Quest Journals
Journal of Software Engineering and Simulation
Volume 9 ~ Issue 11 (2023) pp: 01-14
ISSN(Online) :2321-3795 ISSN (Print):2321-3809
www.questjournals.org

Research Paper

Design of ultrasonic parking system based on lab VIEW

Shuyi Xu Yanting Ni*
School of Mechanical Engineering, Chengdu University, China
Corresponding Author: Yanting Ni

ABSTRACT: *At present, the traffic is rising gradually in our country. The number of cars is increasing day by day. Crowded parking areas make the reality of parking more complicated, the accuracy of driver parking is limited, and accidents occurred frequently. If intelligent functions of cars can be used to assist people to park, it will be more convenient. How to make automatic parking system technology more suitable for human needs and promote its intelligent direction is particularly important.*
In order to solve the practical problems of parking, this paper designs the ultrasonic parking system based on LABVIEW, which can realize the function of automatic parking within the safe distance and display the distance under the state of reversing motion. In this system, a car model similar to the actual vehicle movement law is used as the research object. The car starts to reverse at a uniform speed and stops automatically when it reaches the minimum distance of the stop line. The automatic parking system uses ultrasonic sensor ranging, data collection and transmission to the MCU, SCM receives and processes the distance information between the car and the parking board, when the minimum parking distance is reached, control the motor to realize automatic parking. At the same time, LABVIEW displays the parking distance in real time in the panel, realizing the functions of safe distance monitoring and automatic parking of the car when it enters the warehouse.
KEYWORDS: *LABVIEW，ultrasonic，SCM*

***R**eceived 05 Nov., 2023; **R**evised 18 Nov., 2023; **A**ccepted 20 Nov., 2023 © The author(s) 2023.*
P**ublished with open access at **www.questjournals.org

I. INTRODUCTION

At present, Chinese transportation enterprise is rising gradually, whether it is cars, or people who use cars, the number is increasing.So that had an impact.From the perspective of environmental resources: as the number of these two increases, parking lots, roads, and even the pavement of the community without parking lots become crowded, thus reducing the parking area of each car. Crowded parking areas make the reality of parking more complicated.From the perspective of human beings, the technical level of drivers is uneven. Some of them are novices and their driving skills are not mature. Moreover, the accuracy of parking based on human judgment and experience is limited, and accidents occur frequently.On the contrary, it will be more convenient to use the intelligent function of cars to help people park.Therefore, the introduction of automatic parking system will solve many problems encountered in practical applications.Parking is naturally inseparable from the parking environment. Instead of people's self-judgment, automatic parking system can first detect the environment around the vehicle and obtain environmental information. After detecting environmental information, the car can better judge whether it should park, so as to avoid environmental and human risks in the parking process.Compared with artificial parking, which has a high accident rate and uncertain accuracy rate, automatic parking system improves the intelligent level and safety of vehicles, further reduces the difficulty of driving vehicles for novice drivers, meets people's demand for automobile intelligent function, and lays a foundation for the realization of vehicle autonomous driving in the future.So in this context the automatic parking system is very meaningful.

II. MAIN RESEARCH CONTENT

This system design will adopt a car model similar to the actual vehicle movement rule as the research object. The car will reverse at a constant speed and automatically stop when it reaches the minimum distance of the stop line. In the whole process, the information collected by the ultrasonic sensor will be transmitted to the single chip microcomputer for processing.The LABVIEW panel visually displays the distance from the parking panel, allowing the driver to monitor the distance from the stop line throughout the process.At the same time the single chip microcomputer using the measured distance, combined with the program to control the car stop.Considering the more complex road conditions in reality, the system also adds infrared obstacle avoidance module.The specific research contents are as follows:

(1) Building the car model: according to the signal characteristics of the test object, the hardware selection is carried out, the motor module is built, the lower machine is built, and a car that can normally complete the reversing movement is made.The rear of the car is equipped with ultrasonic sensor module, and the left and right ends of the car are equipped with infrared obstacle avoidance module, which is used to collect signals and realize corresponding functions.

(2) Ultrasonic sensor ranging: the ultrasonic sensor is used to collect analog signals, and transmitted to the MCU.The STC89C52 single chip microcomputer is used to receive and process the data information collected by the ultrasonic sensor, and then the data is transmitted to the control unit. According to the program design, the control motor module makes the corresponding action to realize the automatic parking function of the car when it reaches a certain distance in reverse.

(3) In the LabVIEW development environment, the ultrasonic detection platform is built, and the data transmitted from the lower computer is processed and calculated through serial communication, so as to realize the collection, processing and display functions of the distance signal on the labVIEW panel.

(4) infrared obstacle avoidance module: the use of infrared sensor to detect whether there is an obstacle, if there is an obstacle, no matter whether it has reached the minimum stopping distance set automatic parking.

III. OVERALL SYSTEM DESIGN

3.1 OVERALL DESIGN

In the design of this system, the whole parking system includes information acquisition system, drive control system, and display platform.The information acquisition system consists of ultrasonic module and infrared obstacle avoidance module.Ultrasonic mode is responsible for sending ultrasonic waves as well as detecting ultrasonic waves that bounce.The distance between the car and the parking plate is calculated by combining with the single chip microcomputer timer.The SCM sends the calculated distance data to LABVIEW for processing and displaying data.The infrared obstacle avoidance module is responsible for sending infrared rays and detecting infrared rays reflected by obstacles. The converter converts analog signals to high and low levels and transmits them to the single chip microcomputer, which then controls the drive module to control the movement and stop of the car.The drive control system consists of a motor drive module, which determines the motion and stopping state of the car.

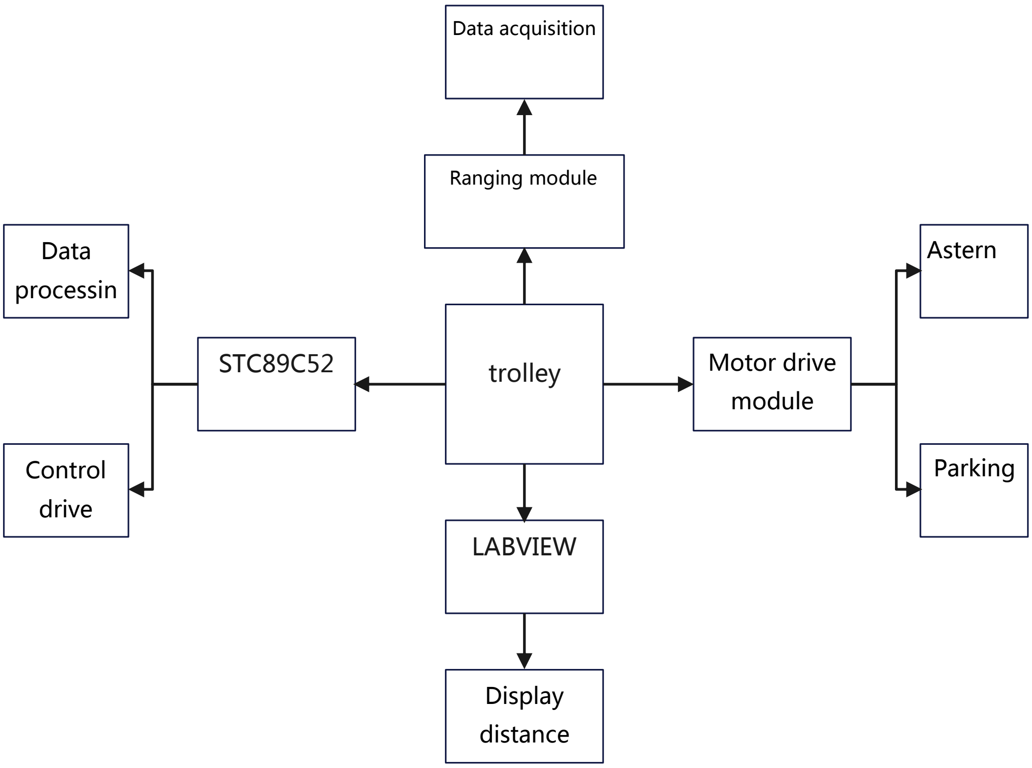

Figure1

The ultrasonic automatic parking system based on LABVIEW is composed of STC59C52 microcontroller, which receives and processes ultrasonic signals collected by ultrasonic sensors. When the distance between the car and the parking board calculated by the microcontroller has reached the minimum parking distance set, the microcontroller will control the motor to make the corresponding automatic parking action.At the same time, LABVIEW displays the stopping distance in the panel through the calculation data transmitted by the single chip computer through the serial port communication office.The interaction between each module, data transmission processing and control, so as to realize the car reversing automatic parking, obstacle avoidance and safety distance monitoring functions.
espect to θ_1 and θ_2, respectively.The momenta equations are described as the partial derivative of the Lagrange with respect to the angular velocities. Therefore:

3.2 Overall structure design

Because there are many parts of different modules, the structure of the car and the position of each module also need to be designed.Acrylic plate is transparent material, which is easy to build the front and back parts of the car, so the overall frame of the car model uses acrylic plate to build.In order to facilitate wire connection, the power supply is located in the center of the acrylic plate;The tail of the car is the MCU main control module;After the main control module is supported ultrasonic ranging module;Infrared obstacle avoidance module adopts two, respectively located at the left and right ends of the car, easy to detect the car body around the obstacles;The driving module does not detect obstacles, so it is located in the front;The two steering engines are connected with the tires and located on both sides of the car below;It is also necessary to install a roller which can change the direction under the tail of the car. The roller and two steering gear form a triangular structure to support the whole car smoothly.The overall effect is shown below:

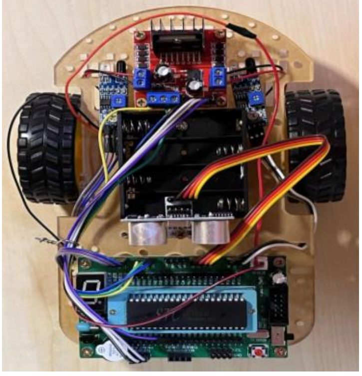

Figure 2

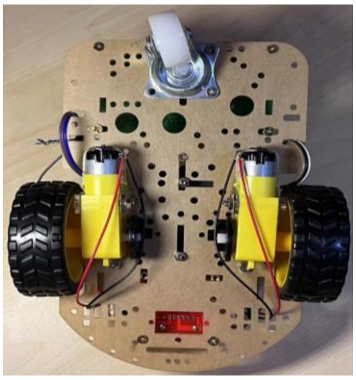

Figure 3

3.3 Hardware Selection

3.3.1 SCM

First of all, we should choose the main control module of the system. This design mainly considers the use of single chip microcomputer as the main control module.SCM is a single chip microcomputer, is a typical embedded microcontroller, widely used in the field of industrial control.It is not a chip that performs a logical function, but a computer system integrated onto a chip.A small volume of a set of computer, controller, memory, input and output equipment, it is small, light weight, cheap, strong anti-interference ability, easy to learn, application and development, so very suitable for the design of the system.

And this design mainly considers the AT89C51 microcontroller and STC89C52RC microcontroller, the two comparison is as follows:

AT89C51 microcontroller:

The microcontroller is a new generation of microcontroller AT89 series launched by ATMEL company in 2003, is its typical high performance, low cost microcontroller products.It is a low voltage, high performance Cmos8-bit microcontroller with high efficiency and mature development. It is also widely used in the electronics industry.

STC89C52 microcontroller:

The series of microcontroller encryption is strong, difficult to decrypt, and has strong anti-interference, which is reflected in the high anti-static, ESD protection, can easily pass 2KV/4KV rapid pulse interference, that is, EFT test.In addition, the wide voltage used makes it not afraid of the influence of power jitter.Its high temperature range of -40 ° C to 85 ° C also greatly reduces the effects of normal temperature fluctuations.The I/O port, the clock circuit, the reset circuit, the power supply system and the watchdog circuit of the single chip microcomputer have been specially treated.The chip consists of 8KB of erasable read-only program memory

(PEROM), 256 bytes of random Access Data memory (RAM), 40 pins, 32 external bidirectional input/output (I/O) ports, and 2 external interrupts.Three 16 16 bit programmable timing counter, two full duplex serial communication mouth, read and write two lines, one contains 8 k bytes of repeatable wipe flash (flashreadprogrammablememory) and includes a 256 byte RandomAccessDataMemory, moreover,This series of single chip microcomputer can be programmed in the system, no programmer, no simulator.

To sum up, the STC89C52 microcontroller is larger than AT89C51 microcontroller memory, and there is one more timer, so STC89C52 microcontroller is chosen as the total control module of this system design.

3.3.2Motor drive module

Small cars require efficient electric drives, DC motors are more efficient, have attractive speed and torque characteristics, and are easier to adjust.

Motor driver needs motor driver chip. Motor driver chip is a chip integrated with CMOS control circuit and DMOS power device, which can form a complete motion control system with main processor, motor and incremental encoder.It can be used to drive inductive loads such as DC motors, stepper motors and relays.

This design mainly uses L298N motor drive chip, L298N is a kind of high voltage, large current motor drive chip produced by ST company.The chip adopts 15-pin package, the main feature is high working voltage, the highest working voltage can reach 46V;The output current is large, the instantaneous peak current can reach 3A, the continuous working current is 2A;Rated power 25W.High voltage and high current full bridge driver with two H Bridges can be used to drive DC motor, stepping motor, relay coil and other inductive loads.

Using the L298N chip drive motor, can drive a two-phase stepper motor or four-phase stepper motor, can drive two DC motors.It is a motor driver that accepts high voltage and can be driven by both DC and stepper motors.One drive chip can simultaneously control two DC reduction motors to do different actions, in the voltage range of 6V to 46V, to provide 2 amperes of current, and has the function of overheating self-break and feedback detection.L298N can directly control the motor. By setting its control level through the I/O input of the main control chip, it can drive the motor forward and reverse.

Using the L298N chip drive motor, can drive a two-phase stepper motor or four-phase stepper motor, can drive two DC motors.It is a motor driver that accepts high voltage and can be driven by both DC and stepper motors.One drive chip can simultaneously control two DC reduction motors to do different actions, in the voltage range of 6V to 46V, to provide 2 amperes of current, and has the function of overheating self-break and feedback detection.L298N can directly control the motor. By setting its control level through the I/O input of the main control chip, it can drive the motor forward and reverse.

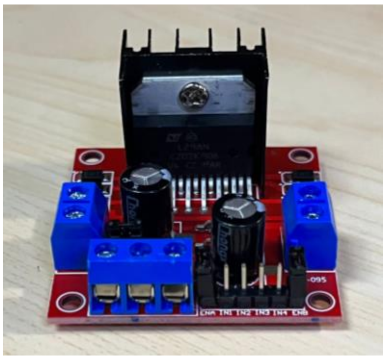

Figure 4

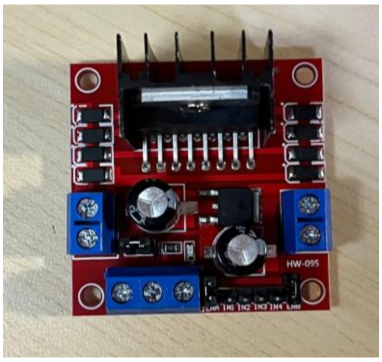

Figure 5

3.3.3Ultrasonic module

The working principle of ultrasonic sensor should be understood before selecting the module.Ultrasonic sensors use sound to determine the distance between the sensor and the nearest object in its path.How do you use sound to determine distance?Ultrasonic sensors are essentially sound sensors that operate at a higher frequency than human hearing.As a kind of sound wave, the propagation speed of ultrasonic wave is affected by temperature. When the temperature increases by 1℃, the sound velocity will increase by about 0.6m/s. In order to improve the measurement accuracy of the system, the influence of temperature should be compensated.The sensor emits sound waves at a specific frequency, and then it listens for that specific sound wave to bounce off the object.The sensor tracks the time between sending the sound wave and returning it.If you know the speed of something and how long it took to travel, you can find out how far it traveled.This can be combined with the MCU timer to calculate the distance.

This design uses HC-SR04 ultrasonic ranging module.HC-SR04 ultrasonic ranging module is often used in robot obstacle avoidance, object ranging, liquid level detection, public security, parking lot detection and other places.The sensor is small, easy to use in any robotics project, and provides excellent non-contact range detection between 2 cm and 400 cm (approximately 1 inch to 13 ft) with an accuracy of 3mm.Since it operates at 5 volts, it can be connected directly to the Arduino or any other 5V logic microcontroller.

The core of HC-SR04 ultrasonic distance sensor is composed of two ultrasonic sensors, namely two universal piezoelectric ceramic ultrasonic sensors, and peripheral signal processing circuit.One of them is used as a transmitter to convert electrical signals into 40KHz ultrasonic pulses.The receiver, on the other hand, listens for transmitted pulses and, if they are received, produces an output pulse whose width can be used to determine how far the pulse travels.His control principle is to send a high level of more than 10US through the Trig pin, you can wait for the high level output at the ultrasonic rebound wave receiving port;But there is an output, the MCU can open the timer to start time, when the receiving port into a low level, you can read the value of the timer, at this time for the ranging time, in order to calculate the distance between the object and the car within this period of time.Such continuous cycle measurement, can be successfully measured to the design of the car real-time moving measurement distance value.

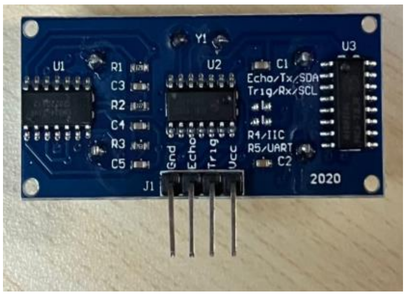

Figure 6 **Figure 7**

3.3.4Infrared obstacle avoidance module

Due to the more complex road conditions in reality, obstacles may appear all the time in the parking process, not only to pay attention to the car behind the parking board, so this design also designed the obstacle avoidance module.Obstacle avoidance module adopts traditional infrared sensor.

Infrared temperature sensor can calculate the surface temperature of an object by measuring the intensity of infrared radiation emitted by the object without touching the target.Non-contact thermometry is the biggest advantage of infrared thermometry, which allows users to easily measure objects that are difficult to approach or move.The sensor is an integrated infrared sensor. The sensor, optical system and electronic circuit are integrated in the stainless steel shell.Easy to install, metal housing on the standard thread can be quickly connected with the installation site;At the same time, there are optional parts (mounting bracket) to meet the requirements of various working situations.

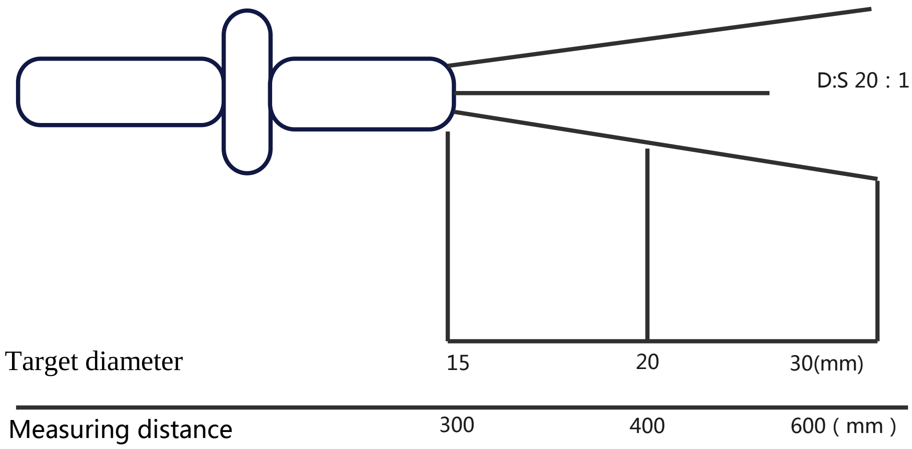

Figure 8

The sensor has a pair of infrared transmitting and receiving tubes, which emit infrared rays of a certain frequency. When the detection direction meets obstacles (reflecting surface), the infrared rays are reflected back and received by the receiving tube. At the same time, the signal output interface outputs digital signals (a low level signal), and the detection distance can be adjusted through the potentiometer knob.The effective distance is 2 ~ 30cm, and the working voltage is 3.3V-5V.The detection distance of the bottom transfer device can be adjusted by potentiometer, with small interference, easy assembly, easy to use and other characteristics, can be widely used in robot obstacle avoidance, obstacle avoidance car, pipeline counting and black and white line reach many occasions.

The basic principle of the infrared photoelectric sensor is to convert the reflected photoelectric analog signal into current signal through the LM393 converter by using the infrared reflected back from obstacles, and then convert the high and low levels through the AD to be recognized by the single chip microcomputer.

IV. HARDWARE CIRCUIT DESIGN

4.1Reset circuit

Microcontroller system debugging operation is affected by external factors, may be stuck or can not run normally, to make the microcontroller continue to work, must restart.Therefore, it is necessary to design a system synchronous reset circuit, which includes an up key and a reset key.

When the MCU is affected by the external environment or objects, the system has problems in the operation process, press the reset button of the reset circuit, the system will automatically restart.The designed switch reset and crystal oscillator circuit is shown in the figure below. The XTAL1 pins and XTAL2 pins of the single chip are connected to crystal oscillator and fine tuning capacitor, so that the enabling end EA is connected to the reset switch. Press the reset button once, and the system is reset once.The resistance R2 is 100, the capacitor C1 is 1uF, the capacitor C2 and C3 are 33pF, and the crystal oscillator is 11.0592MHz.The circuit diagram is shown in Figure 3.1 below.

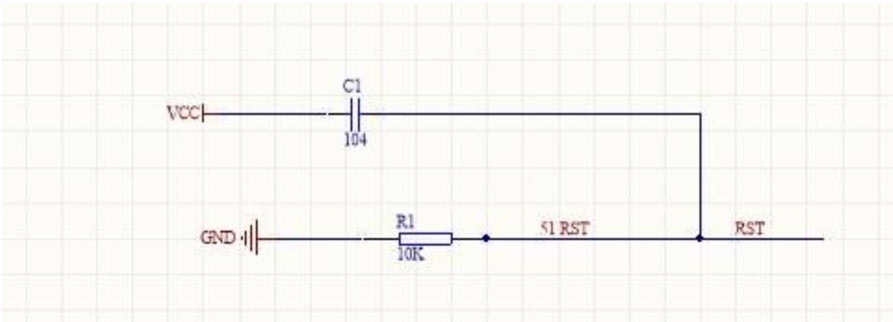

Figure 9

4.2HC-SR04 ultrasonic sensor circuit

When the car model starts to reverse, the automatic parking system of the car model is started first and initialized.Then, the ultrasonic sensor began to emit ultrasonic waves, the timing counter inside the MCU will start counting, after the ultrasonic receiving probe receives the echo signal, the timing counter will stop counting, and open the external interrupt;By using this method, the ambient temperature of the vehicle can be monitored in real time, so as to obtain the corresponding sound velocity, and the distance between the vehicle and the obstacle can be calculated by the sound velocity equation.If the distance between the vehicle and the obstacle is smaller than the stated safe distance, the dolly model will automatically stop according to the procedure.

In order to simplify the design, the ultrasonic ranging module is used by HC-SR04 ultrasonic sensor, the sensor support working voltage is 3V to 5.5V, the working voltage used in this design is 5V, the maximum measurement value of the sensor is 450cm, the detection range is 2~450cm, the detection Angle is 15°.Output mode is GPIO, output by the IO port of single chip microcomputer.The ultrasonic sensor has only four pins, which are VCC, GND, TRIG and ECHO. TRIG is used to send out ultrasonic waves, and ECHO is used to detect ultrasonic echoes.

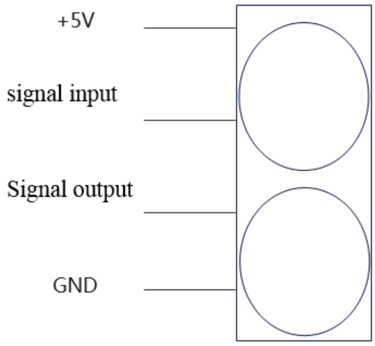

Figure 10

In order to simplify the design, this ultrasonic ranging module adopts HC-SR04 ultrasonic sensor, whose working voltage range is between 3V and 5.5V, VCC and 5V power supply, GND is connected to the ground, TRIG pin is equipped with 10KΩ pull-up resistance, in the process of measurement, through the IO port of CPLD, the TRIG pin is first pulled down.Then output a high level signal of more than 10 microseconds, the sensor will automatically send out 8 40kHz square waves, so as to stimulate the transducer to emit ultrasound, in practical application, maintaining a high level value of 40-50 microseconds is the best.After receiving the ECHO signal, the sensor will send the high level to CPLD through the Echo pin of the input and output ports. The time maintained by the high level is the time between the ultrasound and the echo.Based on the high level time, the distance from the transmitting point to the obstacle can be calculated.The distance is (high level time *340m/s) /2.

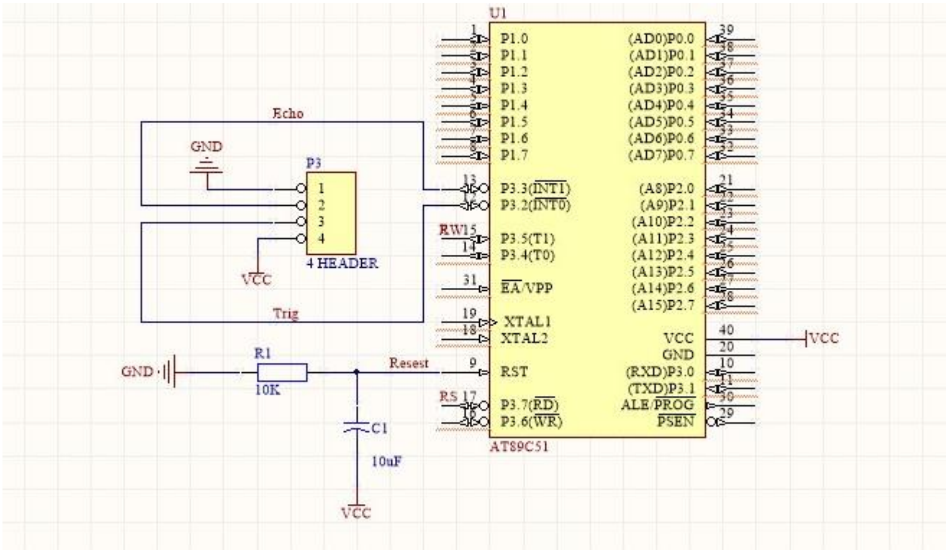

Figure 11

4.3 Infrared sensor circuit

Infrared obstacle avoidance sensor, also known as infrared tube sensor, the sensor has two infrared tubes, one is the infrared sending tube, the other is the infrared receiving tube.The sensor is very adaptable to ambient light, strong anti-interference, and easy to install.The structure of the infrared obstacle avoidance sensor includes a pair of infrared transmitting tube and infrared receiving tube, as well as a sensor circuit. The sensor has three pins, namely VCC, GND and OUT.The working principle of the infrared obstacle avoidance sensor is that the infrared transmitting tube is responsible for transmitting the infrared ray, while the infrared receiving tube is responsible for receiving the infrared ray reflected back by the obstacle. When the infrared sensor does not receive the infrared ray returned by the obstacle, its OUT pin will output high level; when it receives the infrared ray returned by the obstacle, the OUT pin will output low level.

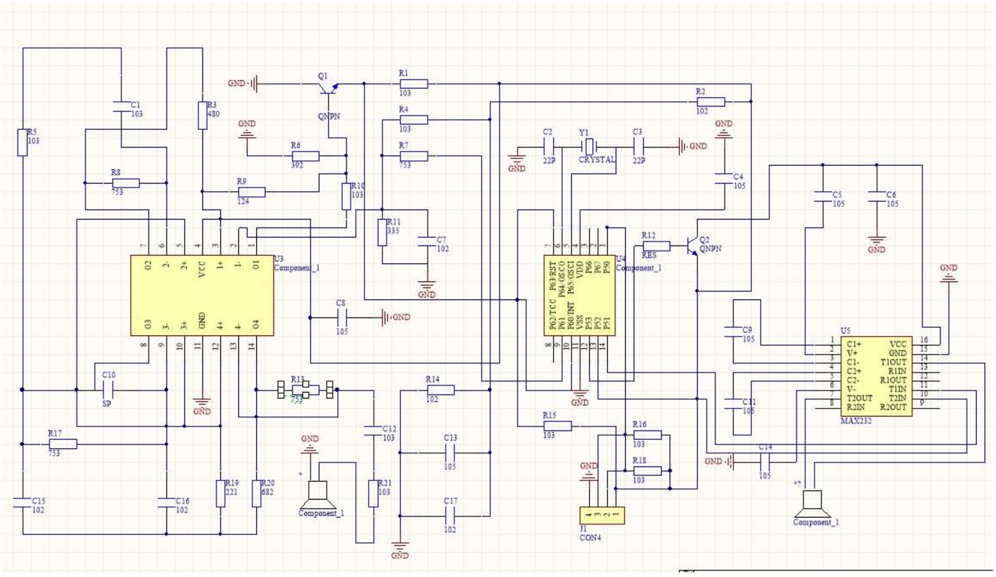

Figure 12

The structure of the sensor also includes a regulator for detecting distance. Changing the knob of the regulator can change the measuring distance of the sensor. The minimum measuring distance of the sensor is 2 cm and the maximum measuring distance is 20 cm.It operates at a relatively low voltage, but can detect objects with an offset Angle of 40°.When the infrared sensor detects that there is an obstacle near the car, the light on the module will turn green and its OUT pin will output a low level.The circuit diagram is shown in Figure 3.7.The sensor output port OUT needs to be directly connected with the IO port of the single chip microcomputer.The PB12 pin of the microcontroller is connected with the output serial port OUT of the sensor. The VCC of the sensor module is connected with the power supply voltage of 3.3V. The GUD pin of the sensor is connected with the GUD pin of the microcontroller.

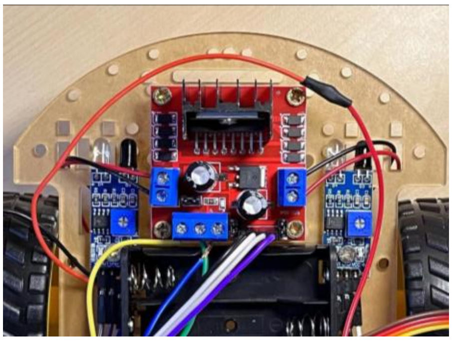

Figure 13

4.4 L298N motor drive circuit

L298N motor drive module operating power supply voltage up to 46V, total DC current up to 4 amps, logic "0" input voltage up to 1.5 volts (high immunity), low saturation voltage, overheating protection.It is an integrated monolithic circuit and a high voltage, high current dual full bridge driver in a 15-pin PowerSO20 package designed to receive standard TTL logic levels and drive inductive loads such as relays, electromagnetic coils, DCS, and stepper motors.The emitter of the transistor on the lower side of the bridge is connected as a whole, and the outer end of the bridge can be connected with the outer resistor to provide additional power input for the circuit to achieve low voltage operation of the circuit.The actual picture is shown in Figure 3.8 below.

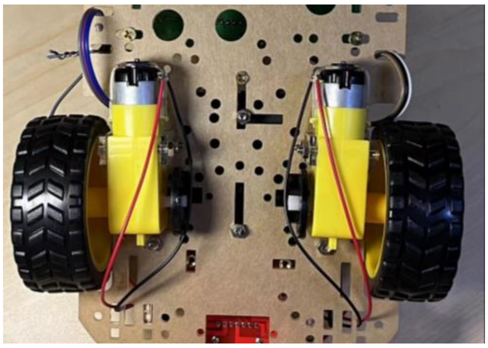

Figure 14

The power output part of L298N integrates two power output parts. The power output part is a bridge structure, and its output part can drive the induction load in different ways according to the different input.The current through the load is output from the inductance of the bridge: the external resistance (RSA);RSB) can detect this current intensity.Each bridge is driven by four grids whose inputs are in In1, In2, EnA, In3, In4;When the En input is high level, the In input is In to set the bridge state;On the bridge, all inputs conform to TTL standards.

This module requires a non-inductive capacitor, usually 100nF, between Vs and Vss and between ground and as close to the GND pin as possible.If a large capacitor in the power supply is far from the integrated circuit, another small capacitor near L298 needs to be taken into account.The ground resistance of the induction resistance (non-winding) must be near the negative voltage electrode, which must be near the GND pin of the integrated circuit.Each input passes through a short channel to connect to the driver signal source.The external bridge of diode D1 to D4 is made up of 4 quick-return units, and VF should be minimized when there is minimum load current.See Table 3.1 for specific parameters.The induced output voltage may be used to control the amplitude of the current through the input of the circuit breaker, or to provide an overcurrent protection for switching to a low level.The maximum limit current of braking action (motor emergency stop) shall not be greater than 2 amps.When the repeated peak current required by the load is greater than 2 amps, the parallel structure is adopted.When the driving conductive load, and when the IC input is chopped;Schottky diode is preferred.The L298 can drive up to 3 amps in DC operation and up to 3.5 amps in repeated peak currents.The enable input must be driven to the low state before the auxiliary voltage is turned off and off.The circuit diagram is shown in Figure 3.8 below

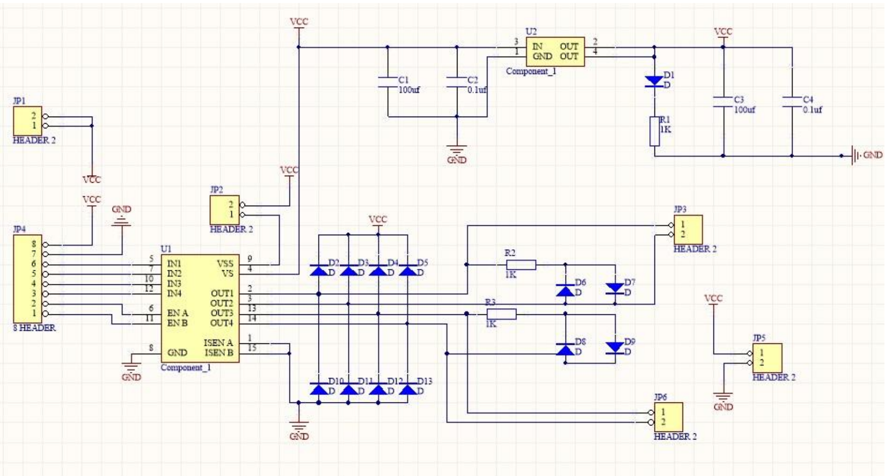

Figure 15

V. SOFTWARE RESEARCH AND DESIGN OF THE SYSTEM

At present, the hardware selection of each module of the ultrasonic parking system based on LABVIEW has been determined, the circuit connection diagram of each module has been drawn, and the connection between the modules has been designed, and now the software design begins.Software research and design can make each hardware module contact with each other, according to the program to achieve the corresponding function.In the software research and design of this system, mainly designed the flow chart of the main program, the flow chart of ultrasonic ranging, the flow chart of the main program of the infrared sensor module, the flow chart of the LABVIEW panel and the single chip microcomputer connection program, a simple description of how the ultrasonic sensor to transfer the measurement data to the single chip microcomputer and LABVIEW and display.How to judge the data, and control the motor in the car into the set distance after automatic stop, and infrared sensor infrared receiver received the obstacle reflection of the infrared ray will be transmitted to the MCU, and then control the red light.

5.1 Main program flow design

The main function of the system is to control the other ultrasonic ranging module, infrared sensor obstacle avoidance module, and LABVIEW panel display data subroutine.This is a large framework for how all system programs are connected to each other.As shown in the flow chart, after the power is switched on, the microcontroller enters the initialization stage.

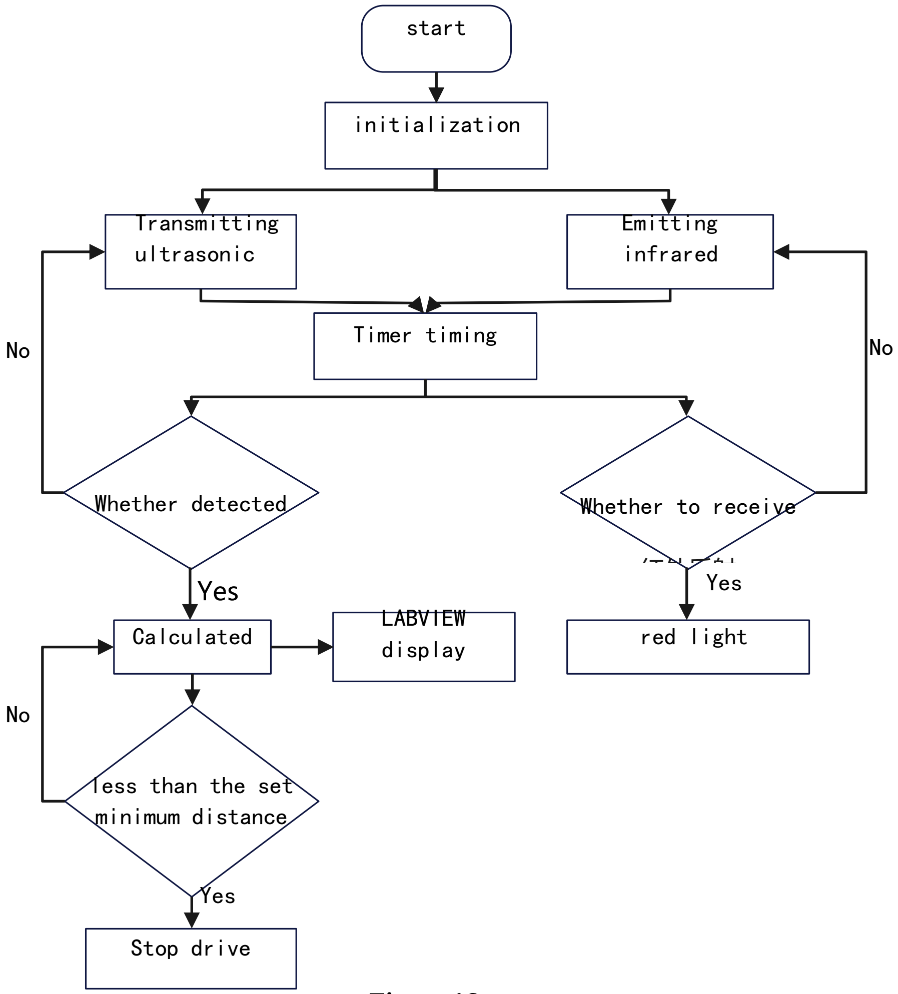

Figure 16

In the initialization stage, the microcontroller AT98C51 and the registers of the ultrasonic and LABVIEW panel are cleared to zero.Then the MCU gives a command to drive the ultrasonic sensor to emit ultrasonic waves, infrared sensors emit infrared signals, the timer will start.After the ultrasonic wave hits the parking plate, it will reflect the ultrasonic wave, after detecting the ultrasonic wave, the microcontroller will calculate the distance.This distance is transmitted to LABVIEW, which builds a panel that displays the current calculated distance.And the MCU will judge whether the distance is less than the minimum stopping distance set by the system. If it is greater than the minimum distance, it will continue to emit ultrasonic wave and continue to calculate the distance.If the current distance is less than the set minimum distance, the motor will stop driving.The other module, once the infrared sensor receives the infrared ray reflected back, it means that there are obstacles in the car two, and the red light on the sensor represents the detection of obstacles.

The main function of the system is to control the other ultrasonic ranging module, infrared sensor obstacle avoidance module, and LABVIEW panel display data subroutine.This is a large framework for how all system programs are connected to each other.As shown in the flow chart, after the power is switched on, the microcontroller enters the initialization stage. In the initialization stage, the microcontroller AT98C51 and the registers of the ultrasonic and LABVIEW panel are cleared to zero.Then the MCU gives a command to drive the ultrasonic sensor to emit ultrasonic waves, infrared sensors emit infrared signals, the timer will start.After the ultrasonic wave hits the parking plate, it will reflect the ultrasonic wave, after detecting the ultrasonic wave, the microcontroller will calculate the distance.This distance is transmitted to LABVIEW, which builds a panel that displays the current calculated distance.And the MCU will judge whether the distance is less than the minimum stopping distance set by the system. If it is greater than the minimum distance, it will continue to emit ultrasonic wave and continue to calculate the distance.If the current distance is less than the set minimum distance, the motor will stop driving.The other module, once the infrared sensor receives the infrared ray reflected back, it means that there are obstacles in the car two, and the red light on the sensor represents the detection of obstacles.

5.2 Ultrasonic module program flow chart

The first module is the ultrasonic ranging module, the flow chart is shown in the figure above.After the car and the system are powered on, the ultrasonic ranging module enters the initialization stage, and then the microcontroller sends a pulse signal, which is orally transmitted to the ultrasonic trig pin through the microcontroller p13. When the ultrasonic crystal oscillator receives the pulse signal sent by the ultrasonic trig pin from the microcontroller, the ultrasonic crystal oscillator will resonate with the pulse signal.The ultrasonic sensor starts to send ultrasonic signals, and the timer starts to time.The ultrasonic signal will be immediately bounced when it meets the parking plate behind the car. The bounced ultrasonic signal will be received by the ultrasonic receiver. After receiving the ultrasonic rebound signal, the timer will stop immediately and the MCU will pass the time recorded by the timer.According to the formula, the corresponding distance between the end of the trolley and the parking plate in this time is calculated.

5.3Infrared obstacle avoidance module program flow chart

The next module is the infrared sensor obstacle avoidance module.After the car is powered on, the infrared sensor is first initialized, and the infrared sensor transmitter sends infrared ray. If an obstacle suddenly appears near the infrared sensor at both ends of the car during the astern process, the infrared ray will be reflected back after encountering the obstacle, and the reflected infrared ray will be accepted by the receiving tube of the infrared sensor.When the infrared sensor does not receive the infrared ray returned by the obstacle, its OUT pin will output a high level; when it receives the infrared ray reflected by the obstacle, the OUT pin will output a low level.At this time, the analog signal will be converted to the high and low level by the LM393 converter and sent to the IO port of the MCU, which receives the high and low electrical frequency and thus controls the red light.

VI. DEBUGGING RESULTS AND IMPROVEMENTS

6.1Debugging result

This design mainly uses LABVIEW simulation, LABVIEW is a kind of program development environment, it is a kind of graphical editing language G programming, the program produced by it is different from other programs is the form of block diagram.In the simulation results of this time, ultrasonic ranging and infrared obstacle avoidance can not be simulated, so the system debugging is mainly the debugging of LABVIEW panel display ultrasonic ranging.Ultrasonic sensor and SCM program are combined to measure the distance in real time. The data needs to be transmitted to LABVIEW through Bluetooth module. The commonly used Bluetooth module HC-05 is mainly used in this design, as shown in the figure below:

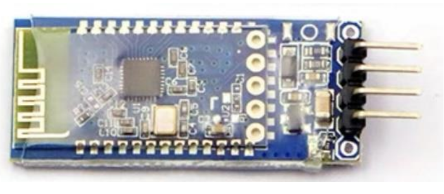

Figure 17

Then, the baud rate and serial port number can be properly adjusted through the serial port assistant software, as shown in Figure 5.2 and Figure 5.3.After debugging, LABVIEW will receive the ultrasonic ranging data information transmitted by the Bluetooth module and then transmit it to LABVIEW.After debugging the serial assistant software, under the condition of ensuring the correct connection of the LABVIEW panel and the program block diagram, when the car starts to reverse, the real-time distance in the LABVIEW data display box will keep changing, and the bar chart of the distance will also change in real time, showing the distance data more intuitively.The ultrasonic ranging can be displayed in real time by LABVIEW.

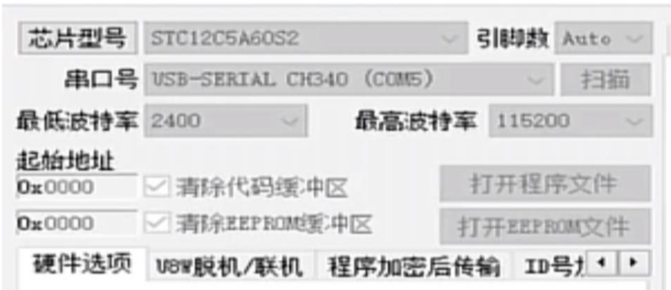

Figure 18

6.2Function realization

First, the pin of the ultrasonic sensor is connected to the corresponding SCM IO port, and the car is connected to the power supply.At this time, the Bluetooth module and the serial communication assistant debug and receive the signal, click the Start button on the LABVIEW panel, and turn on the car switch after confirming that each module is connected correctly. When the car backs up, the LABVIEW panel starts to display the distance, as shown below

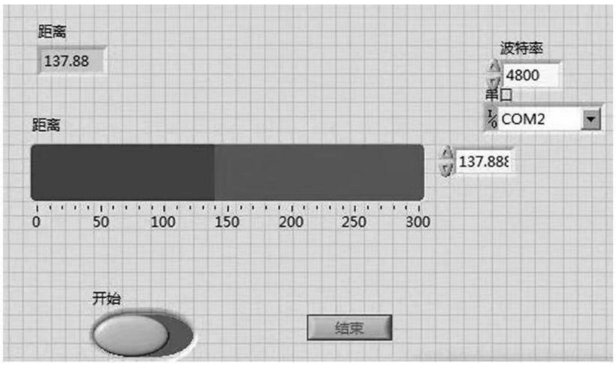

Figure 19

After confirming the connection of each module, open the car switch, and the lights of each module will light up, indicating that each module is normally energized. At the same time, the car will automatically start uniform astern, and the ultrasonic ranging module will start ranging. When the minimum value of the car rear and the parking plate is reached, the car will suddenly stop automatically.

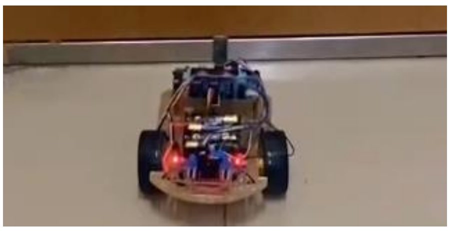

Figure 20

Power on, turn on the car switch, each module is energized and lights on, and the car starts to reverse at a uniform speed. In the process of reversing, the obstacle is close to the infrared sensor. At this time, the infrared sensor at both sides of the car senses the obstacle and lights up the second red light in addition to the power lamp, that is, the double red light phenomenon.

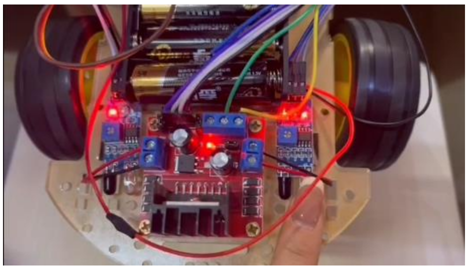

Figure 21

6.3 System improvement and prospect

In this system design, there are still many deficiencies and can be improved, in this will be divided into the following parts respectively:

The distance can be combined with the time display better, LABVIEW timer can realize real-time time display. Ultrasound can also be used for radar display, scanning out the location of obstacles and displaying them on the LABVIEW panel. And can be installed buzzer, when closer to the parking board when the buzzer alarm will be more rapid, this will also play a more warning role.In addition to the distance display on LABVIEW, you can also install a 1602 LCD display on the car to display the distance.

The initial speed of the car is fast and uniform, and it would be better if the car speed could automatically slow down as the distance gets closer and closer.When reversing, a buzzer alarm device can be added, and the closer the parking board is, the more rapid the buzzer alarm will be. This will be more intuitive when combined with the automatic parking function when the car reaches the parking distance setting.And ultrasonic can only detect the parking board, if the parking environment is based on the parking line, the use of infrared sensor to detect the black line will be more appropriate.

At present, the obstacle avoidance function is the red light when encountering obstacles. If the alarm is added, it will be better. And the steering gear is installed to automatically turn when encountering obstacles.If the left side detects an obstacle, turn right; if the right side detects an obstacle, turn left; if both sides detect an obstacle, go backwards.

VII. CONCLUSION

Conclusion Under the background of the gradual rise of the transportation industry, the car reversing safety is particularly important. Therefore, a series of studies on automatic parking system are derived. The ultrasonic parking system design based on LABVIEW in this paper has its significance.

The four main modules of ultrasonic parking system design in this paper include driving module, ultrasonic ranging module, infrared obstacle avoidance module and LABVIEW display distance module.Among them, it is difficult to realize the module of distance display of LABVIEW, which needs to build the panel of LABVIEW. The microcontroller and the serial port of LABVIEW also need to debug based on the serial port assistant software.Here will summarize the design of the basic principles of each module and the connection between each module, as well as the final implementation of the function.

First of all, the drive module uses the L298N motor drive chip, and sets its control level through the I/O input of the main control chip, which can directly control the motor and drive the motor in both positive and negative directions.The infrared obstacle avoidance module uses the principle that the OUT pin will output low level when the infrared sensor receives the infrared ray returned by the obstacle, which is transmitted to the I/O port of the single chip microcomputer. The I/O port receives the high and low electrical frequency, so as to control the motor to stop running.The principle of ultrasonic ranging module is that the microcontroller will send a pulse signal to the ultrasonic trig pin, the crystal vibration of the ultrasonic wave will produce resonance with the signal, and the timer also begins to time.The LABVIEW panel requires serial debugging signals to transmit distance information.

Through the above design principles, the final design achieves the ultrasonic automatic parking function based on LABVIEW. When the car reaches the set distance value, it will stop automatically. At the same time, if there are obstacles in the parking process, it will also stop automatically.

REFERENCES

[1]. Yuan Ziyang, Xiong Fuli.Design and implementation of Automatic Parking System based on SCM and LabVIEW [J/OL].Computational Measurement and Control :1-9[2022-11-07].http://kns.cnki.net/kcms/detail/11.4762.TP.20220818.0918.004.html

[2]. zhi-wei wang.Path planning based on safe passage of key techniques of automatic parking system [D]. Jilin university, 2022. The DOI: 10.27162 /, dc nki. Gjlin. 2022.001779.

[3]. Dong Yanli, Jia Zheng.Automatic parking System based on Matlab [J]. Agricultural Technology and Equipment,2021(06):81-82. (in Chinese)

[4]. ji. Automatic parking system based on ultrasonic wave radar research [D]. Beijing jiaotong university, 2021. The DOI: 10.26944 /, dc nki. Gbfju. 2021.000696.
[5]. Zhou Ling, Gao Huai, Liu Mengying, Li Yangke, Zhu Yixian.Design of Automatic Parking System based on single Chip Microcomputer [J]. Journal of Shanxi Datong University (Natural Science Edition),2021,37(01):19-22+118.
[6]. BAO Junwei, GENG Jing, LIU Qingshan, Liu Xingchen. Design and Production of "Automatic Parking System" [J].Information Technology and Informatization,2020(07):214-215.
[7]. Meng Jiangbo. Automatic parking system based on ultrasonic sensor [D]. Henan university of science and technology, 2020. The DOI: 10.27115 /, dc nki. Glygc. 2020.000263.
[8]. Ma Haicheng, Fan Yani, Chen Lishi, Zhao Wenle, Lai Fang.Research on Automatic Parking System of Intelligent Car [J]. Industrial Control Computer,2019,32(07):145-146+149.
[9]. Zhang Haomiao, Zheng Fei.Design of automatic parking System based on STM32 Microcontroller [J]. Scientific Consultation (Science and Technology • Management),2018(05):47.
[10]. Zhang Lili.Research on Automatic Parking System Based on Ultrasonic Distance Measurement [D]. Chang 'an University,2017.
[11]. QU Long. Simulation Research of Automatic Parking System Based on MATLAB [D].Shenyang Polytechnic University,2013.
[12]. Dai Shaogang, Shi Xuecheng.Model design of automatic Tracking Parking System Based on Ultrasonic Distance Measurement [J]. Electronic Devices,2012,35(02):204-207.

*Corresponding Author: Yanting Ni