Location-related gestures as landmarks in pedestrian SLAM for ambient-assisted living

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ABSTRACT

Indoor localization at minimal deployment effort and costs is relevant for many ambient-assisted living scenarios. Applications include the identification of hazard zones at home (e.g. areas of frequent falls or freezing of gait in Parkinson's disease patients), gait rehabilitation exercises embedded in daily life and patient monitoring. Systems should be capable of mapping the a-priori unknown home environment and allow accurate localization within that map, using body-mounted sensors only.

We propose a gesture-based simultaneous localization and mapping (SLAM) algorithm, where the drift error of pedestrian dead reckoning (PDR) is corrected by the history of landmark observations. The position update of our particle filter SLAM implementation relies on foot-mounted inertial measurement units (IMUs) and zero-velocity update PDR.

The key novelty of our approach lies in the observation update phase. Instead of Wi-Fi signal strength vectors or visual landmarks, we use location-related gestures such as 'door opening' or 'sitting' for closing the loop. These gestures were shown to be recognizable from body-mounted sensors only. This makes our system independent of the environment and suitable for daily-life applications.

We evaluate the algorithm in a setup simulating daily life at home and characterize the key parameters influencing it: 1) PDR accuracy, 2) gesture recognition accuracy and 3) the required density of location-related gestures per distance travelled. Results show that the algorithm allows reliable tracking with mean error of <1m during an hour-long recording. The simultaneously built map of the three-room apartment in our experiment accurately reflects the building layout.

In future we will extend the system with other multimodal information such as radio fingerprints and GPS where available to link indoor maps within a world map and enable longer-term studies. A practical application will be the mapping of hazardous zones at the home of elderly persons.

KEYWORDS: Pedestrian SLAM, activity recognition, pervasive health, patient monitoring