

# STAT 654 Project Proposal

**To:** Dr. David Jones

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**Subject:** STAT 654 Project Proposal

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The team intends to implement a filter using various sensors from the existing Autonomous Trolleys in the Unmanned Systems Lab to increase localization accuracy. Localization accuracy is currently limited by the precision of the GPS/INS module, and excludes the additional information provided by the steering angle, wheel speed, and knowledge of the vehicle dynamics.

In order to maximize location accuracy, the team intends to use an error state formulation of the Extended Kalman Filter (EKF) which will include the position offset values for the Inertial Measurement Unit (IMU), as shown in the figure below. This produces the best linear unbiased estimator of the linearized vehicle dynamics while incorporating updates from both the wheel odometers and GPS measurements. Due to the remote working conditions, we plan to use a previous dataset collected, which includes wheel odometry, a [VectorNav IMU/GPS](#), and steering angle measurements. Applying the filter to this data should produce a dataset of the vehicle state as a function of time, which will include position and orientation, as well as the offset errors.

Given sufficient time, the team will also strive to implement this filter to function in real-time. This would allow the results from this project to be implemented on the autonomous trolleys.

Lastly, the team would like to use a least-squares formulation to estimate the error terms of the accelerometer and gyroscopes. Once an initial value is found, it would be possible to include these terms in the error state of the EKF for real-time estimation updates.

## **Deliverables:**

### **Baseline**

- Positional offset estimations ( $\hat{R}_{offset}$ ) between the IMU, and Vehicle frames
- Filtered vehicle position that incorporates IMU, GPS, and the vehicle model

### **Aspirational**

- Estimation of sensor calibration terms
- Real-time filtering support
- Real-time updates of accelerometer and magnetometer calibration terms

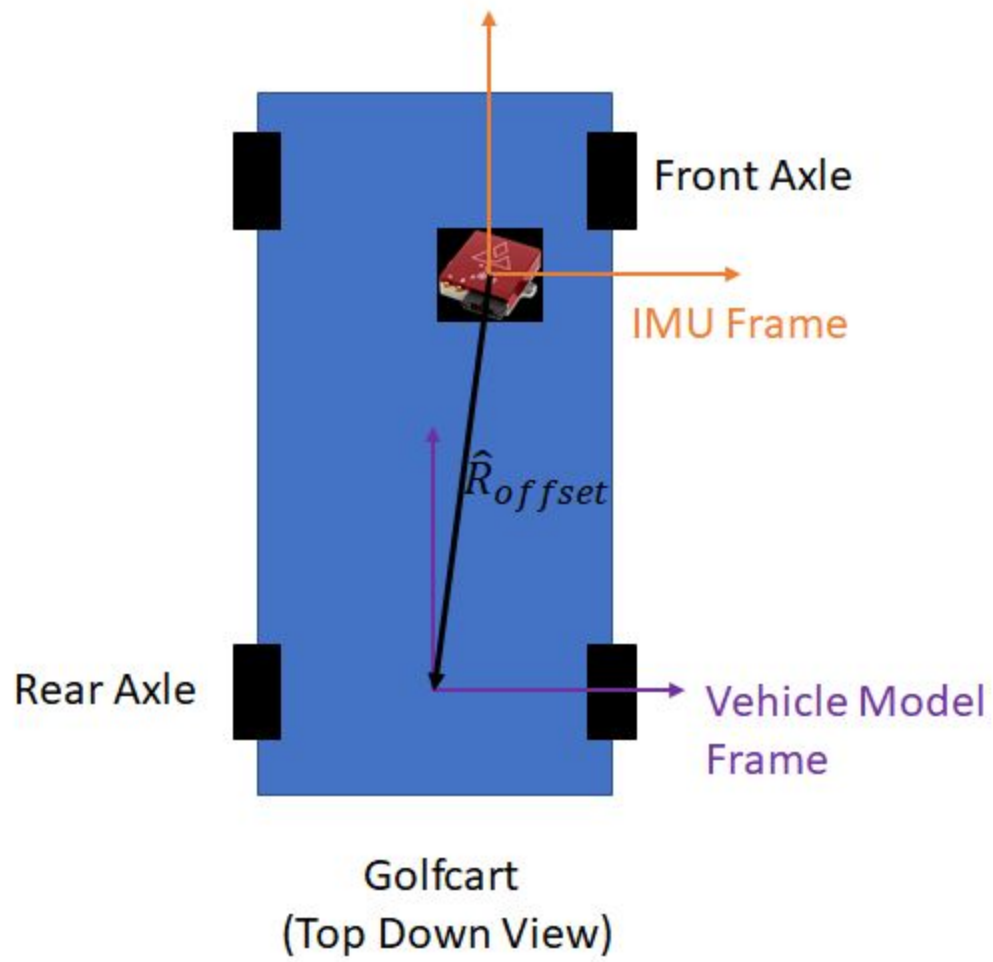


Figure 1: Golfcart and IMU Diagram