Dataset for Experimental Validation of Wi-Fi Sensing

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Introduction

- Simultaneous localization and mapping (SLAM) is an actively researched problem in the robotics and computer vision community, and a wide range of sensors, including 2D laser scanners (LIDAR), 3D LIDAR, monocular cameras and RGB-D sensors, are used to accomplish 2D and 3D mapping.

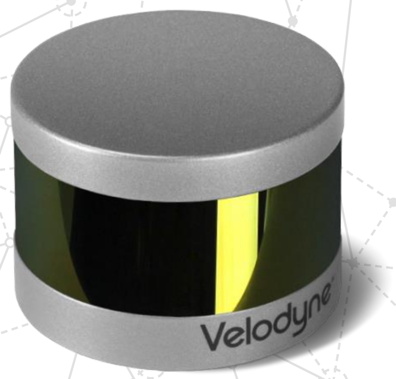

Figure 1: Velodyne VLP-16 3D LIDAR

Figure 2: Microsoft Kinect RGB-D Camera

- Wi-Fi can be used to augment SLAM algorithms by providing additional information for localization.
- The presented dataset will be **the first** to incorporate RGB-D streams of indoor spaces with Wi-Fi information such as BSSIDs and corresponding signal strengths, allowing researchers to test their algorithms incorporating Wi-Fi sensing with visual sensing for other activities.

Data Specifications

The dataset will be provided in the ***rosbag*** format, to be used with the **Robotics Operating System (ROS)** framework. It will consist of the following information:

- **Odometry** from the robot's wheel encoders.
- **RGB-D stream** from the Kinect RGB-D Camera.
- **Wi-Fi data** from the robot's on-board computer.
- **3D LIDAR scans** from the Velodyne VLP-16.

The dataset will also contain the ***groundtruth*** maps of the indoor spaces to compute an accurate trajectory of the robot for benchmarking the developed algorithms.

The Robot

The robot being used to gather the dataset is the **Turtlebot 2** and it has been outfitted with the following:

A. Microsoft Kinect v2 – RGB-D camera.
B. Velodyne VLP-16 – 3D LIDAR scanner.
C. NVIDIA Tegra K1 – On-board Computer

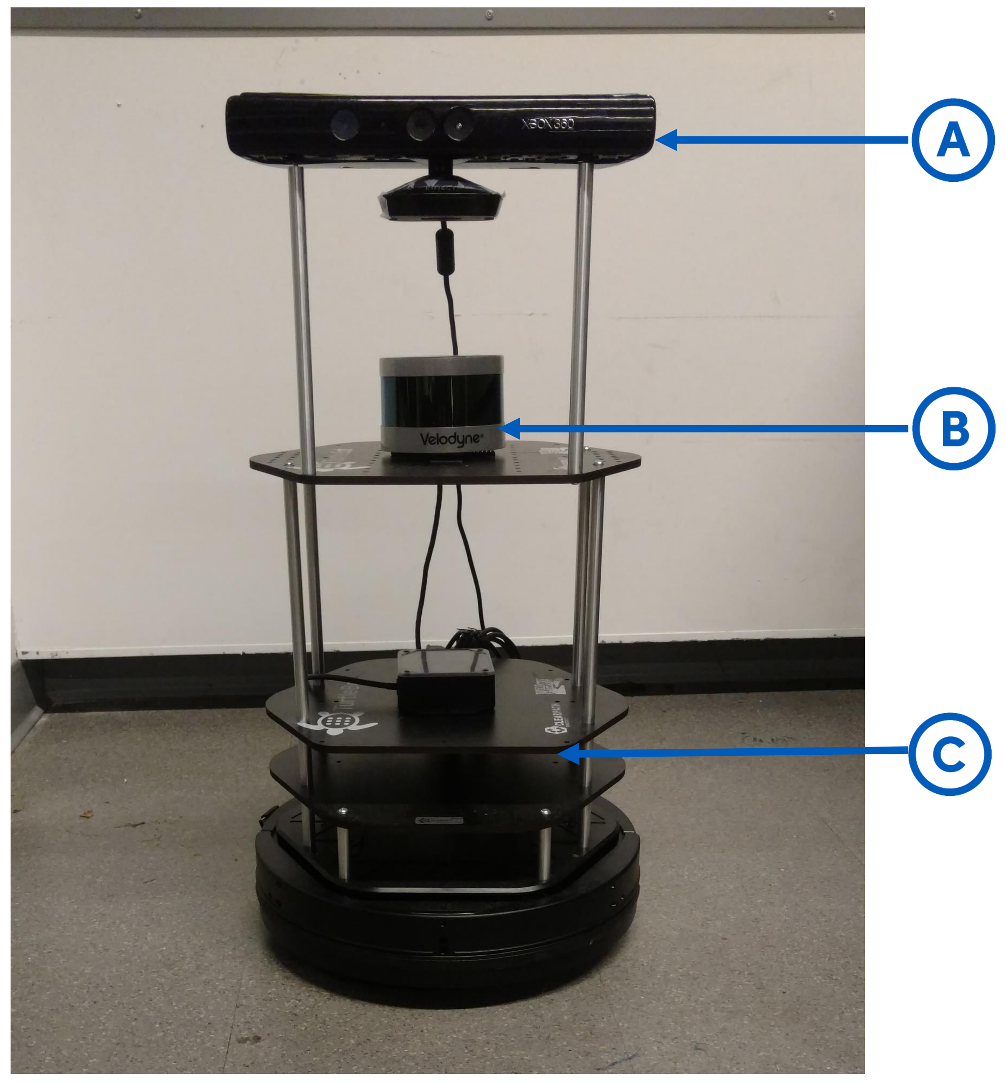

Figure 3: Robot setup with sensors and computer

Ground Truth for the Dataset

The ground truth map and trajectory will be obtained by the following:

1. Running Google Cartographer on the robot and drive it around, covering as much of the floor as possible and over several iterations.
2. Manually edit and smooth the map obtained in **step 1** using the floor plan of the building as reference. This will be the ground truth map
3. Using this map to generate the trajectory of the robot during the data collection round.

Results

Incorporating Wi-Fi into existing algorithms can be useful to enhance the efficiency, accuracy and computational requirements of the algorithm. The following are examples of results from using the dataset to enhance SLAM.

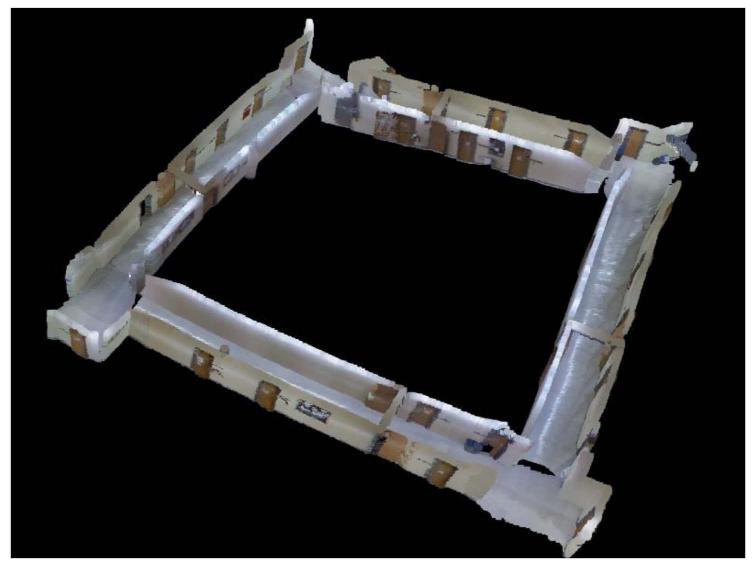

Figure 4: Wi-Fi optimized map of Cook Hall

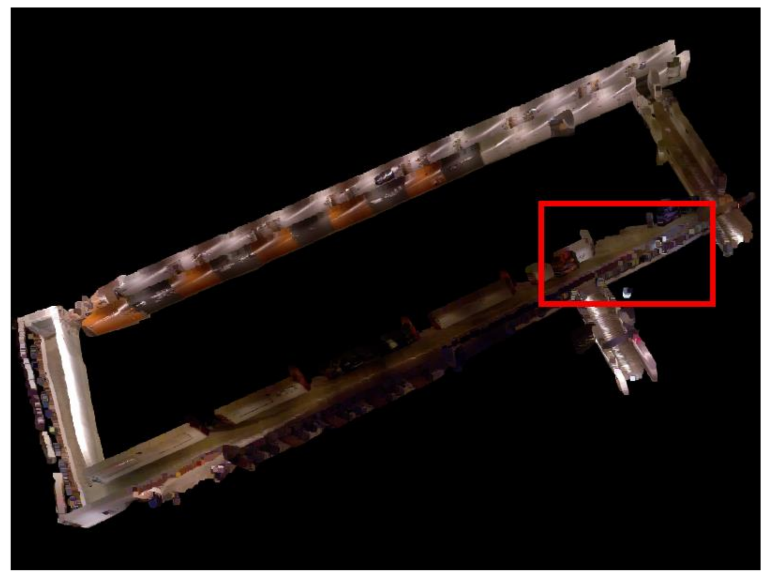

Figure 5: Wi-Fi optimized map of Davis 3rd floor. The red box depicts the region of loop-closure.

Example Ground Truth Maps

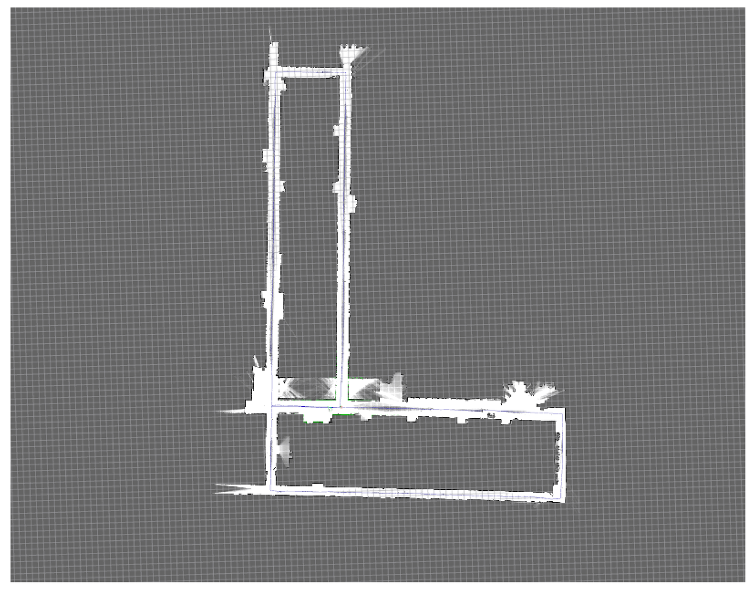

Figure 6: Pre-corrected Ground truth map of the 3rd floor of Davis Hall, obtained using Google Cartographer

Future Work

The dataset can be improved by:

- Gathering data from a diverse set of floors, with different number of loops and branches, and layout in general.
- More extensive ground truth. This can be accomplished by possibly using methods like Iterative Closest Point (ICP) to obtain an accurate trajectory.

References

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