Track4 – Long system description

BUPTer

In the constantly evolving landscape of indoor positioning systems, our innovative Foot-Mounted Inertial Measurement Unit (IMU) Tracking System stands as a paradigm shift. The system's principal mission is to deliver robust and meticulously precise location tracking. In this endeavor, the system harnesses a plethora of on-board sensors integrated into a foot-mounted device. The primary engine powering this intricate setup is the IMU, which is adept at determining a user's position with extraordinary accuracy.

A crucial facet of our system is its reliance on Pedestrian Dead Reckoning (PDR), a sophisticated process that computes an individual's current position using previously established ones as reference points. By considering each step as a progression, our system employs a state-of-the-art step detection algorithm. This algorithm is adept at identifying intervals when a foot is stationary, typically observed at the culmination of each step. The algorithm extensively utilizes data from the IMU's accelerometer and gyroscope, maximizing the efficacy of the available technology. By tracking the user's movement path in real-time, our system assures high-precision positioning.

Notwithstanding the inherent merits of PDR and IMU-based navigation systems, they grapple with certain challenges. A notable one is the phenomenon of drift, which refers to the gradual accumulation of errors over time. Drift primarily originates from the double integration of accelerometer data required to estimate displacements. Our system, however, adeptly addresses this concern by implementing the Zero-Velocity Update (ZUPT) algorithm. Exploiting the brief moments of stationary foot during each gait cycle, the ZUPT algorithm rectifies the drift, markedly bolstering the overall positioning accuracy. This approach is crucial in tackling the subtleties within each gait cycle, significantly enhancing the reliability and accuracy of our system.

Accurately tracking a user's vertical displacement, especially across different floors within a building, is a complex aspect of indoor navigation. Our project tackles this by integrating a barometric sensor for accurate altitude estimation. By calibrating this sensor to a known reference pressure level, the system is capable of computing the user's relative height. This allows it to identify the specific floor level with precision. The utilization of atmospheric pressure variations in this manner offers a dependable solution to the three-dimensional intricacies of indoor positioning.

To assure reliable positioning across diverse scenarios, our system employs data fusion, integrating data from various sensors. This is achieved through the implementation of the robust Kalman filter, an algorithm designed to amalgamate data from different sensors to generate precise and reliable positioning estimates. The dynamic nature of the Kalman filter allows it to handle noisy sensor data and predict the system state even under conditions of uncertainty or missing measurements. In doing so, our system effectively manages and integrates diverse sensor data, enhancing the precision and reliability of its positioning capabilities.

In summary, the proposed Foot-Mounted IMU Tracking System is a comprehensive and pioneering solution for indoor navigation. By harnessing modern sensor technology, sophisticated algorithms, and advanced data fusion techniques, our system delivers robust and precise positioning data. Its versatility extends to its functionality, designed to operate efficiently across a wide spectrum of environments. Be it within the confines of intricate architectural structures or in the unpredictability of outdoor spaces, our system remains committed to providing users with precise and continuous position tracking services.