

# Intelligent Parking System based on Internet of Things

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**Abstract:** With the development of urbanization, the number of car holdings is growing dramatically and the problem of parking difficulties is becoming more and more prominent. The irrational distribution of vehicles and parking measures in today's cities not only wastes limited road resources, but also brings great challenges to urban traffic management. Therefore, the demand for a smarter parking system is increasing to provide more convenient services and reduce the loss of human and material resources. The IoT-based intelligent parking system adds the functions of parking reservation and real-time detection to the original parking system, which realises the visualisation of parking information and makes it more obvious to see the real-time situation of the car park, thus making parking more convenient and quicker.

**Keywords:** Internet of Things; Intelligent Parking System; ZigBee; Transducer.

## 1. Introduction

With the development of social economy, the amount of car ownership is increasing, and now it has become the most common means of transport. At present, the market scale of intelligent car park equipment in China has reached 5 billion yuan, and is growing at a rate of 20% [1]. Statistics show that as of the end of September 2023, the national motor vehicle ownership reached 430 million, of which 330 million cars, new energy vehicles 18.21 million; motor vehicle drivers 520 million people, of which 480 million people driving cars [2].

These conditions have led to the problem of "parking difficulties" to become more prominent. The main problems include the tight parking space situation, the unclear parking space situation in the car park, and the problem of not being able to find the nearest parking space when there are too many parking spaces. Therefore, the intelligent parking system based on the Internet of Things (IoT) technology has emerged. This system improves the management efficiency and parking experience in car parks by using sensors, cameras, internet and other technologies to achieve a series of functions such as parking space management and parking space navigation. At the same time, it can also conduct big data analysis on the use of car parks, providing reference for the planning and management of car parks.

## 2. System Design

### 2.1. Overall Design

Our smart parking system consists of three main aspects: terminal nodes, data transmission and cloud platform. The terminal node (composed of ultrasonic sensors, CC2530 microcontroller and OLED prompt module connection) is responsible for collecting the parking space information and transmitting the data to the coordinator through ZigBee protocol; the data transmission part is composed of coordinator, serial converter and WIFI communication module is responsible for transmitting the collected data to the cloud platform; and lastly, the cloud platform uploads the data to the server side. On the cloud platform users can access and query the data through their own accounts.

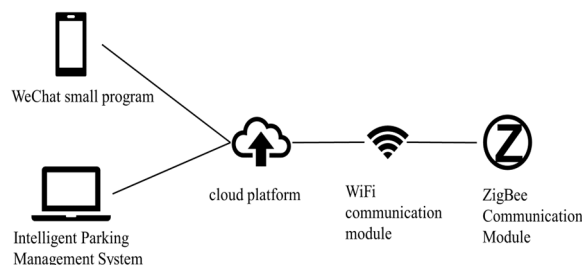


Fig 1. Intelligent parking system operation flow chart

### 2.2. Hardware Designs

#### (1) Main Control Modules

The system uses a 2.4GHz IEEE 802.15.4/ZigBee system-on-chip solution CC2530 wireless microcontroller. CC2530 based on Zigbee technology consists of CPU and memory related modules; clock, peripherals, power supply part; radio related part. The main function is to be responsible for the collection of relevant information, processing and coordination of various modules.

#### (2) Coordinator Hardware Design

The hardware selection used in the coordinator node is the same as that of the terminal node, and they both use the CC2530 chip based on ZigBee technology. In order to achieve wireless communication between the coordinator node and the sensor node, they need to comply with the protocols specified in the ZigBee wireless protocol stack to transfer information correctly, so they have the same CC2530 chip. At the same time, a microcontroller chip is added inside the coordinator node, which is mainly used for processing and analysing the incoming data from the sensor nodes to collate and package them and send them to the computer through serial communication.

#### (3) WiFi Module Design

The design mainly uses the mode of STA+AP in ESP 01S WiFi module to send the signals collected by the ultrasonic sensors via HTTP protocol, and finally upload the data to the OneNet cloud platform.

#### (4) OLED Module Designs

The communication method used in this design is the I2C bus protocol, with a screen size of 0.96 inches, which establishes a bus between multiple devices by controlling the high and low level timings of the serial data line (SDA) and the serial clock line (SCL), thus enabling the transfer of data.

### (5) Ultrasonic Sensor

Ultrasonic sensors are mainly used to measure the distance of objects. When a vehicle enters within the measurement range, the ultrasonic module obtains the distance information, and when it is less than a fixed value, we default that there is already a vehicle parked in the parking space and transmit the data to the cloud platform by passing it to the coordinator through the ZigBee terminal node.

## 2.3. Software Design

This software design includes three parts: ZigBee wireless communication software, WiFi wireless communication software and user system software.

### ZigBee-based wireless communication software design

In the software design of this module, we mainly design the coordinator programme, the terminal node programme, the sensor programme and the display module programme using ZigBee technology. In this way, the connection of each module is tightened.

### Software design based on ESP 01S module

We firstly connect the ESP 01S to the CC2530 module correctly, and then initialise the ESP 01S by calling the initialisation function and setting the parameters. Then, through a series of steps, we upload the data obtained from the terminal node to the cloud platform.

### User and management system software design

We chose to use the applet as our user side and for the admin side we chose to use the web side, which finally enabled the user and admin to visualise the data from the car park.

## 3. Implementation of System Functions

### 3.1. Car Parking Information Collection

We have an ultrasonic sensor in the parking space. When a vehicle enters the parking space and the distance between the vehicle and the sensor is less than a certain fixed value, the space is considered occupied and the data is transmitted through the ZigBee terminal node to the coordinator and then to the cloud platform to be sent down to the applet.

### 3.2. Transmission of Parking Space Information

When a vehicle is detected at the terminal port by entering the car park, the ultrasonic sensor detects the vehicle information and transmits the information to the CC2530 and then gives the lifting command to control the vehicle to enter or leave the car park.

### 3.3. Information Transmission

Our information transmission is mainly designed as a coordinator module. In our hardware system, it consists of ESP 01S, which mainly receives information from ZigBee terminal nodes and sends this information to achieve the control of the hardware system, so we use the STA+AP mode to send the information collected by ultrasonic waves to the OneNet cloud platform.

## 4. Innovative Points of this Project

This system adds the function of viewing real-time parking

spaces to the traditional parking system. Compared with the traditional parking system, this system can know the information about the car park in real time, which is convenient for the car owner to find the nearest parking space. In addition, we have also added the function of electronic payment, which can greatly save the owner of the car payment time. Compared with the traditional parking system, the system's real-time parking space function and electronic payment provides great convenience to the owner, and saves a lot of manpower and material resources for the management of the car park.

## 5. Conclusion

With the rapid development of contemporary society, technology is also advancing, people's income level is rising, and per capita disposable income is also increasing. People are more and more keen to choose the way of travelling by private car. As urbanisation continues to accelerate, the number of cars grows sharply and the parking problem becomes more and more prominent. Unreasonable vehicle distribution and parking measures not only waste limited road resources, but also bring great challenges to urban traffic management. China is a populous country, in the motor vehicle ownership also has a huge base, as of the end of 2023, the national motor vehicle ownership of 435 million, of which 336 million cars; motor vehicle drivers up to 523 million people, of which 486 million car drivers. 2023, the country's newly registered motor vehicles 34.8 million, the new license driver 24.29 million people. Newly registered cars 24.56 million, new registrations have exceeded 20 million for 10 consecutive years. In 2023, 34.8 million motor vehicles were newly registered across the country, an increase of 16,000 over 2022, or 0.05 per cent. Among them, 24.56 million newly registered cars, an increase of 1.33 million over 2022, an increase of 5.73 per cent. So, the "parking problem" is becoming more and more visible to us. Therefore, we need a more intelligent parking system to try to solve the problem of "parking difficulties", so that car owners can find more convenient parking spaces. At the same time also reduce the workload of car park staff. It can be seen that intelligent parking system has a broad prospect and great social value in the future.

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