Designing of Intelligent Parking Lot Based On MQTT

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***Abstract*—With the development of economy and the improvement of people's living standards，people's lives are getting inseparable from cars, the contradiction between the number of parking spaces and the increasing demand for parking is becoming more and more outstanding. It is necessary to design a intelligent parking system. This paper analyzes the drawbacks of the traditional parking system ,and design the main functions and solutions of the intelligent parking. This paper present the whole architecture of the system, and discusses the key technologies: ZigBee networking, MQTT protocol, Node.js, and mobile client technology. This paper proposed an effectively way of urban parking problem.**

Keywords-Intelligent Parking System; ZigBee; MQTT; Node.js; O2O

I. FOREWORD

With the development of economy, the number of motor vehicles increased rapidly, the contradiction between the number of parking spaces and the increasing demand for parking is becoming more and more outstanding. Traditional parking lots do not meet the demand of parking. So intelligent parking system for improving the traffic management situation plays a vital role[1].

Traditional parking lots have been unable to meet the needs of modern parking development in terms of parking efficiency, energy consumption, safety performance, yard management operations, most conventional parking systems have the following problems:

The parking system only records the number of parking vehicles or remaining parking spaces, parking can not provide location specific information.If the parking lot is large, it is difficult for the owner to quickly find the right parking space.

The car park can not provide spare parking spaces online display function. For an open car park, the owner can not understand whether the parking lot will have spare parking spaces, until the owner arrived at the parking lot only found there have been filled. This is undoubtedly a waste of time and resources.

There is little resource sharing between parking systems.The current system of each parking lot is separate of the "information island" [2], the parking system can not share data,even if some parking lot is full, and some parking lots have a lot of free parking spaces, and the system can not provide optional parking options from other parking lots.

Therefore, it is necessary to develop and design a complete intelligent parking management system [3].It can

effectively reduce the pressure of parking, alleviate the problem of modern city traffic jam and parking.

II. SYSTEM FUNCTION

The intelligent parking management system aims at the shortcomings of the traditional parking area,combined with the research status of intelligent parking system at home and abroad, add the following functions for the system：

A. Free parking spaces online view function

In the O2O mode, the user can remotely view the parking spaces in the parking lot via the PC website or the terminal of the mobile phone. When the parking spaces are parked or left, the parking status changes are displayed on the user terminal in time.Users can ahead through mobile phones and other mobile terminals to check information, and pre-set parking spaces,make a planned arrangement to eliminate the blindness of the search for parking spaces.

B. Parking Reservation Function

Through the mobile terminal to view the free parking spaces, the user can mark and make reservations.And the user-marked parking spaces will limit the other vehicles parked, until the user arrives at their booking the parking spaces and operate through the mobile terminal ,then car into place.

C. Parking guidance function

Users can view the parking lot layout and parking situation through the mobile terminal, and according to the guide to find a pre-appointment or vacant parking spaces.

D. Parking lot information sharing and parking spaces recommended function

When the user through the mobile terminal to reserve parking spaces, the system controls the hardware, take coercive measures to protect the parking spaces, such as raising a row of piles or lever to prevent other users from entering.But this is obviously a waste of public resources, it is better practice, only to mark the reservation of parking spaces, when the user reservate parking spaces occupied by other users, the system can recommend parking spaces for the user to provide optional parking program.

III. SYSTEM STRUCTURE

The intelligent parking system is divided into three parts [4]: data source, data processing and release, as shown in Figure 1.

First of all, the original data in the system are derived from the data source layer, through the infrared, ultrasonic and other equipment to collect parking sensor data[5].The collected sensor data be sent to the PC host computer through ZigBee sensor network for centralized data preprocessing.

Second, the data service layer runs on the server, receives the sensor data from the PC host computer,and finally processes it conversion to parking status information stored in the database.The Webservice specification is used to publish the data interface to provide data sharing.

Finally, in the distribution layer, the system supports a variety of clients, users can easily view the parking lot parking information, and use parking spaces, parking guidance and other functions.

IV. SYSTEM DESIGN AND KEY TECHNOLOGIES

The system to achieve the idea is: in accordance with the O2O concept [6], offline use ZigBee for data collection, with Arduino controller control hardware, online use Node.js to deal with data storage and data distribution, with the mobile phones and other mobile terminal APP.Through this way, parking space resource management is realized.The overall structure of the system shown in Figure2.

The system mainly uses ZigBee data transmission, MQTT message push, Node.js data service, mobile client and other key technologies.

A. ZigBee WSN

In the intelligent parking system, the lower computer uses the ultrasonic sensor to detect the distance to determine whether there is parking on the parking spaces.

Through the Arduino controller to manipulate the sensor acquisition data,then send to the PC host computer. The data on the host computer for pre-processing (to eliminate noise), the final submission to the server.On the other hand, the host computer can also receive server control information, and through the ZigBee network to send control information to

the Arduino controller, finally achieve reverse control. This system can not only obtain the sensor data through the mobile terminal to view the function of parking spaces online, but also through the mobile phone control system hardware, to achieve the function of parking spaces.Ultrasonic sensors and Arduino controller, ZigBee and the host computer are using serial communication protocol to exchange data.

B. MQTT message push

Intelligent parking system requires data to be independent two-way flow.In the host computer and server communication process, the sensor data changed due to parking spaces or leave, host computer initiative to inform the server, the server to receive new data and storage.On the other hand, the user sends feedback data to operate the parking space, the server can take the initiative to notify the host computer, then the host computer transfer the user control instruction data to the ZigBee network, inform the Arduino controller operation related hardware.

Because of the HTTP protocol has a passive type, the simple use of the HTTP protocol can only ensure that the sensor data is correctly submitted to the server, but can not guarantee that the server data changes can take the initiative to notify the server, unless the client long polling (the host computer to send HTTP requests to obtain the latest server data).But this way is very costly system resources. Therefore, it is more reasonable to use MQTT protocol, which has the characteristic of message subscribing mechanism, to communicate between server and host computer.

MQTT (Message Queuing Telemetry Transport, Message Queue Telemetry), with lightweight release and subscripte messaging mechanisms to support two-way messaging.In the MQTT protocol, there are three types of roles for subscribers, publishers and proxies. The first two are presented in the form of MQTT clients, and the latter is presented in the form of MQTT proxy servers.The relationship between the subscriber and the publisher is coordinated by the MQTT agent. The mechanism is that the MQTT proxy server maintains the relationship between the MQTT clients. When client issues a message, the proxy server first receives the message,queries the user who subscribes to the type of message, and forwards the message to the subscriber, who can then actively receive the message. The system communication model is shown in Figure 3.

The system uses the Python-based open source tool Paho to implement the MQTT client on the host computer, interacts with the MQTT proxy server running on the server, and completes the message push to the host computer。 Using the HTTP protocol to achieve the host computer to the server communication, when the sensor data changes beyond a certain threshold,send HTTP requests, and then submit the data to the server.Generally speaking, through the HTTP protocol and the MQTT protocol, the data can flow automatically between the server and the host computer.

C. Node.js data service

The server uses Node.js technology, can achieve service mount, data operation, data distribution and other functions.

Service mount.In the Node.js environment can be simultaneously loaded MQTT proxy server and HTTP server to push the message to the host computer, but also allows the host computer to send HTTP requests to submit the sensor data.In the Node.js environment, you can use Mosca [8] to build MQTT proxy server and creating MQTT client. when the database update message, notify the host computer to perform the appropriate action.

Data operation.MongoDB is a NoSql database based on distributed file storage. you can store relatively complex data types, suitable for large data query services.In the intelligent parking system, the server receives the sensor data and then maps the sensor data to the occupancy status information of the parking spaces according to certain rules, expressed in JSON format and stored in MongoDB.

Data distribution. Webservice provides an interactive specification for applications running on different systems or platforms. RESTful Webservice is widely used in mobile Internet applications due to its lightweight, efficient, easy-to-use and easy-to-use design.Express lightweight Web framework using the Node.js platform,You can design APIs that conform to the Rest specification for quick and easy data distribution and sharing.Mobile client can obtain parking space information from the database by call REST API, then displayed on the mobile device.

In short, in the Node.js environment, the functions can be easily achieved [9], the overall organizational structure shown in Figure 4.

D. Mobile client technology

Using Java, Swift, React Native [10] and other technologies can develop App for each platform, get the parking status by calling the Rest API provided by the server, and use the third party SDK to integrate some useful functions.For example, the use of Baidu map SDK for the App integrated map and navigation functions [11] [12]; use Alipay SDK can be integrated for the App online payment function. the user through the App can quickly view the parking lot layout and parking spaces of the current occupation of information, advance booking parking spaces.

V. CONCLUDING REMARKS

Based on the analysis of the existing parking system and the advanced technology, this paper puts forward the overall architecture of an intelligent parking system according to the O2O model, and focuses on the key technologies that may be used.The system can provide free parking spaces online parking, parking spaces online booking, the user parking guide, the nearby parking lot recommended and intelligent billing system and other functions, to achieve automatic parking management, to ease the growing car ownership to bring the city parking pressure.

According to the development trend of information technology, the future intelligent parking lot mainly from the following aspects to deepening:

Break the information island. Rely on the Internet technology, data sharing between the parking lot and build a unified IOT platform, integration and effective use resources .

To achieve a high degree of automation. Through the mobile self-help payment, use the sensor technology to automatic billing, and use the computer vision technology to achieve rapid identification, realize the parking lot unattended management, saving human resources.

Accurate parking guidance.Through the sensor location technology, the parking area layout can be automatically generated, which can provide more accurate parking guidance and reverse search for users.

The mobile terminal supports more features. Such as parking automatic navigation, automatic payment, in accordance with the parking spaces back to the car and other functions.

Overall, with the development of Internet of Things technology, parking system will become more and more intelligent, "urban parking difficult" problem will gradually slow down.

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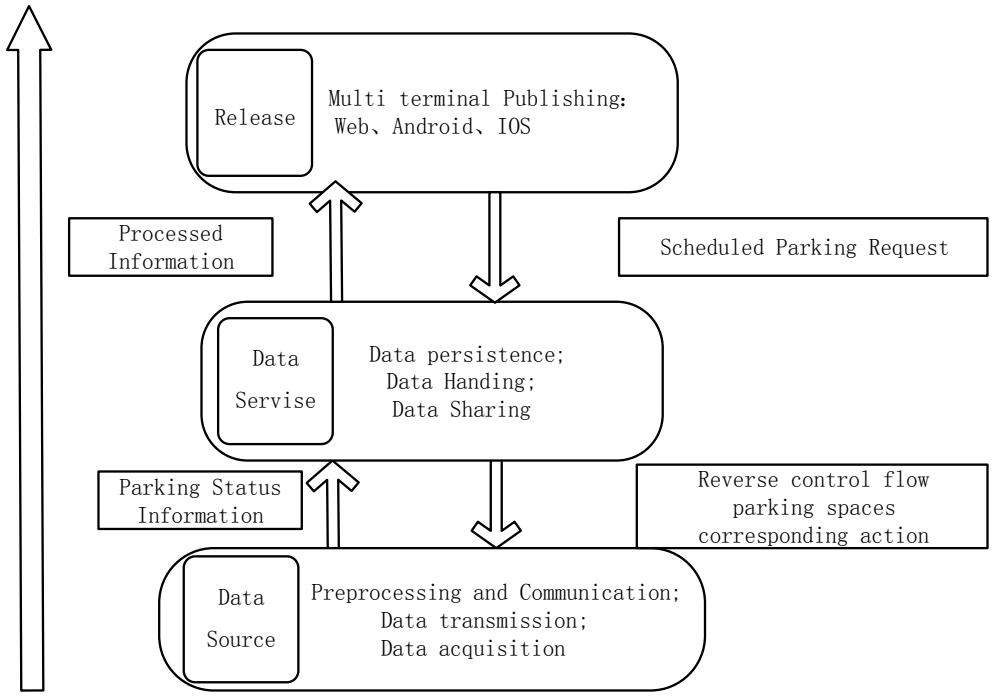

Figure 1. System overall framework

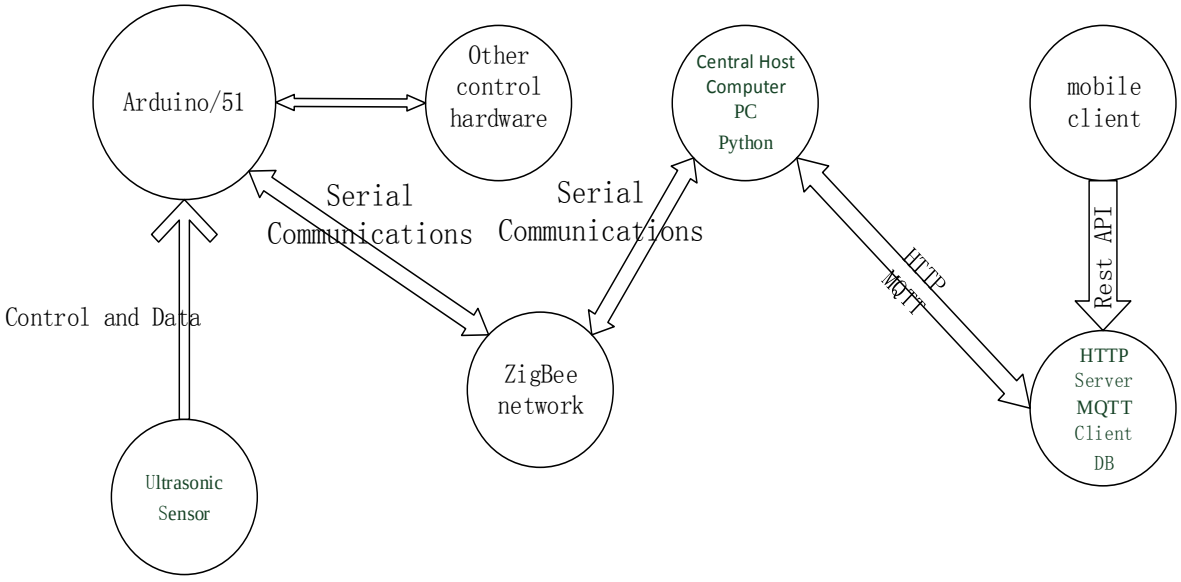

Figure 2. The overall structure of the intelligent

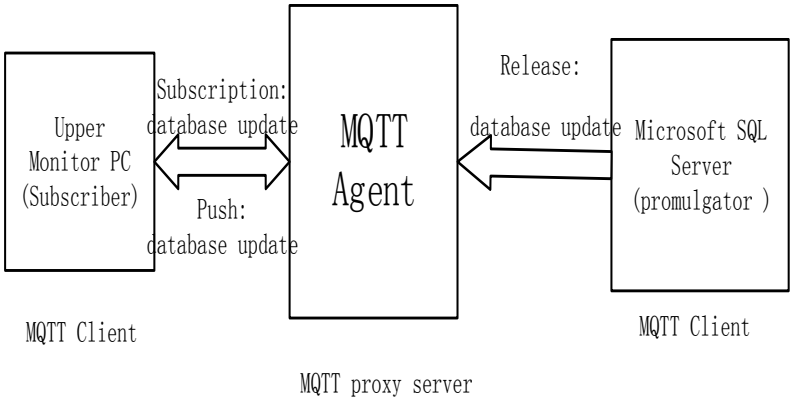

Figure 3. Figure 3 MQTT protocol communication model

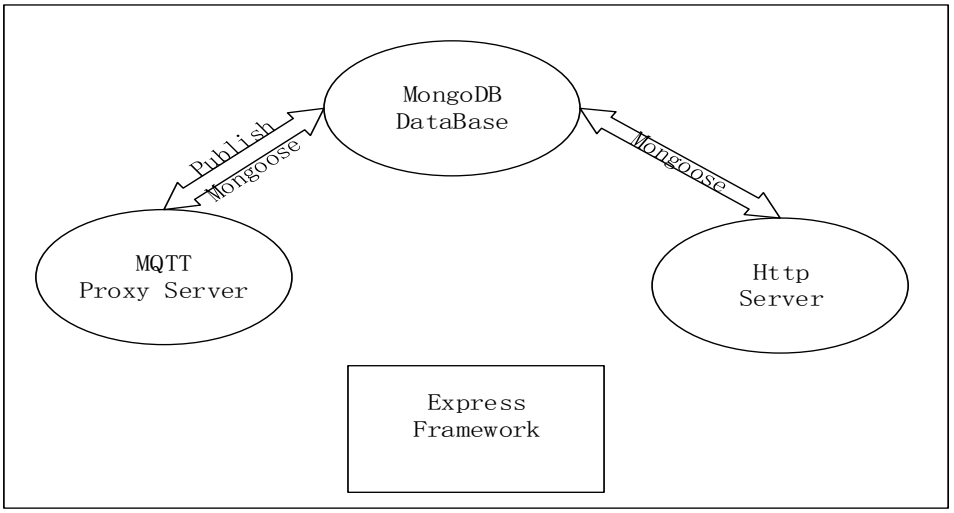

Figure 4. organization structure of node.js environment