Visual-Inertial Odometry & Machine Learning
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Abstract

This thesis was designed around the upcoming technologies of Augmented and Virtual Reality. In order to apply these technologies the system on which they are running needs to have a constant knowledge of the device’s position and orientation. Tracking this position and orientation using a selection of sensors is called odometry. A distinction is made between Visual Odometry, which utilizes one or more cameras as main sensors, and Inertial Odometry, in which the device’s inertial sensors (e.g. IMU) function as the main input. Last, both forms of odometry can be fused to get Visual-Inertial Odometry.

For this thesis a Visual Odometry system called ORB-SLAM2 was tested and it’s performance served as a benchmark for the rest of the thesis. Next, a series of experiments was performed to see whether a Machine Learning system in the form of a Multilayer Perceptron could be designed which could perform Inertial Odometry by estimating the position and orientation from IMU sensor data. While accelerometers are noisy sensors the desired performance was not achieved for position estimation. For orientation estimation the results were better but still not accurate enough when compared to the benchmark. Last, research was done on an existing system designed for Visual-Inertial Odometry. The system fuses the output for Visual and Inertial Odometry using a Kalman Filter. The goal of this thesis was to investigate the influence of sensor noise on such a system. The way this is done was to use ORB-SLAM2 as the Visual Odometry and the KITTI dataset ground truth as the Inertial Odometry. By adding different amounts of Additive White Gaussian Noise to the ground truth the influence on the system could be analyzed. As expected, adding more noise decreases the accuracy. By calculating the crossover point (where the Kalman Filter starts favoring the Visual Odometry) we can determine how accurate any Inertial Odometry system has to be for it to aid the Visual Odometry system. The goal in the future is to design such accurate Inertial Odometry systems which will improve the Augmented and Virtual Reality experience for its users.