

Design of Multi-functional Sweeping Robot Control System based on 51 Single Chip Microcomputer

Anyuan Zhang

School of Food Biological Engineering, Henan University of Technology and Science, China

Abstract

Design a set of robot control system with STC89C52 single-chip microcomputer as the control center. Based on the characteristics of the single-chip microcomputer, such as excellent integration, strong stability and expansibility, and rapid response, the design goal is defined as a ground dust cleaning robot. Under the conditions of the operating area, the target has the functions of autonomous movement, infrared obstacle avoidance, arbitrary cleaning, round-trip cleaning, and edge cleaning. Promote the application of such smart home appliances to a more humanized and universal development.

Keywords

Single Chip Microcomputer; Automatic Control; Infrared Obstacle Avoidance; Mode Switching.

1. Introduction

With the advent of the era of Industry 4.0, the smart home appliance industry is undergoing rapid changes. The emergence of intelligent sweeping robots makes people no longer worry about housework cleaning outside the complicated work, so that people can devote their energy to more meaningful fields. However, how to significantly improve work efficiency under complex environmental conditions is a problem that still needs to be solved for intelligent cleaning robots [4-5].

The task of this subject is to design and assemble a control system to realize the functions of autonomous direction change and multi-trajectory operation of the wheeled robot. It not only avoids the occurrence of problems such as item damage and personal safety that may be caused by collision, but also improves the situation that common cleaning robots have a single operation mode and cannot go through the corners of the room [2], and can also ensure that there is no dead angle and no operation within the working range. The active collision in the direction greatly improves the user experience.

2. Design of Hardware Part

This system includes six important modules: main control module, power module, sweeping module, motor drive module, key module and infrared obstacle avoidance module. The infrared obstacle avoidance sensor is used as the receiving end of the identification signal and the transmitting end of the control signal [8], the STC89C52 single-chip microcomputer is selected as the internal main control chip, the power supply module provides power, the sweeping module is used as the working module, the motor drive module and the infrared obstacle avoidance module drives and controls the stepper motor, and the button module controls the operation mode switching, so that the robot can realize functions such as autonomous movement, obstacle avoidance, round-trip cleaning, arbitrary cleaning, edge cleaning, mode switching [6,7]. The detailed process is shown in Figure 1.

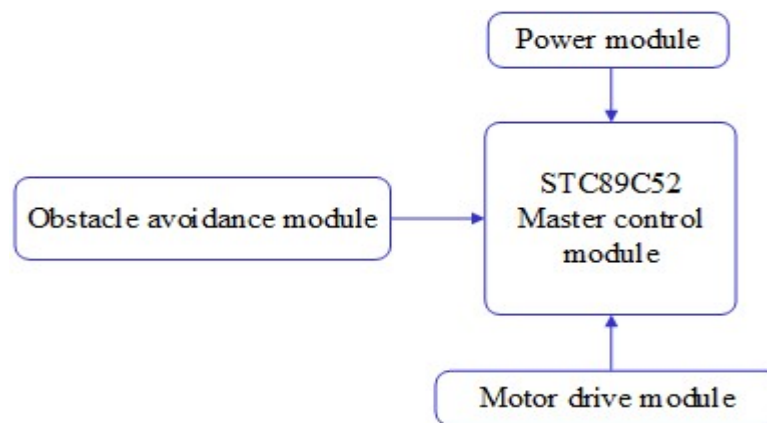


Figure 1. System structure block diagram

2.1. Power Module

The DC power socket is adopted, and 6 AA battery boxes are externally used as the input power supply and the positive voltage regulator of the model L7805CV, and the power supply voltage reaches 7.2-9.0V. The power cord is connected to the socket after the DC plug, the end of the socket is connected to the main switch, and the main switch is used to control the power on and off.

2.2. Infrared Obstacle Avoidance Module

It consists of three photoelectric converters for infrared emission and reception. The principle is to connect the output ports of the conversion sensing module in the left, right and front directions to the 5V pin of the STC89C52 microcontroller. After the circuit is turned on, a pulse width modulation control signal is generated, the speed of motor rotation is regulated by L298, so that the trolley executes the instructions of direction rotation, forward movement and termination movement [3]. The detailed process is shown in Figure 2.

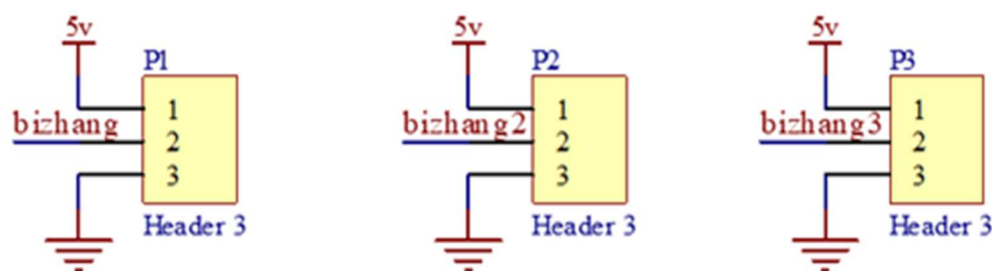


Figure 2. Infrared obstacle avoidance module circuit

2.3. Motor Drive Module

Choose L298 double H bridge DC motor. The speed, start and stop of the chassis tires of the sweeping robot are controlled by the PWM signal transmitted to the L298N circuit by the microcontroller [1].

3. Design of Software Part

C language is selected to write and modify the program content, and the obstacle avoidance circuit is designed with three infrared obstacle avoidance sensors in the front, left and right directions. In the main program, the standard reference value is prefabricated first, and the obstacle avoidance module reads the data and compares it with the established standard reference value, so as to realize the deployment of the logic circuit. When the obstacle

information is detected, the infrared sensor receives the signal, and the system executes the obstacle avoidance procedure to avoid the collision between the car and the obstacle. The detailed process is shown in Figure 3.

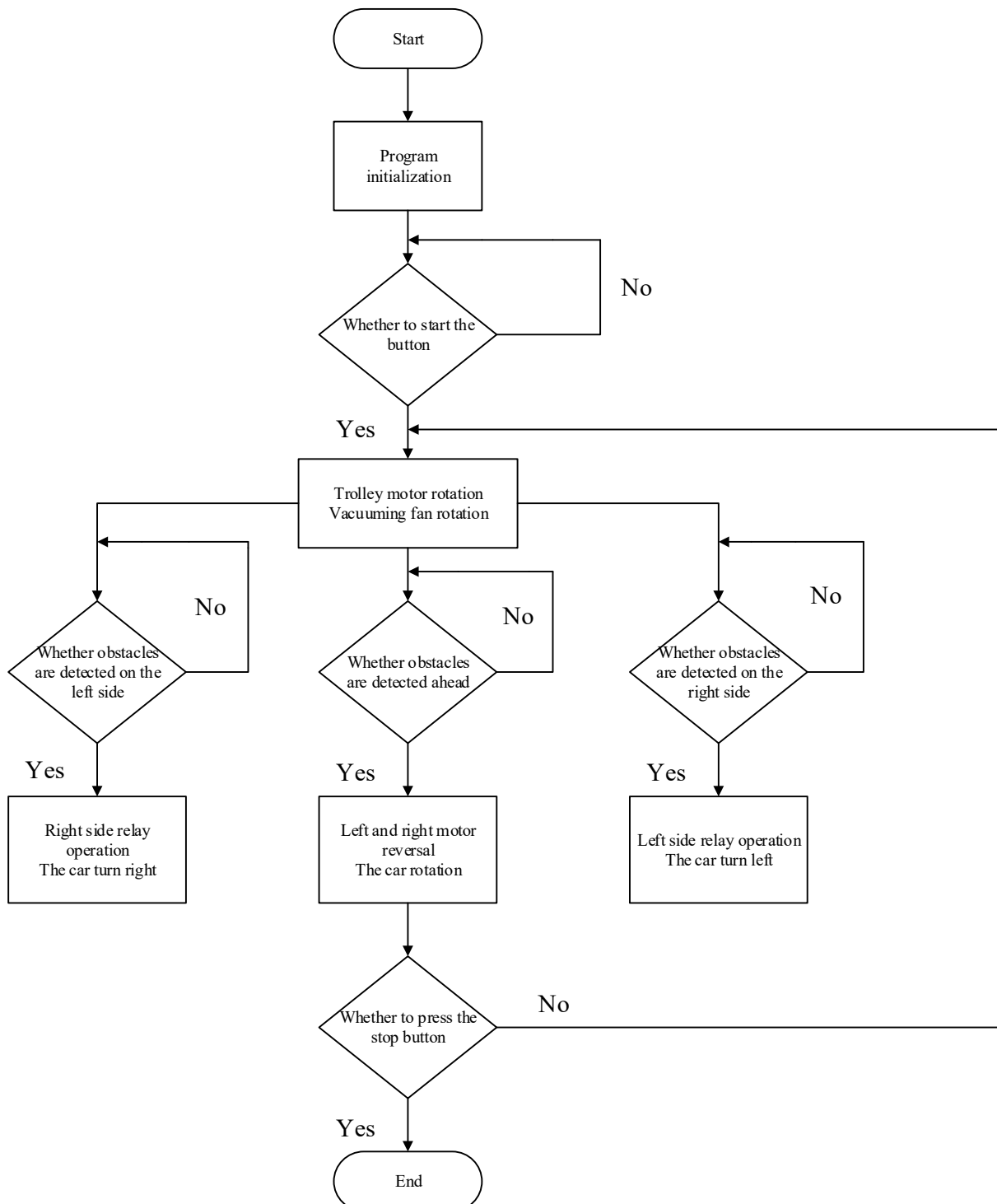


Figure 3. Overall logic diagram of the main program

4. Conclusion

This scheme adopts the control mode of infrared detection and obstacle avoidance, and designs three operating modes: in "reciprocating cleaning mode", the robot cleans back and forth in an S-shaped trajectory in a certain area, and changes its motion state when an obstacle is detected

in the running direction; In "arbitrary cleaning mode", the robot maintains a uniform linear motion in the area until it encounters an obstacle in front, then backs up and turns right; in "edge cleaning mode", the robot maintains a V-shaped swinging forward and backward movement pattern in the area, along a straight line run in a given direction. It is ensured that various operation modes can be switched independently, so that the smart home appliance travels without active contact, which greatly reduces the safety risk.

References

- [1] M. Hammock, A. Chortos, B. Tee, J. Tok, and Z. Bao, "25th Anniversary Article: The Evolution of Electronic Skin (E-Skin): A Brief History, Design Considerations, and Recent Progress," *Advanced Materials*, vol. 25, no. 42, pp. 5997-6037, 2013.
- [2] B. Argall, S. Chernova, M. Veloso, and B. Browning, "A survey of robot learning from demonstration," *Robotics and Autonomous Systems*, vol. 54, no. 5, pp. 469-483, 2009.
- [3] T. Someya, Y. Kato, T. Sekitani, S. Iba, and Y. Noguchi, "Conformable, flexible, large-area networks of pressure and thermal sensors with organic transistor active matrixes," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 102, no. 35, pp. 12321-5, 2005.
- [4] J. Kober, J. Bagnell, and J. Peters, "Reinforcement learning in robotics: A survey," *International Journal of Robotics Research*, vol. 32, no. 11, pp. 1238-1274, 2013.
- [5] P. Rawat, K. Singh, H. Chaouchi, and J. Bonnin, "Wireless sensor networks: a survey on recent developments and potential synergies," *Journal of Supercomputing*, vol. 68, no. 1, pp. 1-48, 2014.
- [6] S. Li, Q. Jiang, S. Liu, and Y. Zhang, "A DNA nanorobot functions as a cancer therapeutic in response to a molecular trigger in vivo," *Nature Biotechnology*, vol. 36, no. 3, pp. 258-+. 2018.
- [7] Okamura, M. Allison, C. Simone, and M. O'Leary, "Force modeling for needle insertion into soft tissue," *IEEE Transactions on Bio-Medical Engineering*, vol. 51, no. 10, pp. 1707-16, 2004.
- [8] C. Wang, X. LI, and Y. Zhang, "Carbonized Silk Fabric for Ultrastretchable, Highly Sensitive, and Wearable Strain Sensors," *Advanced Materials*, vol. 28, no. 31, pp. 6640-+, 2016.