Development and design of Bluetooth intelligent car

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Abstract. Bluetooth is a kind of radio technology that supports short distance communication (usually within 10m). It can exchange wireless information among many devices, including mobile phones, PDAs, wireless headphones, laptops, and related peripherals. Using "Bluetooth" technology can effectively simplify the communication between mobile communication terminal devices, and also can successfully simplify the communication between devices and the Internet, so that the data transmission becomes more rapid and efficient, and broaden the way for wireless communication. This paper starts from the mechanical design and electrical control design of the intelligent car, designs the software and hardware of the Bluetooth intelligent car, mainly involving several technologies: wireless transmission technology; AVR single-chip technology; pulse width speed regulation and other related technologies. Realize the function of controlling the car forward, backward, left, right, acceleration and deceleration with Bluetooth.

1. Introduction
City Internet plus like a raging fire turn the world upside down with the rapid development of Internet technology. The construction of intelligent transportation under the background of "Internet +" is developing rapidly. Vehicle networking is an important means to ensure road traffic safety and realize intelligent traffic. In the future, the automobile industry will actively explore the application of 5g and the Internet of vehicles, lead the development of intelligent transportation and the city, and provide better products and services for consumers. Intelligent vehicle integrates the latest research results of automatic control, artificial intelligence, information fusion, sensor technology, image processing technology, computer and other disciplines. It is one of the most active research fields at present.

Wireless remote control intelligent vehicle control system is composed of intelligent vehicle and console. In addition to traditional vehicle functions, intelligent vehicle can also be remotely monitored and controlled at the console, including visual and body status feedback information monitoring, start, stop, accelerate and decelerate, run according to the program and other operations, as well as automatic alarm, automatic brake and other functions [1, 2].

Nowadays, most of the vehicles are driven by people, and the development trend of vehicles is intelligent. The intelligence of the intelligent car is reflected in environmental perception, independent decision-making and independent driving. Intelligent car is a typical high-tech combination, in which we add scientific computing, intelligent sensor, data communication, artificial intelligence and voice control technology. The development direction of intelligence is that in a pre-designed state, the product can run autonomously and achieve the expected or better results without human intervention. The hot project in the field of vehicle research in the world is to improve the safety and adaptability of small cars so as to achieve good human-computer interaction. This is also an important part of the process of developing the Internet of Things and intelligent Transportation System. With the
development of the times and the progress of science and technology, intelligent driving system has been widely used. Many commercial intelligent cars are nothing new in developed countries. Even in the fields of medical service and business supermarket, intelligent car is a very mature technology. No matter from the perspective of scientific research or market competition, it is imperative to research and explore the intelligent vehicle. China has always advocated reform and innovation, and the development of intelligent cars is in line with this big wave. The research of intelligent vehicle is an indispensable part of China's economic development [3].

Wireless communication is a kind of communication mode which uses the characteristics of electromagnetic wave signal that can be spread in free space to exchange information. The wireless communication realized in mobile is also called mobile communication. People call both wireless mobile communication. Several mainstream wireless communication technologies: EnOcean, ZigBee, Z-Wave and Bluetooth. These technologies have their own advantages and disadvantages, and they are respectively applied in various occasions [4].

2. Design of Bluetooth intelligent car

The car is mainly controlled by AVR single-chip ATmega16, which sends data to Bluetooth module from mobile phone. Bluetooth module sends data to single-chip microcomputer after receiving the data, and then the single-chip microcomputer processes the data. Through these different data, the single-chip microcomputer controls the driving module to drive the car forward, backward, left, right, acceleration and deceleration functions. In the driving process of the intelligent car and as shown in Figure 1, the flow chart is the overall design idea of the car.

![Diagram](image)

**Figure 1.** The flow chart of the overall design idea of the car.

3. Mechanical design of Bluetooth intelligent car

There are two shafts in the reducer, one is the input shaft connected with the motor, the other is the output shaft connected with the tire. The reducer is fixed under the trolley base plate, while the control system is placed above the trolley base plate. Their connection is shown in Figure 2.

![Diagram](image)

**Figure 2.** Connection.
3.1. Design and analysis of reducer

According to the way of gear engagement, it can be divided into three categories. The first is the gear mechanism with external engagement. Two external gears are meshed, and two wheels turn in the opposite direction; the second is the internal meshing gear mechanism. A large internal gear is meshed with a small internal gear, and the two wheels turn the same; the third is the gear mechanism of the gear rack. An external gear is meshed with a rack, the gear rotates and the rack moves. This design adopts an external meshing gear mechanism. In addition, according to the shape of the gear teeth, the gear mechanism can be divided into: straight gear mechanism; helical gear mechanism; herringbone gear mechanism. This design adopts the straight gear mechanism. According to the appearance and shape of the gear, the gear mechanism can be divided into cylindrical gear mechanism and bevel gear mechanism [5].

Gear mechanism is one of the most widely used transmission mechanisms. It has the following advantages: it can ensure a constant instantaneous transmission ratio between the two shafts; it can be applied to a wide range of peripheral speed and power; it can realize parallel, intersecting and staggered transmission of the two shafts; it has high efficiency; it works reliably and has long service life. However, the gear transmission mechanism also has its disadvantages: the manufacturing and installation accuracy requirements are high, so the manufacturing cost is also high; it is not suitable for the transmission with a long distance between the two shafts. So the gear transmission mechanism can be judged to meet the design requirements of the trolley by considering the above advantages and disadvantages.

Gear train is widely used and has many types. According to whether the axis of each gear is fixed relative to the frame, gear train can be divided into two basic types: fixed axle gear train and epicyclic gear train. When the gear train is running, the position of the geometric axis of the gear train relative to the frame is fixed, which is called fixed shaft gear train. When the gear train is running, the position of the geometric axis of at least one gear relative to the frame is changed, and the gear train rotating around the fixed geometric axis of other gears is called epicyclic gear train. According to the definition, the teeth used in this design can be determined. The gear train is a fixed axle gear train.

The transmission ratio is the ratio of the angular velocity of two rotating members in the mechanism, also known as the velocity ratio. This gear train is used to obtain the appropriate transmission ratio, which can provide sufficient horsepower and stable speed for the car. The transmission ratio of the gear train refers to the ratio of the speed or angular speed of the first and last two gears in the gear train. According to the calculation, the transmission ratio of the gear train is 24:1, and the no-load speed is 200r/min, which meets. Meet the power and speed requirements of the trolley.

3.2. Design of trolley base plate

The trolley is made of 3mm thick aluminum plate with high mechanical strength. The density of aluminum is 2.7g/cm³. The mass of the bottom plate of the trolley is about 4400g, which conforms to the mechanical strength of the trolley. When selecting the bottom plate of the car, several materials are considered: PCB, plastic plate, iron plate, PCB. The mechanical strength of PCB is OK, but the price is high; plastic plate is light in weight, but its mechanical strength is not enough; iron plate is high in mechanical strength, but its mass is too heavy; aluminum plate is comprehensively considered as the bottom plate of the car.

4. Design of Bluetooth intelligent car control system

4.1. Main control module design

The main control module system of the car is controlled by single-chip microcomputer. At present, there are 51, MSP430, AVR and other mainstream single-chip microcomputers in the market. There are three options:

- Scheme 1: AT89S52 single chip computer of ATMEL company is selected. The single chip computer adopts 51 core, which is rich in system resources and cheap in price. 51 series single chip
computer can carry out bit operation and is more convenient in programming process. The program memory is flash type, which is easy to erase. However, the running speed of the single-chip microcomputer is too slow. When the crystal frequency is 12Mhz, the machine cycle reaches 1 μs, which is not suitable for the system design with high real-time requirements. Moreover, when there are many processing control peripherals, the processing speed is at an obvious disadvantage.

Scheme 2: a 16-bit ultra-low power MSP430F449 single chip of Texas Instruments (TI) company is selected. Although the single chip has powerful functions, ultra-low power consumption, abundant on-chip resources, large on-chip program memory and data memory, and fast processing speed. The design of the system is relatively simple, and the single chip is relatively expensive. If this single-chip microcomputer is applied to this design, it will be pure pompous and wasteful.

Scheme 3: ATmega16, an AVR series 8-bit microcontroller developed by ATMEL company of the United States, is selected. AVR microcontroller is a relatively novel microcontroller developed by ATMEL company. Its remarkable features are high performance, high speed and low power consumption. ATmega16 is rich in on-chip resources. In addition to the on-chip resources of other single-chip computers, it also has on-chip EEPROM, A / D converter, PWM and other resources. In addition, it also has rich bus resources for peripherals, including full duplex serial bus, SPI bus and IIC bus. Moreover, the price of the single-chip microcomputer is relatively low, which can be said to be a single-chip microcomputer with high cost performance.

Therefore, considering the design requirements and cost performance, ATmega16 single chip computer of ATMEL company is selected as the main control module chip of this design.

AVR is developed by ATMEL company. RISC single-chip microcomputer with Harward structure is adopted. AVR single-chip microcomputer absorbs the advantages of PIC and MCS51 series single-chip microcomputers. The system on the chip is rich and has high cost performance. In 1997, Mr. A and Mr. V of the Norwegian design center of ATMEL company developed a high-speed 8-bit single chip microcomputer (AVR) with RISC reduced instruction set by using the flash new technology of ATMEL company. Compared with the earlier and more mature 51 series single chip microcomputer, AVR series single chip microcomputer has more abundant on-chip resources and more powerful interface. At the same time, because of its low price advantage, it can replace 51 series single chip microcomputer in many occasions.

![Diagram](image-url)

**Figure 3.** Minimum system of ATmega16 single chip microcomputer.
ATmega16 has the following features: 16K bytes of system programmable flash (with the ability to read and write at the same time, i.e. RWW), 512 bytes of EEPROM, 1K bytes of SRAM, 32 general-purpose I/O port lines, 32 general-purpose working registers, JTAG interface for boundary scanning, support on-chip debugging and programming, three flexible timers/counters (T/C) with comparative mode, on-chip/off interrupt, programmable serial USART, universal serial interface with starting condition detector, 8-channel 10 bit ADC with optional differential input stage programmable gain (TQFP package), Programmable Watchdog Timer with on-chip oscillator, one SPI serial port, and six power-saving modes that can be selected by software. ATmega16 chip is rich in resources, and the price of the single-chip is relatively low, it can be said that it is a high cost-effective single-chip. The minimum system is shown in Figure 3 [6].

4.2. Wireless module design
The function of wireless module is to receive the data from Bluetooth software to realize the wireless control of the car. Wireless control technology can be applied in the more dangerous environment. At present, there are two main types of short-range wireless data transmission technology. One is based on IrDA infrared wireless communication technology, the other is based on ISM (industrial scientific medical) band radio frequency technology. Bluetooth technology belongs to the latter.

4.3. Motor drive module design
In this design, the motor driver module is L293D (as shown in Figure 4). L293D is packaged in 16 pin dip, the internal part of the module is integrated with bipolar H-bridge circuit, and all the opening values are made into n-type. This bipolar pulse width modulation method has many advantages. For example, its current is continuous current; the motor can operate in four corners; when the motor stops, there is micro vibration current, which plays the role of "dynamic lubrication"; it can eliminate the dead zone of static friction in the positive and negative direction; good stability at low speed, etc. L293D generates enable signals through internal logic. The input of the H-bridge circuit can be used to set the rotation direction of the motor, and the enable signal can be used for PWM. In addition, L293D integrates two H-bridge circuits into one chip, which means that one chip can control two motors at the same time. Each motor needs 3 control signals en12, in1 and in2, among which en12 is enable signal, in1 and in2 are motor rotation direction control signals. When in1 and in2 are 1 and 0 respectively, the motor rotates forward, otherwise, the motor reverses. A PWM circuit is selected to connect en12 pin, and the speed of motor can be adjusted by adjusting the duty cycle of PWM. If select an I/O port, connect in1 and in2 pins respectively through reverser 74hc14 to control the forward and reverse of the motor.

4.4. Design of Bluetooth software for mobile phone
Bluetooth software of mobile phone is the control terminal of this design. Its function is to send data to Bluetooth module through this software. General Java programming in the eclipse development environment is used to develop Android mobile applications. Through the buttons in the application software, the car's progress can be controlled.
5. Conclusions
Through the comprehensive design and debugging of Bluetooth car, the results are as follows:
1) The trolley can move forward, backward, turn left, turn right, accelerate and decelerate normally.
2) The power system of the trolley is sufficient and the driving is stable, and the trolley can be driven in a straight line.
3) The effective remote control distance from the tested mobile phone to the Bluetooth car is about 10 meters.
In the foreseeable future, the intelligent vehicles will develop with the development of related auxiliary technologies, with a very broad prospect and a huge market. We believe that in the future, we can enjoy the convenience brought by technological progress in driverless intelligent vehicles.

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