Robust & High Accurate Navigation Solutions for GPS-Challenged Environments

Robust and highly accurate navigation systems are demanded for many applications (e.g., for robotics, automotive industry). In the field of positioning and navigation, the Global Positioning System (GPS) receiver has dominated the market for decades. However, it does not work in all environments. Therefore, as an autonomous navigation system, the inertial navigation system (INS) shows its great suitability to be used here. The integration of INS and GPS is highly recommended, due to their complementary natures, which combines the best of two worlds, working in all environments, and constitutes a potential and powerful alternative to the GPS alone navigation devices.

One research focus of the navigation group highlights the algorithmic development for the integrated system. The objective is to promote the system robustness and estimation accuracy using low-cost sensor systems. As compared with conventional integrated solutions, the improvements are made mainly in the following aspects:

- Advanced sensor fusion algorithms guarantee the robust and highly accurate navigation solution for applications, in which the GPS signal environments vary over time.
- Inertial sensor errors are accurately estimated and compensated during run-time. Therefore, the sophisticated inertial sensor calibration process is optional, or not needed.
- Algorithm complexity reduction reduces the computational load and tailors the algorithm into a programmable processor (e.g., DSP).

The integrated system exploits a tightly-coupled integration scheme with advanced sensor fusion algorithms. Numerical results from field experiments show its outperformance with respect to that of conventional navigation systems. Moreover, using advanced Kalman filtering approaches, the integration of GPS with low level inertial sensor exhibits comparable system performance as compared to that of using higher level inertial sensors.

In the future, substantial research efforts are also devoted to other topics, such as the realization of Gyro-free inertial sensor systems, robust navigation for GPS-denied environments (e.g., indoor) and for unmanned aerial vehicle (UAV) based applications. Navigation based on other global navigation satellite systems (GNSS) is also in the focus. For instance, a software GPS + Galileo receiver is under development.

Hardware-in-the-loop system & sensor devices

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