Precise Indoor Location Through Multiple Devices

A Motion Tracking Solution for Indoor Location Using Multiple Sensing Devices

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OVERVIEW

While modern smartphones are equipped with very powerful sensors, sometimes it is required to cripple their performance to benefit characteristics such as the device cost or battery life, resulting in reduced sampling rates or signal range. To mitigate this issue, a new system was developed to merge sensor data from multiple devices attached to strategic locations of the human body, enhancing an already developed indoor positioning system.

This approach envisions a future where sensor hubs may be present in common clothing items or wearable fashion, thus making use of all the available potential.

Calculated positions are displayed on an Android application, either within a blank canvas, a custom map or a Google Maps widget.

TECHNOLOGY

With multiple streams of inertial and environmental data available (accelerometer, gyroscope and magnetometer), this system starts by cross-validating each sensor hub's performance, so that erroneous data can be discarded, or a malfunctioning sensor can be ignored. After this step, each stream should be behaving similarly, which allows for signal smoothing and enhancing, compensating for sensor drift and reduced sampling rates. Finally, the outcome can be dynamically processed, so that step detection and stride estimation algorithms can favor sensor devices located near the feet, and orientation calculation can come from devices attached to the torso.

Simultaneously, magnetic field data are retrieved from all available streams, creating an extended view of the environmental conditions, which enables a deeper understanding and interpretation of the environment.

These data are transmitted, via Bluetooth low energy, to a single smartphone, where a Wi-Fi radio also monitors radio-frequency fluctuations, which is compared against a multi-dimensional feature spot map alongside the previously mentioned magnetic field readings.

All of this information is merged inside a particle filter, which dynamically assigns weights to each source based on their behavior and outcome, prioritizing the most relevant contribution at any given time. Lastly, the outcome is incrementally fitted inside the current building's floorplan, creating a final layer of improvement. After each particle filter iteration, a position is determined and translated either to custom map coordinates or a latitude and longitude pair.

REQUIREMENTS

This system is centered around a host Android smartphone equipped with an inertial measurement unit, a magnetometer and a Wi-Fi radio. Connected to it are several sensor hubs, containing the same inertial measurement unit, a magnetometer and a Bluetooth radio. Scanning the region of interest in advance is required to generate the appropriate feature spot maps, while access to floor plan data is needed to improve algorithms performance and to display the positioning outcome. Finally, an initial position must be provided to this system.