Research of speed measurement and prediction system for railway train based on single chip microcomputer

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Abstract. The main content of this research is how to know the speed, location and arrival time of the rail train, and provide the information for passengers to take the rail train. Because urban rail transit is built in the underground environment, there will be some limitations in the selection of speed measurement and positioning methods for rail trains. This research is based on the actual situation, using the hardware system based on the single chip microcomputer as the vehicle equipment, real-time speed measurement, positioning and prediction of the rail train. Provide effective data information for train operation, dispatching and passengers' taking.

1. Introduction
The working method of Balise is that when a train runs on the ground balise, the on-board equipment of Balise will send the induced energy to the ground balise with a certain frequency through the electromagnetic induction method. The internal circuit of Balise starts to work after receiving the energy, and transmits the stored data to the train through the electromagnetic induction in a certain modulation way. At present, pulse speed sensor and transponder are widely used for train speed measurement and positioning. The initial position and running direction of the train are provided by a reference balise group composed of two or more balise, which is called the nearest related balise group. The function of pulse sensor is to measure the wheel angular velocity of train, and the obtained wheel angular velocity has a linear relationship with the train speed to obtain the train running line speed, and then the train displacement can be obtained by integrating the speed. The train positioning can be realized by accumulating the moving distance of the train since the last transponder.

2. Selection of control mode
First of all, when I got the research topic "the research of the speed measurement and prediction system of the railway train based on single chip microcomputer", I had an idea to challenge myself. Because I have studied C language, digital electricity, analog electricity and single-chip computer in my four-year study in University, so I think it's time to show what I have learned in my four-year study in University.
2.1. System function module
In this research, the special wheel set in the train is installed with speed measuring module to monitor and collect the train speed information in real time, which is sent to the single-chip microcomputer for data processing through pulse mode, then the local display screen connected by the single-chip microcomputer will display the obtained speed, position and time information locally, and finally the obtained train information will be transmitted to the train through GSM wireless communication Control the dispatching center to achieve the prediction effect of train operation information.

2.2. Data acquisition module
In terms of working mechanism, Hall effect element is a magnetic sensitive element, which has wide working range and low requirements for working environment and is easy to use. Using the infrared reflection photoelectric sensor, the optical pulse sensor can respond to the speed measurement of the motor quickly. The black-and-white or occlusion and space of the code disk on the axis make the photoelectric sensor produce high and low level pulse. From the oscilloscope, we can see the perfect square wave collected, and the single-chip computer can get the desired speed by collecting the pulse data processing. In contrast, the infrared reflection photoelectric sensor simplifies the overall circuit research and has better performance.

2.3. Data processing module
The data processing module is a single-chip microcomputer, which is simply a single-chip microcomputer. Single chip microcomputer is a device that integrates CPU (operation, control), RAM (data memory), ROM (program memory), input and output (serial port, parallel port) and other functions into one chip. The difference between single chip microcomputer and PC main board is that CPU, ROM, RAM are all individual chips on PC board.

3. System hardware research
Firstly, a train operation simulation equipment is needed to simulate the normal operation of the train. Here, a DC power supply equipment, a speed regulating equipment and a DC motor will be used. DC power supply equipment is a battery box that can hold four No. 5 batteries. When it is used, four No. 5 batteries can provide stable 6V stable voltage for analog equipment. Speed control equipment is a PWM DC motor governor, which is used to change the speed of DC motor to make the whole simulation equipment more close to the actual situation. The 4-6V DC small motor is used to replace the train wheel. When it is used, a code disk will be installed at the front end of the motor to realize transcoding speed measurement.

In order to facilitate the speed acquisition equipment, the slot type optocoupler sensor module with the same working principle is used to replace the actual optical pulse sensor. The module uses a slot type optocoupler sensor, with a slot width of about 5mm, a bolt hole for convenient installation, and a power supply and output indicator light. When there is occlusion in the module slot, the receiving tube is closed, the output high-level light at the do end is off, and when there is no occlusion, the receiving tube is on, and the output low-level light at the do end of the module is on. LM393 wide voltage comparator is used to output more than 15 mA signal, which produces better waveform, and the output form is digital switching value 0 and 1. is shown in Figure 1.

In data processing and program operation, STM32 single chip microcomputer is used as data processing center for all program operation and data processing. The STM32 singlechip is based on stm32f103rct6. It has 48KB SRAM, 256Kb flash, two basic timers, four general timers, two advanced timers and two DMA with six channels Controller, three SPIs, two IICS, five serial ports, one USB, one can, three 12 bit ADCs, one 12 bit DAC, one SDIO interface and fifty one universal IO ports.
Figure 1. Schematic diagram of OLED display

The sim800c wireless communication module is selected in this research. The purpose is to be closer to the reality, which is affected by many conditions in the underground communication, so this method is suitable. Sim800c chip brief summary: sim800c is a four frequency module that can be used all over the world. It has TTL level interface, and can realize the functions of calling, sending SMS, GPRS data transmission, etc.

Brief introduction to the selected sim800c module:
1. A set of TTL level interfaces compatible with 5V / 3.3V.
2. The frequency is 850 / 900 / 1800 / 1900 MHz.
3. The range of power supply voltage from USB to TTL shall be at least 5V and at most 20V, and the current shall be more than or equal to 1a before normal operation. If the supply voltage of lithium battery meets 3.6V-4.2V, the current can be ensured to be more than or equal to 1a.
4. Working temperature: - 40 °C to + 85 °C
5. Two LED indicators: one is network indicator and one is power indicator.
6. Size: 49 * 52mm.
7. Simcard card holder: use micro simcard holder which can directly insert small card.
8. Sim800c pin description: the whole module is composed of power interface VCC, GND and TTL level serial port vmcu TXD RXD.

Power supply: as long as the working voltage and current conditions are met, external power supply or TTL serial port can be used. Ensure that the pin VCC is 5V to 20V and the current is no less than 1a. GND must be grounded. The recommended voltage here is 5V and the current is 2A. The acquisition of external standard voltage is relatively simple. It is necessary to pay attention to the required external current. No matter where the power is obtained to provide power to the module, it must be ensured that the current supplied to the module is as high as 1A or above. Otherwise, the module may restart. It is recommended to use a better mobile phone charger head for power supply or use a 5V power supply on the usb-ttl module or choose a circuit regulator with stable output voltage to power supply.

When the module needs to communicate with 5V system, please connect the vmcu voltage to 5V; when the module needs to communicate with 3.3V system, please connect the vmcu voltage to 3.3V. The vmcu can be connected to different voltages (2.85V or 4.2V) by connecting a 0603 resistor to R7 or R8, or by connecting external voltage to vmcu is shown in Figure 2.
4. Conclusion
The train speed measurement and positioning technology involved in this research is one of the key technologies in the rail transit under the automatic control system. In order to ensure the safe and efficient operation of the train, it is necessary to control the train operation accurately and effectively at all times.

5. Acknowledgments
This work was financially supported by The theoretical basis of gait and intelligent coevolution of bipedal robot under the cognition of human walking mechanism, NSFC 61503325; General program of Natural Science Research of Jiangsu University, No.: 19KJD460006; Suzhou science and technology development plan project: SYG201902, research on Key Technologies of intelligent detection of solder joint defects of BGA chip based on improved convolutional neural network; Research start-up fund project of Suzhou Institute of industry and technology: 2017kyq022, design and manufacture of Halbach research on the design and manufacture of permanent magnet.

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