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IoT Based Indoor Navigation System

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Abstract:

This project work is to provide an effective structured map of building to user for effectively find the route of particular location inside the building. We divide the indoor navigation system into two parts: the construction of signal fingerprint database and user navigation. Firstly, the navigator carries out the signal acquisition of navigation route, and transfers the original signals to cloud server so as to construct the fingerprint database. Secondly, user can choose the offline navigation or online navigation, the user can use the DTW (Dynamic time wrapping) algorithm for fingerprint matching. When user would like to obtain better navigation results, they can choose online navigation. The control and the maintenance is made through Internet of Things. The implementation of this project will be very useful to the society.

Keywords **– Indoor navigation, dynamic time wrapping, Particle filter, offloading, NB-IoT.**

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I. INTRODUCTION

Now days Indoor navigation system plays very important role.Most of the people use Global Position System (GPS) for outdoor navigation which has brought great convenience. As long as people have a smart phone, they can easily find the path to the destination in an unknown location.Although GPS outdoor location technology is mature and is applied extensively, GPS is not suitable for indoor area because of the weak satellite signal.In the NB-IoT indoor navigation system, if users choose online navigation, the navigation task will be offloaded to the cloud server with powerful computing power to execute, thus accurate navigation results can be obtained. When computing task are offloaded, the path selection is first performed by using the k-nearest neighbour (KNN) algorithm, and the data are offloaded to the cloud server sends the computed target moving direction back to mobile terminals.

Particle filter (PF) is based on the Monte Carlo method, which uses a set of particles to represent the probability and can be used in many state space models. Dynamic time warping (DTW) algorithm, which is based on the idea of dynamic programming, is a simple and effective method to solve the problem of template matching with different pronunciation. DTW algorithm is an earlier and more classical algorithm in speech recognition, which is used for isolated word srecognition. When the geomagnetic signal intensity fingerprint database is matched, we choose PF algorithm and DTW algorithm by different

navigation forms, i.e., offline navigation and online navigation. In online mode, the data of mobile terminal will be offloaded to the cloud end, and the end matches the fingerprint by using PF algorithm and indicates the user's forward direction according to the matching results.

Since geomagnetic signals have a good stability, they have been used in localization and underwater navigation. In, geomagnetic signals and WIFI signals as well as PF algorithm are used in indoor localization, and obtain high accuracy. However, in these geomagnetic indoor navigation methods, the change of floor level in building is mostly determined by barometer. In this paper, we will build up fingerprint databases to achieve indoor navigation instead of building structure map, which can address the problem that the building structure map is difficult to obtain. The main contribution of this paper can be summarized below.

- We utilize geomagnetic field signals and acceleration to differentiate the floor level change for indoor navigation instead of barometer. The stability of geomagnetic signals brings convenience to indoor navigation. We employ geomagnetic signal to determine of going straight and turning.
- We develop a new fingerprint matching method based on DTW algorithm and PF algorithm. For offline navigation, we propose the DTW based fingerprint matching method, where the DTW reduce the computational complexity of mobile terminals.
- We develop an effective indoor navigation strategy by offloading geomagnetic signal data to the cloud in NB –IoT. When the user choose offline navigation, mobile terminal will offload geomagnetic signal data to the cloud, and the cloud server completer the fingerprint matching by using PF algorithm.

II. PROPOSEDSYSTEM

In this paper, we give the system block diagram of NB-IoT for indoor navigation as shown in figure.

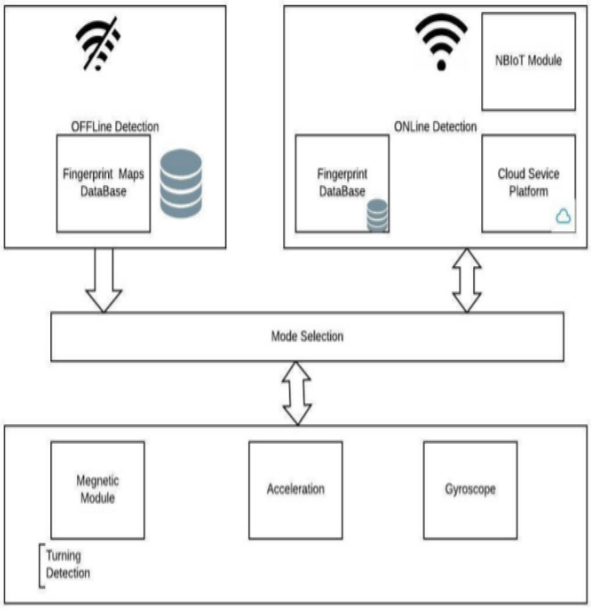

Figure: - block diagram of indoor navigation

The system block diagram is made up of four parts. The first part contains magnetic module, acceleration module, and gyroscope module, and this part mainly achieves the front-end signal acquisition. The second
Part is mode selection such as learning mode or navigation mode. The third part is online detection which contains NB-IoT module, fingerprint map database, and cloud service. The fourth part is offline detection which mainly completes offline navigation guidance.

III. WORKING

A. Fingerprint Map Database Construction :

The fingerprint database will be built by learning in navigation process. When choosing learning mode, the navigator will begin to walk from the entrance to the destination. We assume that the route of navigator will be considered as the most convenient route. In the meantime, the mobile device will send magnetic signal, angle signal and acceleration signal to the cloud service platform by NB-IoT base

station. Then, the cloud service platform receives all kind of uploaded signals and form fingerprint database.

B. Task Offloading:

Offloading is best solution to enhance the computing and storage capacity of mobile device by migrating computation task to computer or server with more resources. Offloading model include NB-transmitters, user/mobile devices, and cloud service platform.

When the user want to gain better navigation results, offloading strategy will be used, and the sampling data of mobile terminal will be offloaded to the cloud. When the mobile node lies within the coverage of NB transmitter, the mobile node will connect to the NB node automatically, and then offload data. At the same time, when network connection are poor, the offloading will stop immediately, and the navigation will become offline mode. Once the network condition become well, the navigation will restart the offloading strategy.

C. Matching of fingerprint :

Since the navigation system is divided into offline and online modes, according to the computing power of device, we will apply DTW algorithm and PF algorithm in fingerprint matching.

1) Matching of fingerprint with DTW:

This is the process of matching the route of the user's actual walking will be similar to the route that the navigator's actual walking. The DTW algorithm is an effective way to achieve this contortion which calculates the similarity between two time series by shortening time series. Thus we utilize this algorithm to effectively solve the problem of fingerprint matching.

2) Matching of fingerprint with PF :

The core idea of PF algorithm is to express the distribution by the random state particles extracted from the posterior probability, which is a sequential importance sampling method. The main steps of PF algorithm are listed as follows,

1. **Initial state:** received user signal is simulated by a large number of particles, and the particles are distributed evenly in the space.
2. **Prediction stage:** according to the state transition equation, we get the prediction particle for every particle.
3. **Correlation Stage:** we evaluated the predicted particles, and if the particle is closer to the real state, its weight will be se as a large number.
4. **Resampling:** the particle is screened according to the weight of the particle.
5. **Filtering:** We take the resampling particle into the state transfer equation and get the new prediction particle.

IV.HARDWARE COMPONENTS

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The Raspberry Pi:

It is series of little single-board PC's created in the United kingdom by the Raspberry Pi Foundation to advance educating of essential software engineering in school and in developing nations. The first model became more well-known than anticipated, selling outside its objective market for utilization like robotics. It does exclude peripheral (for example, keyboard and mice) or cases. However, a few accessories have been included in few official and unofficial packs.

NB-IoTTransmitter:

NB-IoT provide indoor coverage, low cost, long battery life, and high connection density. NB-IoT utilize a subset of the LTE standard, but restrict the transfer speed to a single narrow-band of 200kHz. It utilize OFDM modulation for downlink communication and SC-FDMA for uplink

communications.IoT applications which need more frequent communications will be better serviced by NB-IoT, which has no duty cycle limitations working on the licensed spectrum.

Google Cloud:

Google Cloud IoT is a completed arrangement of structure to interface, methodology, store, and inspect data both at the edge and in the cloud. An incorporated programming stack for edge/on-premises handling with AI capacities with regards to all your IoT needs.

What is the KNN Algorithm?

K-Nearest Neighbours is one of the most fundamental yet essential classification algorithms. It is broadly dispensable in real-life situation since it is non-parametric, which means, it doesn't make any hidden assumption about the distribution of information. We are given some earlier information (also called training data), which classifies coordinates into groups identified by a characteristics.

Polling Algorithm:Polling is used for resource allocation. There are large numbers on nodes inWSN. Group of nodes cooperate in some way. These nodes need to make decisions. The node that needs resource sends request to other nodes. A nodethat gets request needs to answer as shown in Figure 4.1. If the requestingnode gets yes, it is elected. After polling is done different states are used todetermine which node is selected as shown in Table 4.1.A polling based program continuously polls or tests whether or not data isready to be received or transmitted. Polling mechanism avoids the loss of data. Polling I/O requires CPU to ask a device, if device requires service. Inpolling code is in continuous loop, until device is ready.

V .CONCLUSIONS

We propose an indoor navigation technique by utilizing the force of the geomagnetism signals, the speeding up and edge of the guide. Specifically, we utilize offloading procedure to coordinate fingerprint of geomagnetic signal by utilizing particle filter (PF) algorithm in NB-IoT, At the point when client choose offline mode, we propose the DTW fingerprint algorithm to match the fingerprint of user and navigator. When navigation is given across floors, the starting and ending points of elevator are calculated by using the variation of three axis acceleration and the intensity of geomagnetic field. Meanwhile, we use angle change and geomagnetic field intensity to complete going straight and turning.

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