A Particle Filter Approach to Indoor Navigation Using a Foot Mounted Inertial Navigation System and Heuristic Heading Information

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Foot mounted inertial navigation is an effective method for obtaining high quality pedestrian navigation solutions from MEMS sensors. Zero-Velocity information from stationary periods in the step-cycle can be used to regularly correct position drift and update estimates of the inertial sensor biases, hence dramatically improving the navigation solution.

However the causes of heading error remain poorly observable and so foot mounted inertial navigation suffers from considerable drift over time. To address this problem the authors previously developed Cardinal Heading Aided Inertial Navigation (CHAIN). CHAIN makes use of the fact that when in a building, obstacles such as corridors and furniture constrain pedestrians to move in one of four directions parallel to the outside walls of the building. This knowledge is then appropriately weighted and used in an Extended Kalman Filter to improve error estimation.

Although the CHAIN method is very effective at improving the quality of the heading estimates, position errors still accumulate with time, and threshold tests are required to cope with periods of motion away from the cardinal headings. In this work we investigate the use of a building floor plan to further aid navigation. This is achieved using a particle filter approach whereby particles which cross walls are removed and those which navigate in open spaces are allowed to continue. Previously the particle filter approach has been computationally intensive process requiring many particles to effectively model the navigation errors.

In our work we recognise that heading is the primary source of navigation error and therefore incorporate heuristic heading information into the particle filter design. By weighting particles according to their heading we reduce the number of particles required to maintain a small failure rate and improve system performance in more open areas where there are few mapped walls to aid navigation.

This paper will describe the design of our particle filter and the heuristic heading approach. Results from a number of representative test walks using a MEMS IMU will be used to demonstrate the system performance.