JEMUEL STANLEY PREMKUMAR

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Demonstrated proficiency in developing machine learning solutions tailored for 3D computer vision and motion planning algorithms for robot learning, with a focus on advancing vision-aided robotic manipulation and locomotion projects. Adept at seamlessly integrating machine learning techniques and libraries, coupled with proficiency in micro-services communication stacks for efficient robotic system interaction.

EDUCATION

University of Michigan **Ann Arbor, MI, USA**
MS in Robotics *Aug 2022-Present*

- **Relevant Coursework :** Robot Learning for Planning & Control, Deep Learning for Robot Perception, Robotics Systems Lab, Machine Learning, Action and Perception, Robot manipulation, Intro to Algorithmic robotics, 3D Robot Perception

SRM Institute of Science and Technology **Kanchipuram, Tamil Nadu, India**
B. Tech Mechatronics with specialization in Robotics *2018-2022*

- **Relevant Coursework :** Advanced Robotics, Robot Control, AI for Robotics and Vision, Planning and Decision making for Robotics, Computer Vision and its applications

EXPERIENCE

ABB Corporate Research Centre, Raleigh **Raleigh, NC, USA**
Robotics Intern | Robot Perception and Manipulation | Prompt Engineering *Jan 2023–Apr 2024*

- Currently involved in debugging previously developed system
- In the process of integrating 3D object tracking solutions (BundleSDF)
- Testing the developed task-planner and interface on a variety of **short and long-horizon grasping and trajectory generation tasks** on the ***ABB GoFA collaborative robot***
- Restructuring the task-planning with behavior trees

ABB Corporate Research Centre, Raleigh [Presentation][Demo] **Raleigh, NC, USA**
Robotics Research Intern | Manipulation | LLM | Microservice *May 2023 –Aug 2023*

- Engineered a modular framework for visual-language reasoning, leveraging Bard as the embodied agent for high-level task planning
- Adopted prompt-engineering tactics for developing the embodied task planner
- Executed **long-horizon manipulation task planning** for novel natural language commands, achieving seamless execution on the ***ABB GoFA collaborative robot***
- Developed a gRPC framework for platform-independent microservices for vision, robot control and UI
- Established a pipeline for the **Segment Anything Model** within an existing bin-picking project

TECHNICAL SKILLS

Programming Languages: Python, C/C++, MATLAB, RAPID | HTML, Javascript, CSS

Hardware: Intel Realsense RGB-D cameras (D415, D435), Kinect RGB-D camera, ABB IRC5, ABB Omnicore, Raspberry Pi, RP LiDAR, Arduino

Software stack: MATLAB-Simulink, RobotStudio, Git, Docker, ROS, Flask

Networking and communication: gRPC, Socket programming

Robotics/Other Libraries: PyBullet, OpenGym, OpenCV, Matplotlib, Numpy, Open3d, cvxpy, py_trees

ML Libraries: PyTorch, Tensorflow-keras, scikit

OS: Ubuntu, Windows

RELEVANT PROJECTS

Spot Robot Directed Research – Prof. Dmitry Berenson [Demo] **UMich**
Grasp planning-BT | Robot Perception and Manipulation *Jan 2023-Present*

- Demonstrated simple pick-and-place tasks with the existing SDK
- In the process of improving the Boston Dynamics Spot Robot's manipulation capabilities for better manipulation and grasping with behaviour-trees and grasp candidate generation

Development of grasp localization system based on DL aided vision system [Demo][Report] **SRM IST**
Grasp Localization | Robot Perception and Manipulation *Dec 2021 – May 2022*

- Developed a deep learning aided vision system to perform 6-DOF robotic grasp on novel objects using ***ABB Yumi Dual Arm Collaborative Robot*** and an overhead kinect RGB-D camera.
- Demonstrated diverse approaches to **grasp localization**, including ***ContactGraspNet***, ***GQ-CNN*** *(DexNet 2.0)*, and ***PointNetGPD***, with an additional presentation of a classical computer vision model.
- Established a Python-based interface between a Linux-based OS and IRC5 controller for efficient system integration.
- Conducted a brief study, analyzing and comparing results using appropriate grasp metrics.

Learning implicit shape representations for 3D reconstruction [Report][Presentation][Code] **UMich**
3D Perception and Reconstruction *Oct 2023 – Dec 2023*

- Efforts lead to replicate results of ***DeepSDF*** to learn 3D aware shape representations from latent code on ***ShapeNet*** dataset
- Demonstrated closed-reconstruction from partially observed pointcloud

Motion Planning and trajectory generation **UMich**
Motion planning | Simulation | PyBullet *Oct 2023 – Dec 2023*

- Collision-avoiding motion planning and trajectory generation using RRT-connect
- Inverse kinematics with Geometric Jacobian
- DMP (Dynamical Motion Primitive) controller for collision-avoiding goal reaching

Learning 3D grasp affordances from point clouds [Report][Presentation] **UMich**
3D Perception | Deep learning | Grasping *April 2023*

- Designed a **PointNet** based neural network for point cloud classification and segmentation for learning grasp affordances
- Demonstrated tool grasping in a simulated environment with known affordances

NeuralODE for learning dynamics [Report][Code] **UMich**
Learning Dynamics | Simulation | OpenGym *April 2023*

- Implemented a NeuralODE model utilizing the adjoint method to predict the dynamics of a Franka-panda-robot in gym simulated environment
- Involved in collecting trajectories by strategically sampling from the environment, ensuring diverse and representative data.
- Conducted thorough evaluations on three distinct setups: NeuralODE, Residual NeuralODE, and Residual Dynamics, showcasing comprehensive model comparisons and performance analyses.

Trajectory Optimization and control **UMich**
Linear MPC | MPPI | Simulation | PyBullet *Feb 2023 – Mar 2023*

- Conducted in-depth work within PyBullet's Franka panda robot environment, focusing on the collection of transition episode data for block-pushing tasks and evaluated pushing tasks
- Implemented **Linear MPC** and **MPPI** techniques for trajectory optimization of the panda robot, showcasing proficiency in advanced motion control algorithms.

Vision-aided autonomous manipulation of colored wooden blocks [Report-CV,Report-RC][Demo] **UMich**
Robot Perception and Manipulation | Computer Vision | ROS *Aug 2022 – Oct 2022*

- Developed a computer vision system to perform 5-DOF robotic grasp on colored blocks using Interbotix Reactor-X 200 serial robot arm and an overhead **Intel Realsense LiDAR RGB-D Camera**
- Demonstrated performance of the manipulation on 5 different pick-and-place tasks

Autonomous Non-holonomic Differential Drive Robot with LiDAR [Report][Demo] **UMich**
SLAM | LiDAR | Odometry | Robot Navigation and Reasoning *Oct 2022 – Dec 2022*

- Concerned with the development of an autonomous wheeled mobile robot (MBot) for SLAM with onboard LiDAR, Raspberry Pi, Picoboard, IMU and magnetic wheel encoders.
- Performed MCL and developed particle filter based on action model and sensor model
- Performed **A* path planning** and frontier-exploration for navigating in an unknown environment