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Development of Intelligent Self-propelled Sprinkler Car Based on Single Chip Computer

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***Keywords*— self-propelled car; Arduino UNOR3; sprinkle water; follow the trail and avoid obstacles**

***Abstract*—** *This paper designs an intelligent self-propelled sprinkler car with Arduino UNOR3 as the control board. The vehicle is equipped with an ATmega328P single chip microcomputer, sensor expansion board, L298N motor drive module, infrared tracking sensor, infrared obstacle avoidance sensor, sprinkler module, and power module, and also equipped with a speed measurement code disk. C code written by Arduino IDE software is used to control the car, so as to realize tracking cruise and infrared obstacle avoidance functions. The car system can cruise according to the black route set in advance on the flower base, and control the car through the C code written by Arduino IDE software, so as to realize the tracking cruise and infrared obstacle avoidance functions. This design realizes the self-walking water spraying function on this theoretical basis.*

I. INTRODUCTION

Traditional agriculture used to require a lot of manpower to solve the problem of growing crops, and today, productivity and science and technology have made greater progress, and now the young people who are willing to engage in agricultural work are decreasing, so a large number of machines is needed to replace human labor in agricultural mechanization production. In the current social environment of rapid development of science and technology, the development of science and technology has provided an innovation rate of more than 50% for the progress of agricultural science and technology. Agricultural scientific and technological innovation has been significantly improved, and the transformation and promotion of achievements have been continuously expanded and strengthened, which basically covers the production and planting of major improved crop varieties, and the proportion of livestock and poultry of excellent varieties has increased year by year. These measures undoubtedly make important contributions to ensuring the safety of food production, the effective supply of agricultural products, and the improvement of farmers' income [1].Agricultural science and technology is gradually becoming the core competitiveness of modern agriculture, the source of endogenous after-effects, and a new sector of transformation and upgrading. The importance of modern science and technology in agriculture is becoming increasingly prominent. The overall management level of traditional agricultural science and technology enterprises has been continuously optimized and improved, and breakthroughs have been made in basic research and strategic high-tech innovation, A large number of major innovative teaching achievements have been achieved at the world's advanced cultural level, and high-quality results have been obtained. The flower industry is one of the fastest growing and most stable industries in the world [2] and one of the sunrise industries with the greatest development potential in the world. Countries all over the world now attach importance to the development of flowers to increase their competitiveness in the international market. Efforts to develop the flower industry can occupy a favorable position in the future international competitiveness.

Science and technology are the primary productive forces. In order to enhance the competitiveness of the flower industry, it is necessary to improve the technical content of flower products [3]. In mountainous and semi-hilly areas, faced with a small area of arable land, it has brought great difficulties to mechanized operation, and mechanized planting cannot be carried out to improve efficiency and yield. Such a growing environment, if not adjusted, cannot keep up with the development of modernization and can not further improve the income of farmers.

Due to the backward development level of planting information technology and mechanization, the quality of flowers is poor and the lack of market competitiveness. At present, the sales market of high-end flowers in China mainly relies on imports, which is one of the reasons why flower products cannot be promoted quickly. In small flower planting and flower wholesale bases, flower irrigation has become a technical problem. According to the traditional artificial intelligence irrigation management method, workers need to use hand watering cans to sprinkle water, and there is a serious waste of water resources through artificial irrigation. The flower industry is labor-intensive and requires a large number of people [4]. Market feedback, general small flower plants, and flower wholesale base available labor shortage. There may be a shortage of manpower in the booming season, which leads to some flowers withering. Flower quality decline caused dehydration, to a certain extent, affecting the sales of flowers.

Under the environment of vigorously supporting agricultural innovation, with the continuous development and innovation of single-chip microcomputers technology, single-chip microcomputers has become simple and easy to learn, and the application field of single-chip microcomputer has gradually broadened, and is favored by many agricultural technical personnel. Intelligent cars based on Arduino motherboard control have also become a hot issue in the field of artificial intelligence technology. From the current market prospect analysis, self-propelled vehicles are widely used in industry, national defense, logistics, agriculture, and other fields. From the perspective of market development economic research, this design designs a self-propelled sprinkler car that should be used in small flower beds and small flower factories. The small car system can cruise according to the black route set in advance on the flower base, and it also has an infrared obstacle avoidance function. On the basis of this theory, the self-walking sprinkler function can be realized. Because the intelligent car controlled by the Arduino motherboard has a relatively complete measurement system and man-machine operating system. Compared with other chips, it is easier to use in agriculture. Dual-function address segment of on-chip RAM, so that the user is very convenient to use, and the fault tolerance rate is low, more human. The use of multiplication and division instruction, this instruction to programming also brings a lot of convenience. Otherwise, in the case of many 8-bit microcontrollers without multiplication functions, it is very inconvenient to program and call the subroutine when multiplying. The microcontroller has been effectively developed in the development of electronic information technology. The enterprise can ensure that the microcontroller can work normally and orderly in a very complex computer and control working environment.

In order to continuously improve agricultural innovation and mechanization of flower planting in mountainous and semi-hilly areas, an intelligent self-walking sprinkler car with Arduino UNOR3 as the control board is designed in this paper. The vehicle is equipped with an ATmega328P monolithic machine, sensor expansion board, L298N motor drive module, infrared tracking sensor, infrared obstacle avoidance sensor, sprinkler module, power module, and other modules, and equipped with a speed measurement code disk. C code written by Arduino IDE software is used to control the car, so as to realize tracking cruise and infrared obstacle avoidance functions. The intelligent self-propelled sprinkler car solves the problem of serious waste of water resources caused by workers' need to carry the water bottle to sprinkle water, and also improves the mechanical rate of flower planting.

II. HARDWARE AND SYSTEM DESIGN

2.1 Motor drive system

Based on the use of two 18650 lithium batteries, the L298N DC motor drive module is used to control the movement of the motor. L298N is a special drive integrated circuit, belonging to the H-bridge integrated circuit, its output current increases, power increases. Its output current is 2A, the maximum current is 4A, and the maximum operating voltage is 50V [5]. The L298N chip can drive two two-phase motors or one four-phase motor with simple circuit and convenient use, and realize the forward and reverse of the motor through the control of the I/O port [6]. Since the digital signal output of the drive module needs to be controlled to control the car, the module is connected to the Arduino UNOR3 controller. The received digital signal is processed, then fed back to the motor drive module, and finally the motor is driven to operate [7]. In the selection of the motor, because the power supply is not an AC power supply, four DC motors

are selected as the drive motor. The electric pulse generated by the DC motor during operation has less influence on the MCU, so the error can be controlled in a reasonable range. If AC motors are used, not only should the power supply be replaced with a AC power supply, but we also need to increase the AC voltage regulator. Because the DC motor can provide enough power and torque for the normal drive of the car, if the output power of the DC motor is not enough, it can also increase the torque by improving the structure of the motor wheel, so that although the speed of the car is reduced, it can provide enough power for the car to drive in the mountainous and semi-hilly areas. The specific method of motor logic forward and reverse rotation is shown in Table 1:

Table 1: Motor logic control [8]

1	IN2	ENA	Motor state
X	X	0	Stop
0	0	1	Stop
1	1	1	Stop
1	0	1	Foreward
0	1	1	Reversal

2.2 Control module

The control board uses the ATmega328P microcontroller with 32KB memory and the ATmega16 data processing chip with 32KB memory. There are 14 digit ports on the control motherboard, six of which are PWM outputs [9]. It is also equipped with an OREF standby port for use by external extenders. Processing control chip and data processing chip, the motherboard is also equipped with a power connector to provide +5V for VCC use. The analog input interface on the motherboard can be seamlessly used with many types of digital-to-analog converters and analog-to-digital converters, so the Arduino motherboard can be perfectly combined with the sensor expansion board, with low fault tolerance, high efficiency, easy control, and accurate input and output. The USB data transmission port on the motherboard can be directly connected with the COM driver port of the computer, which reduces the error in the process of program burning. The advantage of the Arduino UNO R3 motherboard compared with the traditional STC51 microcontroller is that the motherboard is equipped with the ATmega328P microcontroller with convenient control and the ATMEGA16U2-MU(R) data processing chip with strong data processing capacity. In this way, you do not need to build a single-chip microcomputer minimum system like a 51 microcontroller to realize the processing of the electrical signal collected by the sensor. The Arduino UNO R3 motherboard control system is simple. The built-in digital-to-analog converter and analog-to-digital converter not only make the system simple, but also make the data processing more accurate and efficient [10]. Although the circuit diagram of the STC51 microcontroller is simple, excluding the chip itself, it is necessary to attach a lot of control components to build a complete system, and the Arduino UNOR3 motherboard itself is equipped with many control components and converters, which is equivalent to the smallest system of a microcontroller.

2.3 Selection of single chip microcomputer

SCM has many characteristics, such as small size, high integration, easy system expansion, high reliability, and a short application development cycle [9]. According to the sensor and function requirements of the self-propelled car, the design chooses ATMEGA16U2-MU(R) as the CMOS control chip. ATmega16L, an 8-bit AVR microprocessor with high performance and low power consumption, is adopted, which can execute 131 instructions [12], which is the optimal choice of this design. Moreover, 32 programmable IO ports can be used simultaneously in the execution time of instructions in a single clock cycle. The running time of the program is greatly shortened [13]. The ATmega16 package pin definition is shown in Fig 1 :

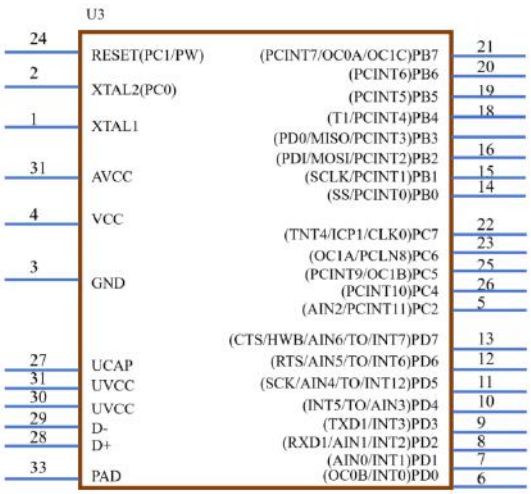

Fig 1. The ATmega16 package pin definition

Table 2. Other pin details [13]

Definition / Pin	Function	Special Function
VCC	5V Power source	NC
GAD	Ground connection	NC
PAD-PA7	8-bit bidirectional I/O port	NC
PBD-PD7	8-bit bidirectional I/O port	NC
PCD-PC7	8-bit bidirectional I/O port	Timing oscillation pin
PDO-PD7	8-bit bidirectional I/O port	Input and output matching pins
RESET	Reset the output pin	NC
XTAL1	Reverse oscillation amplifies output	On-chip current is fed into the end
XTAL2	Reverse oscillation amplifies output	NC

The VCC pin in the figure is A digital power pin, GND is a ground pin, and pin PA7-PA0 is the analog input of an A/D converter. Under normal circumstances, PA is in a high resistance state, and the corresponding level of the MCU is low. Pin PB0-PB7 is also an eight-bit bidirectional I/O port, with pin characteristics similar to PA7-PA0. PC0-PC7 is also an 8-bit bidirectional I/O port, which can be connected to a pull resistor to maintain the low level of the pin [13]. The pull-up resistance can be activated if some pins are grounded and acts as a control element. At the same time, the pin PC can also be used for different special functions. Other pin details are shown in Table 2. It is precisely because ATmega16 has these advantages, so that the car can be active development in future development, but also to allow developers to achieve in-machine rectification, without destroying the integrated PCB board, you can directly carry out active development.

2.4 Motor drive module

Because the DC motor has the characteristics of small size, light weight, large torque transmission, and easy control, the self-propelled sprinkler uses four small DC motors, which are installed on both sides of the chassis, to drive the four wheels of the car, which is the power part of the car. Because the output voltage of the pin is weak through the single-chip microcomputer system at a high voltage, it is difficult to directly invest in driving the DC motor, so the L298N motor drive is installed, the software control of the L298N is simple, compatible programming languages and syntax are more, and the working voltage can reach 46V. The output current is large, the instantaneous peak current can reach 3A, and the continuous working current is 2A [5]. Rated power: 25W. The L298N chip contains two H-bridge high-voltage and high-current full-bridge drivers, which can be used to drive DC motors, stepper motors, relay coils, and other inductive loads. The external detection resistance can be connected to feed back the change to the control circuit dynamic module [15] . This design uses 4 pins provided by the module to enter the microcontroller signal, adopts a jumper cover for flexible selection, adopts PWM speed control, and bit microcontroller output pins to provide sufficient driving force for the car to run in mountainous and semi-hilly areas. The schematic diagram of the L298N circuit is shown in Fig 2 .

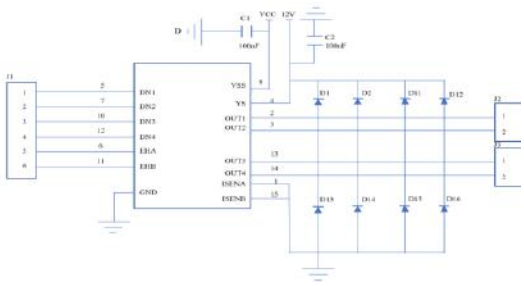

Fig 2. Schematic diagram of motor drive circuit

2.5 Infrared tracking module

The infrared detection sensor module is made according to the principle that the infrared tube detects the reflected light outside the red, the deep color is weak, and the light color is strong. In the tracking process of the car to the black line, if the black line is detected, the microcontroller will return a low level. When the microcontroller pulls the level high, that is, the high level, the car stops moving forward. The distance between the front end of the photoelectric sensor and the reflector should be kept within the specified range. The sensor must be installed in a place that is not directly exposed to strong light, because the infrared light in the strong light will affect the normal operation of the infrared transmitter current of the photoelectric sensor of the receiving tube, which will reduce the anti-interference performance of the transmitter sensor on the one hand, and the sensitivity of the receiver will be stricter because the signal is too weak. The circuit schematic diagram based on TCR5000 infrared tracking is shown in Fig 3 .

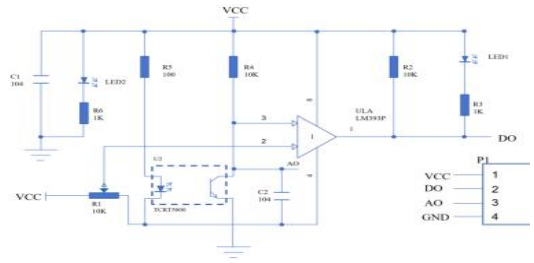

Fig 3. Circuit diagram of infrared tracking module

2.6 Sprinkler system

The design scheme of the sprinkler system designed in this study is to add a separate rotating nozzle to the top of the car connected to the water pipe, and the water pressure is different from the spraying range. The nozzle has two modes, adjustable Angles of 15-45 degrees, to achieve direct and oblique injection modes. Each group has four nozzles at different angles. The single-chip machine is used to drive the pulse signal of the stepper motor to subdivide the angular displacement, so that two sprinkler modes are switched by rotating the nozzle angle: direct spray for a large quantity of water, and oblique spray for a large area of water [15]. At the same time, each sprinkler rod of the three-way propeller has its own four development angles to carry out different water outlets, and each water outlet is sprayed to each corner at a different angle to make irrigation more uniform and cover a greater impact on the area. A water storage tank is installed behind the car, and then a variable flow centrifugal pump is installed, and then connected to the nozzle, so that agricultural irrigation can be achieved. The addition of water tanks and centrifugal pumps also increased the weight of the car, so it was necessary to convert two lithium batteries into storage pools to improve the durability of the car. Since the L298N can only input a maximum voltage of 33V, it is necessary to add a voltage regulator control module. This design scheme requires the car to have good waterproof performance, so the Arduino motherboard needs to be waterproof packaging. The intelligent sprinkler car can solve the problem of needing manpower to irrigate the flower field, reduce the use of labor, and improve the productivity of flowers and other.

2.7 Infrared obstacle avoidance module

Compared with some other infrared obstacle avoidance sensors, this design adopts the LM393 infrared obstacle avoidance module. The infrared obstacle avoidance module can be directly connected with the MCU system, and the module has its own analog-to-digital converter, so it does not need to build an analog control circuit. The working principle of infrared obstacle avoidance and infrared tracking is the same. All functions are performed according to the degree of infrared light acceptance. Therefore, infrared obstacle avoidance is also the same as infrared tracking, which is limited by more factors and prone to problems, so other obstacle avoidance modules are needed to supplement the obstacle avoidance system of the car. The circuit of the LM393 infrared obstacle avoidance module is shown in Fig 4.

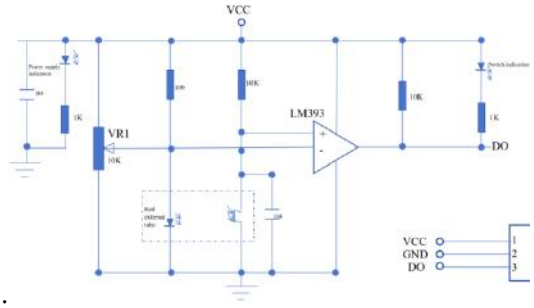

Fig 4. Circuit diagram of LM393 infrared obstacle avoidance module

In the entire control logic, the control logic of infrared obstacle avoidance and infrared tracking is the same, and even the entire control program is the same, but the definition and scope of variables are not the same.

2.8 Ultrasonic obstacle avoidance sensor module

Ultrasonic sensor is a range sensor. Developed according to the characteristics of ultrasonic waves, it has the characteristics of high quality and low price. Acoustic ranging refers to the use of the speed of ultrasonic propagation in the medium, by measuring the ultrasonic propagation time, calculate the distance between the measured object and the ranging equipment. The formula for the propagation speed of ultrasonic wave in the medium is: $c = f\lambda$ [16] , where c is the propagation speed of ultrasonic wave in the medium, f is the frequency of ultrasonic wave, λ is the wavelength of ultrasonic wave in the medium. Test distance $D=(T\times C))/2$, high electric level time T, and sound speed are expressed by C, C=340m/s [17]. Ultrasonic obstacle avoidance is real-time and effective, which is not possessed by red obstacle avoidance. However, there are also certain limitations, such as detection time blind area, ultrasonic transmission speed instability, reverberation signal interference, and other problems [8], so this design also adds a radar obstacle avoidance sensor.

2.9 Radar obstacle avoidance sensor

Lidar is composed of a rotating triangle rangefinder. Through continuous rotation, measurement of the distance can be obtained with the radar as the center of the circle, the distance of a number of points around, if the data is drawn in the polar coordinate system, you can see a two-

dimensional map, if the computer has obtained a map of the space, so that the positioning of the machine is possible. This is the promising application of SLAM, also known as CML. This design intends to use ROLIDARA 1360°5.5 Hz OPTMAG optical magnetic fusion laser scanning ranging radar. The radar has a measuring range of 12 meters radius, 360 degree scanning ranging, and 8000 measurement frequencies per second. But considering the practicability problem, this design only carries on the software control to the radar module. From the analysis of software control debugging results, radar detection and control are very difficult, and the control program is larger than other sensor modules, but the core of the whole radar detection and control is not the collocation of hardware circuits but the writing of the software control program. The combination of a radar obstacle avoidance sensor, infrared obstacle avoidance, and ultrasonic obstacle avoidance improves the obstacle avoidance of the car in the process of irrigation of flowers more accurately.

2.10 Bluetooth remote control module

The Bluetooth module used in this design adopts the BC417143 Bluetooth chip, which is a new module suitable for wireless transmission of embedded serial ports. It not only realizes wireless communication between measurement and control instrument and PC but also wireless communication between multiple measurement and control devices and can reduce complex onsite connections [19]. The Bluetooth chip works at 3.3V, while the MCU works at 5V, and there is a logic level mismatch problem. And the T0 pin cannot tolerate the MCU's 5V logic level. For this reason, the 1117 chip is used for level conversion and 3.3V output [5]. There is much research on the influencing factors of limited control activities on PC. Many flower planting and production bases and flower wholesale bases in China are not equipped with PC terminals, which brings a lot of inconvenience to users [20]. When the flower field is not suitable for infrared tracking, the car can also be flexibly controlled by the blue tooth remote control to water the flowers.

III. PROTOTYPE TESTING

According to the working principle of each module, the car is installed, and the C code written by ArduinoIDE software is compiled, verified, and recorded on the motherboard, and the infrared obstacle avoidance and infrared tracking functions of the car are tested. After testing and improvement, the vehicle can be used to achieve tracking cruise and infrared obstacle avoidance. After the car is fixed, the various sensors of the car are tested according to the set procedure to determine whether the car can display a specific function. Within a certain range, draw a thick black line to test the tracking function of the car, and then test the obstacle avoidance function of the car with a straight line program. Place the car within a specific obstacle range, make the car move towards the obstacle, and observe whether the car avoids the obstacle [9]. Before the test, the ATmega16 chip and ATmega328P chip need to be tested. Only when these two chips work properly, can the subsequent test be carried out normally. It is difficult to test ATmega16 directly, so the 51 MCU learning board is used for auxiliary testing. In this test process, an AD converter and a DA converter are required. During the process of screwing the potentiometer, if the digital tube on the test board can respond to the corresponding change and the digital tube shows a value between zero and two hundred and fifty-five, it is normal [20]. In order to make the test results more accurate, two test programs are used to test, one is to respond to the change of AD, and the other is to respond to the change of DA. After the test, it was found that the display of the digital tube was normal, and then the DA was tested, and this test process only needed to observe the process of the LED going from dark to light and then out. After testing, it was found that the LED appeared from dark to light and then to extinguish the phenomenon, which is a normal phenomenon.

According to the above test results, the ATmega16 chip can process data normally and act as a data processing chip, which meets the design requirements [13]. After testing the ATmega16, the ATmega328P chip is also required to be tested to ensure the normal operation of the self-propelled car. This test is based on the 51 microcontroller learning board. During the test, the 80C51 microcontroller on the learning board is replaced by the ATmega328P microcontroller. Because the temperature signal is the easiest signal to detect and process, this design uses temperature as a variable to test the response of the L298N drive motor based on ATmega328P control. Set at a certain temperature, when the temperature is greater than or equal to the temperature, the motor runs, when the temperature is less than the temperature, the motor stops running. In order to observe the temperature change more clearly, it is necessary to display the temperature on the computer through serial communication to ensure the accuracy of the test results [11]. Before using serial communication, it is necessary to test the COM port of the computer, and the next test can be carried out after the test is wrong. After the test, the working state of the LED can be accurately fed back to the computer, that is, the COM of the computer meets the serial port exchange protocol, so the next test can be carried out. After testing, the MCU can respond to the changes of the sensor, and the MCU can also control L298N according to the different values for

different actions. From the above tests, it can be seen that there is no temperature of slow response and inadequate response of the monolithic machine, and there is no problem of data processing error and unsuccessful response of the data processing chip. Therefore, the hardware circuit can be built and all modules can be tested.

IV. RESULTS AND DISCUSSION

Multiple rounds of repeatability experiments were carried out to consolidate the reliability of the experimental results and verify their repeatability, and the functional test results of cars numbered 1 to 15 were analyzed, as shown in Table 3. As can be seen from Table 3, no exception was found in each user module in the second, third, ninth, eleventh, fourteenth, and fifteenth tests, and no exception was found in the other tests. From the whole test results, except for the sixth experimental test, there is only one module exception in each exception test. In the sixth test, infrared sensor tracking and ultrasonic obstacle avoidance were abnormal. The number of infrared obstacle avoidance anomalies was 3, 4, 8, and 13, respectively. There are six and ten anomalies in the infrared tracking. There were 5 ultrasonic obstacle avoidance anomalies, which were 1, 5, 6, 7, and 12 times, respectively. From the frequency analysis of the fault, the frequency of some faults in ultrasonic obstacle avoidance reaches the highest, followed by infrared obstacle avoidance, and finally infrared tracking. It can be seen from the above analysis that, in addition to the motor drive, other modules have anomalies in the test process, among which the ultrasonic obstacle avoidance module has more abnormal times, and the infrared tracking and infrared obstacle avoidance module has fewer abnormal times. The L298N motor drive module is hardware controlled, so the failure rate is zero.

N: Normal

U: Unnormal

Table 3 Test experimental data

module / Serial number	Infrared obstacle avoidance	Infrared tracking	Ultrasonic obstacle avoidance	Motor drive
1	N	N	U	N
2	N	N	N	N
3	N	N	N	N
4	U	N	N	N
5	N	N	U	N
6	N	U	U	N
7	N	N	U	N
8	U	N	N	N
9	N	N	N	N
10	N	U	N	N
11	N	N	N	N
12	N	N	U	N
13	U	N	N	N
14	N	N	N	N
15	N	N	N	N

When the infrared tracking module works, infrared rays are emitted from the TCRT5000 sensor. If the emitted infrared rays are not reflected back by the ground or have been reflected back, in this case, the voltage of pin 3 is lower than the voltage of pin 2, the DO of the output pin is high, and LED1 is in the off state. Otherwise, the sensor has the following characteristics: the detection reflection distance is 1mm-25mm; LM393 output, strong driving capacity, more than 15mA; operating voltage: 3.3V-5V [11]; TCRT5000 infrared reflection sensor is adopted. Due to the limited detection reflection distance, a length of 5 mm should be reserved when installing the infrared tracking sensor. In the process of testing, the front end of the sensor should be parallel to the work piece object to be tested, so that the conversion efficiency of the photoelectric sensor is the highest. The distance between the front end of the photoelectric sensor and the reflector should be kept within the specified range. The sensor must be installed in a place where it is not directly exposed to strong light, because the infrared light in the strong light will affect the normal work of the current of the infrared transmitter of the photoelectric sensor of the receiving tube, which will reduce the anti-interference performance of the transmitter sensor on the one hand, and the sensitivity of the receiver will be stricter because the signal is too weak. The probability of infrared obstacle avoidance problems is higher than that of infrared tracking. Not only the light has an impact on the obstacle avoidance sensor, but as long as the time is long, the impact of the LED emission line frequency on the obstacle avoidance function of the entire car is also self-evident.

Compared with infrared obstacle avoidance, although the range of distance measurement is not very large, the accuracy of the ultrasonic ranging system can reach the upper level of millimeters. Using a serial debugging assistant and an oscilloscope to assist the test, the realization of the system is more reliable. Of course, there are many factors that affect ultrasonic distance

measurement, but as long as the program control is done well, the advantages of ultrasonic obstacle avoidance are far greater than infrared obstacle avoidance. Infrared tracking, infrared obstacle avoidance, and ultrasonic obstacle avoidance are controlled by software, with more shadow and noise factors and a higher failure rate than motor drive modules. In software control, the key factor is the program itself, the code quality directly affects the stability and reliability of the system. By optimizing code structure, simplifying logic, and adopting good programming habits, the probability of program error can be significantly reduced, and the maintainability and extensibility of the system can be improved. Therefore, it is necessary to optimize the design of C code, improve variables, syntax, and parameters, and use two designs to represent certain statements in the program, the alternate control program. Because of the compatibility problem of the control program, the backup program can play a protective role in the process of software debugging. At the same time, the standby program as a comment does not take up chip memory. In Bluetooth control, by simplifying C code, the problems of Bluetooth module matching failure, data transmission being inaccurate and not timely are solved.

（1）C code before modification

Void blinker_car_detect(){if (!digital Read(C_BAR_PIN))

{if (!is Warn){

Blinker.vibrate();Is Warn=true;car_os_time=millis();}

Else if (millis()-car_os_time>=5000)

{isWarn=false;}}

else{

Is Warn=false;}}

Modified C code:

Void

bilnker_car_control(uint8_tcl_pwm,boolcl_dir,uint8_tcr_pwm,boolcr_dir)

{digitalWrite(IN4,cl_dir);DigitalWrite(IN1,cr_dir); Analog Write(IN3,cl_pwm);Analog Write(IN2,cr_pwm);}

（2）C code before modification:

#if defined(BLINKER_CAR_DEBUG)

BLINKER_LOG4("L_PWM:",L_PWM,"|L_DIR:", L_DIR);//Return value

BLINKER_LOG4("R_PWM:",R_PWM,"|R_DIR:" ,R_DIR);Blinker.delay(2000);

#end if

Modified C code:

{void loop()

Blinker.run();{if ((millis()-t)>timeout)//Read the number value directly without returning it

t=millis();timeout=2000;blinker_car_init();}

The modified code uses complex embedded syntax, which is easy to cause numerical reading errors, while the modified code uses function parameters to reduce embedded statements to pass the PWM value and direction of the left and right wheel, avoiding the use of global variables, making the function more modular and easy to maintain, and making the code numerical reading more accurate. It can be seen from before and after the modification that the modified code is simpler and the syntax is clearer. By simplifying logic, standardizing variable naming, and adopting function encapsulation, the readability and maintainability of the code are improved, and the error probability is reduced. It not only reduces the size of the entire program, but also significantly the probability of program errors. The application of Bluetooth modules in intelligent cars is increasingly widespread, but its real-time and stability still need to be further improved. By optimizing the Bluetooth communication protocol and data processing algorithm, the accuracy and timeliness of data transmission can be improved to meet the needs of more application scenarios. In summary, the intelligent sprinkler car based on a single chip microcomputer has achieved remarkable results in ultrasonic ranging, C code optimization, and Bluetooth control, which provides a useful reference for the development of the intelligent car field. In the future, the comprehensive performance and stability of the system can be improved through further technological innovation and optimization.

V. CONCLUSION

This design is based on the control of Arduino by the motherboard to increase the sprinkling function. After the system is powered on, the designed intelligent irrigation car shows good reliability, stability, and fast response speed. The car can set the irrigation route of crops in advance according to the flower base, which solves the problem of inconvenient watering time of small flower beds and flowers to a certain extent, and the system can provide convenient watering of flowers for some people who like to cultivate flowers but have difficulty moving. It also brings convenience to flower planting and flower wholesalers to a certain extent, improves work efficiency, and also promotes the application of agricultural innovation in planting flowers. At the same time, this

design has more room for development. In addition to the conventional red obstacle avoidance and infrared tracking functions, the addition of Bluetooth control, ultrasonic obstacle avoidance, radar detection, and scanning functions will make the car in mountainous and semi-hilly areas more flexible to avoid obstacles and more safe driving.

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