Hardware Design of Smart Tracking Car

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Abstract

With the development and advancement of cities, artificial intelligence has been increasingly recognized and implemented by people. Human resources are replaced by intelligent systems thus we are no longer put too much cost on human resources frequently. Due to the continuous innovation of intelligent technology and digital simulation technology, more and more materials are following the trend of intelligence, but they cannot provide the multi-faceted assistance and convenience given by science and technology. Because many technical products are still in progress, if they attempt to reach the required level there must be a long way to go. Nowadays, sensor technology and automatic control technology are developing rapidly; mechanical, electrical and electronic information are also syncretized with each other, which has brought automatic control to an increasingly significant place in the industrial field. "Intelligence" has become a popular word. Sensor technology and automatic control in some foreign countries have reached a very high level now. In order to satisfy the requirement of electromechanical integration towards intelligent automobile development, the idea of smart car is put forward. I intend to design and produce a simple smart tracking car. The article mainly relies on the concept that the hardware and software of the Microcontroller Unit (MCU) / Single Chip Microcomputer (SCM) control system work and cooperate with each other. It's optimization and functionality will be more excellent compared with the original smart car, and it will lead us to a safer and more reliable life. In the design, I will use infrared induction device to control the steering that can track to ensure the stability of body and Pulse Width Modulation (PWM) to regulate the speed and make timely judgement of the distance from obstacles with corresponding steering. The design is mainly for the control of smart car by using STC89C52 SCM as the control core. SCM will automatically make a judgement according to the collected signals of car in different states through the motor driver chip L298N issued a command to control the working state of the motor so that the car can identify the black guide line by itself and keep a rapid and stable driving.

Keywords

Auto Tracing Function; Single Chip Microcomputer (SCM)/ Micro controller Unit (MCU); Infrared Induction Devices.

1. Introduction

1.1 Usage and Development History

At present, with the increasing demand of the society, people's popularity of vehicles is getting much higher. Smart cars have become the focus of people's attention and concern. They have also become an important trend in people's future development. Since then, a variety of functions will continue to launch so that the car is no longer a single running device. The company has learned from foreign functional technologies in many ways including the smart car installation of Wifi, Bluetooth, wireless remote control, as well as a variety of sensors that provide multi-faceted detections of surrounding environment, noise and fault alarm, and sense the distance with intelligent speed control according to the gap between the barricade and the car, giving timely steering to avoid the roadblock so as to achieve the goal of tracking.

1.2 Purpose and Significance of the Research

As a tendency of future development, smart car involves many aspects. Its versatility has obtained support and recognition by an increasing number of people. The function of smart car is also related to human's life. As the front line of the new era, it mainly includes the external and internal hardware components. The key part of current research contains the realizable infrared remote control, sensors, Wifi, obstacle avoidance. The network coverage is constantly comprehensive and diversified thus we can install monitoring for video and vehicle, send out the detailed information of emergency call and intelligent alarm. If the smart car doesn't operate properly with malfunction of range sensor, it can timely alarm to data center because data storage can judge travel safety every day in many aspects.

The design is mainly based on the diversity and complexity of the road section to do the corresponding solutions with timely avoidance of obstacles and adjustment of the body. We can still choose automatic or manual control to make a reaction in accordance with command to foster the information processing ability of the smart car and improve the monotony of the hardware system.

2. Module design of smart tracking car

2.1 System Overview

The smart tracking car adopts STC89C52 SCM as its control core. The system is composed of six parts, namely, single chip microcomputer and its minimum system, infrared sensor, photoelectric sensor, LM324 comparator, L298N driving circuit and DC motor. The block diagram of the structure is shown in Fig. 1.

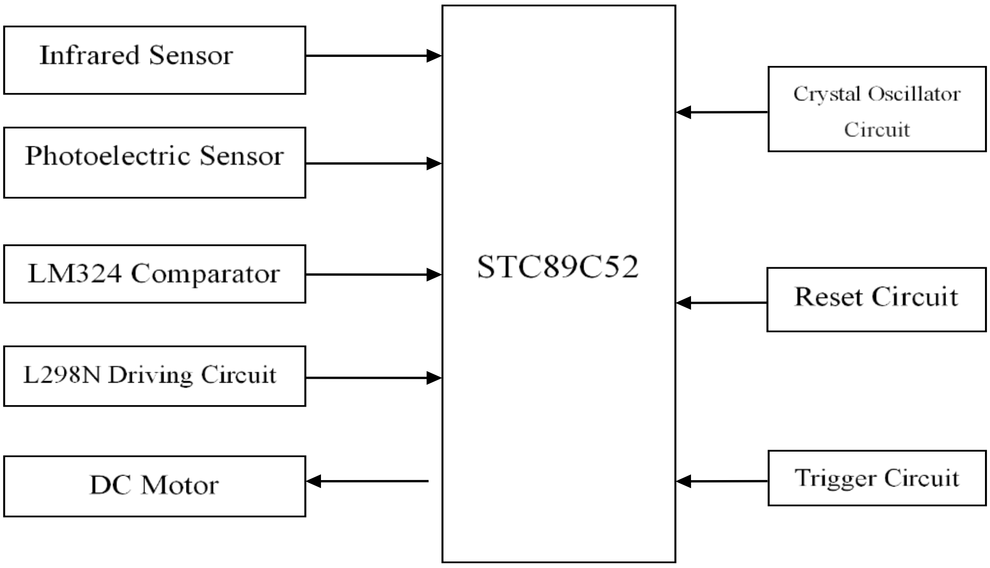

Fig. 1 The block diagram of the structure

2.2 SCM Control System

The working mechanism of the control system not only determines the control mode but also the way in which the smart car will be controlled. The control system of SCM is an essential part of smart car based on which the control command is formed to control the car and respond accordingly. The system is able to complete such a complex control task, to a large extent, attributed to the controller, while the core of the controller is the SCM. The control system of SCM is an integrated logic circuit, using a variety of integrated technologies to set the capacity of CPU and RAM to 4K, the chip has 32KB of space, and can be repeatedly erased up to 100,000 times, Flash as a read-only memory ROM, 32 basic input and output port and interrupt system, two octet timers/counters and other functions integrated into a computer system with high-speed computing functions, plays a key role in programming control[1].

STC89C52 SCM is an 8-bit single chip microcomputer with low power consumption and strong processing ability. It can be programmed and debugged online with easy access to download the program and debug the whole machine. The minimum system of SCM mainly composed of reset circuit, clock crystal oscillator circuit, data connection interface and motor control circuit interface. Its diagram is shown in Fig. 2.

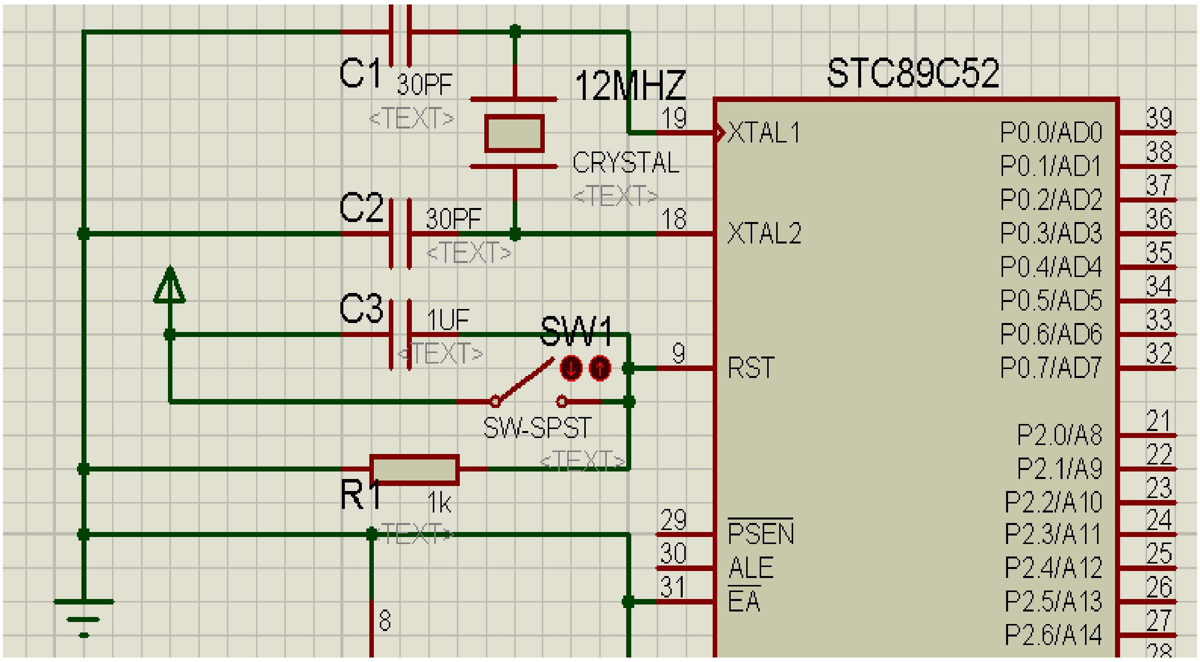

Fig. 2 The minimum system of SCM

2.3 Path Identification

The tracing principle of smart car is that the car runs on the prearranged black tape floor, judging black and white light based on the different reflective wavelengths and intensity of the photoelectric sensor and then making a corresponding turn. The data of reflected wavelengths vary from different colored surfaces. Infrared light is constantly emitted to the ground during the operation of the car. It contacts the white floor and then the reflection difference of the black floor changes the path of the orbit when the sensor has a signal; if the emitted infrared light encounters the black line, most of it will be absorbed, so the photoelectric transistor cannot receive the reflected infrared light, there is no current change and the sensor will not output any signal. The SCM decides the path of the black line based on whether it receives the reflected infrared light. Using two pairs of photocells placed on the outside of the track, after the white line has been detected, the corresponding steering adjustment will be carried out when the car leaves the track until the photoelectric sensor re-detects the white line and resumes the forward drive [2].

2.3.1 LM324 Comparator

LM324 is a four-stage integrated operational amplifier circuit, using 14-pin-dip plastic package with four integrated operational amplifiers and a phase compensation circuit. Power consumption of the circuit is very small and the range of working voltage is around 3~30V or the positive and negative dual power supply operates between 1.5V and 15V. In the detection circuit of black line, the high and low signal used to determine the level of the infrared received signal and whether the hand has a black line. In the circuit, one input of LM324 must be connected to a variable resistor to provide the appropriate comparison voltage by changing the resistance of the adjustable resistor.

2.3.2 Photoelectric Sensor

Photoelectric sensor is a special and common-use sensor based on photoelectric effect. In our real life, many fields have used this sensor, which can accurately detect the travel route according to the band of transmitting natural frequency, which brings great convenience for tracing. There is a LED pin for A and K internally, and a Phototransistor pin for C and E. As for simple black and white road surface, the output signal of the photoelectric sensor can be processed to reflect the results clearly and correctly (white road light on, black road light is not on). However, the actual laying of white pavement is narrow, in the process of passing part of the bend, the edge of the sensor will detect the gray cement road surface, at this time the reaction results are somewhat complicated, so the car will have some abnormal actions when passing these bends. What we should do is to adjust the sliding resistor on the signal processing circuit so that the infrared sensor's reaction to the gray cement pavement is consistent with their reaction to the white runway (In other words, the sensor’s sensitivity is increased so that the gray cement floor is judged to be white).

2.3.3 Infrared Sensor

The LED emits infrared signal and the change of the received signal is judged to detect the state of the object. The transmitted and received signals are converted into digital signals automatically recognized by the SCM after passing through the LM324 comparator so as to avoid obstacles. There are four infrared sensors and each with three pins: a voltage input end, a ground end, and an output signal end. After supplying power to the sensor, a multimeter is used to test the output end of the sensor. When the sensor is close to the white runway, it is found that the voltmeter shows a voltage of about 0V. When the sensor is far away from the white runway, the voltmeter shows a voltage of about 4.5V. When the sensor is not close to the white road, the voltage is between the two, which is a reasonable voltage range. However, such a signal cannot be directly input into the MCU, A/D converter needs to be converted into the MCU automatically recognized digital signal. There are four indicators on the processing circuit. We can judge whether the output is high level or low level by observing the light and shade of the indicators (the sensor is shining on the white runway, the receiving tube can receive the signal, and the corresponding small light in the processing circuit will be on; The sensor shines on the black runway, the receiving tube does not receive the signal, and the corresponding small light in the processing circuit does not turn on.)

2.3.4 Sensor Installation

The route set by the system ensure that the position of the black line and the direction of the car will be detected during the route. Two infrared detectors are installed at the bottom of the smart car to adjust the control direction to improve route accuracy. When the smart car moves forward, it will stay between the two sensors and enter into the program set section. Firstly, it will determine which position of the two sensors to detect the black signal line set in advance. If the right sensor detects the black line signal, this indicates that the right side of the smart car blocked the black line signal, namely the body to the left deviation change, at this time the single-chip machine issued a signal to turn right, the smart car should immediately turn right; if the sensor detects the black tracking line on the left side, then the smart car left black trace, and the body of the smart car is offset, at which point the stymied machine signals a left turn, the smart car immediately turns left; it will deviate from the predicted track with high speed due to inertia and beyond the range of the two square detectors, then the movement of the smart car should be corrected and return to the planned road[3].

2.4 DC Motor Drive

L298N is the primary control core for driving DC motors in the design, and the L298N integrated chip is used to drive two DC motors to control their start, stop and speed.PWM technology can control the motor’s speed and the precise speed is achieved by adjusting the demand ratio. L298N is a high-voltage, high-current motor driver chip manufactured by STMICRO electronics, which contains high voltage and high current full-bridge drivers with dual H-bridges. It is mainly characterized by high instantaneous output voltage, large current and rated power. Heat sink should be added when necessary[4]. The design uses the L298N drive chip to control two sets of DC motors, in which the IN1 and IN2 input signals control the left wheel steering, while the IN3 and IN4 input signals control the wheel steering. In addition, two sets of PWM signals are output from the MCU to connect to ENA and ENB to control the rotation speed of left and right wheels respectively[5]. Because the motor has the smallest start-up torque voltage, the average output PWM signal must not be too small to drive the motor to turn. The following illustration is an internal schematic of the L298N.see Fig. 3.

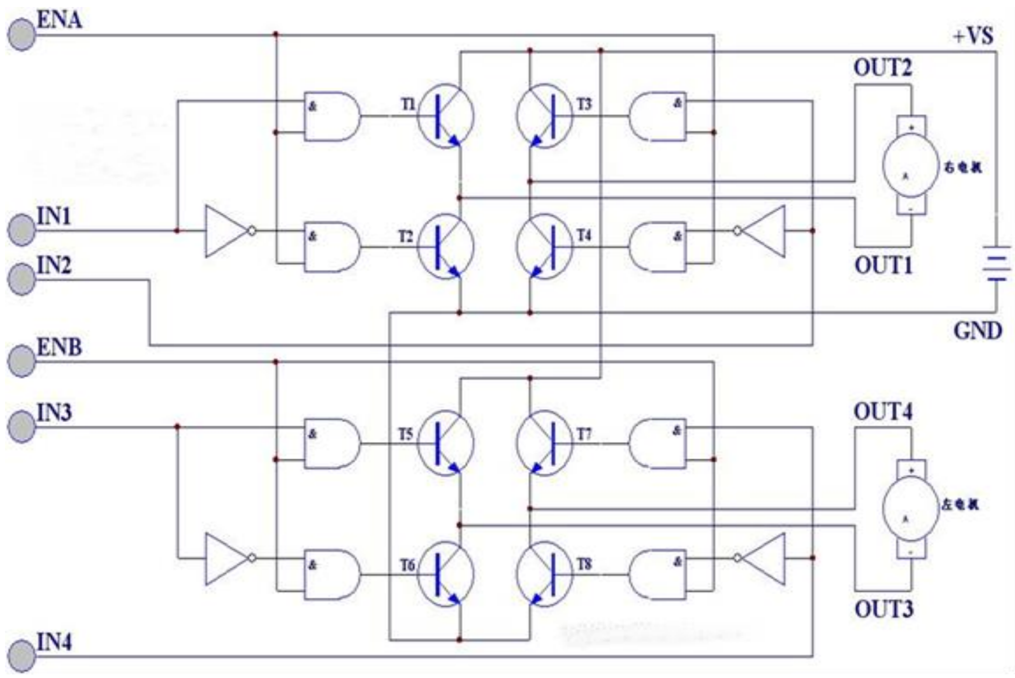

Fig. 3 The Internal Schematic of the L298N

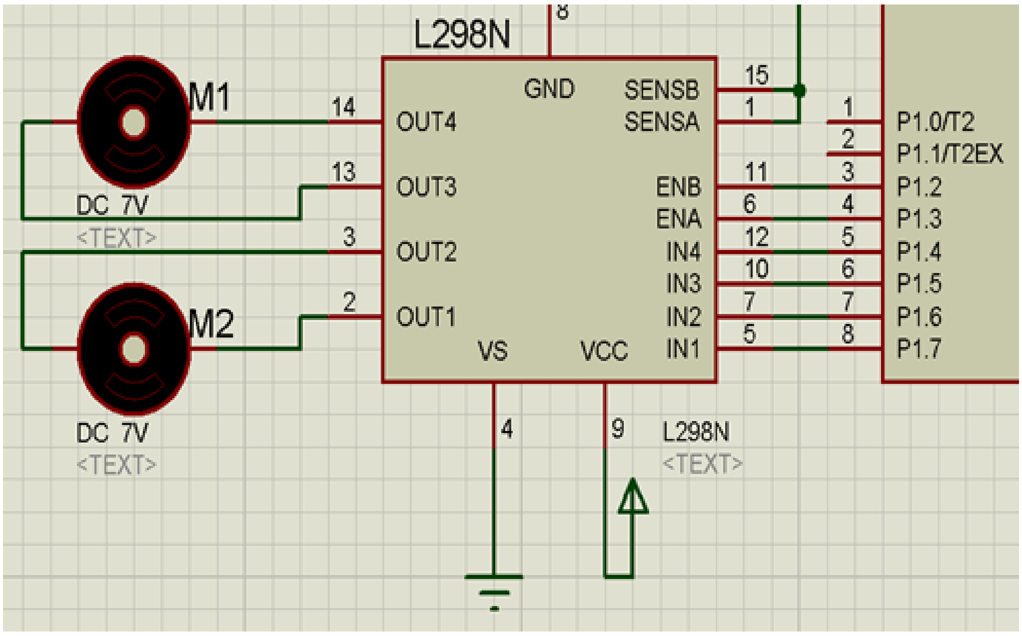

Fig. 4 The Drive Module of L298N DC Motor

The schematic diagram of the drive module of L298N DC motor is shown in Fig. 4. As we can see, Pins 4 and 9 are the power ports of the driver module, while pins 6 and 11 are two logic level input terminals, which control pins 2, 3, 13 and 14 at the output terminals respectively. When pin 6 at the input end is in high power, the output of pins 2 and 3 at the output end is also at high level. It conducts with the positive pole of the power supply through the double-H bridge. When low power is input at the input end, the output of pins 2 and 3 at the output end is low level. Through the double-H bridge and the negative pole of the power supply, the relationship between pins 11 and 13 and 14 is the same. 6. Pin 11 is the drain output fault signal pin, and the low level is effective; When 6 pins of the enabling end are at high level or 11 pins are at low level, the outputs of 2, 3 and 13 and 14 are disabled at the same time, making 2, 3 and 13 and 14 at the output end turn into high resistance state simultaneously. By controlling the level of input terminal 5 and 7, motor 1 can be controlled forward, backward and stop. Similarly, input terminal 10 and input terminal 12 can control the forward, backward and stop of motor 2. Finally, the speed of the intelligent car can be controlled by controlling the pulse width modulation of the level signal at the input end[6].

3. Commissioning

After the preparation of components, it is necessary to remain vigilant in welding to avoid the occurrence of virtual welding and leakage welding. The following points should be noted:

Before welding all components, check the quality of the components, carry out necessary functional tests, and be careful in the inspection process.

During component layout, make sure that the direction is consistent and carefully check whether the circuit schematic diagram is consistent, so as to facilitate later screening or troubleshooting.

The installation of components should be in accordance with the schematic diagram and in the sequence from small to large. Welding smaller components first and then welding higher and more demanding components. In particular, components that are prone to damage are welded later.

Carefully distinguish the polarity of components including capacitors, diode triplets and pay special attention to prevent the occurrence of errors after inconvenient replacement.

All ground lines shall be connected as possible as a public reference point.

After the completion of welding, please carefully check the circuit so as to find whether there is short circuit welding. If there is no other problem, we can turn on the power to test machine.

4. Conclusion

The design takes the STC89C52 SCM as the main component of the hardware design control system. I have taken some factors into consideration including the car's adaptability to the environment, the requirements of various complex terrain, as well as the future development prospects of the application market. We use photoelectric sensors which are low-priced and infrared sensors as the main sensor to achieve the collection and transmission of signals. The LM324 comparator will replace the stymied machine which cannot process analog signals into digital signals quickly. With its design of the circuit-led, the entire smart tracking car circuit uses simulation software to achieve the circuit's early and medium-term design and perfection so that the late physical regulation becomes more simple and low, which will reduce the research funding of the design. Based on my personal plan, I have made a lot achievements on the control circuit simulation and debugging so I began to design post-production which aims to make up for pre-simulation design. Now, the overall control system has been able to run normally and the risk of error is very low. Photoelectric sensors and infrared sensors are very sensitive and can perfect the data collection and transmission, which lays a solid foundation for the correct tracing of the physical car. The speed of the smart tracking car is limited within a reasonable range of debugging measurement. Then the smart tracking car can drive normally and the whole system can complete the corresponding instruction task issued by the SCM. Many simulations and physical tests have showed that all indicators are stable and reliable thus the design scheme of smart tracking car is pragmatic and feasible.

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