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Track 1: Smartphone-based

Ensemble Indoor Positioning System based on dynamic weighting enhanced PDR and Fingerprint

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I. Introduction

MITLab has conducted indoor positioning research in several projects, including Ensemble Fingerprinting Positioning System [1], Pedestrian Dead Reckoning (PDR), Fingerprinting-based Campus Navigation System [2] and PDR-based indoor positioning system with iBeacon-based and map calibration [3]. Based on these experiences, we believe that it can perform a great result in this competition.

According to the rules of the IPIN competition and the restrictions of Track 1, we decided to use the Wi-Fi module and Inertial Measurement Units (IMUs) to implement Fingerprinting and PDR [4] algorithms as ensemble indoor positioning system [5] on the smartphone. Moreover, we focus on improving the multiple-floors decision to achieve a fairly accurate indoor positioning.

II. Approach and Implementation

Before launching the proposed positioning system, it is inevitable to divide the field into several areas in advance and subsequently collect the Wi-Fi Received Signal Strength Indicator (RSSI) in each area as the training materials for machine learning in Fingerprinting. Also, we create the map information that highlights the stairway of the building. When the user enters a stairway, the system can predict a better result of floor-decision by our algorithm.

Once these preparations are completed, the system can use the IMUs data for PDR calculations. At the same time, the system continues comparing the Wi-Fi RSSI, the results of the multiple-floors PDR and Fingerprinting can be weighting by an algorithm in Ensemble Indoor Positioning. Then we can get a higher accurate indoor positioning result. The system structure is represented as Fig. 1 shows.

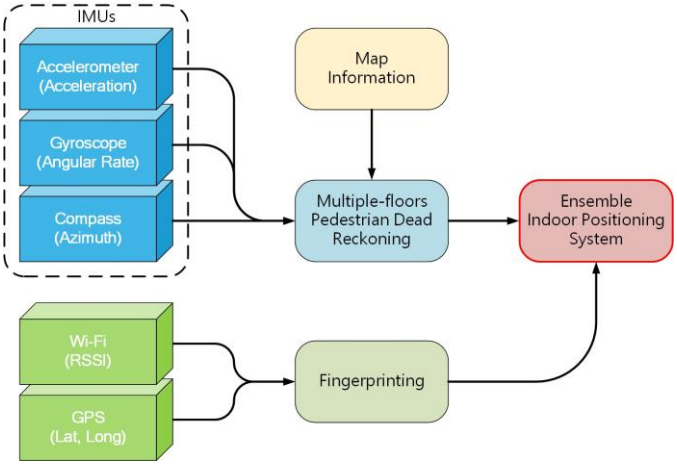

Fig. 1 System structure

1) Global Positioning System:

The proposed positioning system uses the latitude and longitude of the GPS as a coordinate axis, draws the outline of the building, and calculates the central coordinates (calibration points) of each of the fingerprinting divided areas. It is also to have a more efficient integration with the scoring program provided by the competition.

2) Wi-Fi Signal Extraction:

First, the map can be divided into several areas. Second, the surrounding Wi-Fi RSSI is taken as a fingerprint which has only one unique label (manual marker) and one tuple of fingerprints (signal collection) in each area.

3) Fingerprinting:

At first, the Wi-Fi RSSI must be collected in each area that we divide before collection. After that, the collected data can be used as the training data for the machine learning classification model. The result model can be used in the real-time indoor positioning system to predict the position by current Wi-Fi RSSI.

4) Pedestrian Dead Reckoning:

The PDR algorithm converts the data collected by the IMU into moving distance and direction, and operations with the previous position to obtain the current relative position. Based on the experience of previous experiments, we learned that the problem of PDR is the cumulative error. In this competition, the proposed system contains the weight dynamic allocation algorithm to decide when the system should trust the prediction from PDR. Also, the detection of the start is one of the cores of the PDR too. The system uses multiple and dynamic judgments to enhance the start detection to improve the accuracy of the PDR.

5) Map Information:

In our proposed system, we mark the stairway as the specific area on the map. When the user enters the specific area, the system uses different algorithms to detect the upstairs or downstairs to assist in improving the accuracy of multiple-floors positioning.

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