

Design of Intelligent Wireless Charging System for Electric Vehicle

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Abstract: This design takes stm32h743vit6 chip in STM32 Series MCU as the core controller of the intelligent wireless charging system. The electric vehicle system is composed of wireless charging module, image processing system and intelligent vehicle driving module. It can realize the functions of logistics transportation within the set distance, wireless charging at the stop, returning according to the specified route and so on. This design can be applied not only in daily life, but also in short-distance intelligent logistics transportation environment such as AGV.

Keywords: Wireless charging, STM32 single chip microcomputer, Image processing, OpenMV.

1. Introduction

With the design concept of better service for people, artificial intelligence has given birth to many disciplines and directions, such as biometrics, assembly line automatic machines, smart homes, smart appliances, intelligent robots, etc. among them, intelligent robots belong to a major branch of artificial intelligence [1-2]. This design uses artificial intelligence technology to design a wireless charging intelligent vehicle to realize "intelligent transportation" and "intelligent charging". It can greatly reduce human and material resources and make life more intelligent and convenient [3].

2. Scheme Design

2.1. Overall System Design

The smart car system is composed of openmv image processing module, mcnamu wheel, motor control module, super capacitor device and wireless charging module.

2.2. Selection of Control System Scheme

Scheme 1: adopt the traditional 51 series single chip microcomputer.

AT89C51 is an efficient microprocessor. It is cheap and can meet many basic needs. It provides a flexible and cheap scheme for many embedded control systems.

Scheme 2: STM32 series single chip microcomputer is adopted.

STM32 series single chip microcomputer has the characteristics of low power consumption, low working voltage and strong driving ability.

Analysis and comparison: the car is mainly controlled by 51 series single chip microcomputer, and then drives relevant modules to realize tracking and ward number recognition. The operation is relatively simple, but it has great limitations and can not complete high demand tasks such as image processing. Stm32h743vit6 chip in STM32 series is the main control chip of current mainstream image processing module openmv with high reliability. Therefore, stm32h743vit6 is selected as the main control chip in this design.

2.3. Design of Wireless Charging System

Use the wireless charging module to charge the super capacitor. After the timing is over, stop charging. Then the super capacitor discharges, supplies power to the motor and the main control circuit, gives the corresponding signal, and the trolley runs according to the predetermined program.

2.4. Project Implementation Plan

Scheme 1: the electric vehicle automatically plans the path and charges wirelessly.

① Position the electric vehicle. Several base stations are placed in the parking lot area to transmit signals through the base station. At the same time, the signal sent by the base station is received by the positioning module to convert the position of the electric vehicle into coordinates and store it.

② Conduct path planning. Using the algorithm, the starting point and parking point are planned, and the optimal path is selected from many paths.

③ Electric vehicle tracking. The electric vehicle tracks according to the planned path, that is, the path is transformed into a series of coordinates. By looking for the next coordinates, it reaches the parking point.

④ After arriving at the parking point, the car can automatically conduct wireless charging through wireless charging technology.

Scheme 2: the electric vehicle tracks through auxiliary signs and charges wirelessly.

① Auxiliary signs that can be controlled freely shall be installed on the ground of the parking lot area in advance.

② After the electric vehicle enters the parking lot, it will automatically detect a vacancy in the parking lot, and the auxiliary sign will be led to the vacancy.

③ The electric vehicle detects the auxiliary signs on the ground through the sensor, and the auxiliary signs are guided to the parking space.

④ After arriving at the parking point, the car can automatically conduct wireless charging through wireless charging technology.

Considering the complexity and economic cost of the project, scheme II is adopted in this design.

3. Circuit and Program Design

The program design of this design is developed based on openmv ide platform. It has a powerful text editor supported by qtcreator, a frame buffer, a histogram display, and an integrated serial port terminal for openmv debugging output.

3.1. Image Acquisition Module

The image acquisition and processing module selects stm32h743vit and ov7725 to realize the function of openmv. The ov7725 has a frame frequency of up to 150Hz and can be hardware binarized. Openmv is an open source, low-cost and powerful machine vision module. It uses it to continuously absorb road markings and plan pre travel trajectories to adjust the travel attitude of the car.

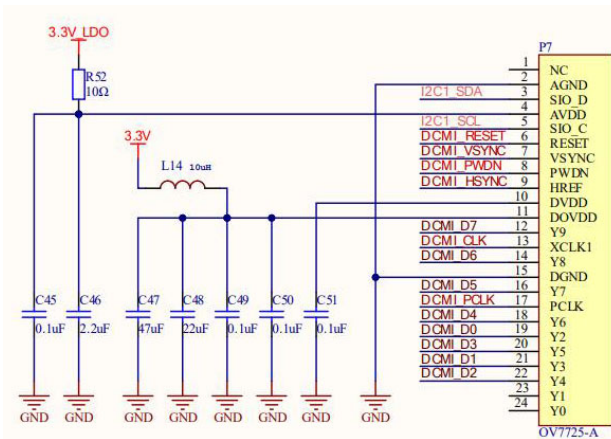


Figure 1. Circuit design of ov7725 camera

3.2. Wireless Charging Module

The wireless charging module is composed of the charging coil at the transmitting end and the charging coil at the receiving end. In order to make the receiving coil on the trolley obtain the rated voltage, it is necessary to generate a high-frequency wireless electromagnetic wave during charging. The coil with 5V, 1a and 5cm diameter is selected to charge the wireless charging module. When the trolley reaches the charging point, the 5V voltage of the DC regulated power supply is transmitted through the transmitting end of the wireless charging module, and then received by the receiving end of the wireless charging module. The received electric energy is stored in the super capacitor, and then the regulated power is directly supplied to the single chip microcomputer system and other modules.

3.3. Drive Module

The system uses the encoding motor and mcnamu wheel as the driving of the trolley. The rotation angle speed of mcnamu wheel is directly proportional to the speed of wheat wheel moving along the roller axis, that is, the actual effective speed. This is the basis of wheat wheel speed decomposition. The test wheel moves in all directions without track.

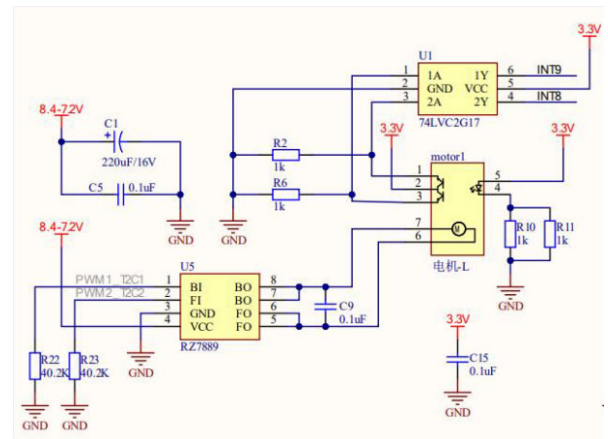


Figure 2. Motor encoder and drive circuit

3.4. Touch Screen

For the display module of the car, our system uses a 2.8-inch QVGA touch screen with a resolution of 240 * 320 as the display module of the car. Before the trolley works, you need to press the corresponding button on the touch screen to start the program. After the program starts, the image collected by openmv and the track to be driven after path planning will be displayed on the display screen in real time.

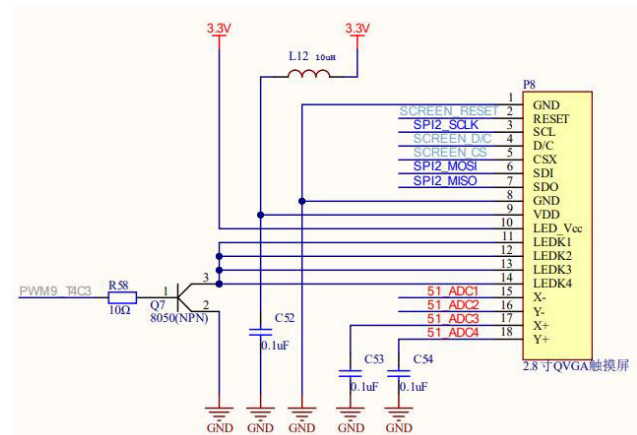


Figure 3. Circuit design of 2.8-inch QVGA touch screen

3.5. Visual Tracking

Visual tracking is to use openmv to capture the road black line, divide the black line into 5 blocks, and take the midpoint of each block for connection. The connection of the five midpoint is the pre driving route planned by the algorithm. In the process of trolley traveling, PID controller is used to ensure the stability of traveling. The midpoint of each block is used for longitudinal zoning. Black blocks are identified in each area. The average value of identification points minus the center line is used to obtain the deviation of offset loop. The deviation of offset loop is calculated by PID controller to obtain the execution amount of offset loop, that is, steering speed. The deviation of the translation loop is obtained by subtracting the center line from the black block in the last area, and the execution amount of the translation loop, that is, the translation speed, is calculated by the PID controller. Steering speed plus translation speed plus straight ahead speed equals output.

4. System Test

4.1. Test Instrument

- ①PC;②OpenMV IDE; ③Simulated runway with black

line; ④ Digital oscilloscope; ⑤ Multimeter; ⑥ DC regulated power supply.

4.2. Charging Function Test

① The DC regulated power supply is set to 5V and the charging current is not greater than 1a. Use a voltmeter to measure the voltage at both ends of the capacitor. The voltage at both ends of the capacitor increases steadily with the increase of charging time. The test results are shown in Table 1:

Table 1. Test of relationship between charging time and capacitor voltage

Test items	Test data				
Charging time /s	15	30	45	55	60
Capacitance voltage/v	1.13	2.79	3.98	4.67	4.99

② When charging for 60s, the trolley can travel about 443cm on the runway.

③ When the capacitance remains unchanged, change the distance between the transmitting end and the receiving end, and measure the traveling distance of the trolley. The test results are shown in Table 2:

Table 2. Relationship Test between charging coil distance and trolley travel distance

Test items	Test data			
Distance between transmitting end and receiving end / cm	1.5	1	0.5	0.1
Capacitor voltage after charging for 60s /v	2.97	3.77	4.32	4.98
Traveling distance of trolley / cm	53.4	223.4	356.7	445.3

4.3. Visual Tracking Reliability Test

Use openmv ide to run visual tracking code to test the reliability of visual tracking. The processing results displayed on the display screen are shown in Figure 4.

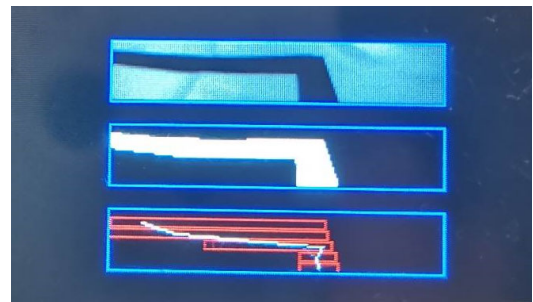


Figure 4. Visual tracking test effect

After testing, the visual tracking is normal, the touch screen display is normal, and the smart car can drive normally on the runway and realize wireless charging.

5. Conclusion

This design can realize the independent tracking of the electric car to the target point and complete the wireless charging function. At the same time, the system is also suitable for the intelligent logistics transportation environment such as AGV. This design has certain reference and practical value, and its innovation is mainly reflected in:

(1) The system uses stm32h743vit6 as the core controller, the data collected by openmv as the car attitude detection system, uses the driving circuit to control the motor, and realizes the closed-loop control of the car through the encoder and as the feedback device.

(2) The system elaborates the principle of PID control, visual tracking and the realization of wireless charging. Through the motion modeling of the car, the PID control algorithm of the car is constructed. The PID parameters are adjusted through the serial terminal in openmv IDE, and finally the system design of the car is realized.

Acknowledgment

Fund Project: Provincial College Students' innovation and entrepreneurship project of Wuhan Technology And Business University (S20211342011).

References

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