Design of Smart Car based on Arduino and Wireless Router Technology

Leian Liu¹, Dashun Yan¹, Ying Zou¹* and Minfeng Wei¹

¹College of Information Science and Technology, Zhongkai University of Agriculture and Engineering, Guangzhou, China
*Corresponding author e-mail: blueleaf@126.com

Abstract. Aiming at the demand of wireless surveying robots in various industries such as industry and agriculture, a wireless smart car based on Arduino and sensor technology was developed. The car consists of an open source electronic platform based on Arduino and a QT-based upper computer control platform. Wireless communication is realized between the car and the host computer through a wireless router. The smart car running platform takes Arduino as the core, mainly realizes automatic obstacle avoidance, remotely monitors and accepts the command of the host computer through the wireless network. The test results show that the wireless smart car communicates normally, runs stably, and better realizes the required functions.

1. Introduction
The design and production of embedded detection equipment has always been a research hotspot for the researchers at home and abroad. As a typical representative, smart cars have the advantages of small size, low center of gravity, flexible movement and simple operation, excellent balance walking on rugged roads, which have attracted the special attention of researchers. From the data obtained from CNKI, since 2004, domestic scholars have been on the rise in research on smart cars. Among them, tracking obstacle avoidance and path planning are the core content of smart car research, and a large number of research papers have appeared [1-7]. The first smart car was developed in 1972 by Nils Nilssen and Charles Rosen for six years and was named shakey [8]. Since the 20th century, the Defense Advanced Research Projects Agency (DARPA) of the United States has set up a ground-based unmanned combat project, and since then, the prelude to the study of smart cars has been opened worldwide. At present, smart cars have been applied to military, industrial manufacturing, exploration, space exploration, life services and many other aspects. However, at present, there are many mature products, which have the disadvantages of high cost. In addition, many intelligent robots are equipped with a variety of sensors to work in various complicated environments, which will make the processor load too large, and the program runs unstable. In response to the above questions, the author selected the latest stable version of the Arduino development board and used wireless routing technology to build a wireless smart car. The wireless smart car is based on the Arduino development board, and a wireless router is used to wirelessly transmit and receive the data. The wireless communication between the PC platform built by QT and the car is realized. The host computer remotely monitors and controls the travel and steering of the car through wireless communication. The smart car running control uses pulse width modulation (PWM).
2. System Basic Structure
The basic structure of the wireless smart car is shown in figure 1. The Arduino development board is connected to the wireless router through the expansion board, receives the command from the host computer, controls the motor operation through the HC01-48 module, and collects the obstacle distance information by the ultrasonic sensor module. The program automatically determines the operation mode and the camera collects the image information and transmits it through the wireless router to the host computer to implement the monitoring function. At the same time, the host computer can intervene in the smart car operation according to actual needs and perform manual control through buttons.

Figure 1. Basic structure diagram of the system.

3. Hardware Platform Design

3.1. Operation Module Design
This module uses L293D as the drive motor, and the circuit diagram is as shown in figure 2. In the L293D, the chip used is a professional chip, not an analog chip. In figure 2, J1 can be powered by a 6-9V power supply. During the power supply to the L293D, the circuit will first pass through a U2 regulated power supply in order to provide stable voltage supply. There are two enable terminals inside the L293D chip, EN1 and EN2, which can be used to control the two motors. When the voltage of EN1 and EM2 is low, the motors cannot rotate. Only when the voltage of EN1 and EN2 is high, it is possible to make the motors rotate. The development board integrates 293D driver chip to drive the smart car with two wheels or four wheels. In addition, it also integrates WIFI interface, ultrasonic obstacle avoidance module interface, 5V power supply voltage stabilizer chip, etc. Among them, 5V power supply voltage stabilizer chip is used to directly supply power to 5V single-chip microcomputer. When conducting circuit connection, connect the left obstacle avoidance module OUT to the core board with 12 pin, and the right obstacle avoidance module OUT to the core board with 13 pin. One signal line of driving motor, IN1, is connected to the core board at 14 pin - A, the other signal line of driving motor, IN2, is connected to the core board at 15 pin - A1, the third signal line of driving motor, IN3, is connected to the core board at 16 pin - A2, and the fourth signal line of driving motor, IN4, is connected to the core board at 17 pin - A3. In figure 2, the input voltage is stabilized at 5V by the three-terminal regulator L7805, and then becomes the standard 3.3V by the three-terminal regulator ASM1117. These two voltages supply power to the whole system to ensure the normal operation of the system.
Figure 2. Operation platform circuit diagram.

3.2. Automatic Obstacle Avoidance Module Design

This design uses the HC-SR04 ultrasonic module, which includes ultrasonic transmitter, receiver and control circuit and provides non-contact distance sensing function. The ranging accuracy can reach three millimeters. Ultrasonic is a kind of high-frequency sound. It will reflect back when it encounters obstacles after launching. By recording the time, the distance from the launch point to the obstacle is calculated according to the time difference between transmission and reception. In terms of calculation, the principle of ultrasonic obstacle avoidance is the same as that of radar. The formula for ranging is expressed as follows:

$$ L = C \times T $$  \hspace{1cm} (1)

Where $L$ is the measured distance length; $C$ is the propagation speed of the ultrasonic wave in air; $T$ is the time difference of the sound wave propagation and $T/2$ is half the time difference from transmission to reception. Through the ultrasonic timing diagram shown in Figure 3, the working process and working principle of this module can be more intuitively understood, which is convenient for later design and programming.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{ultrasound_timing_diagram.png}
\caption{The ultrasonic timing diagram.}
\end{figure}
3.3. Remote Monitoring Module Design
This module connects the ordinary camera and the wireless router, as is shown in figure 4, and performs firmware flashing on the router. After the special firmware for image transmission is brushed in, the relevant port number can be set to realize real-time image transmission.

![Remote monitoring module](image)

**Figure 4.** Remote monitoring module.

4. System Software Design

4.1. Running Platform Program Design
The program design of the running platform of the smart car is shown in figure 5. The smart car is controlled by the host computer. After power-on, the wireless router is automatically activated. The host computer communicates with the smart car through the wireless network. At the same time, the camera on the smart car automatically starts and the image captured is automatically transmitted to the host computer. Before receiving the command of the host computer, the smart car is in a static state. After the host computer issues the command, the smart car runs according to the instruction, and the ultrasonic sensor continues to work. If the ultrasonic sensor detects obstacles in the process of driving, the smart car stops moving and waits for the host computer to re-issue the command.
4.2. Host Computer Program Design
The host computer program flow chart is shown in figure 6. When the smart car receives the instruction from the host computer, it will work according to the instruction of the host computer. The host computer control interface is shown in figure 7.

5. System Testing and Analysis
In order to test the operation effect of the wireless smart car based on Arduino, the performance of each module component is tested on the debugged wireless smart car, as is shown in figure 8. Table 1 summarizes the test results. It can be seen that the designed smart car runs normally and the whole system works well. Figure 8 shows the actual picture of the designed smart car.
Table 1. Test results of system functions.

| Test objects   | Test functions              | Test results |
|----------------|-----------------------------|--------------|
| Slave device   | Motor drive                 | Good         |
| Slave device   | Automatic obstacle avoidance| Good         |
| Slave device   | Remote monitoring           | Good         |
| Host computer  | Control form                | Good         |

Figure 8. Actual figure of the smart car.

6. Conclusion
The smart car designed in this paper takes Arduino R3 development board as the core component, and combines the sensor module carried on it to achieve the required functions stably. In this design, we optimize the program as much as possible and use the latest router firmware to make the whole system run more smoothly. The test results show that the design is reasonable, the control is accurate, the operation is stable, the wireless communication is reliable, and the use effect is good. The next step is to study the automatic parking, road deviation correction, automatic cruise and other functions based on modern advanced cars, so as to make the design more practical and better applied to daily life.

7. Acknowledgments
This research was financially supported by the Science and Technology Planning Project of Guangdong Province under Grant (2017A070709012), the provincial-level characteristic specialty-"Network engineering” and the provincial teaching team-“Teaching team of basic core course of computer major” (Official document by Department of education of Guangdong province ([2017][214])), 2018 higher education teaching reform project of Guangdong province-“Reform and practice of the training mode of network engineering talents based on the cooperation of school-school and school-enterprise” (Official document by Department of education of Guangdong province ([2018] no. 180)), the university-level teaching team-“Network technology core course teaching team”, the university-level high-quality resource sharing course project-“Network security technology” and “Wireless sensor network and RFID technology”, and the National University Students’ innovation and entrepreneurship projects (201711347004 and 201811347008).

8. References
[1] Magnus Lindhe and Karl Henrik Johansson. Flocking with obstacle avoidance: A new distributed coordination algorithm based on voronoi partitions, IEEE International conference on robotics and automation, (2005) 1785-1790.
[2] M.naderi Soorki, H. A. Talebi, S. K. Y Nikravesh. A leader-following formation control of multiple mobile robots with active obstacle avoidance, 2011 19th Iranian conference on electrical engineering, (2011) 1-6.
[3] Zhang P. Design of ultrasonic obstacle avoidance smart car, Process automation instrumentation, 38 (2017) 40-43.
[4] Lv S, Jin Y T, Shen W. Design of intelligent tracking and obstacle avoidance car based on STM32, Computer & Digital Engineering, 45 (2017) 550-552.

[5] Wu B, Kong J P, Wang X. Design and implementation of intelligent car based on Arduino and Raspberry Pi, Electronic Design Engineering, 25 (2017) 58-61.

[6] Li S N. Design of tracking and obstacle avoidance intelligent car based on STM32, Digital Technology & Application, 36 (2018)163–164.

[7] Zhang P, Chen G Z, Hou Y L, et al. Design of WIFI remote control intelligent car based on android platform, Computer Measurement & Control, 26 (2018) 189-191.

[8] N. Nilsson. A mobile automation: An application of artificial intelligence techniques, In Proc IJCAI, 1969.