

Omnidirectional speech recognition control car system

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Abstract: This article mainly introduces an all-round intelligent car with voice recognition control based on the MeCanum wheel. Through the mechanical part of the traditional manual remote control car, the all-round movement of the trolley is realized, which greatly increases the flexibility and practical maneuverability of the trolley. At the same time, the speech recognition system is creatively embedded in the control system of the car, and the user can control the movement through the voice. The design uses STM32 as the main control part of the car. The system can be controlled by non-specific vocals. It has two driving schemes: vocal control and physical remote sensing. The LD3320 voice recognition module recognizes the user's voice command, and the car connects to the remote control through the Bluetooth wireless module. After receiving the action command, the car controls the motor at the bottom of the car through the MCU to achieve the corresponding full-scale operation.

1. Introduction

Voice, the simplest, most natural and convenient way to exchange and control information, is still rarely used in toys, so that toys can understand people, which is one of the important signs that toys become intelligent. It also has broad application prospects. Therefore, this topic designed an intelligent voice interactive smart car system, which can realize the recognition of voice commands and complete the corresponding control of the omnidirectional motion of the car. It combines high entertainment and is one of the important development directions of smart voice applications in the future.

2. Design of overall System

Using the speech recognition control module to communicate remotely with the trolley control terminal through wireless transmission, combined with the actual application scenarios and the research status of speech recognition technology, the overall design scheme of the car voice control system is developed. The system consists of hardware and software. The two parts are composed of hardware components including a voice recognition module, an obstacle avoidance module, an ultrasonic ranging module, a Bluetooth module, a motor drive module, and a liquid crystal display module.^[1]The system structure is shown in Figure 1.

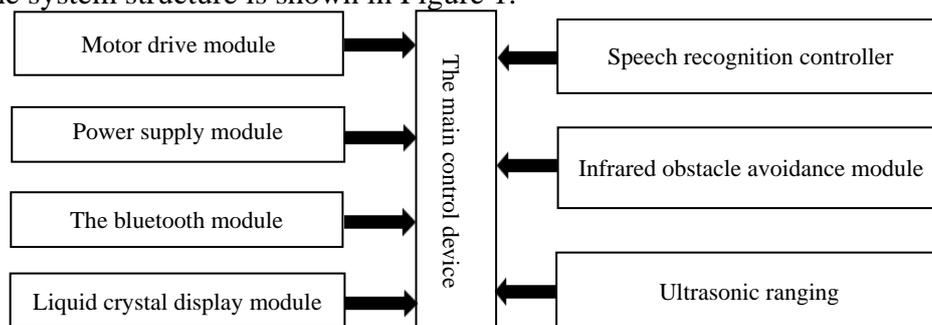


Figure 1 The system structure

3. Design of system hardware

3.1 Design of voice wireless remote control

The module is configured to send a voice signal received by the voice recognition module through the I/O port of the STC10L08XE micro-controller. When the voice signal is sent from the outside, the voice module receives the voice information through the microphone and sends it to the voice chip LD3320 for processing. The identified signal is passed to the MCU and output through its I/O port. As long as the output is connected to the corresponding hardware, the driving effect can be achieved.^[2]The speech recognition module is shown in Figure 2.

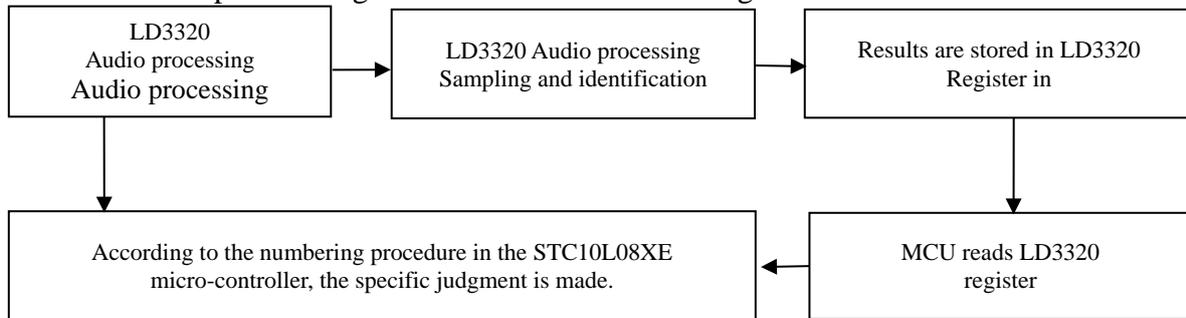


Figure 2 speech recognition module

The working principle of the voice wireless remote controller is as follows: the control command is issued through the microphone, the voice recognition module recognizes, generates a 32-bit control code, and according to the control signal, the storage module of the single chip matches the “keyword list”. The MCU then sends a control signal in the form of a wireless signal that is processed by the vehicle control unit MCU received by the cart to control the cart to generate a corresponding action.

3.2 Design of speech recognition module

3.2.1 The working principle of speech recognition chip LD3320

This topic uses the speech recognition chip LD3320 as the research content to develop a speech recognition solution. The LD3320 from IC Route is based on speech recognition technology that identifies non-specific people. The peripheral only needs a low level single chip level, so the microphone of the MCU control chip LD3320 is connected to the AD pin, which can realize the voice recognition function. The LD3320 features an efficient non-specific human speech recognition search engine and a complete library of functions. The chip can realize speech recognition without connecting any auxiliary chip during use. And the content of the recognition instruction can be arbitrarily edited by the user, and can store up to 50 instruction information at the same time. The LD3320 speech recognition has up to 96% accuracy.

3.2.2 Mode of speech recognition

A control command is issued to the cart, and the system extracts the voice information from the stored voice model through a voice sample of the control command issued by the person to determine which command. If the match is successful, the car will make the corresponding action according to the instructions issued by the user.

(1) Normal mode: This mode is processed immediately when the command is processed. For example, if any keyword in the configuration file is spoken, the module will immediately answer it without any restrictions.

(2) Password mode: The main difference between this mode and the normal mode is that this mode needs to first declare the first-level instruction with serial number 0. In this configuration file, the default first-level password is “car”, as long as the first-level password is spoken. , you can identify the remaining keywords, which is an execution condition. The identification process is completed once for the first-level password to be successful, followed by the secondary password.

This process is required for each recognition. In this mode, the anti-interference ability of speech recognition is extremely strong. In the password mode, after the first level password is spoken, the D1 indicator lights up, indicating that the primary password successfully waits for the secondary password, and the waiting time is about 10 seconds. If there is no secondary password or no trigger for more than 10 seconds, the logo will be automatically canceled and the indicator will go out.

(3) Button mode: This mode is combined with the key2 button to realize voice recognition, that is, the button can be recognized only after the button key2 is pressed, otherwise the external voice recognition is not accepted.

3.3 Design of smart car system hardware

3.3.1 Design of smart car body

The trolley is a four-wheel structure. The steering control system sends control signals to the two drive motors. The PWM signal is used to control the speed of the motor to produce a specific speed ratio, thereby achieving turning and other effects. This design mainly includes the single-chip control system, wireless Bluetooth transceiver module, motor drive control module, obstacle avoidance module and other components.^[3] The smart car design block diagram is shown in Figure 3.

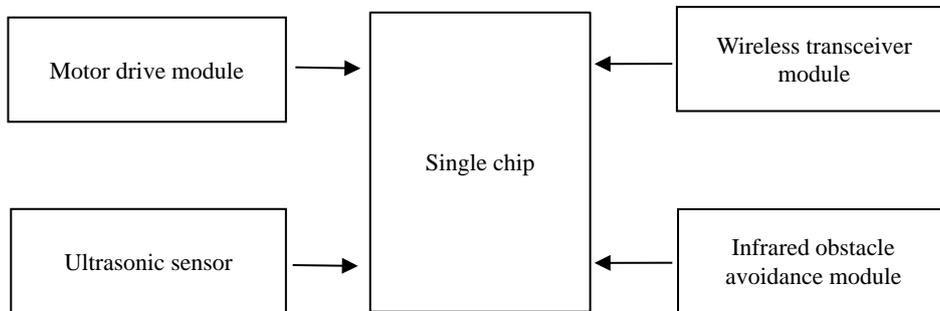


Figure 3 Design block diagram of smart car

The car uses four MeCanum wheels for omnidirectional movement, each with its own DC motor drive. The MCU controls the state and speed of the motor to control the direction of motion of the car.

First, let's take a look at the motion model of an all-round four-wheeler.

The initial time difference is Δt . The left-wheel running speed of the omnidirectional car is v_l , the right wheel is v_r , and the car moves in an arc along point A, and the turning radius is d . Can get:

$$d = \frac{R(v_l + v_r)}{2(v_l - v_r)} \quad (1)$$

The omnidirectional trolley motion offset radian is $\Delta\theta$, which is easy to get:

$$d\Delta\theta = \frac{v_l + v_r}{2} \Delta t \quad (2)$$

From the formula above, the relationship between the eccentricity of the omnidirectional trolley motion $\Delta\theta$ and the speed of the left and right wheels can be obtained:

$$\Delta\theta = \frac{v_l - v_r}{R} \Delta t \quad (3)$$

When the all-round trolley is doing circular motion, the amount of change on the X-axis is ΔX , the amount of change on the Y-axis is ΔY , and the relationship between ΔX , ΔY and the turning radius d is:

$$\Delta X = d \sin \Delta\theta \quad (4)$$

$$\Delta Y = d(1 - \cos \Delta\theta) \quad (5)$$

Substituting the formula 1 into the 45-type can give the relationship between ΔX , ΔY and the running speed of the left and right wheels:

$$\Delta X = \frac{R}{2} \frac{v_l + v_r}{v_l - v_r} \sin \Delta \theta \quad (6)$$

$$\Delta Y = \frac{R}{2} \frac{v_l + v_r}{v_l - v_r} (1 - \cos \Delta \theta) \quad (7)$$

Therefore, by changing v_r and v_l , it is possible to realize all-round car rectification, steering and other motion control, and it can realize any route along the longitudinal, lateral, oblique and swivel directions, and the posture is more flexible.^[4]

3.3.2 Design of power circuit

The whole vehicle is powered by a 5V regulated power supply. It is powered by two 3.7V rechargeable batteries connected in series. The voltage output of 3.3V is given to the main control board, Bluetooth wireless module, obstacle avoidance module and motor drive module, due to the maximum instantaneous power supply. The current can reach 3A, which can fully meet the requirements of large current supply of stepper motor.

3.3.3 Design of Motor driving Circuit

The main function of the motor drive module is to control the operation, speed control, stop and so on of the motor, and connect the motor to the motor through the driving circuit to realize the forward and reverse rotation of the motor. The commonly used motor drive chips are ULN2003 chip and L293D chip. Considering that the ULN2003 chip can only be connected to 5V, L293D can be connected to 12V, and L293D has the advantage of over-current protection. Therefore, L293D is selected as the motor drive chip. For motor speed regulation, PWM speed regulation method is adopted to adjust the motor rotation by adjusting the voltage at both ends of the motor and the duty cycle of the control waveform Speed.

3.3.4 Main controller circuit

The main controller of this project is STM32F103C8T6 chip of ST Company. Chip-based ARM Cortex M332-bit RISC kernel can operate at up to 72MHz, with built-in high-speed memory. A rich set of enhanced I/O ports and peripherals connected to two APB buses. Combining the features of high performance, real-time, low power consumption, low voltage, etc., while maintaining the advantages of high integration and ease of development, the performance and function of 32-bit MCU are improved to a new level.

4. Design of system software

4.1 Design of speech recognition program

The operation sequence of voice recognition is: firstly initialize the voice recognition, self-check whether each module works normally, and then write the recognition list, and the system starts to recognize the voice. If recognized, the register will have a corresponding value, and if the corresponding value, the recognition result is correct. The rule for identifying lists is that the LD3320 chip can only set up 50 commands. After the identification, the voice signal wireless command is issued according to the identification list command, the Bluetooth module receives the password, and then performs the corresponding password action, thereby completing the software loop. The voice wireless remote control system flow is shown in Figure 4.

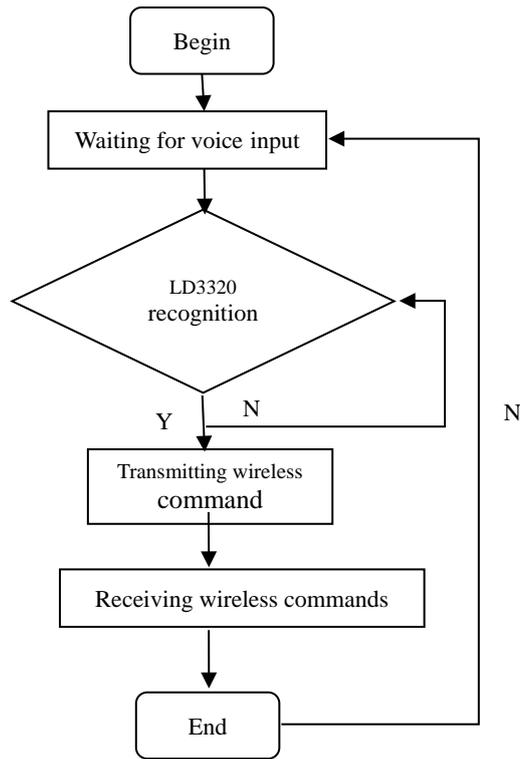


Figure 4 Flow chart of voice wireless remote control system

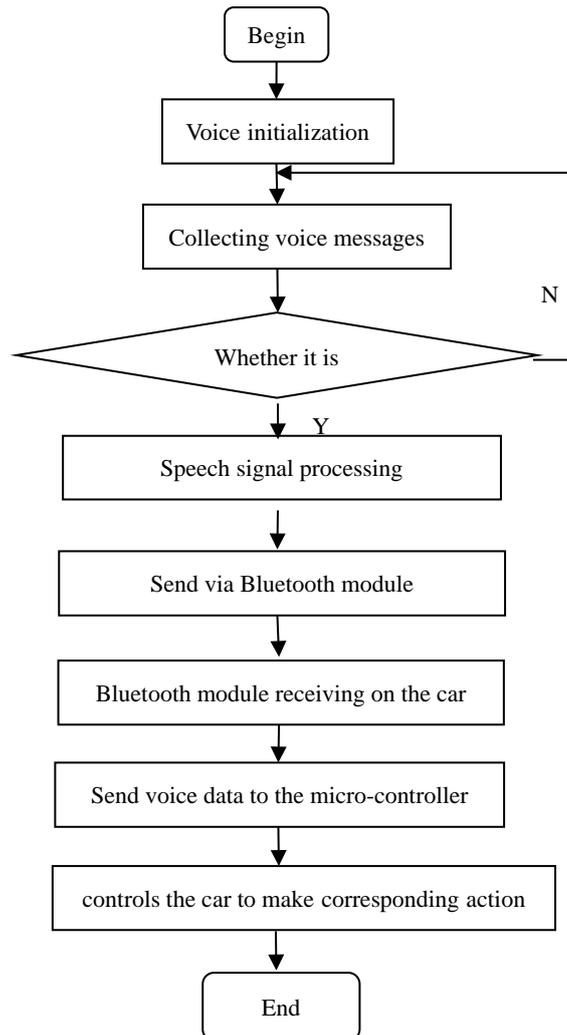


Figure 5 Flow chart of voice control smart car

4.2 Control program of the car

Using Keil software for software design, programming, downloading and debugging, according to design requirements, integrated programming, voice module, wireless transceiver module, motor drive and other modules. Through continuous debugging and improvement, the content of the design was completed. The overall program flow chart of this system is shown in Figure 5.

5. Program innovation and technological advantages

5.1 The program innovation points are as follows:

(1) Can use the voice recognition technology to control the movement of the car in all directions, no longer limited to forward and backward, turn left and turn right, but all movements of any degree of freedom, the flexibility and operability of the car is greatly improved, increasing the user's pleasure;

(2) Speech recognition technology uses three password input methods, namely normal mode, password mode and button mode, which improves the accuracy of speech recognition and effectively prevents misjudgment of other noises;

(3) Provides two modes of operation to control the movement of the trolley, that is, two driving schemes including vocal control and physical remote sensing control;

(4) Master the wireless Bluetooth communication technology for long-distance signal transmission, and the output signal of the voice controller is sent to the car through Bluetooth to perform motion control of the motion.

5.2 By comparing with other similar types of design analysis, it has the following advantages:

(1) At present, toys are developing in the direction of intelligence, humanization and cheap. This voice wireless remote control smart car meets the development trend of toy cars. The whole hardware circuit is about 300 yuan. If mass production, the cost can be reduced to about 80 yuan. Compared with the remote control car on the market, it has great market potential. , not only can be applied to the toy market, but also can be applied to the study of auto driving performance of automobiles;

(2) Compared with Ling yang SPCE061A single-chip microcomputer, it is more suitable for upgrading and re-development. It is mainly composed of single-chip microcomputer and voice recognition chip module, which can be flexibly selected to meet user needs;

6. Performance test

The speech recognition module is considered a hand-held device when considering actual applications. At this time, the working distance is about 20-60cm, and the comprehensive recognition rate is 95.73%. The 60cm is 89.02%, and the actual test environment is quieter, the body noise is smaller (taking into account the wheel noise during the test), and the denoising algorithm can be added later. In terms of recognition rate, the speech recognition rate is lower in a noisy environment than in a quiet environment. In terms of stability, the stability of the system is better in a quiet environment. The speech is said once, and the module can be made up to 2 times. The correct response; in the noisy environment, the stability of the system has decreased. Individual voice commands need to be said to be accurately recognized by the module for 3 or even 3 times. In real-time, the voice in a quiet environment can guarantee the real-time response of the system. Sex, the response time generally does not exceed 1 s, and the response time in a noisy environment is relatively long. Through repeated debugging, the control circuit is realized with the STM32 single-chip microcomputer as the core, and the voice recognition module is connected with the trolley driving module to realize the operation of voice control.

7. Conclusion

In this paper, the traditional control methods of smart cars are not intelligent, and the degree of individuation is low. The existing control technology is deeply studied. Considering the feasibility, cost and convenience of these technologies on smart cars, an intelligent vehicle control system based on speech recognition technology is proposed. Through repeated debugging, with STM32 as

the core, the wireless connection between the speech recognition module and the car drive module realizes the control circuit and completes the system architecture. The most important is the development and application of voice modules. Therefore, the transplantation is very convenient and adaptable, which can meet the needs of all voice electronic products. The second is the development of wireless modules, which make voice control more flexible, just send commands to the voice remote, and the car will execute commands. The significance of this scheme is to effectively combine speech recognition technology, wireless communication technology and single-chip technology to highlight the meaning of the speech recognition system. The system is low in cost, scalable and has great promotion value and potential.

Acknowledgements

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