**Capstone Design Project Proposal**

**Autonomous Terrain Mapping and Asset Localization using Wheel-Based Rovers**

**Proposer:**

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**Project Title:**

* Autonomous Terrain Mapping and Asset Localization using Wheel-Based Rovers

**Problem Statement:**

* The use of autonomous mapping and real-time tracking would be a real asset in all domains, especially in the medical field. Many who work in a hospital spend a lot of time looking for equipment/assets when they can optimize their time helping patients. For example, in a study done by General Electric HealthCare, they found that nurses can spend between 20-60 minutes looking for lost equipment.[[1]](#footnote-0) There is a real need for a system that provides tracking of equipment so nurses can get back to what they do best - caring for patients. Using an autonomous mapping system would only provide benefits for those who use the system as it would give a detailed structure of the floor. A system like this would need to be lightweight and efficient in collecting data so there is no error when trying to look for equipment.

**Current State:**

* The previous team built a sensing system to track wheel-based assets built using two Raspberry Pis (RPi) and inertial measurement units (IMU). The system utilizes multiple 9-degree inertial sensors (accelerometer, gyro, magnetometer) that were installed on the wheels of the assets. Data sampled from the inertial sensors can be collected, stored, and analyzed to extract fine-grained information on the asset mobility. The mobility information recorded includes distance traveled and turns. The system has been tested on wheel-based assets such as wheelchairs in indoor environments. However, the system does not display position relative to objects within an environment. Additionally, it experiences gyroscopic drift due to the choice of sensor, causing readings to diverge from the true position of the asset over time.

**Proposed Deliverables:**

* Updated sensor (rotary optical encoder)
* Autonomous environment mapping capability (SLAM)
* Database to store historical position of assets

**Business and Functional Requirements:**

* BS-1: Reduce time spent looking for equipment
  + F-1.1: Implement a tracking system to locate equipment
  + F-1.2: Display location on screen/UI
* BS-2: Reduce cost of tracking items
  + F-2.1: Attach cheap and lightweight sensor to equipment
* BS-3: Store the last position of an item
  + F-3.1: Implement database to store location data
  + F-3.2: Allow for efficient retrieval of historical data
  + F-3.3: Communicate between sensor and database at regular intervals
* BS-4: Minimize drift and track position accurately over time
  + F-4.1: Replace IMU with rotary optical encoder and supporting components to track movement of wheels
  + F-4.2: Compare rotary optical encoder performance and accuracy to IMU
* BS-5: Autonomously map location
  + F-5.1: Attach sensor capable of measuring depth input
  + F-5.2: Develop a SLAM-like layer to process depth input then output map
  + F-5.3: Visualize map

**Constraints:**

* RPi capabilities
  + 1GB RAM
  + Linux OS
  + GPIO pin voltage max of 3.5V
* Sensor must be hub-mounted on two wheels to be compatible with previous code
* Rotary optical encoder’s vulnerability to dust and other contaminants
* Communication between sensor and RPi must not interfere with wheel rotation

**Anticipated Resources Required:**

* We will purchase two rotary optical encoders, quadrature counters, and units to communicate between the sensors and the RPi (bluetooth modules, wires, etc.).

**Stakeholders:**

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1. [Applying RTLS Technology to Improve Nurse Efficiency and Patient Care](https://www.himss.org/resources/applying-rtls-technology-improve-nurse-efficiency-and-patient-care#:~:text=In%20a%20study%20conducted%20by,shift%20searching%20for%20lost%20equipment.&text=One%20health%20system%20in%20Buffalo,looking%20for%20and%20cleaning%20equipment.) [↑](#footnote-ref-0)