ORIGINAL RESEARCH ARTICLE

# Intelligent Backlash Control System Based on Laser Scanning

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***ABSTRACT***

In the traditional round-trip sports training and competition, the coach or the referee observe the pinch table to measure the athlete's performance, not only there is a large error, it will even miscarriage of justice, and the staff labor intensity and low efficiency. In order to solve these difficulties, the system uses the simple and easy way by using fingerprint identification module to collect athlete information, with low cost, wide application, easy to program the STM32F103C8T6 and ATMEL89S51 as the core control measure a wide range of detection time is short, high precision of the laser scanning athletes through the information to low power consumption, convenient and practical nRF905 RF transceiver starting point and the return point of the communication to the LED display circuit count and display, to automatically and accurately complete the athlete's performance test. This will reduce the workload of the coach or the referee, but also improve the efficiency and quality of work.

***KEYWORDS:*** laser scanning, round trip, intelligence, communication, nRF905

## 1. Introduction

Along with the development of society, the progress of science and technology, people's living standards continue to improve, people in the pursuit of a comfortable life at the same time, didn't forget to improve the physical quality. Especially the success of the 2008 Beijing Olympic Games, people think sport as a fashion to pursue, and running is one of the most popular sports. Therefore, many collective places (such as schools, military, stadium, etc.) appeared running training, and for the training of the results has also been more and more demanding. People take a variety of training and performance testing, most of the methods are not systematic nor professional, for example, people with the naked eye observe the way to catch the stopwatch to the athlete's performance assessment, these manpower assessment methods to the coach or the referee are larger work quantity, and cannot effectively and accurately measure the athlete's performance. In view of these problems, the system requirements of this paper have the characteristics of high automatic degree, accurate measurement result, small amount of labor, low cost and convenient and practical.

## 2. Systems overall design

According to the control requirements, the control system claims the athletes have to went through the starting point and the information of the rebate point for real-time monitoring, then the control system must be divided into two parts: starting point and reentry point. Because the system requires automatic identification function, so in the starting point the equipment is equipped with a laser scanning system, through the wireless transmission module, to achieve the starting point and the reentrant point of real-time communication, to complete the round-trip automatic control.

### 2.1. Starting point control system

The starting point of the equipment is mainly composed of two parts: the laser transmitter and the starting laser receiver. There are equipped with a fingerprint recognition system on the starting receiver to collect the fingerprint information of the athlete. When the athlete passes the starting point, the laser scanning circuit starts scanning the information of the player, and the starting receiver sends the signal to the corresponding CPU deal with. At the same time, the starting CPU simultaneously issues a corresponding instruction to the timing display circuit and the starting wireless transceiver, the timing display circuit starts timing, and the starting point wireless transceiver transmits the corresponding data to the reentrant point device via the wireless transmission module. The starting point system design block diagram shown in Figure 1.

## 2.2. Fold back point control system

The reentrant point device is more similar to the starting point device, and the reentrant point does not require the information storage module and the chronograph counting circuit. It also includes two parts of the reentrant transmitter and the return point receiver. When the athlete scans the athlete's passing signal through the laser scanning circuit of the reentrant point and the rewind point, the rebate point receiver transmits the signal to the corresponding CPU for processing, and sends the instruction to the corresponding rewind point wireless transmission module, the corresponding signal is sent to the starting device via wireless transmission. The design block diagram of the reentrant point equipment system is shown in Fig.

# 3. Unit circuit design

## 3.1. Power circuit design

In this paper, the design of the control system, because it involves a lot of modules it needs a separate power supply module, combined with the actual application, so that it can be easier to live in the dry battery voltage, after MS1117-3.3 series linear regulator chip, combined with capacitor fi ltering Get a more stable 3.3V voltage, used in the system for fi ngerprint identifi cation module and wireless transmission module power supply. The schematic diagram shown in Figure 3. C34, C36, C35, C33 are the fi lter capacitor, LED0 for the power supply indicator light.

## 3.2. Single chip selection and minimum system design's design

Because the starting point control system designed in this paper also includes the fi ngerprint recognition module and the wireless transmission module, and both modules are involved in serial communication, and the folding point is not fi ngerprint identifi cation module, so the starting point is diff erent from the point of return control Chip, respectively, control the starting point and reentry point equipment.

### 3.2.1 Starting point single chip microcomputer control circuit design

As the host computer communication should be used for serial communication, select the chip that must contain two or more serial port. STM32F103C8T6 chip meets the part of the system design requirements, and STM32F103C8T6 powerful, rich peripherals confi guration, cost-eff ective. So in this part of the system circuit using STM32F103CT6 as the master chip, it is enhanced, 32-bit ARM core Cortex-M3 CPU, the working voltage of 2.0 ~ 3.6V, with 512 bytes of fl ash memory program memory, Up to 64K bytes of SRAM, up to 72MHz operating frequency, 3 12-bit analog-to-digital converters, 1s conversion time, 2-channel 12-bit D / A converter, 12-channel DMA controller with 80 fast I / O Port, up to four 16-bit timers, each timer has up to four channels for input capture, output compare, PWM or pulse count and incremental encoder inputs, two 16-bit dead band control and emergency brake, PWM advanced control timer for motor control, 2 watchdogs, 13 communication interfaces, 2 I²C interfaces, 5 USART interfaces, 3 SPI interfaces, can interface, USB 2.0 full speed interface, SDIO interface. These rich peripheral confi gurations make the STM32F103C8T6 large capacity family of microcontrollers suitable for a wide range of applications such as: motor drive and application control, medical and handheld devices, PC gaming peripherals and GPS platforms, industrial applications programmable Controller (PLC), frequency converter, printer and scanner, alarm system, video intercom, and heating ventilation and air conditioning system. There are a variety of low power modes. Easy to use, development tools are very simple [2].

SCM to work properly, need a minimum system auxiliary chip to complete the control of the external circuit, STM32 microcontroller small system includes: ① reset circuit ② oscillation circuit ③ power supply circuit. The minimum system of STM32 is shown in Fig.

### 3.2.2 Design of circuit control circuit for reentrant point

In this paper, the microcontroller is produced by the ATMEL company's low-power, high-performance CMOS 8-bit AT89S51 microcontroller, the market is one of the most common single-chip. It contains 4kb of system-programmable Flash read-only memory, the device uses ATMEL's high-density, non-volatile restorage technology, compatible with standard 8051 instruction system and pin. Its powerful, high-performance, low-cost, easy to use and other advantages by the majority of customers of all ages.

The AT89S51 has the following features: (1) 4k Bytes Flash on-chip program memory; (2) 128 bytes of random access data memory (RAM); (3) 32 external bidirectional input / output (I / O) ports; (6) 2 16-bit programmable timer / counters; (7) 2 full-duplex serial communication ports; (6) 2 16-bit programmable timers / counters; (2) 6 interrupt sources; 8) Watchdog (WDT) circuit; (9) On-chip oscillator and clock circuit; (10) Compatible with MCS-51; (11) Full

static operation: 0Hz ~ 33MHz; (12) Three-level program memory ; (13) programmable serial channels; (14) low power idle and power down mode [4].

Its pin function in this paper is not one by one introduced, if necessary, please see the relevant information.

In the rebate point control system, using AT89S51 chip as the control core, wireless transceiver module and laser scanning circuit control is done by the AT89S51 chip. So we need to do a minimum system to complete the work of the various parts of the circuit. For the 51 series microcontroller, the microcontroller must work with fi ve basic circuits: power circuit, clock circuit, reset circuit, program memory selection circuit, peripheral circuit. So to do the smallest system, including the microcontroller, crystal oscillator circuit and reset the three parts, and then with the external circuit, you can complete the system operation.

Figure 6, AT89S51 40 feet for the microcontroller power input, the operating voltage of 3.3V ~ 5V, we access +3.3 V voltage, the fi rst 20 feet for the GND ground pin. 9 feet for the chip reset signal input, when the boot or rebooting due to interference leaving the program out of control, so that the program is in the case of an emergency cycle need to be reset. The reset of the microcontroller is realized by the external circuit. The signal is input from the RST side. The high level is eff ective. As long as it can keep the 15-pin high-level machine cycle, the MCU can reset normally. There are two common reset, one is power-on reset (automatic reset), the other is a key reset (manual reset), we use the power that is automatically reset. AT89S51 microcontroller is a timing circuit, you must always end the signal to work properly. Clock signal can be provided by the crystal oscillator circuit, AT89S51 18 feet and 19 feet are single-chip clock reverse amplifi er output and input, at both ends of the crystal, with two 20PF ceramic capacitors can be obtained by the microcontroller the clock signal. The chip's 31 pin (EA) selects the input for the internal and external program memory. AT89S51 internal with 4kb of program memory, it is usually connected to high, CPU fi rst access to the on-chip ROM, the implementation of the internal program memory instructions, when the program counter exceeds 0FFFH, will automatically switch to off -chip program memory, the implementation of 1000H instructions The If EA is low, regardless of whether there is program memory on the chip, CPU only access the off -chip program memory, where we use the high level of the way. Simple peripheral circuit design is completed, can work with the external circuit.

## 3.3. Laser scanning circuit design

Laser scanning circuit equipment is at both ends of the runway, respectively, put the laser launcher and laser receiving device, by detecting whether the athletes through the starting point or reentrant point, to capture information, and sent to the microcontroller for processing. So the laser scanning circuit is two separate parts. In the detection technology, we choose the laser as a scanning test because the laser with ordinary light does not have the characteristics, that is, monochromatic good, good coherence, good direction and high brightness.

### 3.3.1 Selection of laser emitting tube and photosensitive receiving tube

Since each of the light transmitters and receivers has its own range of emission wavelengths and the wavelength range of the receiving wavelength, the laser is the same, so be careful to choose the material avoid problems that the two periods do not match after the laser cannot be received. There are many kinds of commonly used laser tube wavelength, in this system, we choose the wavelength of 650nm, low-power, red dot-like semiconductor copper head laser tube to launch laser. Receiving part, we use XL245PT photodiode, the receiving wavelength of 36 ~ 1000nm, to meet the design requirements. And visible and invisible light can be detected, so the use of more convenient.

### 3.3.2 Laser scanning circuit design and working principle

Laser scanning circuit module is divided into two parts, namely, laser emission circuit and laser receiving circuit, respectively, distributed on both sides of the runway, the receiving part of the photosensitive tube to the launch part of the tube to detect laser light, you must strictly control the two part of the location of the device, its repeated calibration debugging. Single from the circuit point of view, is relatively simple. For the transmitter module and receiver module to provide 3.3V voltage, the transmitter module into the 300-ohm resistor on the laser tube partial pressure, laser emission tube to the rated voltage within the range, it will issue a laser beam, hit the runway opposite the photosensitive tube. The photodiode is a photodiode of type XL245PT, and the photodiode is equivalent to a photo resistor whose resistance varies with light conditions. When there are no light conditions, the photodiode is equivalent to an infi nite resistance; when there is a laser irradiation, the resistance of the photodiode decreases. Based on this feature, we will be with a 10Kb resistor in series, and then access 3.3V power supply, take the photodiode non-ground terminal potential into the microcontroller I / O port for scanning circuit control and detection. The scanning and receiving circuit of the laser scanning circuit is shown in Fig.

In the case of normal laser emission and reception, the laser is not blocked, the photosensitive diode normally receives the laser light from the laser emitter, its resistance decreases sharply with the light, so the photodiode is

very small, the photosensitive secondary The non-ground terminal potential of the tube is also very low, not enough to trigger the microcontroller work. When the athletes through the starting line, blocking the laser beam, this time the photosensitive diode resistance is very large, so the partial pressure is also high, then the non-ground side of the photodiode to send a high level to the microcontroller to make it work.

## 3.4. Timing display module circuit design

Timing display module task is to track the athletes in real time, taking into account the practical range, we use 4-bit Siamese digital tube as a display module, the display range of 00.00 ~ 99.99S. Because the digital tube is unable to work alone, it must be equipped with a certain driver chip and uses it. There are many digital control chip on the market, the system is considering taking into account and the cost, the use of 74LS245.

### 3.4.1 74LS245 chip introduction

74LS245 is an 8-channel in phase tristate bi-directional bus transceiver, it can be a two-way transmission, commonly used to drive LED display and other devices. 74LS245 can output data, you can also enter the data, which is another function of its two-way/ three-way function! The pin diagram shown in Figure 11.

Pin Description: A-Bus Terminal B-Bus Terminal / G-Tri-State Allowable DIR-Direction Control Terminal

When the microcontroller I / O port bus load reaches or exceeds the maximum load capacity of the I / O port must access the 74LS245 bus driver.

When the three-state allowable end / G low active, DIR = '0', the signal from B to A transmission, that is, signal reception; DIR = '1', the signal from A to B transmission, that is, signal transmission. When the three-state allowable end / G high level is valid, A, B are high impedance state.

### 3.4.2 Four digital tube display module

There are many display devices on the market today. Among the many display circuits, the four-in-one-unit digital tube display circuit is relatively simple and the cost is low, and it is widely used. Therefore, the display module in this paper adopts four-in-one LED display. The four-digit display consists of four '8' -shaped electronic devices consisting of four light-emitting diodes, each consisting of a, b, c, d, e, f and dp. According to the light-emitting diode unit connection is divided into common anode digital tube and common cathode digital tube. The common anode is the anode of all the corresponding light-emitting diodes connected together, the anode is high when the work; common cathode and the common anode opposite.

LED drive in two ways, one is static drive (DC drive), the other is dynamic drive, in this article we will use the latter drive, and be in the following description of the digital tube drive in detail. Before we have to understand the four digital tube internal connection structure, it is a single digital tube with the same name together, the common pole D1, D2, D3, D4 as the four selection side. Four digital tube internal wiring shown in Figure 12.

### 3.4.3 Digital tube drive mode

In the above we mentioned the digital tube has two kinds of drive, respectively, static drive and dynamic drive.

(1) static drive, also known as DC drive. Static drive means that each segment of each digital tube is driven by a microcontroller's I / O port. The advantage of this drive is simple programming, display high brightness, but it takes too many I / O ports, take up too much resources, the actual application is rarely used.

(2) digital tube dynamic drive display is the most commonly used one of the microcontroller one of the drive. The dynamic drive is to connect the same name of the eight display strokes 'a, b, c, d, e, f, g, dp' of all the digital tubes, and add the bit strobe for the common electrode COM of each digital tube Control circuit, bit selection by their own independent I / O line control, when the microcontroller output font code, all digital tubes are receiving the same font code, but what is the digital tube will show the font, depending on the microcontroller bit Gating COM terminal circuit control, so we just need to display the digital tube gated control to open, the bit shows the font, no strobe of the digital tube will not light.

Through the time-sharing control of the digital tube of the COM side, so that each digital tube turns control display, which is dynamic drive. In the rotation display process, each digital tube lighting time of 1 ~ 2ms, due to the phenomenon of human visual persistence and the afterglow eff ect of light-emitting diodes, although in fact the digital tube is not lit at the same time, but as long as the scanning speed Fast, giving the impression that a group of stable display data, there will be no sense of fl ash, dynamic display and static display is the same eff ect, can save a lot of I / O

ports, and lower power consumption. So in this system will be the digital tube drive will be used to drive the way, the design shown in Figure 13.

## 3.5. Circuit design of wireless transmission module

In the traditional signal transmission system, usually the wire transmits the signal, in the round-trip running system, the starting point and the distance from the further away, if the signal transmission with a wire is not only a waste more resources, and wire transmission has the following drawbacks: (1) Produce electromagnetic interference, (2) longer wires will have a larger signal attenuation, (3) chaotic line link. With the rapid development of wireless technology, wireless technology instead of the traditional signal transmission, and relative to the wire transmission, not only to avoid all the drawbacks of wire transmission, it also has its own advantages, such as faster and more convenient, anti-interference ability and many more.

NRF905 RF transceiver is such a faster and more convenient, anti-interference ability of the wireless transmission module, the system is no better choice.

### 3.5.1 Introduction to the nRF905 module

The nRF905 chip is a single-chip RF transceiver from Nordic, Norway. Chip operating voltage of 1.9 ~ 3.6V, 32-pin QFN package, built-in hardware CRC error detection and point-to-multipoint communication address control, work in 433/868 / 915MHz three ISM band, band between the transceiver mode switching time is less than 650us.

NRF905 internal by the frequency synthesizer, receiver demodulator, power amplifi er, crystal oscillator, modulator and other modules, but the sound surface fi lter can also have a good communication eff ect. NRF905 three operating frequency band, 433MHz is open and free to use, the maximum working speed of 50kbps, communication distance of up to 300m or so, to meet the needs of most sports grounds. 1.9 ~ 3.6V operating voltage, standby, the operating current as low as 2.5uA, in the -10dB power transmission, the working current is only 11MA, so low-power users no longer have to worry about energy-saving problems. Send and receive mode between the switching time is only 650us, so the delay will not result in the results of the assessment of athletes have a greater error. Competition venues are generally more complex, interference, and nRF905 using efficient GFSK modulation, greatly improving the anti-jamming capability.

NRF905 module is developed using nRF905 chip. NRF905 module pin interface shown in Figure 14, its pin function as shown in Table 2.

**Table 1.** nRF905 module user interface circuit pin function description

Pin Name Pin Function Description

1 VCC power supply + 3.3 ~ 3.6V DC

2 TX_EN digital input operating mode selection

3 TRX_CE digital output enable chip transmit or receive

4 PWR_UP digital input chip is powered on

5 UCLK clock output (not used)

6 CD digital output carrier detection

7 AM digital output address match

8 DR digital output receive or transmit data is complete

9 MISO SPI interface SPI output

10 MOSI SPI interface SPI input

11 SCK SPI interface SPI clock

12 CSN SPI Interface SPI Enable

13, 14 GND ground

The nRF905 module has two operating modes and two power saving modes. The operating modes include the Shock Burst receive mode and the Shock Burst transmit mode; the power saving mode includes shutdown mode and idle mode. The operating mode of the nRF905 is determined by the three pins TRX_CE, TX_EN and PWR_UP. The mode control of the nRF905 module is shown in Table 3.

**Table 2.** nRF905 module mode control

PWR_UP TRX_CE TX_EN Select mode

0 X X Power Down with SPI Programming Mode

1 0 X Standby with SPI programming mode

1 1 0 Shock Burst receive mode

1 1 1 Shock Burst launch mode

NRF905 module in the Shock Burst mode is characterized by automatic generation of preamble and CRC check code, the use of SPI interface and micro-controller communication, configuration is very convenient. The following is given the nRF905 module SPI serial interface instruction settings:

#define WC 0x00 // Write the configuration register instruction

#define RC 0x10 // read the configuration register instruction

#define WTP0x20 // Write a valid data instruction to the TX Payload register

#define RTP 0x21 // read from the TX Payload register to send valid data instructions

#define WTA0x21 // Write the send address command to the TX Address register

#define RTA 0x23 // Read the send address from the TX Address register

#define RRP 0x24 // Read the received valid data from the RX Payload register

When CSN is low, the SPI interface begins to wait for the next instruction, and any instruction starts with a high to low conversion of the CSN level. Hardware there is no SPI interface, the microcontroller can also control the nRF905 module, you can use the general microcontroller I / O port analog SPI interface.

### 3.5.2 hardware design of wireless transmission module system

The hardware design of the wireless transmission module is divided into two parts: the starting point and the turn back point. The starting point is based on the STM32F103C8T6 single chip microcomputer. The reentrant point is controlled by the AT89S51 single chip microcomputer. The I / O port is used to control the status port, mode interface and the interface of the nRF905 module. SPI interface to control the system, the system hardware design shown in Figure 15 [7].

Wireless transceiver system, whether it is a starting point device or a rebate point device, are based on the microcontroller-based controller, the basic principle of the same, and nRF905 module with the use of data transmission and reception functions. The round-trip wireless transmission system is composed of a pair of nRF905 modules that communicate with each other. The transmitter of the transmitter sends the data to the nRF905 module of the transmitter by sending the TRX_CE and TX_EN pins high at the same time. The microcontroller at the receiving side sets the TRX_CE pin high and the TX_EN pin is low and the receiver receives data from the nRF905 module. Wireless transceiver system using half-duplex communication mode, you can achieve two single-chip system between the two-way data transceiver.

### 3.5.3 Software Design of Wireless Transmission Module System

A) Wireless transmission system software design

Send the end of the microcontroller, it will receive the address and the data that's finished, it is necessary to control the nRF905 module to send out the data, nRF905 module in the send mode it will automatically generate prefix and CRC check code. When the sending process is complete, the data transfer completion pin of the nRF905 module will inform the microcontroller that the data has been transmitted.

Typical nRF905 module data transmission process:

(1) When the microcontroller send data, the receiver's address and data went through the SPI interface in accordance with the timing transmission to the NRF905 module;

(2) The microcontroller provides the high level for the TRX_CE and TX_EN pins of the NRF905 and the nRF905 operating mode starts;

(3) Send the end of the nRF905 module to the process processing: RF register open → data package (plus header and CRC check code) → packet sent →the end of sending, set the DR pin is high.

(4) If AUTO_RETRAN is set high, the nRF905 module defaults sending packets continuously until TRX_CE is set low.

(5) When TRX_CE is set low, NRF905 transmission process is completed, and automatically enter the idle state.

The Shock Burst TM operating mode ensures that once the process of sending data starts, the send process will be processed regardless of whether the TRX_EN and TX_EN pins are high or low. The NRF905 can accept the next transmit packet only if the previous packet has been sent. AT89S51 control nRF905 data transmission flow chart shown in Figure 16 (left) shown.

B) Wireless Receiving System Software Design

Receiver-side single-chip control nRF905 module into the receive mode, when the nRF905 module detects the same band of carrier signals and are matched by the address, it began to receive data packets. When the data packet is received correctly, the receiving end of the microcontroller in the nRF905 module is in standby mode through the SPI interface to extract the valid data in the packet.

Typical nRF905 module data reception process:

(1) The microcontroller controls the TRX_CE to a high level and the TX_EN is set to low, the nRF905 module enters the receive mode;

(2) 650us, nRF905 module detects the incoming information, ready to receive data;

(3) When the nRF905 module detects the carrier with the frequency of chest pain, the carrier pin (CD pin) is automatically set high;

(4) When the nRF905 module receives a valid address, it will automatically set the address match pin (AM pin)

(5) When a correct packet is received, the nRF905 module automatically removes the packet header, address and CRC of the packet, and then sets the data reception completion pin to a high level;

(6) The microcontroller sets TRX_CE to low level;

(7) The microcontroller through the SPI interface at a certain rate to extract the valid data in the packet.

(8) When all valid data is received, the microcontroller controls the nRF905 module data reception completion pin (DR pin) and address match pin (AM pin) to low level, nRF905 enters standby mode.

When a packet is being received, the status of the TRX_CE or TX_EN pin changes, and the nRF905 changes its operating mode immediately and the packet is lost. When the microprocessor receives the signal of the address match pin, it knows that the nRF905 is receiving a packet that can determine whether the nRF905 continues to receive the packet or enters another mode of operation. AT89S51 control nRF905 data reception flow chart shown in Figure 16 (right) [9].

## 4. Auxiliary circuit design

Taking into account the circuit debugging, you can access a buzzer in the circuit, used to alarm system abnormal situation. For example, if the two modules are not aligned, the buzzer will ring, or the runway has a barrier, causing the system to start, so the buzzer is long, indicating that the system is abnormal, you can repair it. At the same time, you can prompt the athletes through the starting point and the reentrant point, because the athletes through the scanning point is faster, the buzzer is only a brief 'drop' sound, you can play a prompt effect.

Since each athlete has finished testing, the next player is tested again and must be cleared to design a key to clear the circuit. When the next player is to perform a performance test, it is manually cleared by the coach or the referee.

In the circle, we use a simple light-emitting diode indicator to show the current athletes can run the number of laps. Generally, with five LED tube it will be able to meet the daily test requirements, respectively, with about 300-ohm resistor in series, then between the I / O port and VCC.

These auxiliary circuits are not listed one by one, see the general picture of the circuit.

# 5. system hardware and software debugging

## 5.1. Starting point equipment commissioning

(1) First on the system power on the boot, the starting point of the laser transmitter and receiver calibration debugging, so that the starting point of the laser transmitter at the starting point of the system receiver, if the buzzer does not ring and not Quasi, the buzzer alarm indicates that the device is installed incorrectly or the runway has a barrier;

(2) Before the start of testing and the calibration of a good laser device normal, the buzzer does not ring;

(3) Each test must be manually cleared by the coach or the referee, and when it is cleared, there is no obstruction to block the laser signal. Cleared by the coach or sentenced the athletes to the starting line.

(4) After cleared, the athletes starting line stepping on the starting line, buzzer sound, into the ready state, if the athletes leave the starting line, timing starts, real-time display circuit to work.

(5) Each test must step on the return line and then return to stepping on the starting line, be considered effective circle, then the number of laps plus 1, the corresponding lap indicator light. When the last lap back to step on the starting line, the stopwatch timing is over, the final show is the final result of the athletes set test results.

## 5.2. rebate point equipment debugging

(1) At the starting point, first start on the system power on the start of the laser transmitter and receiver calibration debugging, so that the starting point of the laser transmitter at the starting point of the system receiver, if the buzzer does not ring, or not aligned, the buzzer alarm prompts the device is installed incorrectly or the runway has a barrier;

(2) Before the start of testing and the calibration of a good laser device is normal, the buzzer does not ring;

(3) Every step on the line have sound and light tips, if the middle of the laser device is abnormal, there is no alignment of the case, the buzzer has been prompted to indicate abnormal equipment.

(4) Every step on the return line must be with the starting line, that is effective through the starting line and then back to the line in order to effectively circle.

# 6. Concluding remarks

After two months of experiment and debugging to single-chip control for the core of fingerprint-based round-trip control system has been successfully debugged to achieve the desired design requirements and a very good realization of the function. In this design process I learned a lot of knowledge, cultivate the ability to access the literature, collect information, theoretical analysis, analysis and problem solving. Improving their own practical skills, to achieve theoretical knowledge and practical application of unity. Design knowledge in the actual engineering design link is essential, feel the knowledge of their own strengths and deficiencies, the usual accumulation of knowledge is not enough, but there are still a lot of things need to learn! In the future to continue to improve their overall quality; at the same time realize that practice is also an indispensable link, and only through the combination of theory and practice, continue to find problems and to solve the problem in order to create a better design work. I have a theoretical in theory with a deep study, broaden their own design ideas, but also in my practice in the face of the problems encountered. Although the research of this subject has achieved some gains, but in many ways it still need to be further improved and improved.

# References


1. T.J. New progress of fingerprint recognition technology [J]. Natural Science Development, 2006,16 (4), P76
2. YH. Wang. STM32 series ARM Cortex-M3 microcontroller principle and practice. Beijing University of Aeronautics and Astronautics Press, 2008
3. L.N. MDK-based STM32 processor development and application [M]. Beijing, Beijing University of Aeronautics and Astronautics Press, 2008
4. JQ. Liu. Easy to play 51 single-chip (including a CD-ROM) [M]. Beijing University of Aeronautics and Astronautics Press, 2011
5. ZW. Huang. National college students electronic design competition system design [M]. Beijing: Beijing University of Aeronautics and Astronautics Press, 2011
6. CX. Li. Single-chip principle and interface technology (concise revision). Beijing: Beijing University of Aeronautics and Astronautics Press, 1999

7. CX. Li. Single-chip principle and interface technology (3rd edition). Beijing: Beijing University of Aeronautics and Astronautics Press, 2005
8. LY. Guo, data transmission. Beijing: People's Posts and Telecommunications Press, 1986
9. T. Cai, wireless communication principles and applications (second edition). Beijing: Electronic Industry Press, 2002
10. HB. Xiao. With me to learn with the microcontroller. Beijing: Beijing University of Aeronautics and Astronautics Press, 2002.8
11. LM. He. Advanced Course of Single Chip Microcomputer. 1st edition. Beijing: Beijing University of Aeronautics and Astronautics Press, 2001
12. Meehan Joanne, Muir Lindsey.SCM in Merseyside SMEs: Benefits and barriers [J]. TQM Journal. 2008
13. MH. Zhang, B. Zhang, TL. Wang. Wireless signal transmission device and transmission method [Z]. CN101694740A.2010
14. ZW. Zeng, CF. Wu. A wireless signal transmission and reception system [Z]. CN1662062.2005
15. ZY. Chen .STM32 embedded micro-controller principle, application technology. Beijing: Electronic Industry Press, 2012
16. LH. Hou, based on single-chip control of automatic round-trip electric car [J], microcomputer principle, 2004 (3): 36-37
17. ZX. Yang, stepping motor stepping subdivision and its intelligent control [M], micro-motor, 1990 (1) 53-54;
18. JZ. Song, PF. Han, Y.L, automatic round-trip electric car [J], computer principle;
19. HR. Zhang. Sensing Technology and Application. Beijing: Tsinghua University Press, 2000: 111-135
20. GH. Kang, Electronic Technology Foundation (analogue) Higher Education Press, 1977;
21. GH. Kang Electronic Technology Foundation (Digital Section) Higher Education Press, 1977