Hardware Circuit Design Of Tracking Car Based On K60

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Abstract

The development of the robot industry is booming. For many repetitive and difficult jobs, using industrial robots to complete them can greatly save money, manpower and time costs. Industrial tracking vehicle has been applied in many fields and has shown good results. Taking the industrial automated guided vehicle as the model, this paper designs a hardware system of intelligent tracking vehicle based on k60. The main work includes hardware circuit scheme design, component selection, schematic diagram and PCB design, PCB board welding.

Keywords: AGV, k60, path search, hardware circuit design

1. Introduction

With the development of information technology and economic globalization, the traditional logistics transportation is far from meeting the fierce competitive logistics market. The development and innovation of modern logistics technology has gradually become a key factor affecting the development of national economy. Therefore, optimizing the enterprise transportation mode and designing the intelligent car and its control scheme for logistics demand will be the focus in the field of enterprise intelligent transportation at home and abroad.

Since the discovery of the world's first New Coronavirus case in December 2019, the epidemic has spread to many industries, and manufacturing and logistics industry is the first to bear the brunt. However, challenges and opportunities coexist. Intelligent manufacturing and UAV distribution show strong growth potential during the epidemic period. Jingdong warehouse is a good example. Among them, automated guided vehicle is widely used to carry and sort goods, which greatly saves the material and human resources required by factories and warehouses for daily production and storage activities.

2. Hardware Circuit Design

2.1 Overall design idea of the system

According to the application requirements of intelligent tracking car in industry, the main functions of hardware are divided into tracking, driving, power supply and control circuit, or human-computer interaction. As shown in Fig.1, it is an idea for the hardware design framework of a simple tracking car:

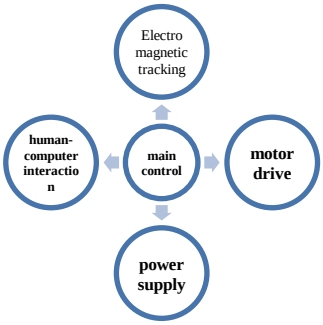

Fig.1. Overall design idea of the system

2.2 Main control chip

MK60DN512ZVLQ10 is used to be the external MCU, which is the Cortex-M4 ARM core and has a 144-pin. The chip has 512KB flash memory and 128KB RAM. And it has more than 100 general-purpose IO ports, multiple timers and serial ports, which fully meet the design of the required pin and memory requirements. The design of the main control chip is shown in Fig.2.

Fig.2. MK60DN512ZVLQ10 chip

2.3 Electromagnetic tracking

The functions of intelligent tracking car in industrial applications are mostly handling and patrol inspection. The electromagnetic tracking method is adopted here. The advantage of this method is that the camera can go out independently to do other identification and monitoring work, saving space, budget and accurate tracking.

The experimental environment is set indoors. The enamelled wire laid on the site is connected with an alternating current of 20kHz and 100mA. The induction module is composed of 10MH I-shaped inductor and 6.8nf capacitor. The I-shaped inductor is a cylinder, occupies a small space and can sensitively detect the change of the surrounding magnetic field.

According to Biot Savart law, the induced magnetic field distribution excited by a straight wire with alternating current is a group of concentric circles with the straight wire as the axis. The magnetic field intensity at all points on the circle with the same radius is the same, and will decrease inversely with the increase of radius. Therefore, five inductors are set in the induction part of the tracking car and installed at the front end of the tracking car according to the way[1] shown in Fig.3.

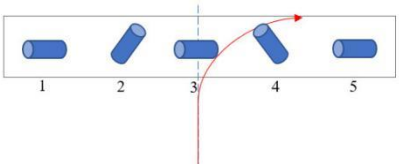

Fig.3. Inductance installation diagram

Among them, inductors 1, 3 and 5 are a group to detect the deviation angle of the forward direction. Inductors 2 and 4 are used to detect the curve.

The AC voltage signal collected by the electromagnetic detection module is amplified and rectified and input to MCU. The amplifier circuit adopts LM386 chip, which is an audio set success rate amplifier chip with low power consumption and adjustable gain. The LM386 can be powered by a single 5V. The gain can be adjusted by the external capacitance and resistance between pins 1 and 8, up to 200, and the total harmonic distortion of the output signal is small. The rectifier part adopts board bridge rectifier, parallel capacitor and resistance to transmit the voltage signal on the resistance to MCU. Fig.4 is a part of the schematic diagram of the electromagnetic amplification circuit. The electromagnetic detection part is composed of the same 5 parts in total.

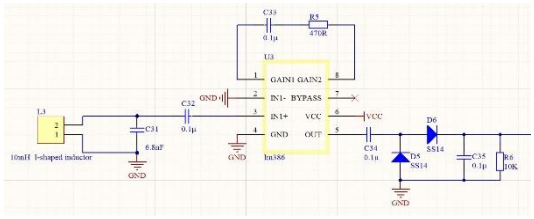

Fig.4. Part of schematic diagram of electromagnetic amplification circuit

2.4 Human-computer interaction

This paper uses three methods to output information: active buzzer, a group of color LEDs and an OLED screen. At the same time, the dial switch and key are used to input information.

There is a simple oscillation circuit inside the active buzzer, which can make sound only by connecting the DC voltage signal. Because the way of displaying information is very intuitive and obvious, it is very suitable for alarm. Since the default solder resist of PCB is green, the LED colors are white, red and blue. This led is very suitable for displaying and adjusting some parameters, especially information related to the "binary" value of threshold. The reserved OLED display interface is used for external OLED to display some key information, such as voltage signal data returned by electromagnetic detection circuit, binary image collected by camera, motor speed collected by encoder, PID parameters, etc., which is convenient for debugging tracking car.

Fig.5 is a partial circuit for displaying output information. Fig.6 shows the peripheral interface for MCU to obtain information.

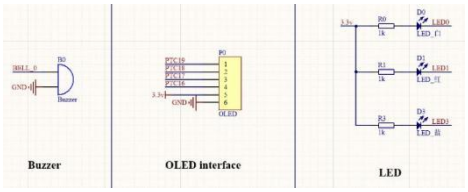

Fig.5. Design of display and output information part

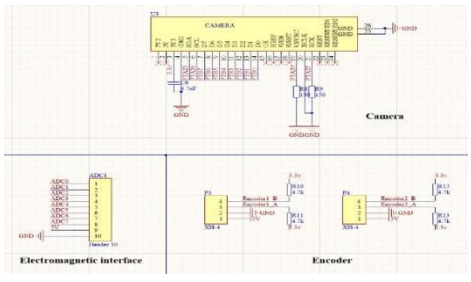

Fig.6. Peripheral Interface

2.5 Motor drive

(1) H-bridge drive principle

Because the DC motor rotates in different directions according to the polarity of the applied DC voltage. Therefore, in order to realize differential turning, H-bridge circuit needs to be used to drive the motor[2]. Fig.7 is a schematic diagram of H-bridge.

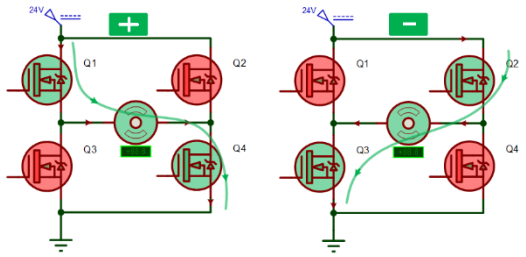

Fig.7. H-bridge

As shown in Fig.7, the circuit is a driving circuit composed of four N-CHANNEL POWER MOS tubes. It is assumed that the left side of the motor is (+) terminal and the right side is (-) terminal. If Q1 = Q4 = on and Q2 = Q3 = off, the (+) terminal of the motor is connected to the positive pole of the power supply and the (-) terminal is connected to GND, so the motor runs in the positive direction at this time. Conversely, if Q2 = Q3 = on and Q1 = Q4 = off, the (+) terminal of the motor is connected to GND and the (-) terminal is connected to the positive pole of the power supply. At this time, the motor runs in the opposite direction. Because the MOS tube and motor that make up the circuit are placed like the letter "H", it is called H-bridge drive circuit.

(2) H-bridge drive design

The scheme design of H bridge is shown in Fig.8.

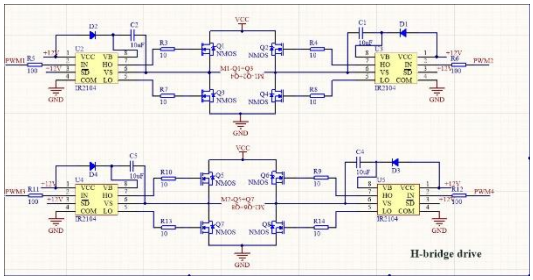

Fig.8. H-bridge scheme design

In the application of H-bridge, the driving performance of N-channel power MOSFET is better than that of P-channel power MOSFET. This design adopts IRLR7843, and its internal integrated diode can be used to protect MOSFET. When the DS two-stage voltage is too high, the bulk diode will be broken down to protect the MOSFET. A reverse path can also be provided for overcurrent caused by inductive load freewheeling or parasitic parameters.

In addition to the MOS transistor, the driver chip is also required to drive the bridge. Here, the chip IR2104 is selected. Fig.9 is an input / output timing diagram of IR2104.

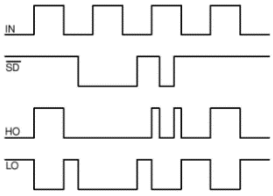

Fig.9. IR2104 I / O sequence diagram

When pin 3 of the chip inputs a high level, the enable is effective and the chip starts to work. When the enable is effective, the high side output HO is consistent with the PWM input by pin 2, and the low side output LO is opposite to HO. Due to the different positions of the motor relative to the MOSFET of the upper bridge arm and the lower bridge arm, the conduction condition of the MOSFET is VGS > Vth. This leads to a large voltage required for the gate to ground if the upper bridge arm MOSFET is to be turned on[3]. At this time, the bootstrap loop is introduced, which makes use of the unidirectional conductivity of the diode and the characteristics that the voltage at both ends of the capacitor can not change suddenly. Combined with the design structure of the driver chip, the upper bridge arm MOSFET can be turned on. Two opposite PWM signals are used to control the two drive chips to make the two half bridge circuits in opposite directions. Then they are combined to form a complete H-bridge circuit.

2.6 Power supply

The tracking car plans to use the most commonly used power supply on the market, which is mainly composed of two 18650 batteries. The rated voltage is 7.4V and the capacity is about 2000mAh. According to the power supply required on the board, the following schemes are designed:

- The battery is used to directly supply power to the motor.
- 7805 chip is used to output 5V voltage to supply power to encoder and operational amplifier.
- AMS1117-3.3 chip is used to output 3.3V voltage to supply power to MCU, camera, OLED and other components.
- SX1308 chip is used to output 12V voltage to supply power to H-bridge drive chip.
- AMS1086-ADJ chip is used to output 6V to supply power to the front wheel steering gear.

3. PCB design

The EDA software used in this design is Altium Designer. After designing the PCB, package the manufacturing documents and give them to the manufacturer. Then purchase components for welding. Fig.10 shows the designed PCB and Fig.11 shows the welded PCB.

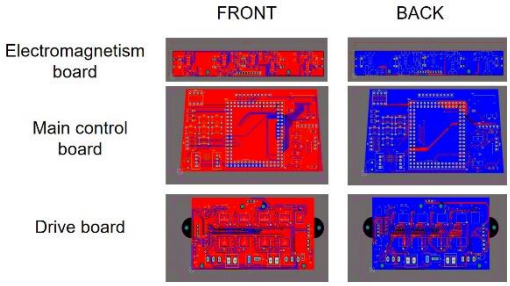

Fig.10. Designed PCB

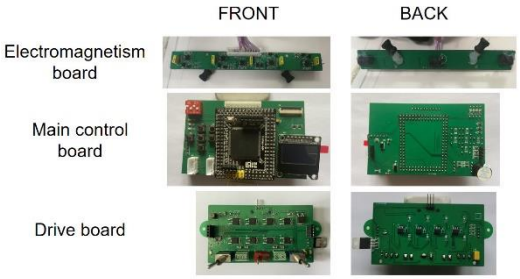

Fig.11. Welded PCB

4. Conclusion

For the design of hardware circuits related to vehicles, their composition is roughly the same. Main control part, driving part, information acquisition part and human-computer interaction part. Among them, the driving part will probably use H-bridge.

Choose different design schemes according to different needs and take them as needed. When selecting devices, it is necessary to carefully study the datasheet and comprehensively consider the packaging, price and other elements.

During PCB testing, first ensure that the power supply part can work normally, and then weld and test other components.

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Authors Introduction

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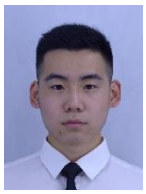

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