Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 13 (15): 3067-3072, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.3067.3072

Design of Intelligent Car Based on Multisensor

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Abstract: In this study, the design of multifunctional intelligent car is presented. The STC89C52 is chosen as the core controller and the high sensitivity infrared sensors are used to achieve the function of automatic tracing and obstacle avoidance. The PWM wave produced by MCU is used to control the vehicle speed. The car can realize automatic light-seeking and fire-detection function by the design of photoresistance and flame inductiveprobe circuit, which uses buzzer and LED to achieve sound and light alarm. The experiments show the validity and efficiency of the proposed scheme. The technology can be applied in many fields such as service robot, intelligent toy, unmanned driving vehicles, light sources and flame detection.

Key words: Obstacle avoidance, light-seeking, fire-detection

INTRODUCTION

Along with the development of computer technology, information technology and microelectronices technology, embedded systems have become an integral part of our everyday life. Intelligent vehicle is widely applied in the fields of industrial manufacturing and automotive manufacturing industry. Nowdays, it becomes closely related to our daily lives. There is no doubt that the using of intelligent cars is an inevitable trend and it is the future development direction of the automotive industry. So the design and development of intelligent car is an important problem that deserves our research. This design uses the embedded system that comprehensive utilizes control, pattern recognition, sensor, electronics, computer, mechanical and many other technologies. Different routes, such as labyrinth, black belt-tracking, obstacle and so on are discussed in (Zhang, *et al.*, 2008, Yan and Yan, 2011, Gao, 2009). In this paper, multifunctional intelligent car design based on multisensor is proposed, which can implement automatic tracking, obstacle avoiding, light-seeking and fire-detecting functions. Because STC89C52 has powerful, high speed, high efficiency, low power consumption, low price and many other advantages (Fang, 2001), this design chooses STC89C52 as the main control chip. The motor driver uses direct current motor that can adjust speed through PWM DC motor.

This design of a multifunctional intelligent electric car uses aluminum body with plastic chassis and rubber wheels. The design can get intelligent four-wheel-drive and can implement the following functions. (1) Auto-searching. It uses an infrared photoelectric sensor circuit to make the car travel along the black track and achieve automatic tracing function. (2) Obstacle avoidance function. This design uses an infrared obstacle avoidance sensor to complete obstacle avoidance function. When the car encounters an obstacle, it can skirt the obstacle and continue to exercise along the track. (3) Searchlight function. The car can achieve light seeking function through the design of photosensitive resistance circuit. When the car finds the light, it will exercise in accordance with the direction of the light source. (4) Flame detection function. We use the flame sensor probe circuit to realize the fire detection function, sound and light alarm function. Thus the design of multi-sensor intelligent car has a certain value.

SYSTEM ANALYSIS

The design of intelligent car includes tracking module, obstacle avoidance module, search light module, flame detection module, driver module, power module and a single-chip microcomputer control module. Tracking module, obstacle avoidance module, search light module and flame detection module are as the system input and

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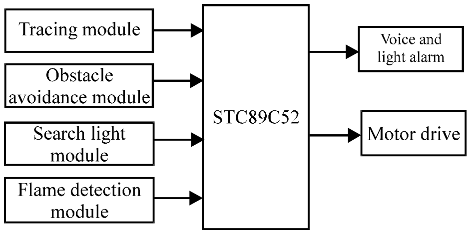

Fig. 1: Frame diagram of intelligent car system

they are responsible for collecting signal passing to the SCM. Through the use of control scheme, the microcontroller output signal is transfered to the drive and control the driving route. The total frame diagram is shown in Fig. 1.

We will discuss the system design in the next section. The system mainly consists of system hardware and system software.

SYSTEM HARDWARE DESIGN

Tracking module design: The design of path identification circuit uses five TCRT5000 reflection infrared electro-optical sensors. The sensor layouts adopt one line font and the granularity is 1.5 cm. These sensors are about a height of 1cm from the ground and they connect the single-chip microcomputer P1.0~P1.4 ports, respectively. The principle of operation is that the reflection infrared photoelectric sensor transmitting tube emits infrared light. When the infrared light encounters black road, the infrared light is absorbed. When the infrared light encounters white road, the infrared light will be reflected back. At this time, if an infrared light is reflected back, the received signal of receiving tube will be opened, otherwise it will be closed. The reflection infrared photoelectric sensors collect different high or low-voltage signals at different roads and then gather the signals using a voltage comparator for digital shaping and get stable digital signal transfering to the single-chip microcomputer for processing. The single-chip microcomputer based on 5-channel signal is used to control the car. The output sensor module on the white surface is set to be high in this design. When detecting the black guide line, the output sensor produces low level output voltage. The tracing circuit is shown in Fig. 2.

Obstacle avoidance module design: The obstacle avoidance module uses infrared obstacle avoidance sensors. This type of sensor is a photoelectric sensor that is a united set of transmit and receive functions. The detection distance is 0~80 cm and

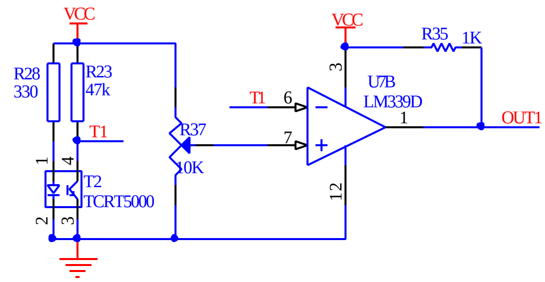

Fig. 2: Tracking circuit schematic

the detection distance can automatically adjust in this area according to the requirements. When there is some obstacle in front of the car, the infrared optical reflective sensor outputs low level and the indicator lamp comes on.

Search light module design: The search light circuit consists of photosensitive resistance, comparators, slide rheostats, resistors, capacitors, light emitting diodes and other components. The photosensitive resistance is responsible for collecting light signals, which can take advantage of the characteristics of photosensitive resistance. When the light resource is raying, the resistance rapidly decreases. This design adopts two photosensitive resistances to inspect the light sources in three directions. LED1 is the power indicator light. LED2 and LED3 are the light source indicator lamp in different directions. When there are light sources in front, left or light, D1 and D2 output 11, 10, 01 state signal, respectively. Then the single-chip microcomputer allows the car to move forward, left or right. The light seeking circuit schematic diagram is shown in Fig. 3.

Flame detection module design: This module uses the flame sensing probe, which can detect the heat source whose wavelengths range from 760 nanometer to 1100 nanometer. The detection angle of the flame sensing probe reaches 60 degree angle and the working voltage is 5V. The flame sensoring probe will conduct when it detects the flame. Then the output voltage signal of the flame sensor probe is passed to the single-chip microcomputer for processing after plastic through shaping circuit. The flame detection distance can be changed by adjusting the rheostat resistance R1. Flame detector principle diagram is shown in Fig. 4.

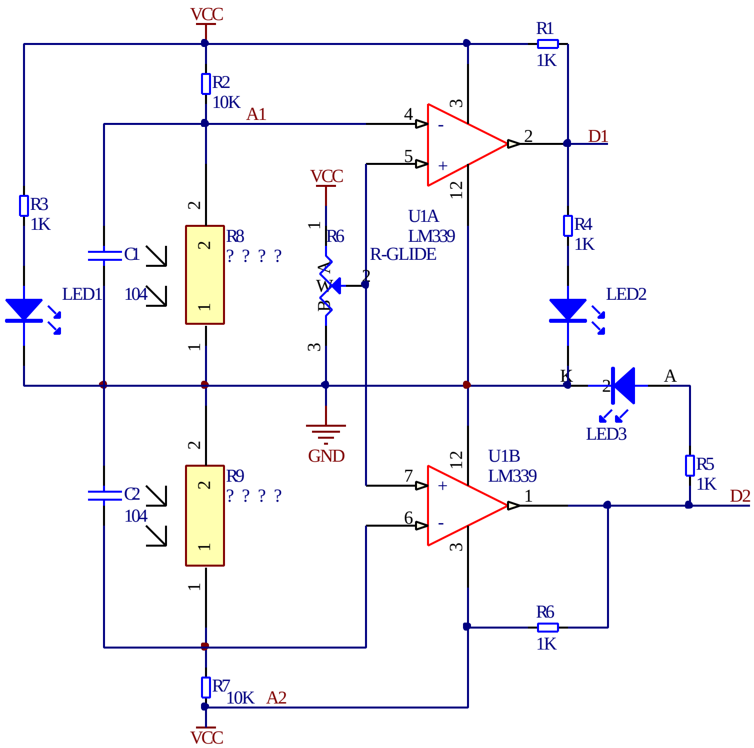

Fig. 3: Light-seeking schematic circuit

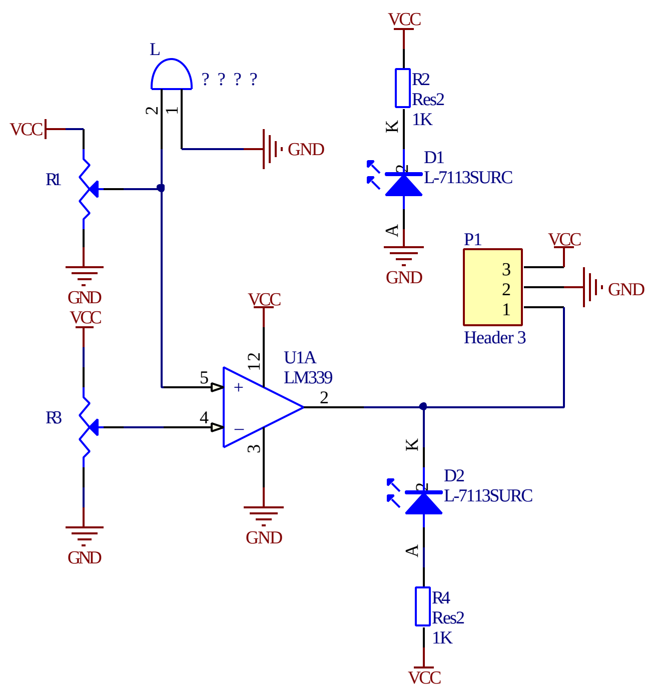

Fig. 4 Fire-detection schematic circuit

Design of single chip microcomputer control drive modul: System control module uses STC89C52 as the core MCU controller minimum system. The used motor is the common direct current (DC) motor. The signal power from SCM output is weak, even when there is no other external loads it can not drive the motor. So in practical circuits, depending on the driving power and the demand for simplicity of connection circuitry, we select the integrated H-bridge circuit chip L298N as the main part of the driving circuit. It can increase the input signal power of the motor.

This intelligent car is a four-drive car. The two left wheels are controled by two motors on the left, which can control the car forward or reverse through two IO ports. As well as aother two IO ports on the right control the two right wheels forward or reverse. The car can drive forward, backward, left or right through regulating the speed of the motors on the left and right.

Power supply module design: The power supply module uses a nickel-cadmium battery of 7.2V and 2A, which outputs 5V voltage through the LM2576HVT-5.0 low dropout voltage regulator circuit. We adopt this module to supply power to the single-chip microcomputer and the entire system.

SYSTEM SOFTWARE DESIGN

The system software design is one of the important components of the system as a whole. After the car turns on, the system is firstly initialized. Then the system scans the acquisition module constantly. Once a corresponding signal acquisition module is detected, the system will perform the corresponding judgement program. The PWM speed-governing function is achieved through the use of control timers T0 severance. Flame detection function uses an external interrupt 1 to implemet. The main flowchart and the interrupt routine flowchart are shown in Fig. 5 and 6, respectively.

SYSTEM TEST

Automatic tracing function test: We place the car on the track of black line with white background. The car that is controled by the steering motor can drive along the track. The control signal of the steering motor is output by P2.3-P2.6 of the single-chip microcomputer. P2.1 and P2.0 ports provide the function of PWM output and control L298N enable terminal. If the duty cycle is higher, the speed is higher. We can utilize the rich PWM resources to provide the steering motor more precise angle positioning. The max duty cycly is 50% in this experiment.

In tracking module, there are five sensors in P1.0~P1.4 prots of the single-chip microcomputer on the formation of nine different control characters, which represent nine location information. Where "0" is a marker bit that means the sensors detect the corresponding black line track. For example, when the sensor detectes the status as "11011", it indicates that the car will go straight and will not turn. If the status is "11110", the car should turn to the right. When the car travels to the junction of

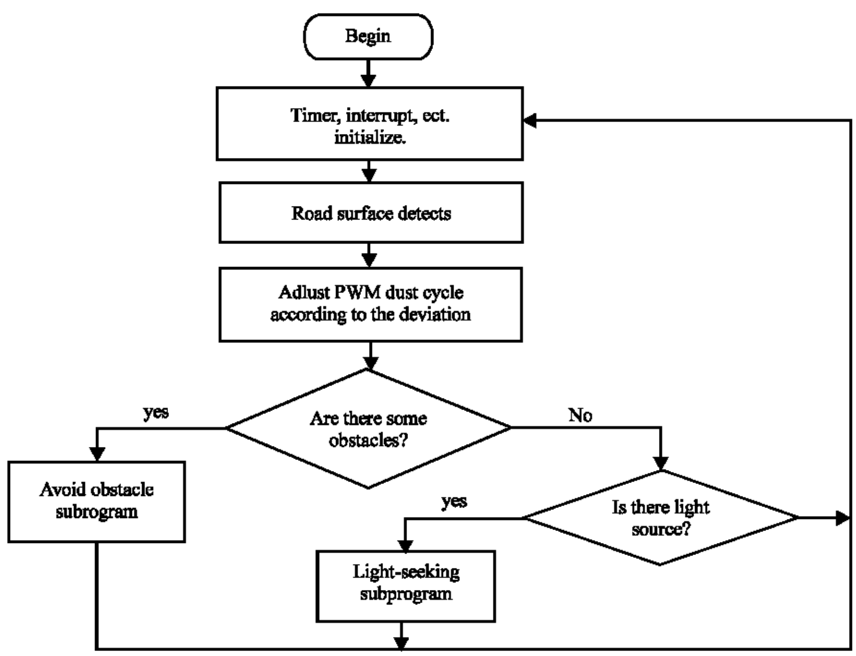

Fig. 5: Flow chart of the main program

Table 1: Steering control table

P1[4:0]	Control method	Motor turning	PWM duty cycle
11011	Forward	Left and right motors	Left and right motor: 50%
11110	Big right-turning	run forward.	Left motor: 5%, right motor: 50%
11100	Moderate right-turning	P2[6:5]=10	Left motor: 15%, right motor 50%
11001	Small right-turning		Left motor: 50%, right motor: 25%
10011	Small left- turning		Left motor: 25%, right motor: 50%
00111	Moderate left-turning		Left motor: 50%, right motor: 15%
01111	Big left- turning		
11111	Stop	Left and right motors stop running. P2[4:3] = 00	Left motor: 0, right motor:
000000	The car drives to the junction of the black intersections and keeps consistent with the same state as a moment ago		

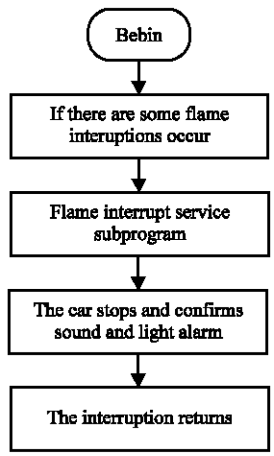

Fig. 6: Flow chart of interrupt program

the black lines, it keeps the same state as the last moment. The motor speed can be changed through adjusting the PWM duty cycle and realizes the functions of pulling to the left or right. The specific steering control is shown in Table 1. During the test process, the car can adjust the driving direction of the path along the black lines, which accomplishs the auto-searching function.

Obstacle avoidance function test: There is an obstacle avoidance sensor in front of the car, which connects to the P1.7 port of the single-chip microcomputer. We use the pop cans as the obstacles that are placed on the track. When the car meets an obstacle, the main program will call the avoidance obstacle subprogram, which can make the car skirt around the obstacle and continue to go along the track.

Light-seeking function test: There are 2 photosensitive resistances about 5~6cm apart in front of the car, which is a triangular-shaped installation. We use the flashlight as the light source to light the searchlight module in the dark room or in the daytime with no lights. The irradiation distance can be changed by adjusting the slip resistance. The car can drive forward, left or right along with the direction of flashlight. The results show that the experiments are better in the dark room than in the daytime because the light-seeking sensitivity is higher.

Flame detection function test: We light a candle as the source of fire. When the flame detector detects the flame (detection range is changed by adjusting the slide resistance), the circuit outputs low level signal to the microcontroller and accomplishs the interrupt function through INT1. Then the car will stop and the buzzer and LED begin the sound and light alarm, which notifices us that the source of fire has been detected.

CONCLUSION

In this study, we accomplish the intelligent car disgign using a variety of sensors to complete tracking, avoidance, seeking light and flame detection, etc. We have given specific hardware circuit design and software programs. After many tests, the experimental results indicate that the car can automatically drive along the black track smoothly. We can use the single chip microcomputer PWM to control the angle of turn. The distance detection and sensitivity can achieve desired goals. When there is an obstacle, the car can bypass it smoothly. When there is a light source, the car can move along the light track. When the car detects the fire, it will stop and realize sound and light alarm. All these functions can achieve the expected target. The hardware circuit design is simple, small size and low power consumption. All these technologies provide some important reference value to the design of intelligent vehicle. Meanwhile, this work is very important in some applications such as robots, intelligent light source, fire detection.

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