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DESIGN OF INTELLIGENT CHARGING MANAGEMENT DEVICE BASED ON QR CODE PAYMENT PLATFORM

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Abstract This thesis designs an electric two-wheeled vehicle charging management device based on STM32 single-chip and two-dimensional code payment, which mainly includes hardware and software. The hardware part is mainly composed of STM32F103RCT6 as the main controller, combined with power supply circuit, power supply control circuit and mutual inductance. The current detecting circuit, the two-dimensional code scanning circuit, etc. are used to realize the basic functions of the two-dimensional code payment electric two-wheeled charging pile. The software part is programmed using MDK Version 5 programming software and C language, including main program, scan code payment program, power supply control program, current detection program and so on. The functions realized by the design mainly include that the device can provide power supply for the electric two-wheeled vehicle charger, and the charging management device has overload detection, no-load detection, timed charging, and can start charging by using the two-dimensional code on the Alipay or WeChat scanning charging device to complete the payment.

Keywords: STM32; QR code payment; charging management; current detection.

1. INTRODUCTION

Amid the rapid development of network technology, smart phones are constantly being updated, bringing more and more functions and capabilities, which have profoundly affected people's lifestyle. In today's consumption pattern, consumption via smart phones has become a daily habit of people, and even an important part of consumption patterns, bringing lots of convenience to people. Not only the way of consumption is changing, but also the way people travel is gradually changing. Under the call of "low-carbon travel", electric vehicles have gradually become a means of transportation for people. Electric vehicles are deeply favored by people with its lightness equal to bicycles and speed as fast as motorcycles. However, statistics show that accidents caused by electric vehicles are on the rise year by year, mostly fire accidents caused by improper charging of vehicles. It can be seen that safety management in electric vehicle charging is nonnegligible. In this study, an electric two-wheeled vehicle charging management device is designed based on STM32 microcontroller and QR code

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scanning payment by using embedded principle of microcontroller and technical principle of code scanning payment. The QR code scanning-based charging management device designed herein has the ability to safely manage charging of electric vehicles, and has functions such as overcharge protection, which can reduce fire accidents brought by charging of electric vehicles. At the same time, by using QR code to pay for charging, no coin is needed, so payment is more convenient, which can bring a safe and convenient user experience to electric vehicle users to a large extent. Hence, the design of intelligent charging management device based on QR code payment platform carries very important research significance.

2. PROJECT DESIGN

2.1. Technical solutions

The main control chip is a 32-bit ARM Cortex-M3 cored STM32F103RCT6 microcontroller, which can support a maximum operating frequency of 72MHz. The chip package is LQFP64. Its internal resources include 128KB FLASH storage and 20KB RAM primary storage. It has 7 timers, 2 SPI serial interfaces, 2 I2C interfaces and 2 USART serial interfaces, which supports SWD and JTAG debug modes [13]. The payment method is to scan the QR code for charging. Through the QR code image on the WeChat or Alipay scanning machine, the user enters the relevant payment interface. After successful payment, the user plugs in the electric two-wheeled vehicle charger and starts charging.

2.2 Basic principles

The code scanning-based charging management device is used to supply power to electric two-wheeled vehicles. The device consists of an external protective shell and a circuit mainboard inside the shell. The device shell is provided with a QR code and a charging interface. The circuit board is provided with a power circuit and a microcontroller main control circuit, storage circuit, charging management circuit and code scanning payment circuit. The system

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general block diagram is shown in Fig. 1.

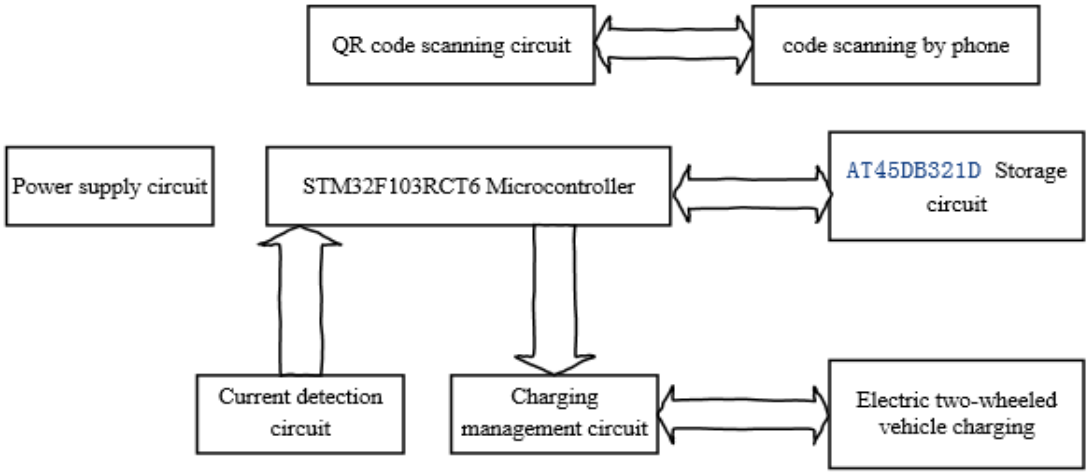

Figure 1. System general block diagram.

3. HARDWARE IMPLEMENTATION

In the project design, STM32F103RCT6 microcontroller is adopted as the core controller, which is supplemented by peripheral auxiliary circuits. The hardware overall schematic diagram is shown in Fig. 2.

The overall hardware working procedure: 220V AC voltage is connected to the power circuit and 7.5V DC voltage is output through the power charger, which is converted to 5V after the 7805 chip and further converted to 3.3V after the ASM1117 chip to power the STM32F103RCT6 microcontroller. After successful payment by scanning the QR code at mobile terminal, the microcontroller controls the charging management circuit during charging of the electric two-wheeled vehicle. The current detection circuit detects the current during the charging process. The STM32 microcontroller serves as the main controller. The overall hardware components include power circuit, QR code scanning circuit, current detection circuit, charging management circuit and other peripheral auxiliary circuits to achieve normal operation of the intelligent charging management device for electric two-wheeled vehicles.

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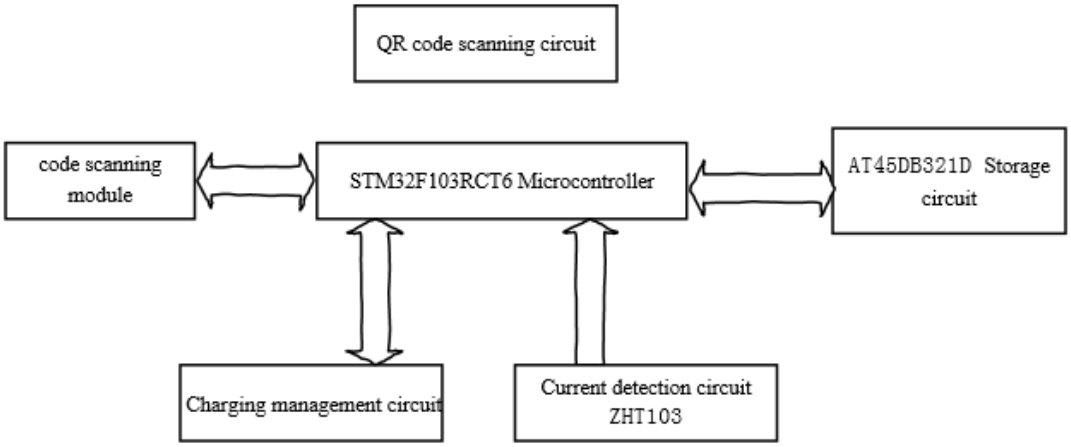

Figure 2. Hardware overall schematic diagram.

4. SOFTWARE IMPLEMENTATION

4.1 Software Function Introduction

The software is designed to mainly act on the various chips and components, and play a driving role to complete various tasks. In the project design, the STM32F103RCT6 microcontroller serves as the main controller, and the main controller and the peripheral auxiliary circuits are connected by invoking the program so that design and implementation of the QR code payment-based charging management device is possible.

The software functions are introduced as follows: 1. Design the basic function program of the microcontroller. The most important matter is to initialize the STM32F103RCT6 microcontroller system and hardware, invoke the program to run the corresponding functions and logic statements so that the basic functions of the microcontroller are executed. 2. Design the code scanning module connection procedure. To let the STM32F103RCT6 microcontroller recognize the code scanning success signal output from the code scanning module, a timer is needed to calculate the width and number of pulses output by the code scanning module. 3. Design the code scanning-based fee deduction procedure, determine the charging standards, and one can use the charging device after successful payment by scanning QR code on Alipay or WeChat. 8 hours' use will charge 2 yuan. 4. Design the current detection procedure so that the relay, ZHT103, fuse, etc. cut off the faulty circuit in the first time when the circuit is short-circuited or overloaded to protect the entire device. 5. Design the charging procedure. After the charging information is successfully matched, charging of the charging device can be started.

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4.2. Software Design Scheme

After the charging management device is connected to a 220V AC power source and electrified, the internal programs need to run in a certain order. The first is to initialize the microcontroller system and hardware and initialize the peripheral auxiliary circuits. After the initialization of the main circuit, the designed corresponding functions and programs need to be started, running the code scanning success identification program, the charging current detection program and the charging management program.

After the charging management device is connected to a power source, related internal procedures need to be executed in order. First, the microcontroller and related auxiliary circuits should be initialized. Second, initialize the ADC and timer module of the microcontroller. The ADC module is used to monitor the voltage output by the transformer to calculate the charging current. The function of the timer is mainly to calculate the charging time and measure whether the pulse signal output by the code scanning module has a 50ms pulse width. Third, after receiving a 50ms pulse signal, confirm that the user has successfully paid. Control the relay closure, and meanwhile, start the timer, start the ADC to detect the transformer output voltage, and calculate whether the charging current is overloaded or empty. Fourth, if the current is overloaded, empty or charging time reaches 10 hours, the STM32 control relay is powered off.

5. EXPERIMENTAL TEST

After the soldered circuit board completes the hardware debugging and software debugging, the prototype can be powered on to run the procedure. The physical picture of the prototype is shown in Fig. 3.

Figure 3. Physical picture of the prototype.

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5.1. Scanning code payment experiment

Scan the QR code using mobile phone APP. After successful payment on the mobile phone, the QR code scanning module receives information from the server. The scanning module will output a 50ms 12V pulse signal. The 12V pulse signal is converted to a 3.3V pulse signal by a photocoupler. The pulse signal is connected to the IO port of the STM32 microcontroller, and the pulse width is measured by an external interrupt and a timer. If the detected pulse width is 50ms, it is considered that mobile phone payment is successful, then relay is closed and the electric two-wheeled vehicle can start charging. In the experimental test, after the successful mobile phone payment, the width of the pulse signal output by the QR code module is 50ms as detected by the microcontroller. If the mobile phone interface indicates unsuccessful payment, width of the pulse signal sent by the QR code module is less than 50ms.

Table 1. Scanning payment experimental test.

Whether the code scanning payment is successful	STM32 microcontroller detects width of the pulse signal output by the QR code
Yes	50ms
No	0

5.2. Current detection experiment

After the successful mobile phone payment, the relay in the charging management circuit is closed, allowing the electric two-wheeled vehicle to charge. Battery of the electric two-wheeled vehicle is exhausted. Then, connect the electric two-wheeled vehicle charger to the mainboard. If the test current is less than 0.3A, the no-load equipment will automatically stop working; if the test current is greater than 3.5A, the overload device will automatically stop working. In the experimental test, after the successful mobile phone payment, the relay in the charging management circuit is closed, allowing the electric two-wheeled vehicle to charge. When the electric two-wheeled vehicle charger is connected to the mainboard, the detection current is 3.6A. When the electric two-wheeled vehicle charger is not connected to the mainboard, the detection current is 0.2A.

Table 2. Current detection experiment.

Connect electric two-wheeled vehicle charger	Charging current
Yes	3.6A
No	0.2A

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5.3. Code scanning-based fee deduction experiment

After the mobile phone scans the charging QR code, choose the package of 2 yuan for 10 hours' charging and make payment. The microcontroller detects that the QR code module outputs a 50ms pulse signal, then confirms successful mobile phone payment. The relay in the charging management circuit is closed to allow the electric two-wheeled vehicle to charge. After the electric two-wheeled vehicle charger is connected to the mainboard, billing starts. In the experimental test, after successful mobile phone payment, the relay in the charging management circuit is closed, allowing the electric two-wheeled vehicle to charge. After the electric two-wheeled vehicle charger is connected to the mainboard, billing starts and the remaining charging time and balance are displayed on the mobile phone APP.

Table 3. Code-scanning based fee deduction experiment.

Charging time (h)	Deducted amount (yuan)	Balance (yuan)
0.5	0.1	1.9
1	0.2	1.8
1.5	0.3	1.7
2	0.4	1.6

5.4. Experimental results

The test conclusions are drawn based on the above experiments and analysis of the experimental data: after the mobile phone registers the current QR code scanner, power on the charging management device and the device can be connected to the cloud server. After successful QR code scanning payment by phone, the device can receive the information sent by the server. After the information is successfully checked, the relay is closed and the device can start to supply power. However, the current detection circuit will detect the current of the charging device. If the current value is within the set value range, the charging device continues to charge; if the current value is outside the set value, the relay opens and the charging device stops charging. In the code scanning payment-based charging experiment, there was 0% error rate. Hence, all the design functions and technical indicators meet the requirements of the project design task.

6. CONCLUSION

This study completes the design of intelligent charging management device based on QR code payment platform, and draws test conclusions by analyzing the experimental data: through design of the intelligent charging management device based on QR code payment platform, one

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can scan the QR code of the charging management device using mobile phone APP. After successful code scanning payment, the code scanning module outputs a pulse signal. After the microcontroller detects the pulse width as 50ms, successful mobile phone payment is confirmed. Then, the relay in the charging management circuit is closed, so that the electric two-wheeled vehicle charger can be charged. When the current detection circuit detects connection of the charger, charging starts. The current detection circuit will detect the size of the charging current in real time. It has an overcharge protection function. The mobile phone APP displays the charging time and the balance in real time. All the design functions and technical indicators meet the requirements of the project design task.

References

[1] João F.C.B. Ramalho,L.C.F. António,S.F.H. Correia,L.S. Fu,A.S. Pinho,C.D.S. Brites,L.D. Carlos,P.S. André,R.A.S. Ferreira., 2018, [INVITED] Luminescent QR codes for smart labelling and sensing. *Optics and Laser Technology* 101, 304-311.

[2] Yupeng Zhu,Wenhui Xu,Yishi Shi., 2018, High-capacity encryption system based on single-shot-ptychography encoding and QR code, *Optics Communications 435,* 426-432.

[3] Jiyoon Lee, Min Ho Ryu, Daeho Lee., 2019, A study on the reciprocal relationship between user perception and retailer perception on platform-based mobile payment service, *Journal of Retailing and Consumer Services* 48, 7-15.

[4] Ma Huateng., 2015, QR code will become the key online and offline entrance [EB/OL]. *http://tech.qq.com/a/20120911/000108.htm* .

[5] Li Siqi., 2018 , Deconstruction of Legal Issues in QR Code Scanning Payment, *China Legal Science*, Vol.03, 110-131.

[6] Liang Dawei, 2018, QR Code Information Security, *Software*, 39(03), 63-66.