A novel hybrid/geomagnetic field based technology for indoor navigation

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ABSTRACT

GiPStech Company proposes a new technology for the localization of users in indoor settings employing a commercial smartphone and/or other commercial "smart" hardware, and describes its accuracy and reliability.

To achieve effective and precise localization, in the absence of adequate GPS signal, GiPStech combines complementary localization algorithms of dead reckoning and geomagnetic signal fingerprinting. Dead reckoning is performed using the accelerometer, magnetometer and gyroscope sensors on-board the smartphones to detect motion and estimate orientation. At the same time, geomagnetic signal is employed to provide an independent position estimate. If any RF signal is present inside the building where the system is employed, especially WIFI or Bluetooth signal, this signal can also be employed by the positioning system to improve its performance in specific conditions.

The core technological solution proposed by GiPStech consists of an algorithm for indoor localization largely based on local variations and anomalies to the geomagnetic field, which are "naturally" present and constant over time inside any building and do not require the installation of expensive infrastructure (as opposed to other, RF-based methods).

In the initial mapping phase, measurements of the geomagnetic field inside the building of interest are collected in a systematic way to compose a complete "fingerprint" of the same building in conjunction with the building blueprint. The resulting map contains at least the coordinates of the points where the measures of geomagnetic field are taken. The measure of the geomagnetic field typically consists of a R^3 vector containing the XYZ components of the geomagnetic field. This initial phase is performed by one person or automatic mean properly equipped with a "smart" device such as a smartphone, and the map holds validity for all subsequent use by other users or devices similarly equipped.

In the following localization phase, the initial map is exploited to estimate the position of any smartphone /smart-device user (receiver) together with measurements of the same user's device sensors. These measurements along with the map are combined with an algorithm based on Particle Filters (PF) that contains some innovative aspect including an autonomous localization algorithm evolution method to estimate and correct PF particles displacement length and direction angle independently one from another.

The technology, implemented in a demo app on selected smartphones, was tested in different indoor environments including offices and shops. It was found to achieve average accuracies of one meter, a precision sizably greater that competing technologies, all of this achieved without the installation of any infrastructure.

This combination of accuracy and low cost of infrastructure is deemed sufficient to develop a variety of new navigation and context-aware applications. GiPStech was therefore incorporated as a Spin-off Company of the University of Calabria to pursue the technology industrialization and commercialization, recently winning primary competitions and earning an angel investment.