Position and Attitude Determination Using Built-in Sensory Data and Front Camera Images for Car Navigation

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Abstract: Car navigation systems are widely used by the benefit of the development of navigation sensors like GPS and manufacturing technology of digital maps. Furthermore, the advent of smart devices increases the usage of navigation more and more. Despite the high usage rate, the navigation is only dependent on the mounted GPS performance and it leads to low accuracy of car's position and attitude. For example, if a car in a road surrounded by high buildings or in a GPS outage section such as a tunnel, its navigation system cannot define the accurate position and attitude of the car. In addition, when a car is in an interchange, the navigation system has difficulty to decide whether the car is on a ramp way or not. Recently, a car employs various built-in sensors such as a speedometer, odometer, accelerometer and angular rate sensor for safety and maintenance. These sensory data can be provided in real time through a CAN (Controller Area Network) bus. In this study, we propose a new method to determine car position and attitude using the built-in sensory data such as a speed, angular rate and images from a front view camera. The method includes two steps. First, we determine the two-dimensional position and attitude of a car using the velocity and angular rate provided in real-time through the CAN bus. We then estimate the three-dimensional position and attitude by conducting sequential bundle block adjustment using the two-dimensional position and attitude and tie points between image sequences. The sequential bundle adjustment can produce accurate results comparable to those from the conventional simultaneous bundle adjustment in real time. This can be rapidly performed with minimal computation using the previous computational results, whenever a new image is acquired. To evaluate the performance of our method, we constructed a system that can acquire and store built-in sensory data and front camera images at the same time. We are still progressing in verifying the method with the real experimental data. Currently, we checked the quality of the built-in sensory data by comparing them with the reference data produced from a high grade GPS/INS system. As a result, the RMS of the velocity and angular rate are 0.9 km/h and 0.28 deg/s, respectively. In the near future, we will estimate the trajectories of a car using the velocity, angular rate and images and then verify the feasibility and improvements of the proposed method.

Keywords : Position, Attitude, Navigation, Image, Speed, Angular rate, CAN