Damanpreet Singh

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EXPERIENCE

Onward Robotics (*formerly* IAM Robotics)   *Pittsburgh, PA*
Robot Perception Engineer II   *Aug 2023 – Present*
- Currently working on replacing visual odometry in **LVI-SAM** with RGBD odometry, for use as localization solution
- Designed ROS prototype for warehouse SLAM using **Realsense D455** & **RTABMap** with **96%** map accuracy
- Designed ROS prototype for warehouse SLAM using **Ouster OS0** & **Google Cartographer** with **84%** map accuracy
- Designed mapping solutions using **Octomap** and **Kiss-ICP** for 2D Lidar sensor data and external pose
- Performed detailed literature review and comparison study on **12 open-sourced SLAM** algorithms
- Prototyped **Hough Transform**-based aisle bound detection as lane lines in occupancy grid at **10 Hz**, in Python3
- Integrated external pose information into Google Cartographer **Odometry factor** to reduce warehouse map skew
- Performed depth accuracy testing and calibration on **Intel Realsense D455** and **ZED X** depth cameras
- Created an application to acquire **time-of-flight sensor** data from custom PCB for fusion into **occupancy grid** at **10 Hz**
- Designed a windowed recording tool to store **boost shared memory** data types as **bytestreams** in C++

The Airlab & Biorobotics Lab, CMU   *Pittsburgh, PA*
Graduate Research Assistant (Prof. Sebastian Scherer, Dr. Mathew Travers)   *Aug 2021 – May 2023*
Project: Heterogeneous multi-robot system for exploration in unstructured subterranean environments (MMPUG, DARPA-SubT)
- Implemented and evaluated SOTA SLAM algorithms - **LIO-SAM**, **LOAM**, **FAST-LIO**, **CLINS** on **Subt-MRS** dataset
- Integrated real-time point cloud colorization in **SuperOdometry** using fiel-of-view analysis between RGB and Lidar
- Enabled natural language query-driven affordance prediction in point clouds, reaching **90%** performance relative to **SOTA**
- Performed ablation study for 3D models: **PointNet**, **PointTransformer** against language-vision models: **CLIP**, **CG3D**
- Developed C++ algorithm for generating SNR graph for radios in multi-robot setup, increasing exploration distances by **90%**
- Integrated and calibrated **FLIR-Boson** thermal camera into sensor stack with **<25 ms** time sync delay and **60 Hz** frequency

SKILLS

Software: Modern C++, Python, Git, CMake, ROS, Docker, GDB, Bash, GTest, Task, pthreads, Linux
Packages: C++ STL, Boost, GTSAM, Eigen, Ceres, PCL, PyTorch, NumPy, SciPy, Matplotlib, Pandas
Sensors: Realsense D455, ZED X, Ouster OS0, Hesai JT256, Velodyne VLP-16, Sick 2D Lidar, Epson IMU, LI RGB, FLIR Boson
Hardware: NVIDIA Jetson Orin, NVIDIA Jetson Xavier, NVIDIA Jetson TX2, Arduino

EDUCATION

Carnegie Mellon University (CMU)   *Pittsburgh, PA*
Master of Science in Mechanical Engineering – Research (Concentration: Robotics)   *May 2023*

Thapar Institute of Engineering and Technology   *Patiala, India*
Bachelor of Engineering in Mechanical Engineering   *June 2021*

ACADEMIC PROJECTS

3D Rendering using Neural Radiance Fields (NeRF) 🌐   *Spring 2023*
- Implemented 3D volume and surface reconstruction pipelines in Pytorch3D, using Neural Radiance Fields
- Extended baseline with Phong relighting and hierarchical point sampling

Learning-based Single View to 3D Reconstruction 🌐   *Spring 2023*
- Designed image to 3D reconstruction using convolutional and MLP networks, for **voxels**, **meshes**, and **point clouds**
- Achieved object reconstructions with **0.88** F1 score and extended the network for occupancy queries

Absolute Conic-based Single view to 3D Reconstruction 🌐   *Fall 2022*
- Designed single image-based camera intrinsics calibration routine using Image of Absolute Conic and vanishing points
- Designed image-based 3D reconstruction using plane annotations and camera intrinsics, with Shapely in Python3

Feature Extractor Voting for Visual Inertial Odometry 🌐   *Spring 2022*
- Incorporated **SuperPoint** feature extractor into frontend of **VINS-MONO**
- Created feature voting and fusion algorithm for SuperPoint and classical features, reducing odometry failure cases by **~40%**

PUBLICATIONS

- *Shibo Zhao, Y Gao, T Wu, **Damanpreet Singh**, ... , Sebastian Scherer et. al. "SubT-MRS: A Subterranean, Multi-Robot, Multi-Spectral and Multi-Degraded Dataset for Robust SLAM" CVPR 2024*
- *Namya Bagree, Charles Noren, **Damanpreet Singh**, Matthew Travers, and Bhaskar Vundurthy. "High Speed Convoy in Unstructured Indoor Environments" IFAC World Congress, 2023*