Design of Vehicle Tracking System Based on Ibeacon

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Abstract

At present, the indoor parking lot is gradually large, multiple space, multi-function, intelligent management direction. The difficult problem of vehicle tracking is increasingly prominent. The advantages and disadvantages of four kinds of Anti in indoor parking lots are analyzed. The positioning accuracy, penetration, anti-interference, mobile phone application, cost and other factors of indoor positioning technology are analyzed. A solution of intelligent parking system based on iBeacon is proposed. The system consists of four layers: terminal layer, positioning, communication network, positioning and map server. Smart phones and other terminals through wechat, access to fast and convenient access to wechat. The positioning network layer consists of iBeacon. The communication network layer is responsible for the interaction of terminal and background servers. Positioning and map server are used to host a map service platform. The positioning network layer consists of a certain number of iBeacon base station and ibeacon node, the owner of the owner of the handheld terminal, administrator terminal, and the background server. The function of the system is composed of four subsystems of the background management system, positioning and map service system, supervision system and ibeacon network management.

Key words: iBeacon, Vehicle tracking, Indoor location technique

1. INTRODUCTION

With the development of economy and the progress of science and technology, the modern indoor parking lot is gradually large, multiple space, multi-function, intelligent management direction of development (LI Huarong, PAN Guobing, ZHAO Yi, WU Hualing, 2016). Indoor parking lot space is bigger, the floor is more, the scene and the sign are similar, the direction is not easy to distinguish, the owners are not easy to find their own vehicles. This not only waste car owner time, but also bring a certain hidden danger to the traffic safety in the parking lot. Therefore, the corresponding intelligent reverse vehicle tracking system arises. Intelligent reverse vehicle tracking system can not only help the owner to find the vehicle as soon as possible, improve the satisfaction of the owner, but also speed up the turnover of the parking lot, improve the utilization and business income of the parking lot (SUN Xiaobo, WU Yulong, CHEN Bin, 2014).

At present, there are four kinds of intelligent reverse vehicle tracking in indoor parking lot. The first is the vehicle tracking system based on Swipe card. The second is the vehicle tracking system based on video recognition. The third is the vehicle tracking system based on wireless network. The fourth is the vehicle tracking system based on QR code.

The vehicle tracking system based on Swipe card is set up multiple location terminals in the parking lot (Beijing Unisplendour Baihui Technology Co., Ltd. 2011). After parking, the card is swiped at the location terminal and uploaded location association records to the server. When looking for a car, the vehicle position can be queried at the query terminal. This way needs to take Parking Card. When the Parking Card is lost, the intelligent reverse TOYMINATOR cannot be implemented. Using this method, the parking lot needs to layout the terminal location, query terminal, server and other equipment. Hardware cost is high, deployment is difficult.

Install the camera in front of each parking space (Xiamen KeyTop Communication Technology Co., Ltd. 2010), so that the vehicle tracking system based on video recognition obtains the vehicle number through the license plate recognition algorithm. When looking for a car, the owner input the license plate number on the query terminal, and obtain the location information of the vehicle. This approach requires the installation of a large number of cameras and query terminals. Its system hardware cost is high and deployment complexity (YANG QinQin, 2010).

The main hardware of the vehicle tracking system based on Wi-Fi positioning includes Wi-Fi base station, server and the smart phone of user in the parking lot. This method requires high demand on wireless network. In order to meet the high positioning accuracy, the system needs to increase the dispersion of network access points. This will increase the system hardware costs and improve deployment complexity.
The vehicle tracking system based on QR code takes smartphone as information collection and processing terminal, combined with QR code scanning positioning technology, inertial sensor indoor navigation technology, ArcGIS map service and offline access technology. The system realizes the intelligent vehicle tracking (LI Huarong, PAN Guobing, ZHAO Yi, WU Hualing, 2016). The system needs to develop app and embed a positioning map in it. The cost of app promotion is higher and more difficult.

The vehicle tracking system based on ibeacon is proposed. Ibeacon uses low-power bluetooth transmission mode. Only button battery can run. It is cheaper in itself. A large number of provisioning will not have too high deployment costs. The user holds integrated blue tooth mobile device. As long as the blue tooth function of the device is opened, the blue tooth indoor positioning system can judge the location of user. It is easy to popularize.

2. LOCATION TECHNOLOGY

2.1 Indoor Positioning Technology

The development of wireless network, mobile computing, pervasive computing technology makes location-based services and applications increasingly popular. While GPS positioning system can not sense satellite signals in the indoor environment or high building dense areas, it can not meet the requirements of positioning accuracy. Therefore, how to accurately obtain the location information of the user in the building or complex has become the core issue of realizing indoor location-based service (ILBS) (XI Rui, LI Yujun, HOU Mengshu, 2016).

The technical branches of indoor positioning are various. The table below is the contrast table of various indoor positioning schemes, as shown in table 1.

<table>
<thead>
<tr>
<th>Interior orientation</th>
<th>positioning accuracy</th>
<th>penetrability</th>
<th>interferenc immunity</th>
<th>Mobile application</th>
<th>power consumption</th>
<th>Deploy ment difficulty</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>UWB</td>
<td>cm</td>
<td>medium</td>
<td>high</td>
<td>no</td>
<td>medium</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>RFID</td>
<td>cm</td>
<td>medium</td>
<td>medium</td>
<td>no</td>
<td>medium</td>
<td>medium</td>
<td></td>
</tr>
<tr>
<td>ZigBee</td>
<td>10m</td>
<td>high</td>
<td>medium</td>
<td>no</td>
<td>medium</td>
<td>medium</td>
<td></td>
</tr>
<tr>
<td>Ultrasonic wave</td>
<td>10m</td>
<td>medium</td>
<td>poor</td>
<td>yes</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Inertial navigation</td>
<td>m</td>
<td>high</td>
<td>medium</td>
<td>yes</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Optical localization</td>
<td>Submeter</td>
<td>poor</td>
<td>poor</td>
<td>yes</td>
<td>high</td>
<td>high</td>
<td>medium</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>m</td>
<td>medium</td>
<td>medium</td>
<td>yes</td>
<td>medium</td>
<td>high</td>
<td>H/L</td>
</tr>
<tr>
<td>Geomagnetic</td>
<td>100m</td>
<td>medium</td>
<td>medium</td>
<td>yes</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>iBeacon</td>
<td>Submeter</td>
<td>medium</td>
<td>medium</td>
<td>yes</td>
<td>low</td>
<td>low</td>
<td>medium</td>
</tr>
</tbody>
</table>

The positioning algorithm of UWB technology mainly uses TDOA or TOA to analyze the label position. The algorithm has a strong time resolution, its positioning accuracy can reach centimeter level (WANG Yang, ZHAO Hongdong, 2016). But UWB is difficult to achieve large indoor coverage. And mobile phones do not support UWB, so positioning costs are very high.

RFID positioning technology is positioning by swiping card. It positions the card personnel or equipment according to the position of the reader. The technology can not locate real-time, low positioning accuracy, no communication ability, and poor anti-jamming ability.

The ZigBee positioning system provides indoor positioning by coordinating communication between each node through a large number of reference nodes. The signal transmission of ZigBee is influenced by multipath effect and movement, and the positioning accuracy depends on the channel physical quality, signal source density, environment and accuracy of algorithm, resulting in high cost of positioning software.

Ultrasonic positioning technology needs to install ultrasonic wave in the room, the user uses mobile phone microphone to detect the sound wave, so as to achieve positioning. The attenuation of ultrasonic in the air is large, and the multipath effect and the propagation of NLOS are greatly affected by reflection ranging, resulting in the investment of the bottom hardware facilities that needs accurate analysis and calculation, the cost is too high.
The inertial navigation system (INS) is an autonomous positioning navigation system based on the gyroscope and accelerometer to accomplish the motion of the moving objects in inertial system (Liu Qi, Zhu Quyue, Feng Sha 2016). Due to the uncertainty of the initial attitude of mobile phone and the accuracy of mobile inertia sensor, the indoor positioning effect is not good.

The LED positioning system is to achieve positioning by using intelligent mobile phone camera of the user to receive and detect the flashing signal that was like the Moss telegraph code from led lamps on the ceiling. The positioning accuracy can be within 1m. The LED positioning needs to transform led lamp, increase chip and increase cost. The infrared can only be spread line of sight. Its penetration is extremely poor. It is easy to be affected by environmental factors such as lighting, smoke, etc.

The Wi-Fi positioning is very popular because of the popularization of Wi-Fi network. The Wi-Fi positioning can reach the meters positioning (1 ~ 10 meters). There are two kinds of Wi-Fi positioning technology. One is triangulation, which applies differential algorithm to calculate and analyze the wireless signal strength of mobile devices and three wireless network access points, to accurately locate people and vehicles. The other is the fingerprint location, which records the signal strength of the huge amount, and then determines the location ("fingerprint") by comparing the signal strength of the newly added device with a database of huge data. However, the IOS does not support Wi-Fi indoor positioning (Apple has locked the thing at the bottom of the Wi-Fi, developers are unable to know some Wi-Fi important information), unable to achieve accurate positioning and response speed is not high.

The products of geomagnetism and computer vision positioning. At present, most of these products are used in military and scientific exploration. Such as the geomagnetic navigation commonly used in military navigation. The navigation of Mars rover is used in computer vision navigation.

The blue tooth positioning technology is positioning by measuring signal strength. This is a short-range low-power wireless transmission technology. It needs to install the appropriate blue tooth LAN access point in the room, configure the network to multi-user basic network connection mode, and ensure that the blue tooth LAN access point is the main device of this micro grid (Piconet), and obtain the location information of users. It can use internal inertial sensors of the mobile phone such as accelerometers, gyroscopes, electronic compass to strengthen the accuracy of positioning, which is called multiple positioning algorithm fusion (Development and status of indoor navigation technology). The original 5-10 m positioning error can be further reduced to 1-2 m. Using this technology as indoor short-distance positioning, it is easy to find equipment and signal transmission is not affected by the line of sight.

2.2 Ibeacon positioning system

The architecture of blue tooth positioning system is shown in figure 1. The coordinates information of each blue tooth base station is stored in the database. The server is mainly responsible for storing map file and location algorithm. After the mobile phone opens the positioning page, the phone gets the map, positioning algorithm and the coordinates of the related blue tooth base station from the server. When the mobile phone is scanned into a set of blue tooth base station, the distance to each base station is calculated by the signal strength of the base station, and the coordinate data of the base station is added. The location of real-time computing is displayed on the map by the triangulation algorithm. The use of mobile phones rather than server-side computing has many advantages. For example, no data upload is needed, the real-time location is more, almost no delay. No traffic is generated during the positioning process.

![Figure 1. the architecture of blue tooth positioning system](image-url)

Before the base station is deployed, the map is completed. Maps commonly used as indoor navigation are vector maps. This map does not affect the display of the map, no matter how scaling. The vector map itself is with coordinate information, and each point on the map has a relative coordinate relative to the reference point.

Base station deployment requires the deployment tool, a mobile app software. The deployment personnel uses the deployment tools to get vector maps from the server. When the deployment personnel deploy the base station, the points corresponding to the actual location on the map, app automatically captures the coordinates of the site from the map, plus the base station number recorded by the deployment personnel, and uploads the data to the server.

The mobile phone positioning process is so. After the user opens the blue tooth scan, the id and signal strength of the surrounding blue tooth base station will be obtained. According to the signal strength and attenuation formula of the high frequency signal, the distance of each base station can be calculated. But
because blue tooth is the 2.4 high frequency signal, the stability of the signal is poor. The indoor environment of various reflection and refraction, the single signal strength is not directly used. Otherwise it will produce huge error, so the corresponding filtering and weighted algorithm must be introduced to reduce the interference of signal noise.

The filtering algorithm can adopt simple Gaussian filtering method (Development and status of indoor navigation technology). The required signal data is filtered directly, and the remaining effective data enters the data list according to the time sequence, and adopts the queue data refresh method of first in first out. In the range of the queue length, The more recent data on the time scale gets higher weight. At the same time, the use of multi angle positioning algorithm is not limited to the use of triangulation.

3. OVERALL DESIGN

Based on the analysis of the existing intelligent reverse vehicle tracking system, make best use of the advantages and bypass the disadvantages, a intelligent parking vehicle tracking system based on ibeacon is proposed. The system consists of four layers. They are terminal layer, positioning network layer, communication network layer, map and positioning server. The overall system structure is shown in figure 2.

![Figure 2](image)

Terminal layer includes Android phone, iphone, pad and other smart terminals, is the final carrier of system application. Its portal is a lightweight portal based on wechat. The traditional architecture is to develop its own app and embed indoor positioning map SDK in app. The wechat architecture is to use HTML5 to achieve indoor positioning on a map. The system uses WeChat public numbers or WeChat shake as a portal to achieve application. The system borrows the force of wechat to obtain the fast and convenient application service entrance. The portal architecture uses wechat architecture. The communication network layer is responsible for the interaction between the terminal and the backend server. It is the basic guarantee of location service. The Positioning and map server is the core of system, which is used to carry on the map service platform of positioned. It is based on the HTML5 technology architecture.

3.1 positioning network layer

The positioning network layer consists of a certain number of ibeacon base station and ibeacon node, the owner of the owner of the handheld terminal, administrator terminal, and the background server. The structure diagram of locate network is shown in figure 3. The ibeacon base station is responsible for the distribution and enhancement of the positioning signal, and unified management of the ibeacon node. Each ibeacon base station can set up an independent ibeacon id composed of three fields of UUID, Major and Minor. The ibeacon base station is based on low power bluetooth, which broadcasts its ibeacon id with a fixed power and frequency. It broadcasts battery power and sensor data in an extended packet (Shao bo,Lian Chaoxi,Liu xiao2016). At the same time, it has the system functions of encryption management, encryption broadcast, cloud management.

![Figure 3](image)
The ibeacon node is responsible for the distribution of signals. After it is bound to the map location information, the phone terminal of car owner receives the node signal feedback to the location server, which can obtain location information. The owner handheld smartphone opens bluetooth and wechat. Through wechat receives the data information of the node, the server will send navigation map or other information to the owner's mobile phone. The background server is used to store, manage, and forward data within the system (ZHANG Zhuosheng, MA Fangfang, XUE Jingyuan, AI Haojun, 2015). The management terminal is used to display the operation of the parking lot in real time.

3.2 systemic function

The function of vehicle tracking system based on ibeacon is divided into four subsystems. They are background management system, positioning and map service system, supervision system, and network management. The system function is shown in figure 4. The background management system realizes the storage, management and forwarding of data. Location and map service system provides positioning, navigation services and map maintenance, etc. The regulatory system is used by regulators to monitor the operation status of the parking lot and the status of users in real time. Ibeacon network management mainly completed the ibeacon signal monitoring, ibeacon power monitoring, illegal ibeacon interference monitoring and ibeacon network maintenance management, and so on.

![Figure 4. system function diagram](image)

4. CONCLUSIONS

In the shopping center, hospital, airport, office and other large parking lots, due to the large parking space, easy to distinguish direction, the owners easy to get lost in the parking lot, the owners can not find their own car. In the vehicle tracking scheme based on ibeacon, the owner uses the smartphone to open blue tooth and wechat, using the WeChat public number and WeChat shake as the entrance into the platform, which can obtain location and navigation.

ACKNOWLEDGEMENTS

This work was supported by 2013FZ098 and 2015C076Y.

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