Abstract

This master thesis investigate the accuracy of a driving assistant system to be sure of its functionality within a reasonable accuracy range. The system uses structure-from-motion to reconstruct the 3D points from series of images.
To do such an investigation, first the sensors and their effects on the system should be taken into account. Since the main sensors are camera and wheel odometry in this driving assistant system, a detailed investigation about these sensor parameters, calibration and effect on the result has been done. In the camera calibration process, the camera parameters as well as lens distortions are obtained. Also repeating the measurements in different time intervals and with different methods, determined an approximate deviation of those parameters. The coordinates of the principal point shows the most deviation. But it has less than 1 centimeter effect on the final results, since the relative position of points are important rather their absolute positions. The focal length deviations are less, but have bigger effect (up to 2 centimeter) on the system. The lens distortion deviations and effects on such a system are negligible. The wheel odometry sensor has been analyzed and its displacement vector error at each epoch showed maximum 2 centimetre error with respect to the reference displacement vector from GPS-IMU. As the wheel odometry is used for scaling the system, its errors have a direct effect on the point clouds. This effect will be larger, for the points far away from the camera. The effect of this error on the system has been shown and concluded that there is a need for at least 4 meter driving of the car (distance of the first and laast camera position) to diminish this effect to less than 1 centimeter and 2 centimeter for the points at 20 meter and 40 meter away from the car respectively.
Second, the structure-from-motion process and its effects on accuracy should be considered. The process and its effects are describe and a program is developed to serve the purpose for this driving assistant system. The program is developed from the concept of structure-from-motion for the case of driving in a direction with mono-camera. Then within this program different strategies have been compared. The SURF feature detector and descriptor has been chosen in comparison with Shi-Tomasi corner detector. Although Shi-Tomasi has shown better point cloud outputs for object detection and less re-projection errors, but it was sensitive to the environmental changes such as light. So in many cases it was not possible to have the car trajectory completely and the connection of images are lost easily. So the SURF feature detector and descriptor have been used for the final calculations and 3D point cloud creations.
In the last step, the validation of such a driving assistant system with the proposed method is implemented. The car trajectory using the camera (visual odometry) showed to be more precise than wheel odometry and comparable with the GPS-IMU trajectory. Also the driving assistant system showed the maximum deviation of 4 centimetre with the ground truth in the sample sequences. The standard deviation of candidate points for the edges of obstacle with respect to the fitted edge is less than 9 centimeter.