# The design of intelligent car based on MSP430F5529

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**Keywords:** intelligent car; sensor; line patrol; navigation.

**Abstract:** In the early 21st century, with the development of automotive electronic technology and intelligent technology, automatic driving is becoming more and more popular. Intelligent car control uses sensor technology, embedded technology, automatic control technology and so on. In this paper, it will introduce the background of intelligent car firstly. After that, the hardware design of intelligent car is displayed, in which the key parts include the motor drive module to realize the function of forward, backward and steering through optocoupler and H-bridge, the infrared line patrol module reads the black and white lines on the road through five infrared sensors to realize the function of automatic line patrol, the infrared navigation module reads the infrared from the beacon through four infrared sensors to realize the function of beacon search. Finally, an intelligent car with the functions of line patrol, automatic parking, distance measurement and navigation is designed.

## 1. Introduction

With the rapid development of automobile industry, intelligent car will be the development trend of future automobile industry [1]. Intelligent car control is to analyse the characteristics of the road, identify the road elements, and use different control algorithms to control the car to deal with different situations when driving on the road. With the help of microprocessor of high computing speed and precision, intelligent car can drive on the road at a fast speed without the need of manual help using intelligent car control.

In order to achieve this goal, it needs to use sensor technology, embedded technology, automatic control technology and so on. In the aspect of sensor technology, infrared sensors and ultrasonic are used to collect road and nearby information to analyse the situation of the intelligent car. In the aspect of embedded technology, microprocessor is used to process the information collected by sensors and output it to control other components. In the aspect of automatic control technology, the algorithm is used to process the information to control the steering engine and DC motor of the intelligent car, so as to control the direction and speed. Through the use of these technologies, intelligent car can respond flexibly according to different situations.

In this paper, the main tasks include enabling the intelligent car to move following the guide line, stop at the terminal zone, display the length of the guide line, search for the beacon and park at the parking zone.

## 2. Hardware

### 2.1 Power interface circuit

The 7.2V battery is connected to the PCB through the two-interface connector. When the switch is set at port 1, the power supply is on; when the switch is set at port 3, the pin is suspended, that is the power supply is off. Between the 7.2V and the ground is a capacitor, which is connected with the load in the circuit to form RC network. It is used to filter interference so as to provide stable power supply. The capacitance value of 0.1uF is used to filter the noise less than 100MHz. The circuit is shown in Figure 1.

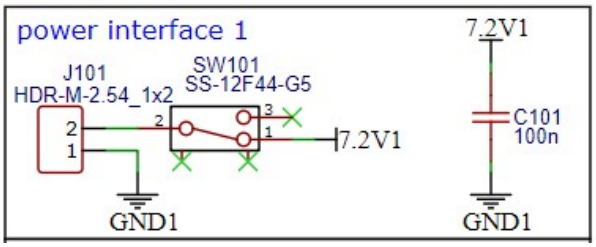


Figure. 1 Power interface circuit

### 2.2 DC-DC converter circuit

In order to supply 5V voltage to some components, a voltage regulator chip which can output constant voltage is needed. LM2940 is a low-voltage differential linear regulator integrated circuit. The loss between the input and output of the chip is relatively small. When the input voltage is in the range of 5.8V to 26V, the output voltage is 5V and maximum output current is 1A. In addition, there are two filter capacitors connected to the “input” and “common” pins, “output” and “common” pins, they will reduce the output impedance, smooth the output voltage and increase the output capacity, to improve the impact resistance, and according to the recommendation from datasheet, they are chosen as 47uF and 220uF. The circuit is shown in Figure 2.

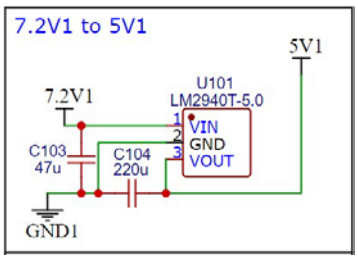


Figure. 2 DC-DC converter circuit

### 2.3 Motor drive circuit

The optocoupler TLP521 uses light as the medium to transmit the electric signal by encapsulating the light-emitting device and the light-receiving device, so as to realize the "electric-optical-electric" conversion, thus having a good isolation effect on the input and output electric signals. Power supply is 5V at the input and 7.2V at the output of the optocoupler. The 390Ω resistor is used to limit current, the two 1kΩ resistors are used to pull up, and the 100nF capacitor is used to filter interference.

The signal input from the port of the single-chip microcomputer is amplified to control the opening or closing of MOS tubes in the H-bridge circuit [2]. The H-bridge circuit mainly controls the flow direction of the current, which is from 7.2V supply voltage, through the opening or closing of four MOS tubes 2SK3134, so as to control the rotation of the motor, the motor is connected to the PCB through the two-interface connector. Among them, the MSP430F5529 ports P2.4 and P8.2 control the speed and steering of the left wheel motor, P2.0 and P8.1 control the speed and steering of the right wheel motor. For left wheel motor, when P2.4 generates PWM and P8.2 generates low level, if the circuit is on, the MOS tubes in the upper left corner and the lower right corner are on, the motor rotates forward; when P2.4 generates PWM and P8.2 generates high level, if the circuit is on, the MOS tubes in the upper right corner and the lower left corner are on, the motor rotates reverse. Due to the presence of NOT gate, the two MOS tubes on the same side will not be connected at the same time, that is, they will not form a short circuit to the power supply. The 0.1uF capacitor at both ends of the two-interface connector is used to ensure the stable power supply of the motor drive circuit, and the 1mF capacitor between the 7.2V supply voltage and the ground is used to avoid the impact on other circuits. The diodes 1N4001 are used to protect MOS tubes and the 1kΩ resistors are used to limit current. The circuit is shown in Figure 3.

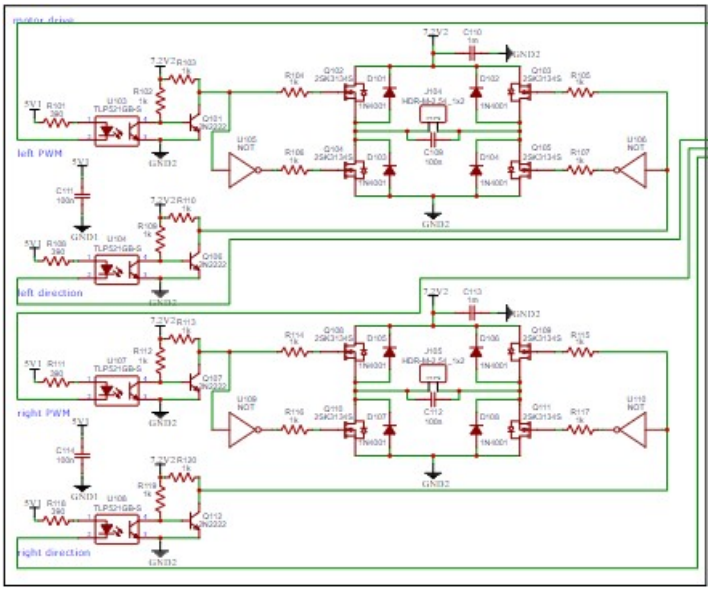

Figure. 3 Motor drive circuit

### 2.4 Ultrasonic circuit

HC-SR04 is chose for which the trig of I/O port is used to trigger ranging and give high-level signal of at least 10us, and the module automatically sends 8 square waves of 40kHz to detect whether there is signal return. Two 1000pF capacitors are added to filter the ripple and two 100Ω resistors to limit the current. The circuit is shown in Figure 4.

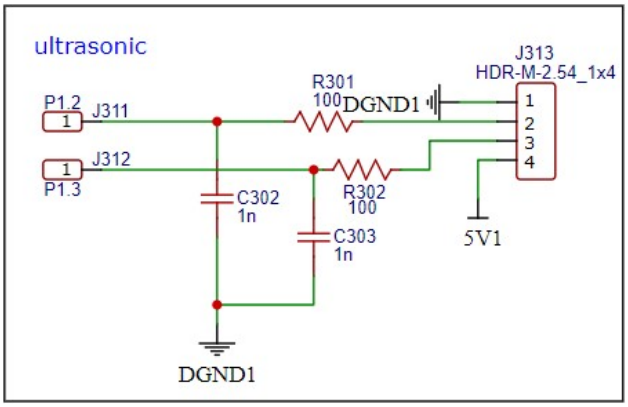


Figure. 4 Ultrasonic circuit

### 2.5 Photoelectric encoder circuit

Install the encode disks on the axles of the wheels, and the photoelectric sensors over the encode disks, the photoelectric sensor is connected to the PCB through the three-interfaces connector. There are 20 holes in the encode disk, when the photoelectric sensor detects 20 pulse signals, it will turn the wheel once. Output the pulse signals of the left wheel and the right wheel to the MSP430F5529 ports P1.4 and P1.5 respectively. The distance travelled can be obtained through the code calculation. The circuit is shown in Figure 5.

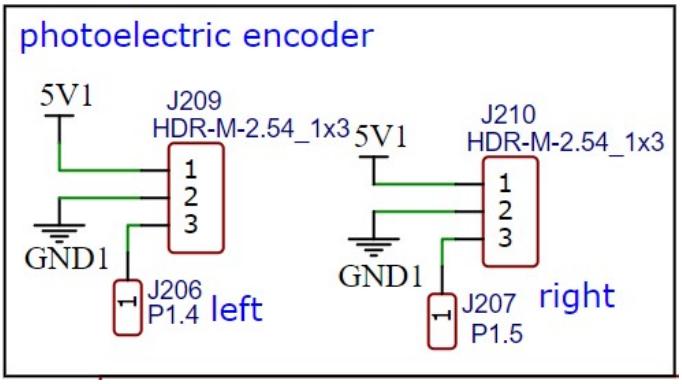


Figure. 5 Photoelectric encoder circuit

### 2.6 LCD circuit

For LCD1602, it uses 5V power supply to VDD and A, which is backlight positive. V0 can adjust the contrast of LCD by adjusting the differential pressure of sliding rheostat. RS is the register selection pin, data register is selected at high power level and instruction register is selected at low power level. RW is read/write signal line, which can be read at high power level and written at low power level. E is enabled terminal, when the terminal changes from high level to low level, the LCD module executes the command. DB0-DB7 are 8-bits bidirectional data lines. The MSP430F5529 ports P3.1, P3.2 and P3.3 control RS, RW and E, ports P4.0, P4.1, P4.2 and P4.3 control DB4-DB7. The 10kΩ resistor and 5kΩ sliding rheostat are used to divide the voltage and adjust the contrast of LCD. The value is determined by the actual experiment. The ideal situation is when the sliding rheostat is adjusted to about 2.9kΩ. The circuit is shown in Figure 6.

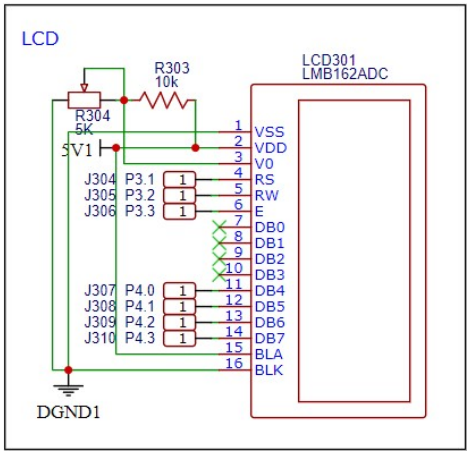


Figure. 6 LCD circuit

### 2.7 Infrared line patrol circuit

ST188 is selected to be infrared detection sensor, which is composed of high emission power infrared photodiode and high sensitivity phototransistor, has relatively large detecting range of 4mm-13mm and takes non-contact detection method. Therefore, if A is connected to high-level and K is connected to low level, infrared emission diode will emit infrared, then add the peripheral circuit on sensor to detect signal of receiving tube, then it can be identified whether it receives infrared.

While detecting the white zone, the receiving tube will receive the reflective infrared, and the phototransistor will conduct, the voltage of receiving tube is 4.8V, which is near to VCC(5V), if it's black zone, the receiving tube won't receive the reflective infrared, and the phototransistor won't conduct, and the voltage of receiving tube is 0.5V, which is near to GND(0V). The circuit is shown in Figure 7.

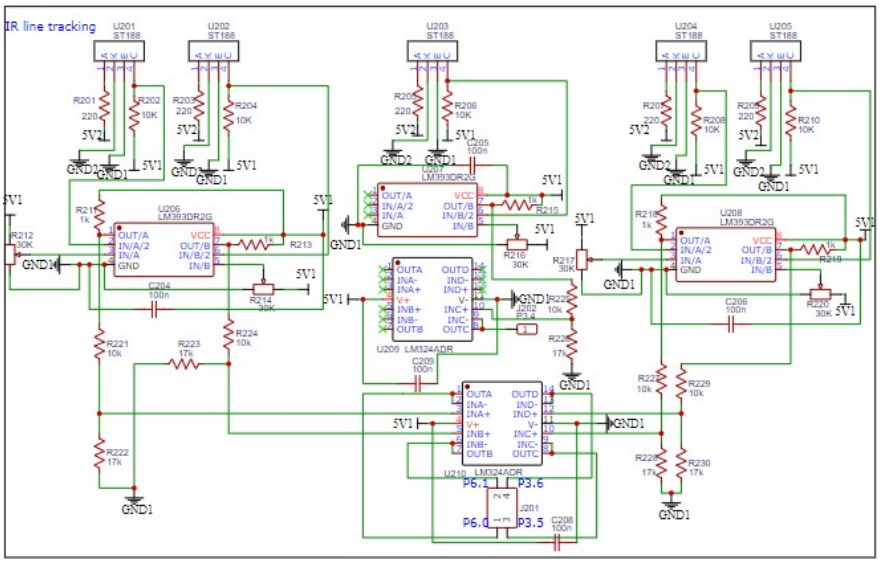


Figure. 7 Infrared line patrol circuit

## 2.8 Infrared navigation circuit

There are three sensors on the topboard of PCB detect analogue signal, another one is used to detect digital signal on baseboard. The output signal from TSOP4840 will be compared with adjustable reference voltage, then MSP430F5529 can read high and low level. Once the three infrared receivers on the topboard detect weak signal and the infrared receiver on baseboard receive high level, the robot will reach the designated parking zone [3]. The circuit is shown in Figure 8.

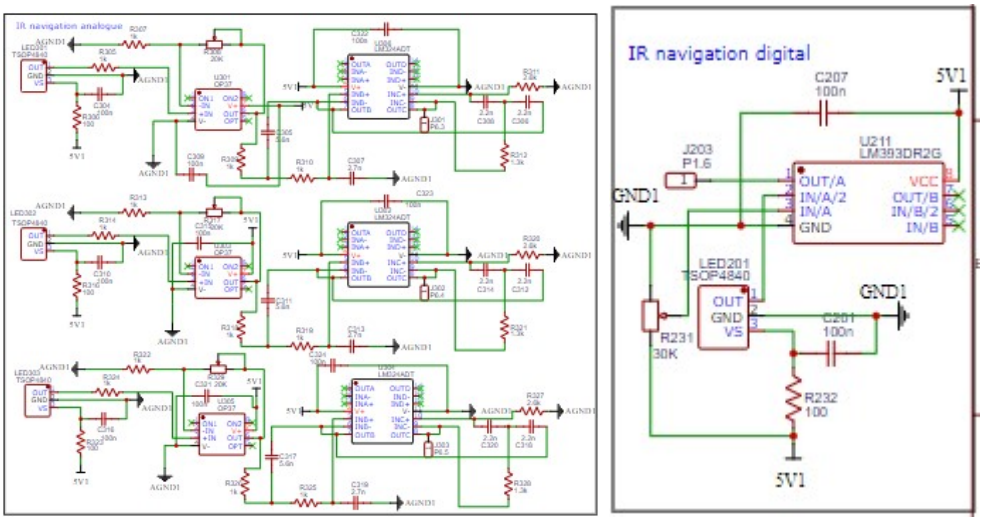


Figure. 8 Infrared navigation circuit

## 3. Conclusion

In this paper, there are many circuits in the intelligent car, including power interface circuit, DC-DC converter circuit, motor drive circuit, ultrasonic circuit, photoelectric encoder circuit, LCD circuit, infrared line patrol circuit and infrared navigation circuit, which enable the intelligent car to move following the guide line, stop at the terminal zone, display the length of the guide line, search for the beacon and park at the parking zone.

This design is a more common way, but it has a wide range of applications, and there are no too many defects. It can be directly applied and improved or added some functions on this basis, and even applied to UAV. The hardware is the basis of the intelligent car. After designing the required circuit according to the requirements, the hardware part is basically completed, and the intelligent car can be

obtained by writing the corresponding code and assembling it. In the future development of automobile industry, automatic driving will become a trend.

## References

[1] Jian Yang, Ruina Dang, Tao Luo and Jin Liu. The development status and trends of unmanned ground vehicle control system, Cyber Technology in Automation, Control, and Intelligent Systems (CYBER), 2015:1946–1952.

[2] Hsin-Chuan Chen. A PMOS-driven H-bridge without dead time for industry applications, Consumer Electronics-Taiwan (ICCE-TW), 2016:1–2.

[3] Lin Li and He Zhang. Remote Control System for Projectile of Infrared Imaging Fuze Based on GPS and Navigation Technology, Mechatronics and Automation, 2006:2383–2387.