Indoor Navigation Platform Based on Signals Fingerprinting and Aided IMU

Alexey S. Smirnov
Navigine Research and Development
Moscow, Russia
aleksei.smirnov@navigine.com

Alexey A. Panyov
Navigine Research and Development
Moscow, Russia
apanyov@navigine.com

Vasiliy V. Kosyanchuk
Navigine Research and Development
Moscow, Russia
v.kosyanchuk@navigine.ru

ABSTRACT

This work outlines Navigine indoor navigation platform that is based on fingerprinting technics aided with Inertial Measurement Unit (IMU). The system doesn't use any demanding infrastructure, easy to implement and can be performed on any handheld devices in real time mode. The solution is currently deployed in more than 15 buildings including airports shopping malls and office buildings. The average localization accuracy is from 1 to 4 meters in different environmental conditions.

Categories and Subject Descriptors

K.8.m [**Personal Computing**]: Miscellaneous

General Terms

Algorithms, Measurement, Theory.

Keywords

WiFi/Bluetooth based localization; inertial measurement unit, pedestrian dead reckoning; Gaussian processes; particle filter; step detection.

1. INTRODUCTION

Nowadays there is a big variety of indoor navigation systems that are based on different localization technics which can be divided into two main groups: software based systems that don't use any complex infrastructure and hardware based systems. The first type is mostly used for navigation and tracking of mobile hand-held devices, e.g. commonly used Android/iOS smartphones.

2. Localization Method

Navigine localization platform belongs to the first one and utilizes signals fingerprinting method that means that deployment step is required. It should be performed one single time. On this stage user goes through location where navigation is required and measure radio map of the signals at the set of reference points (RP) evenly distributed around the building. These signals compose Wi-Fi/Bluetooth Received Signal Strength (RSS) and geomagnetic measurements. Nowadays Wi-Fi is largely available in many places, at the same time there can be more then 5-7 different access points. Currently, the Bluetooth low energy signals are becoming widespread, as its beacons can transmit signals for a few years without a need for a recharge, its small size and low cost are another advantages. Each building has its unique geomagnetic field due to presence of metal objects and building construction that is usually reinforced. All these data compose map of the building that is used on navigation stage.

The main drawback of such a map is its discreteness due to discrete positions of RPs. To make a continuous data map and predict signals in areas, where there are no measurements, Gaussian Processes (GP) are used (fig.1). GP is an extremely powerful tool especially when it's used in cooperation with a particle filter.

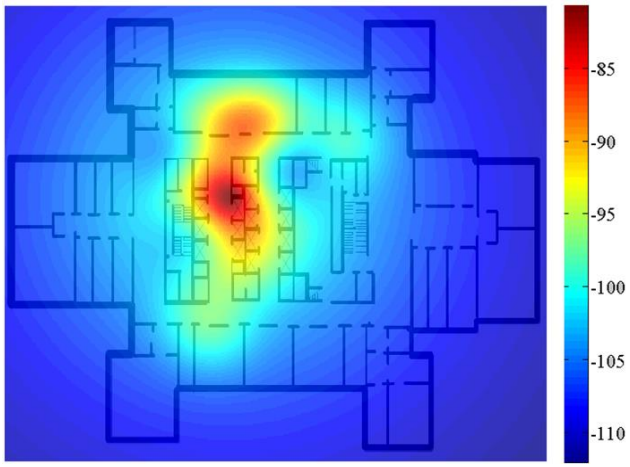

Figure 1. GP radio map prediction for Wi-Fi access point

2.1 Particle Filter

Nowadays maps and floor plans of many buildings could be accessed via the Internet or be drawn into any digital format. The main idea is that while people are moving, they can't walk through the walls or suddenly jump over to another end of the building. For minimization of these effects particle filters can be used. Particle filtering uses a set of particles (or samples), which are scattered across a building and have a certain weight. Having these numbers one is able to estimate the most probable location and put constrains on the trajectory to avoid crossing the walls and other obstacles. The main advantage is the possibility of combining digital map with Pedestrian Dead Reckoning system [1] (PDR). By processing IMU and magnetometer readings PDR performs three important functions:

1. Steps moment detection and determination of patterns of humans gate.

2. Step length estimation.

3. Using step length and heading angle, calculated by sensor fusion algorithm, PDR predicts position of the user.

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GP map is used during correction phase of particle filter for mitigation of errors, accumulated during sensor readings processing. Current device measurements of RSSI/Geomagnetic data are compared with GP data map to estimate the most probable user position.

More details about this localization system can be examined in [2].

3. REFERENCES

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