Embedded Inertial Measurement Unit for Real-Time Sensor Integration and Data Processing

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ABSTRACT

For a reliable and precise positioning of people and materials in indoor multipath environments, it is a common technique to combine the position estimations of an RF-based localization system with an inertial navigation system (INS). The latest advances in micro-electro-mechanical (MEMS) acceleration and gyroscopic sensors support the design of a low-cost and miniaturized inertial measurement unit (IMU).
A custom MEMS-based IMU using a three-axis accelerometer, a three-axis gyroscope and a fluxgate magnetometer is proposed. Beside the noise characteristics of the IMU sensors, the sensor integration and data processing in real-time are the main issues to enable low INS position drifts. The digital processing unit (DPU) is based on the Cortex-M4 architecture, offering a floating point unit for complex data processing in real-time (e.g. for Kalman filter, attitude and heading calculation, coordinate transformation, sensor fusion).
The calibration of the sensors and the evaluation of the system performance are investigated using a custom-made calibration table with a step motor and PC-based motor control. A comparison with purchasable IMU systems like the iNEMO platform shows the outstanding performance of the custom solution regarding sensor noise and real-time processing.

KEYWORDS: Inertial Measurement Unit, Inertial Navigation, MEMS, Pedestrian Navigation