NOOPUR KOSHTA

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EDUCATION

Worcester Polytechnic Institute — *Worcester, MA*
Master of Science in Robotics Engineering — *Aug 2022 - May 2024*
Nagpur University, India — *Nagpur,India*
Bachelor of Technology in Information Technology — *Aug 2011 -May 2015*

SKILLS

Programming Languages and Technologies: Python, C++, MATLAB; Data Structures and Algorithms
Tools: OpenCV, CUDA, ROS2, Gazebo, Rviz, CARLA, Drake, Git, Blender
Deep-Learning libraries and frameworks: PyTorch, TensorFlow, Keras, PCL, Boost

WORK EXPERIENCE

Multi-Agent Reinforcement Learning for smart mobility of Autonomous Vehicles for Nonstop Crossing of Signalized Intersections — *Worcester, MA*
Graduate Research Assistant| Reinforcement Learning — *Jan 2024 - Present*

- Trained multi-agent policies using **MAPPO** on environment imitating the dynamics of the Duckietown multi-agent testbed, with different levels of domain randomization.
- Rewards of the transferred policies with MAPPO and domain randomization are approximately 1.85 times superior to the rule-based method.

Motion Planning around Obstacles with Convex Optimization — *Worcester, MA*
Graduate Research Assistant| Motion Planning, Manipulation and Grasping — *May 2023 - Aug 2023*

- Path planning of Franka Emika manipulator to collect hanging fruits, using **Hybrid A* and RRT* with convex optimization** on Drake. Built a 3D farm map and estimated the motion trajectory using **ORB-SLAM**.
- Replaced the dual arm manipulator with a hollow tubular sack connecting the body and end-effector, to pick by encapsulating the hanging fruit in the tube.

Laser based Larynx Surgery — *Worcester, MA*
Graduate Research Assistant| COMET Lab — *Aug 2022 - Dec 2022*

- Designed the unidirectional notched-tube continuum arm. Determined each notch deflection by **Castigliano's Second Theorem**, alongwith modeling the frictional forces from the actuation tendon.
- Proposed segmented variable constant curvature along the length of the wrist, and calculated accurate kinematics for the end-effector to reach the target position..

Robotics Department — *Worcester, MA*
Graduate Teaching Assistant|Introduction to Robotics — *Aug 2023 - Present*

- Taught **Introduction to Robotics and (**RBE 1001) and evaluated the assignments. Helped students with designing their robots and resolving their queries in Vex using C++.

Ignitarium Technology Solutions Pvt — *Bangalore, India*
Senior AI Engineer | Computer Vision — *Nov 2021 -June 2022*

- Implemented in-built functions of OpenCV for **parallel processing of image pixels on edge devices** in C++ and CUDA.
- Reduced memory usage by 20% using shared and coalesced memory. Generalized the kernels for any image size.

Persistent Systems — *Pune, India*
Senior Machine Learning Engineer| Machine Learning and Deep Learning — *May 2016 - Apr2020*

- **Modified U-net based Medical Image Segmentation of Diabetic Retinopathy:** Used ResNet-34 as encoder and periodic shuffling for up-sampling with sub-pixel convolution instead of decoder. This modification in architecture gave faster convergence and a dice score of 99% for all classes.
- **Optical Character Recognition (OCR):** Implemented adaptive thresholding for handling varied lighting conditions, and content-aware page warping. Trained **zero-shot classifier** for character recognition in different fonts. Obtained accuracy of 99% on the content text and 97% on company names inscribed inside logos.

RELEVANT PROJECTS

Attitude Estimation using Filters [Github link] — ***[Python]***

- Implemented 6-DOF state estimation from gyroscope and accelerometer readings, using **Complementary Filter, Madgwick Filter and Unscented Kalman Filter.**
- Compared the obtained odometry with the ground truth data given by Vicon motion capture system

Trajectory Generation [Github link] — ***[Python, Blender, OpenCV]***

- Tuned the PID controller of the quadrotor to follow the desired trajectory generated from **RRT*** and smoothened using **Quintic Spline**.
- Implemented optical flow to detect the gap. The quadcopter then hovered to align with the center of the gap to pass through smoothly.

Home Service Robot [Github link] — ***[C++, ROS]***

- Implemented SLAM on a pick-and-place robot which localized using **Adaptive Monte-Carlo Localization**. Deployed a graph-based SLAM approach known as **Real-Time Appearance Based mapping (RTAB-Map)** on the simulated robot in ROS to create 2D and 3D maps of the environment.

AutoPano [Github link] — ***[Python, PyTorch]***

- Estimated homography between image pairs using feature correspondences. Used Adaptive non-maximal suppression for uniform features and RANSAC for removing outliers among feature matches. Lastly, warped, stitched and blended images to obtain the panorama.
- Trained **HomographyNet,** a CNN based supervised learning architecture to estimate the 4-point homography using synthetically generated data, which gave MSE loss of around 0.012.
- Trained unsupervised model in which 4-point homography obtained from CNN is used by **TensorDLT** to produce a homography matrix. This matrix is then used by **Spatial Transformer Network (STN)** to warp the images.

3D reconstruction using Structure from Motion (SfM) and Neural Radiance Fields (NeRF) [Github link] — ***[Python, PyTorch, OpenCV]***

- Reconstructed 3D scene using **SfM** via RANSAC, estimating camera poses from Essential Matrix, Perspective-n-Point (PnP) triangulation, Bundle Adjustment, and Non-Linear Optimization techniques.
- Implemented **NeRF** original paper for images of a scene taken in different lighting conditions.

Visual Inertial Odometry [Github link] — ***[Python, PyTorch]***

- Implemented a filter-based stereo visual inertial odometry that uses the **Multi-State Constraint Kalman Filter (MSCKF)** and obtained RMSE of 0.17.
- Trained a **Convolutional Neural Network (CNN) and Long-Short Term Memory (LSTM) Network** on synchronized visual and inertial EuROC data respectively and obtained 98.2% trajectory overlap on trajectories.

AutoCalib [Github link] — ***[Python, OpenCV]***

- Implemented intrinsic and extrinsic camera calibration method as presented by Zhengyou Zhang in his 1998 paper from Microsoft.
- Used eigen decomposition for solving homogeneous systems of linear equations & MLE for optimization of calibration parameters. The mean re-projection error post optimization was close to 0.5 pixels

Probability based Edge Detection [Github link] — ***[Python, PyTorch, OpenCV]***

- Implemented pb-lite, which detects boundaries by examining texture, color and intensity discontinuities across multiple scales. Outperformed Canny and Sobel by suppressing the false positives produced by classical methods in textured regions.

Kinematic Path Planner with Non-Holonomic Constraint [Github link] — ***[Python]***

- Developed a kinematic path planner namely **Hybrid A* and Probabilistic Roadmap Planner (PRM)** for vehicles (differential drive robot, car, and truck with a trailer) with non-holonomic Ackerman model to park without collision.

Deep Q-Learning to play Breakout [Github Link] — ***[Python, OpenAI]***

- Implemented **Double Deep Q-Learning Network (DDQN)** to play Breakout for an average reward of 80 points in 100 episodes.

Sensor Fusion [Github link] — ***[C++]***

- Instance segmentation and depth estimation of vehicles around the ego vehicle using Lidar, Radar and Camera data from KITTI dataset with RMSE of 0.8.