Motion Model and Filtering Techniques for SVEA Vehicles with Fiducial Detection

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December 2, 2019

This project aims to estimate pose (position and orientation) of SVEA vehicles (Small Vehicles for Autonomy) by different methods and compares the estimated values to the true pose of the vehicle as determined by a motion capture system (Qualysis). The objective in all the provided goals will be to reduce the pose estimation error of the vehicle by developing a highly accurate motion model using IMU measurements and/or control inputs. We will then use the accurate motion model to compare both Kalman Filter and Particle Filter estimators for all cases. All observation measurements will come from relative pose estimates of RGB cameras to fiducial (ArUco) markers and all process updates will come from the developed motion models. The project has been divided into four goals of increasing difficulty:

- For the first task, we will be calculating the estimated pose of a SVEA using a stationary vision camera. It detects the ArUco marker placed on the SVEA vehicle which is being driven remotely inside the Smart Mobility Lab (SML). There will be long periods of occlusion, so an accurate motion model will be critical.

- For the second task, we will estimate the pose of the original SVEA using a camera in a dynamic environment. This will be accomplished by placing the vision camera on a second SVEA vehicle driven remotely near the original SVEA.

- For the third task, we will be implementing the motion models and filtering techniques in conjunction with a graph SLAM algorithm using multiple ArUco markers placed throughout the SML.

- For the final task, we will attempt to autonomously drive/control the second SVEA by detecting the ArUco marker on the first SVEA vehicle **(if time permits)**. The first SVEA vehicle will be remotely driven, as in all cases above, and the second will attempt to follow closely behind.