Inertial Odometry System and Methods

Tech ID: 33038 / UC Case 2021-594-0

BACKGROUND

Although GPS can be used for localization outdoors, indoor environments (office buildings, shopping malls, transit hubs) can be particularly challenging for many of the general population, and especially for blind walkers. GPS-denied environments have received considerable attention in recent years as our population's digital expectations grow. To address GPS-denied environments, various services have been explored, including technology based on Bluetooth low energy (BLE), Wi-Fi, and camera. Drawbacks with these approaches are common, including calibration (fingerprinting) overhead using Wi-Fi, beacon infrastructure costs using BLE, and unoccluded visibility requirements in camera-based systems. While localization and wayfinding using inertial sensing overcomes these challenges, large errors with accumulated drift are known. Moreover, the decoupling of the orientation of the phone from the direction of walking, as well as accurately detecting walker's velocity and detecting steps and measuring stride lengths, have also been challenges for traditional pedestrian dead reckoning (PDR) systems. Relatedly, blind walkers (especially those who do not use a dog guide) often tend to veer when attempting to walk in a straight line, and this unwanted veering may generate false turn detections with such inertial methods.

TECHNOLOGY DESCRIPTION

To help address challenges with inertial-based localization and wayfinding, and specifically in regards to orientation drift and biases in path length estimation, investigators at UC Santa Cruz (UCSC) have demonstrated a new system and methods which combine pedestrian dead reckoning (PDR), two-stage algorithm for turn detection (leveraging machine learning algorithm e.g., a recurrent neural network (RNN)), and particle filtering through the Particle Filtering–Mean Shift (PF-MS) algorithm. UCSC's simple "Turns/Steps PDR" can be customized for particular types of walkers (e.g., blind persons walking with the help of a long cane) and it can be implemented with or without the assistance of a map of the pedestrian environment, including the interior of a building. Turns/Steps PDR can be used in map-less environments for assisted return, providing spatial information and direction to a user who is backtracking their path. Turns/Steps PDR's two-stage system is capable of robustly detecting turns at multiples of 45 degrees or 90 degrees, combined with an RNN-based step counter with learned fixed stride length. The two-stage turn detection, formed by UCSC's orientation tracker and a straight walking detector, has proved to enable a more accurate path reconstruction than competing algorithms in the face of certain adversarial situations, such as blind walkers who veer when attempting to walk on a straight line. In map-less testing, Turns/Steps PDR produced better results than its more sophisticated state-of-the-art peers e.g., Robust Neural Inertial Navigation (RoNIN) algorithm.

APPLICATIONS

- indoor navigation
- indoor localization
- mobile applications

ADVANTAGES

- no calibration required
- no specialized hardware
- effective in unoccluded environments
- outperforms peer algorithms like RoNIN
- attuned to blind pedestrian users

INTELLECTUAL PROPERTY INFORMATION

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INVENTORS

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OTHER INFORMATION

KEYWORDS

inertial odometry, odometry, wayfinding, GPS, localization, pedestrian dead reckoning, indoor pedestrian tracking, navigation, pedestrian navigation, route planning

CATEGORIZED AS

- **Communications**
  - Wireless
- **Computer**
  - Software
- **Sensors & Instrumentation**
  - Position sensors
- **Transportation**
  - Personal
- **Engineering**
  - Other

RELATED CASES

2021-594-0

Patent Pending

RELATED MATERIALS

- Ren, P.; Elyasi, F.; Manduchi, R. Smartphone-Based Inertial Odometry for Blind Walkers. Sensors 2021, 21, 4033. - 06/11/2021

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Camera-Based Reader for Blurry and Low-Resolution 1D Barcodes
- Using Virtual Tile Routing For Navigating Complex Transit Hubs

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