLAM** for a differential drive robot moving through a building, in order to create an **occupancy grid map** and color **texture map** using **structure from motion**
- **PointNet-based neural network** in PyTorch to solve the **point cloud registration** problem, and achieved performance close to **Iterative Closest Point** (ICP) method on basic trajectories in Eden dataset
- (C++) **String library** with underlying buffer manager. **Achieved 25% lower memory usage than C++ std::string** for common string operations: append, replace, insert, erase, search
- (C++) Graph-based **in-memory JSON datastore** with query capability
- (C++) **Compressing archive tool** with add, extract, retrieve capability

## SKILLS

C++, Python, SQL, Numpy, Pandas, PyTorch, Keras, CVX, JAX, OpenCV, GCP, PySpark, Hadoop, Airflow, ROS, ROS2