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Design of Logistics Robot Based on STM32

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ABSTRACT :*With the continuous expansion of manufacturing enterprise scale in recent years, it is proposed that the enterprise internal transportation link is more efficient and more economical. In this context, manual handling is more and more difficult to meet the needs of large-scale logistics. Enterprise internal logistics automation will be the mainstream direction of future logistics handling links, and logistics robots will become the backbone of logistics automation. This paper designs a kind of logistics robot, which can drive according to the preset route in advance and make the robot load and unload automatically at the designated place through sensors and wireless communication, which can improve the efficiency of logistics transportation. This design uses STM32F103C8T6 microcontroller to be responsible for the cargo transfer of the robot and the control of the robot driving, through the way of infrared sensing to complete the tracking of the logistics robot. When the logistics robot arrives at the loading zone, the infrared sensor transmits signals to trigger the conveyor belt in the loading zone to transmit the goods. When the goods reach the set quantity, the conveyor belt stops and sends the completion signal to. The logistics robot will transport the goods to the unloading area according to the specified trajectory to complete the unloading. In the whole process, individuals can check the running state of the logistics robot through the mobile terminal and start and stop the robot according to the requirements. The design has the advantages of fast response, stable operation, practicability and intelligence.*

KEYWORDS *Single chip microcomputer; Wireless communication; Infrared tracking; Internet of things*

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I. INTRODUCTION

With the expansion of China's economy in recent years[1], the size of manufacturing enterprises is increasing. As a result, the internal transportation of enterprises is becoming more efficient and economical. The traditional logistics handling mode cannot fully meet today's modern logistics requirements, as it is mainly based on manual labor, which increases costs and limits the long-term development of enterprises. To solve this problem, more intelligent equipment is needed to improve handling efficiency, and logistics robots are born. Based on technologies such as embedded technology and incorporating wireless communication technology and infrared sensing technology, logistics robots can eventually transport goods between loading and unloading areas within an enterprise, improving internal logistics efficiency[2].

The logistics robot can follow a pre-defined route to the pre-defined loading point, then complete the task of automatic loading, and finally reach the destination to complete the automatic unloading, thus improving the efficiency of internal logistics transport, reducing logistics transport costs, and meeting the increasing demand for goods transport. The STM32 microcontroller-based logistics robot uses the microcontroller as the control core to achieve robot motion control, motion control and human-computer interaction, which is an important direction in developing logistics robots[3].

Logistics robots can be considered intelligent vehicles, also known as AGVs. The first autonomous guided vehicle system in history, the AGV, was invented by Barrett Electronics in 1954 as a platform for transporting goods on a fixed route, but it had the most basic feature of an intelligent vehicle - it was driverless. - The AGV was developed with the aim of increasing the level of automation in transport. In 1959, AGVs began to be used in the USA in practical handling and industrial production lines. By the 1980s, there were more than 2,100 AGV systems in the US[4], and AGVs had become an important core of US automation equipment. By the 1990s, the US had become more mature in mobile robotics, with intelligent mobile robots being used for space exploration. In the 21st century, research into logistics robotics became more advanced, and in 2009 the Indian company Gray Orange built a handling robot called Bulter, which is used in modern logistics and other industries. A robotics company called Fetch Robotics, founded in 2014, has a robot called Fetch, which has an automatic navigation function that allows it to perform automatic cargo handling tasks and move quickly[5].

Research on logistics robots in China started relatively late compared to foreign countries, with the first AGV developed in 1975, but with the rapid development of the logistics industry in recent years. Zhao Yueteng et al[6] designed a logistics vehicle adapted to the logistics sorting and handling system, the core of which is STM32F407. The sorting function of this vehicle reads the cargo information by scanning the barcode, and the robot arm is controlled by the microcontroller to open and close to complete the handling task. PID control is used for speed control, which makes the vehicle stable. The vehicle is equipped with an LCD screen that displays information such as motor speed, vehicle travel distance and vehicle travel status in real time.

II. OVERALL SYSTEM DESIGN

This design conducts research for the application design of a logistics robot. The design of a logistics robot, the robot body consists of C-car model, STM32F103C8T6 microcontroller, servo, motor driver, infrared sensor and other parts; the set up of the loading point conveyor part mainly consists of STM32F103C8T6 microcontroller, motor driver, infrared sensor. The control algorithm was completed using Keil5 software to enable the logistics robot to achieve basic control effects in a simulated environment. The overall design scheme is shown in Figure 1, Figure 2 and Figure 3. The design is divided into seven modules: microcontroller module, robot tracking module, driver module, infrared detection module, wireless module, IoT module and power management module.

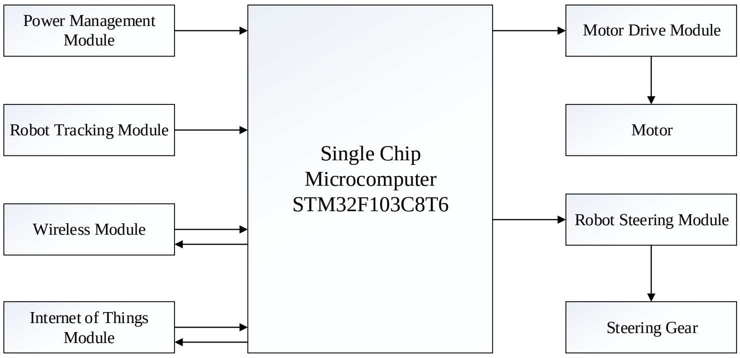


Fig.1 Block diagram of the logistics robot structure

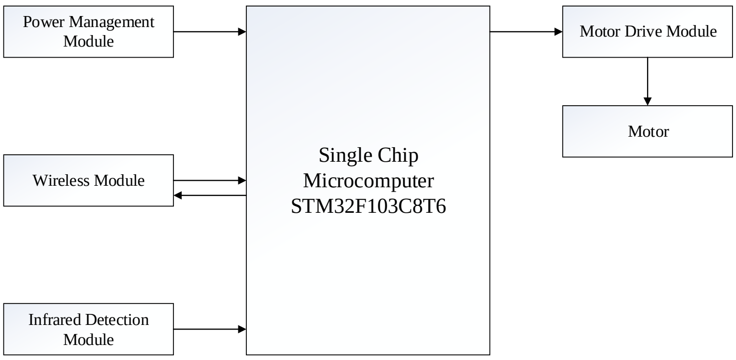


Fig.2 Block diagram of the loading point conveyor structure

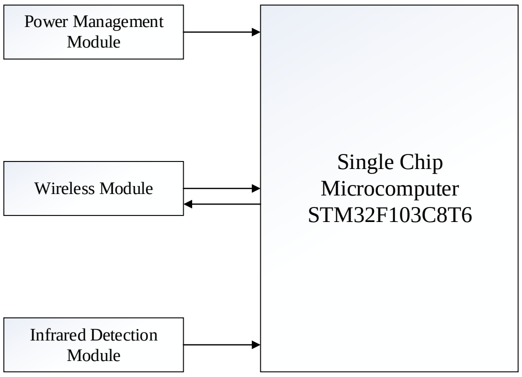


Fig.3 Block diagram of the infrared detection structure in the unloading area

III. CIRCUIT DESIGN

The circuit design includes a power supply module, a step-down module and a driver module. The power supply is powered by a 7.2V lithium battery. The step-down module utilizes 5V and 3.3V voltage regulator modules. The 5V type is used for the driver module, infrared sensor, wireless module and IOT module. The 3.3V power supply is used for the microcontroller power supply and the robot tracking module. Drive module: The basic principle of the drive circuit is the H-bridge drive principle. In order to save space and improve efficiency, we use two double H-bridge motor drivers. The overall circuit diagram is shown in Figure 4, Figure 5 and Figure 6.

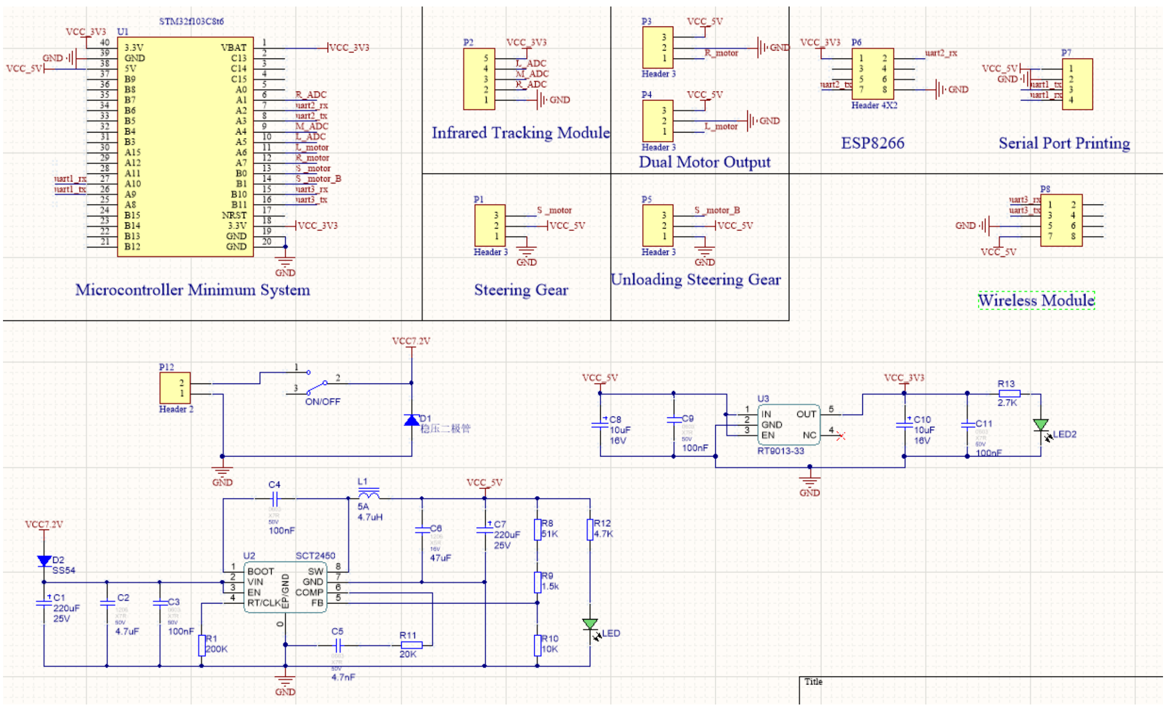


Fig. 4 Logistics robot circuit schematic

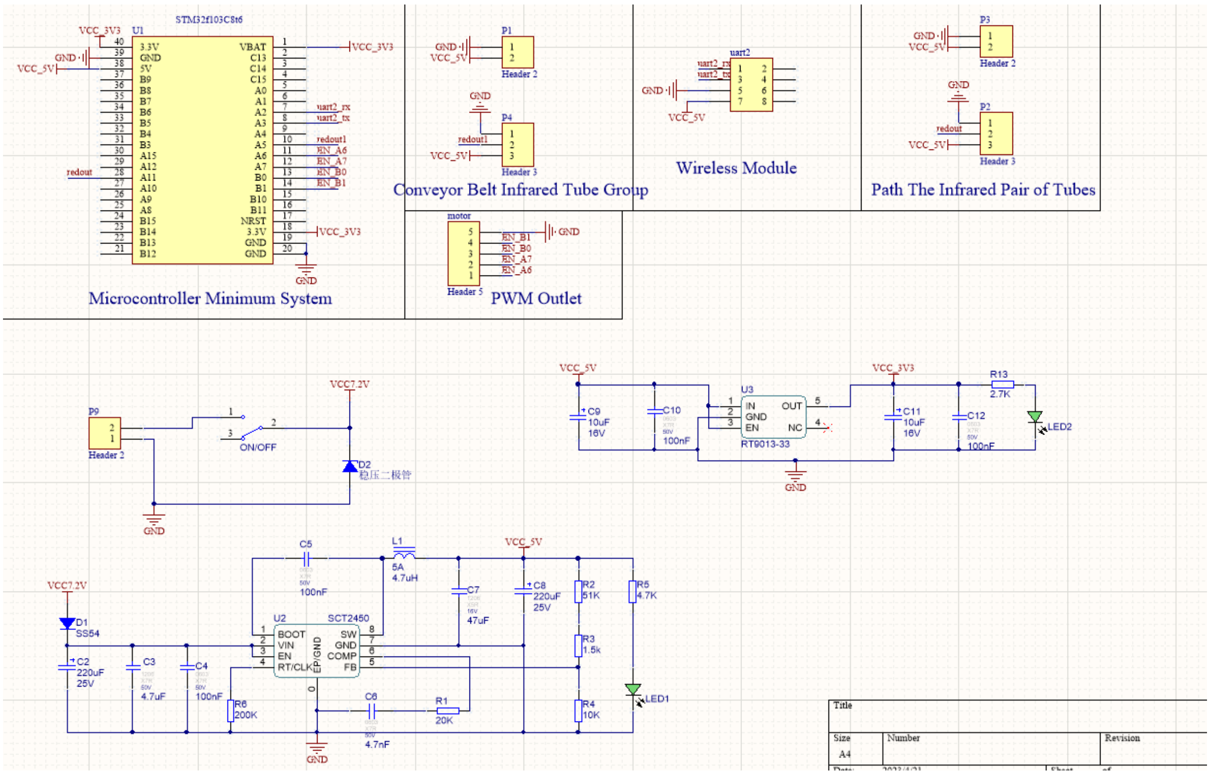


Fig.5 Circuit schematic of the loading point conveyor

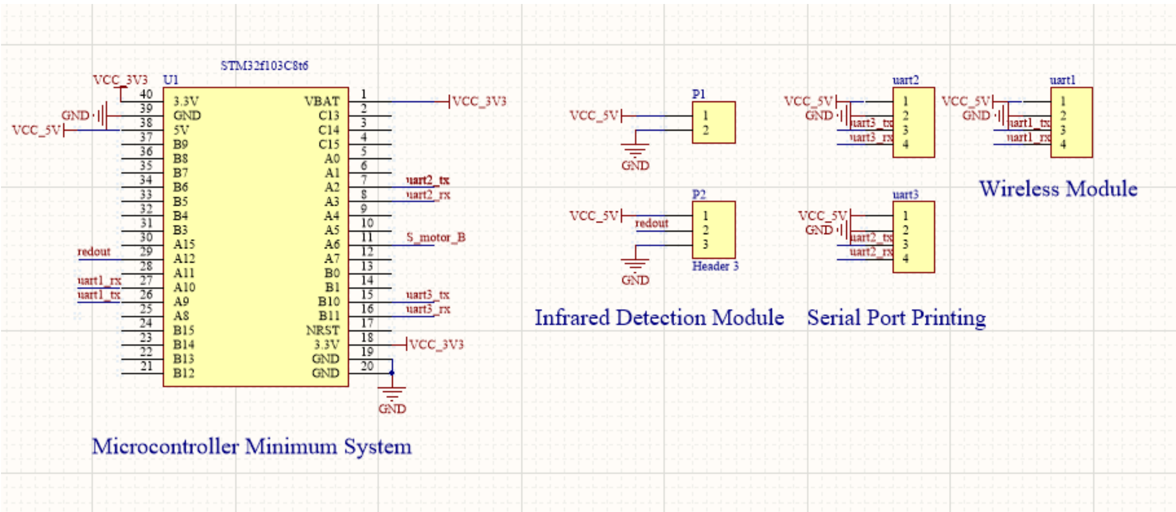


Fig.6 Circuit schematic of the unloading area

IV. SYSTEM SOFTWARE DESIGN

After initialization, the mobile controls the logistics robot via the IoT module subroutine. The robot automatically follows the trajectory and follows the route. The infrared detection subroutine detects whether the robot has reached the loading point and, if so, sends a command via the radio module to stop the robot and wait for loading. If it is not full, the robot continues to wait until it is. When the goods are full, the conveyor stops and the robot is activated by sending a command via the radio module. The infrared detection subroutine detects whether the robot has reached the unloading area and, if so, sends a command via the radio module to stop the logistics robot and to automatically unload the goods. Throughout the process, the mobile side can check the robot's operating status and control the start/stop via the IoT module subroutine. The overall design of the logistics robot system is shown in Figure 7.

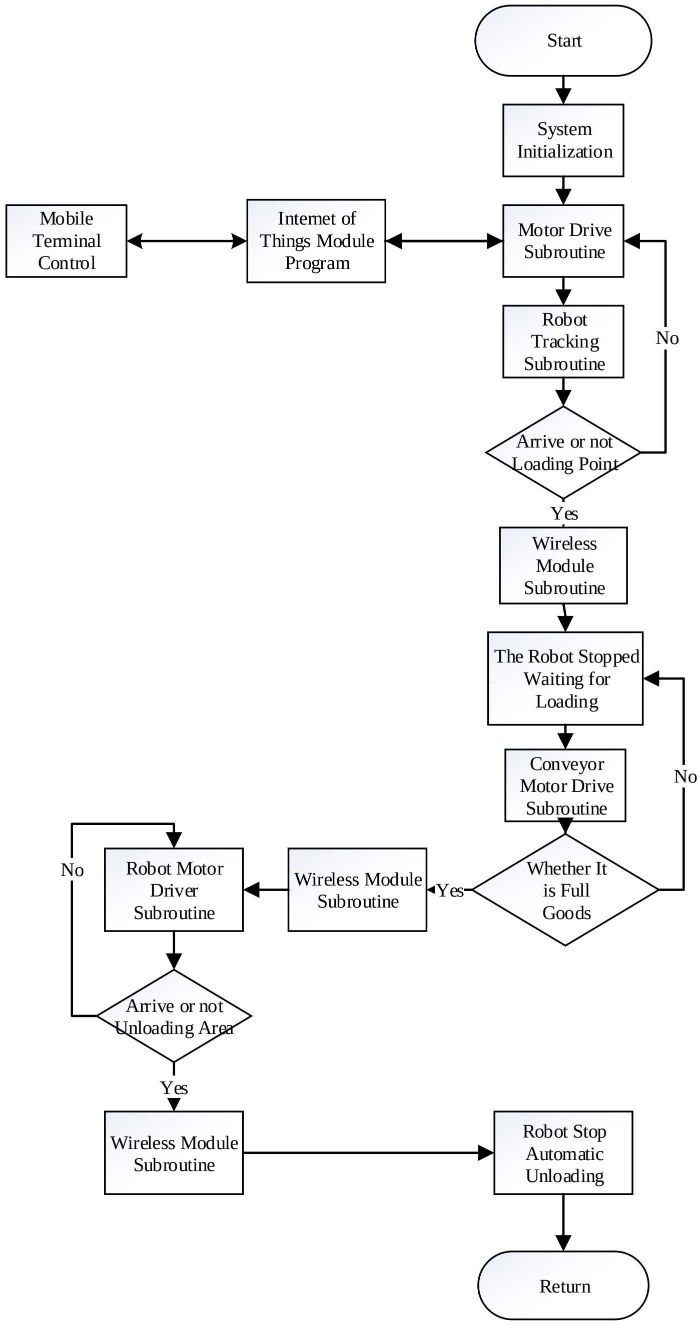
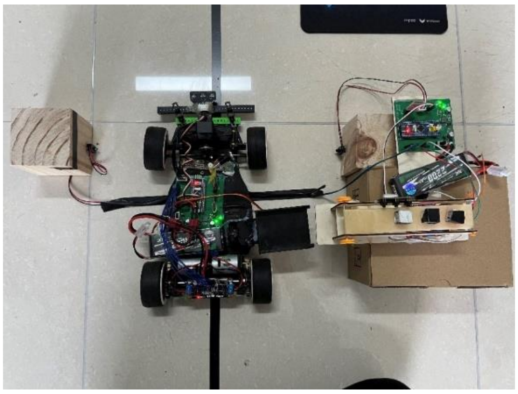


Fig.7 Overall design of the logistics robot system

V. EXPERIMENTAL TESTS

When the logistics robot reaches the loading location, the infrared detection module at the side of the road recognizes the logistics robot and sends a signal via the wireless module to stop the logistics robot and sends a signal to the conveyor belt, which starts to transfer the products, setting the logistics robot to load three products at a time. If it is not full, the logistics robot continues to wait until it is full, the loading task is completed and the logistics robot leaves. The loading process of the logistics robot is shown in Figures 9 and 10. After several iterations of testing and debugging, we found that the robot could indeed load the specified number of goods and that the loading process was relatively stable. This proves that our design solution is feasible.



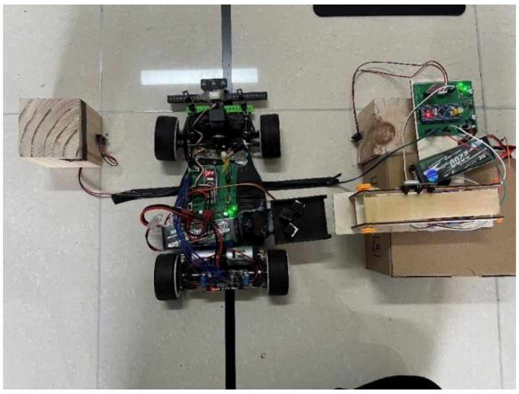
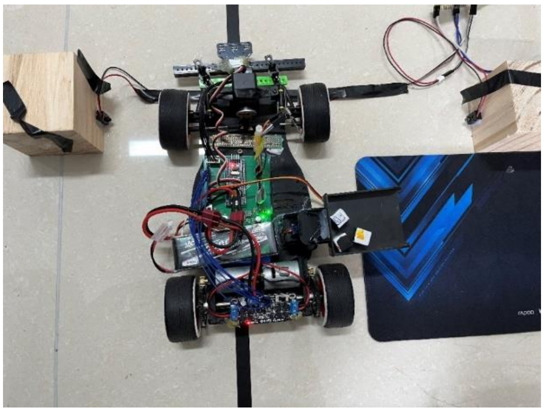


Fig.8 Diagram of the robot starting to load **Fig.9 Diagram of completed robot loading**

When the Logistics Robot reaches the unloading area, the infrared detection module in the unloading area recognizes the Logistics Robot and transmits a signal through the radio module to stop the Logistics Robot and cause the unloading device on the Logistics Robot to reverse to complete the task of automatic unloading, as shown in Figs. 11 and 12. After several tests, the logistics robot sometimes stops abnormally and unloads incompletely in the unloading area, which is checked because sometimes the logistics robot is not detected by the infrared detection module, so it does not stop in time. By improving the stability of the infrared detection module and changing the tilt angle of the unloading device, the logistics robot can have a high degree of unloading stability and complete the automatic parking and unloading function more smoothly.



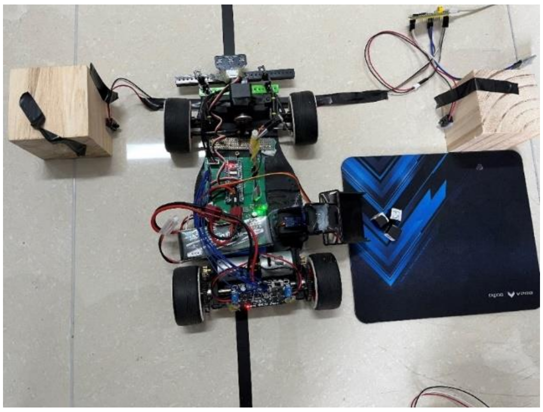
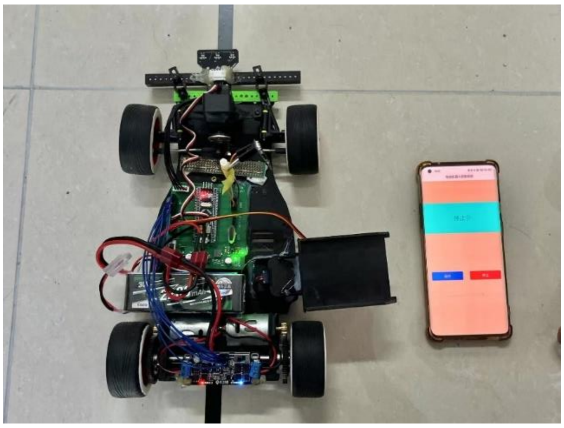


Fig.10 Diagram of robot unloading **Fig.11 Completed robot unloaded diagram**

Finally, the IoT module is responsible for transmitting the operating status to the mobile and for controlling the start/stop of the logistics robot on the mobile. When the user needs the robot to transport goods, the robot can be operated remotely from the mobile terminal and the operating status of the logistics robot can be monitored remotely. Figure 13 and Figure 14 show the operating status of the logistics robot on the mobile terminal.



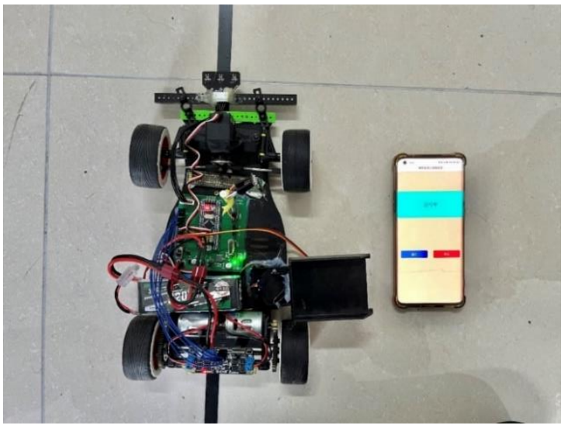


Fig.12 Mobile-controlled robot stop diagram **Fig.13 Mobile control of robot operation**

Through the above many iterations of testing and debugging, the logistics robot can complete the entire design process, proving that our overall design solution is feasible.

VI. CONCLUSION

Based on the current background of rapid socio-economic development of the logistics industry, the paper proposes a design solution for a logistics robot based on the STM32. The development prospect of logistics robots is very broad. In the near future, logistics robots will play a greater role in the industry, helping people to complete more tasks, improve more efficiency and create more benefits and value for society.

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