Sensor Data Fusion
for Localization

The Navigation group of the department Power Efficient Systems (Leistungsoptimierte Systeme, LOS) concentrates its R&D activities on global navigation satellite systems (GNSS). Special attention is being paid to new algorithms to reduce the start times or to improve the acquisition and tracking of weak satellite signals, and to enable the localisation and navigation in indoor environments.

Additionally to the enhancement of the algorithms for both GPS and Galileo signals other approaches for indoor localization are being investigated in cooperation with the Chair of Information Technology LIKE at the University of Erlangen-Nuremberg. Where GNSS shows its weakness, it is possible to complement it with other Fraunhofer IIS technologies like a Wi-Fi Localization System (WPS) or an Inertial Navigation System (INS).

Beyond GNSS: Sensor Data Fusion

Sensor data fusion is based on the combination of different sensor signals of different systems to calculate a more accurate and robust system solution. Thus, it is possible to combine GNSS, WPS, and INS sensor data using recursive filters as the Kalman Filter to obtain a better position solution: More accurate, since it is possible to interpolate the GNSS and WPS data thanks to the inertial sensors. And more robust, since system outages from both systems can be bypassed.
These algorithms can be used for post processing and for real-time operation depending on the application.

Moreover, the inertial sensors allow to obtain information not only about the position but also and especially about the orientation or attitude of the system.

**Inertial Measurement Systems**

To evaluate the benefits of the inertial sensors, Fraunhofer IIS develops different inertial measurement units (IMU). The resultant hardware and software can be easily adapted for different applications. Figure 1 shows the latest IMU developed: the iSens-3.

This sensor module consists of three MEMS-accelerometers, three MEMS-gyroscopes and three magnet field sensors. A barometer and a 13,56 MHz RFID-unit can be additionally added, see Figure 2.

All of the sensors are mounted orthogonal to each other, to get the necessary 3D-information.

Nevertheless due to the intrinsic error characteristic of the MEMS-based sensors, to get a realistic and proper performance it is necessary to provide accurate sensor models to the algorithms, especially for localization purposes, where the accuracy is of paramount importance.

Thus, parameters as the offset, scaling-factor and assembly non-orthogonalities have to be determined, through an accurate calibration process and later through a dynamic on-the-fly process by means of, for example, Kalman-filtering.

**Calibration Service**

The Department Power Efficient Systems possess a 2-axis rotary stage for sensor characterization. The calibration routines are planned to be used not only with the IMU-Hardware developed at Fraunhofer IIS, but also to characterize sensors of other parties. Static calibration allows for the determination of the scaling factors and misalignment matrix.

*Please do not hesitate to contact us for additional information.*

**Applications**

Inertial measurement units can be found in a lot of applications. The most well-known are the Wii-Console and the Segway Personal Transporter.

Other fields of applications for the inertial measurement units:

- **Logistics:** to assure a complete monitoring of goods, in security areas, to monitor especially valuable or dangerous goods.
- **Medicine:** to properly steer surgeon equipment, for rehabilitation purposes or for analysis of high-performance athletes.
- **Navigation systems:** the inertial measurement unit together with the sensor data fusion algorithms are the key to develop systems as for example context-aware guidance systems for exhibition touring, electronic guide for blind or visually impaired, public safety services such as E911 and integrated navigation system for pedestrians.