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# Design of intelligent parking lot based on Arduino

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**Abstract.** With the single chip of Arduino series as the main control terminal, this article establishes the intelligent parking system by using various sensor. Through the connection of the single chip with Ethernet W5100 network port, this design transmits the collected information to the server and then uploads it to the Web interactive platform after processing. It achieves the query and booking functions through the WeChat public number platform so that the car park can be much more efficient and intelligent.

## 1. Introduction

Along with the social economy rapid development, the rapid increase of the public vehicle, more and more people of car travel "parking" parking difficult, difficult problem in every city the increasingly significant, collect fees in disorder, parking, difficulties in and out of the parking lot phenomenon exists generally, this already affected the urban landscape, more affecting the harmonious development of the principle of dynamic traffic. In most cities still belongs to traditional parking in the parking lot, single function, low efficiency, low degree of automation, many of the serious shortage of parking signs, parking line, guide arrow, deceleration cushion, parking management facilities such as vehicles inducing sign, even more difficult for parking.

Therefore, it is very necessary to develop and design a complete intelligent parking management system. Based on the intelligent parking lot under the Arduino microcontroller development can real-time monitoring parking lot conditions, convenient understand empty car number, as well as lighting control system, able to quickly find empty car into the garage car navigation. In order to save time, the intelligent parking lot, through the Internet of things technology, performs the reservation parking within the LAN, which greatly facilitates the owner to find the car.

## 2. System function analysis

### 2.1. system functional requirements analysis

This system for the urban three-dimensional parking management information system, on the function should be able to meet the demand of informatization and intelligent parking lot management, of the vehicle to ensure the orderly and efficient access, store and ensure the safety of the vehicle. The urban parking lot is open 24 hours everyday, allowing vehicles to enter and leave at any time. Therefore, the system should have the following functions:



- 1) identify vehicles (including license plate number and vehicle type, etc.) as they enter and leave the parking lot.
- 2) guide the vehicle to park properly.
- 3) dispatching mechanical equipment to store the vehicle correctly.
- 4) statistical analysis function (such as residual parking space, parking time, etc.).
- 5) automatic charge function.

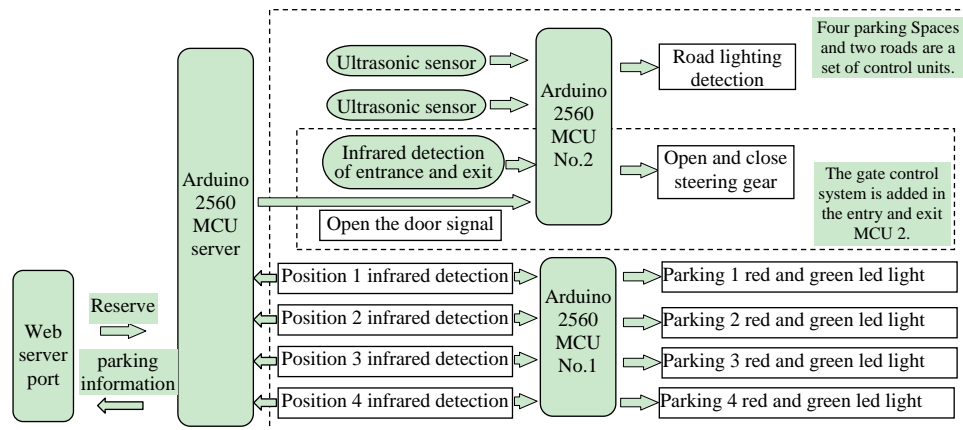


Fig. 1. Whole system principle

### 3. Overall design scheme and block diagram of the system

The overall system is shown in figure 1. The working process of the main control unit of the MCU number one: when a vehicle parking, infrared detection sensor detects vehicle parking, converts high level signal to a low level signal transmit to MCU/O mouth, single-chip signal judgment after open the current parking on red-leds switch tips parking cars, and turn off the navigation to the green LED navigation light switch in the parking lots. When vehicles out of the parking lot, infrared detection sensor detects no car parking Spaces, the low level signal is converted to a high level signal transmit to MCU I/O port, single-chip signal for judging the red LED on the closed after the current parking switch and open the green LED navigation light, navigate to the parking and maintain state to the next state changes.

Main control unit of the MCU workflow no. 2: when a vehicle lane detection, ultrasonic sensors of fixed PWM signal, the collected signal is transmitted to the microcontroller PWM mouth, calculate the high level of time, and the formula to calculate the vehicle from the mouth of the detection distance, to locate the vehicle location, and open the current vehicle front and upper part of the light switch. Near the position of the entrances and exits or double parking lot one-gallon, 2 master microcontroller also has infrared detection sensor and steering gear, inward and outward in different ways, the export program, when the infrared detection when the vehicle is detected, the infrared sensor converts high level signal to a low level signal transmit to MCU/O mouth, single chip microcomputer to get signal output PWM signal control steering gear after open the door, when the infrared detection state changes, single-chip microcomputer closed output PWM signals. Entrance program, due to add the booking and determine the problem of full car, require an external control to determine whether meet the conditions to open the door, and the incoming signal to open the door, when the infrared detected after the car has entered the parking lot, steering gear door closing entry.

Booking system is the booking number and empty digits compared, when two equal, close button booking and walk-in open procedures, vehicle can only be accessed by entering a booking number, enter the confirmation number, booking number will be a reduction, and empty car parking lot after comparison, its parking is greater than the reservation parking number, you can click to open the door key to enter directly. Figure 2 is the illustration of prototype and the algorithm used.

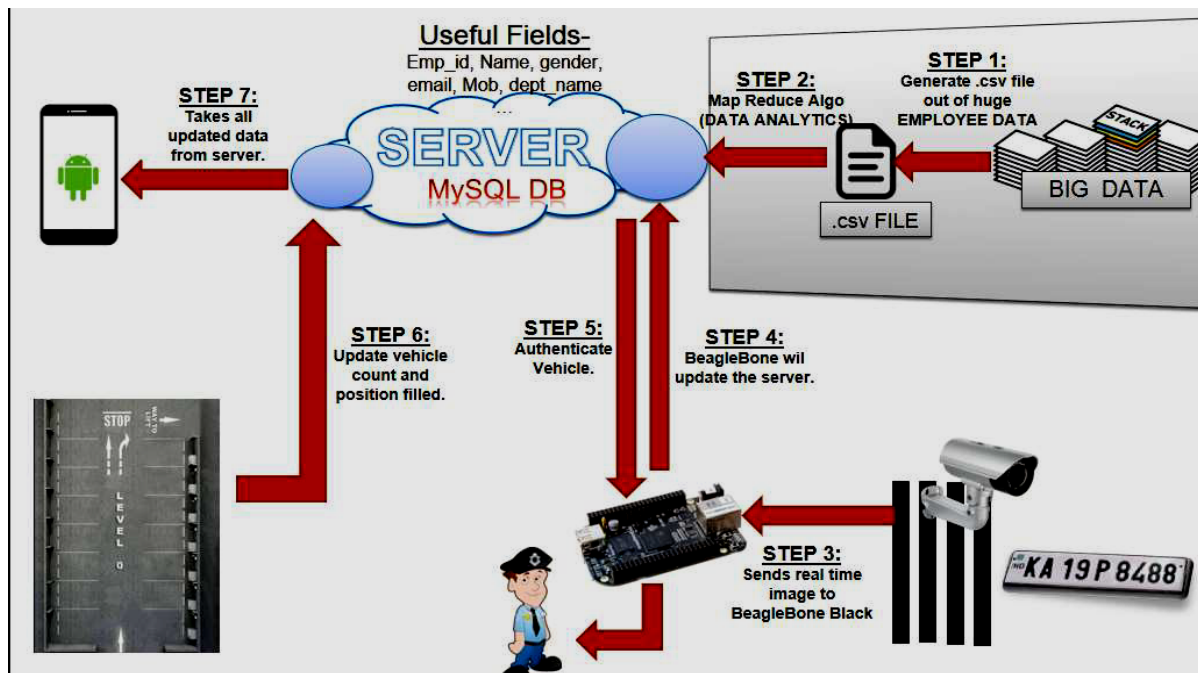


Fig. 2. Block Diagram for Proposed Model

#### 4. Main chip and module analysis of the system

Arduino electronic prototype platform, including Arduino boards and sensors and software (Arduino IDE), is an open source convenient and flexible. The Arduino boards can sense the environment through diverse sensors and feedback and influence the environment by controlling motors, lights, voice and other devices.

##### 4.1. The Arduino Ethernet chip W5100

Arduino Ethernet is a microcontroller based on ATmega328, its network chip USES W5100, is a versatile single-chip network interface chip, internal integration 10/100 Mbps Ethernet controller, its function can make and computer or other microcontrollers communicate, at the same time support the TWI and SPI communication.

##### 4.2. Infrared obstacle avoidance sensor module

Infrared sensors that measure 2~30 cm obstacle avoidance control within the scope of the object, after electrify to produce the infrared signal, the receiver to receive after the object under test reflection signals, after return to convert optical signals into electrical signals, are compared, and the voltage signal output from high and low level.

##### 4.3. HC-SR04 ultrasonic ranging sensor module

HC-SR04 ultrasonic distance sensor can measure the distance between the object and the module within 2400cm, and its accuracy can reach 3 mm. MCU I/O port for at least 10  $\mu$ s Trig sends a high level signal, module automatically sent eight 40 kHz square wave, and return signal detection, from the Echo output signals to the single chip microcomputer, through the detection of high level time to calculate the object to the distance of the ultrasonic sensors, test distance(cm)=output high level signal /58.

#### 5. Software design of the system

System used the administrator client/Server architecture, software module in the study of the overall is decomposed into core content as follows: vehicle identification module, information display

and parking guidance module, mechanical equipment control module and the backstage database management module. Therefore, the following discussion is carried out.

### *5.1. Vehicle identification module*

There are mainly two kinds of car identification technologies, camera identification and RFID radio frequency identification at present. Specifically, the license plate recognition technology to identify vehicles parked the car process: when the car into the parking lot by a camera at the entrance of the vehicle shape and license plate number, automatic storage after system boot vehicle parking, Or it is after the owner input take car license plate number, vehicle drove to leave after the exit fee. And adopt the RFID technology to identify vehicles parked the car process is: the car into the garage when first choice vehicle type and then take a card, according to the instructions after parking system arrange warehousing, pick it up some time after the charge, the vehicle to return the car at the exit card fee after the leave.

### *5.2. Background database management module*

This module is a basic function modules of the system, any data related to the parking lot must be recorded in the database, the module should guarantee the data warehousing, data editing and updating, the realization of the function of data query and application, etc. The basic customized framework processing mode mainly includes: the information storage of the vehicle after it is recognized in the parking lot; New vehicle parking allocation and other parking management work; Data updates after parking and pickup; Statistical calculation of parking time, number and other data; Equipment management, staff management and various cost management, etc.

### *5.3. Information display and parking guidance module*

Parking guidance information display and module should be able to through the analysis of the data in the database, get the current remaining parking garage and through the display present status identification, a more important role is to be able to in the background database distribution after the new car parking guide the vehicle to the right place. In terms of the research implementation method, the information of opening to traffic can be displayed to the owner through LED indicator or display screen, supplemented by the warning of voice equipment. Once the owner according to the guidelines parked at a specified transmission platform, after leaving the transmission platform and vehicle storage button, the region's photographic equipment will automatically identify vehicles and judge the correctness of the park, if correctly indicates that the owner can leave, if error warning and reboot parking.

### *5.4. Mechanical equipment control module*

The control module of mechanical equipment is mainly to organize and guide the lifting, lateral shifting, rotary and other mechanical operation processes in the development strategy of vehicle parking and warehousing and vehicle pickup and vehicle transfer. After the correct parking, the mechanical equipment will transport the vehicle to the designated location according to the parking number assigned to the vehicle in the system database. When the owner takes the car, he needs to enter the license plate number first. After the system inquires the parking number, the car will be transported by mechanical equipment to the pickup port for parking.

### *5.5. Procedures of infrared detection and navigation lights and indicator lights*

Infrared detection need to loop on 4 parking Spaces on the infrared sensor (infra) for data collection, when parking infrared acquisition to low levels, according to the current car parking, close the current parking Spaces on the navigation lights and open the red indicator light; Conversely, turn off the red indicator and turn on the corresponding navigation light. In order to simplify the program, array is used to define various interfaces and nested repeatedly with multiple for statements, so as to reduce the program storage space of SCM and improve the running speed.

### 5.6. Ultrasonic ranging and lighting control procedures

Ultrasonic sensor for at least 10  $\mu$ s high level start PWM signal, therefore, the program gives high level 10ms, when the state changes immediately with `pulshIn()` function to detect pulse width, the calculation formula of the corresponding distance and the judgment, the driveway before opening and all lighting, as after turning off the location of the car and the lights of the vehicle. Automatically turn off the lights when the car pulls out of the road. Concise definition adopted array to program each interface and judgment for statement nested statements, judge the statement when the distance is less than  $t \times 9$  cm, open the first  $t$  period of light, use a for loop can be opened to achieve from beginning to end to Max ( $t$ ) section of the light.

### 5.7. Add the WeChatt function to public account

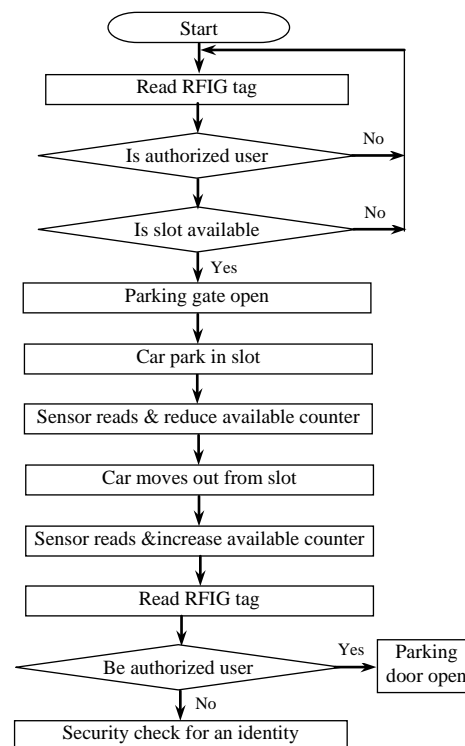
The URL is relatively difficult to remember when the system needs to access the LAN. After paying attention to the public number through WeChat, The URL can be accessed easily. First, register a public account with WeChat, log in the Wechat public account platform, edit the corresponding text in the customized menu, enter the URL and save it. In the automatic reply, select the key word auto reply, and set "query", "reservation" and "parking" as the key word, then enter the URL in the reply box.

## 6. Implementation

The overall flow diagram of Arduino based car parking system is shown in Figure 3.

The Arduino board is given 12V through the bridge rectifier which is used to convert Alternating current to Direct current. Microcontroller consists of three part, respectively, the Microcontroller Arduino (Datasheet), Reset Button and Crystal Oscillator. The datasheet contains all the authorization details data related to the user, for example, car number and about driver. The reset button is used to start the execution from start itself when the project hangs somewhere. Crystal Oscillator generates the clock pulses signal.

RFID Tag is coded and has some unique number, stored in datasheet with details. Once the RFID card punches on RFID reader, then it will be displayed on screen and the signal will be sent to relay board to open gate. IR sensors are used to check the availability of free parking slot. Relay board is used to vary the voltage to open gate. If parking slot is available, the relay board gate will be opened and the car can be parked, otherwise, the gate will not be opened even if he is authorized.



**Figure 3.** The overall flow diagram of car parking system.

## 7. Conclusion

This article is based on Arduino UNO microcontroller, micro public letter number, Internet of things intelligent parking lot, its core processor ATmega328 by controlling the duty ratios of the ultrasonic sensor to control the brightness of the navigation lights, to ensure the safety in the vehicle quickly find a parking space, use of parking space at the top of the infrared detecting module with single chip microcomputer processing, to prompt the owner of this car is a car; Network part adopts ATmega2560 with Ethernet W5100 for the construction of the network port, use the HTMLS and CSS programming to design a good interaction and, the owner can query by micro letter number public

platform and book a parking space. Convenient on the 1st of the intelligent parking system to quickly find a parking space, reduce traffic congestion, but also reduce the yard of the artificial cost and improve the utilization rate of yard, to wisdom city.

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### References

- [1] Saraswati Saha, Anupam Majumdar. "Data Centre Temperature Monitoring with ESP8266 Based Wireless Sensor Network and Cloud Based Dashboard with Real Time Alert System", J Ambient Intell Human Comput, vol.7, pp.131–138, 2016.
- [2] Sankalp Mehra, Tanmay. "Disaster Detection System Using Arduino," International Conference on Information, Communication & Embedded System(ICICES 2017), pp.1-6,2017.
- [3] F.M. Li, Y.G. We, Y.G.Chen, and X. Zhang. "System Design of Online Monitoring and Controlling System Based on Zigbee in Greenhouse," CCTA 2014, IFIP AICT 452, pp. 702–713, 2015.
- [4] Y.C. Xie. "The Design of Temperature and Humidity Measure Based on USB Interface," Proceedings of the 2015 International Conference on Communications, Signal Processing, and Systems, Lecture Notes in Electrical Engineering 386,pp. 935-942,2015.
- [5] Kunja Bihari Swain, Satyasopan Mahato."Cattle health monitoring system using Arduino and LabVIEW for early detection of diseases," 2017 IEEE 3rd International Conference on Sensing, Signal Processing and Security (ICSSS), pp79-82, 2017.
- [6] Adeel Javed, Lake Zurich, Illinois "Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications," USA.2016.
- [7] Hong He, Yaqing Hou, Zhihong Zhang"Research on Indoor Environment Monitoring System Based on ZigBee," 2017 29th Chinese Control And Decision Conference (CCDC),PP. 2054-2057.2017.