A Study on Indoor Pedestrian Localization Algorithms with Foot-Mounted Sensors

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ABSTRACT

The work presents a foot-mounted sensor system for combined pedestrian indoor/outdoor localization. The localization system is based on a zero-velocity-update scheme formulated as an Unscented Kalman filter with quaternion orientation representation and employs a custom low-cost sensor unit with only basic sensor calibration. Both, the MEMS accelerometer and gyroscope biases are estimated along with the foot's position, velocity and orientation. The presented filter is compared to a more conventional EKF formulation both in terms of speed and estimation accuracy. A detailed analysis is provided with respect to different filter state formulations, stance still detection mechanisms and associated filter parameters. The work also demonstrates how this pure inertial system can be augmented with magnetic field sensor for heading correction and discusses some of the challenges due to magnetic field disturbances for indoor environments.

The position estimation results are provided for several representative scenarios including indoor/outdoor localization and multi-storey environments. The challenging setup with an elevator segment is addressed by augmenting the system with a barometric pressure sensor for height error correction. We also demonstrate how the absolute position drift can be corrected with low-cost passive RFID tags placed on the floor. For the RFID-based scenario we also show how the estimation quality can be improved by reformulating the position estimation as a smoothing problem between RFID detection events. Finally, we discuss an ongoing work on the implementation of the algorithms on an Android based device and the incorporation of GPS information for outdoor scenarios.

The work clearly demonstrates the feasibility of the localization approach even for the case of low-cost sensors without sophisticated calibration procedures, and shows a possibility to reduce or even avoid long term position drift without the need of an active external infrastructure, such as WLAN.

KEYWORDS: Indoor Localization, Pedestrian Navigation System, Zero Velocity Update Method, Unscented Kalman Filter, Inertial Measurement Unit.