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Design of the Intelligent Trace-Keeping Robot Car Based On STM32

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Abstract: In order to realize the independent runing requirement of educational robot, given a system design for robot car to intelligent realize trace-keeping. The system based on STM32F103VET6 to identify paths by photoelectric sensor YL-70 and comparator LM339 circuit and to measurement and display the date of distance of obstacle by ultrasonic sensor US-100 and Serial port screen; The system using DRV8833 to drive DC motor and to add intelligent algorithm of tracking and obstacle avoidance, realized the trace-keeping robot car system in the end. Experiment shows that the car is able to move along the established route and can automatically avoid obstacles when encountered obstacles.
Index Terms: tracking; Obstacle avoidance;robot car;motor drive

I. INTRODUCTION

With the rapid development of robot, it is not only a hobby or works for geek, it has penetrated into all walks of life, and gradually come into thousands of households.In the process of promoting quality education in the Ministry of education, the robot education has been strongly supported by the relevant government departments.the educational robot is produced under this kind of environment, it can be used as a teaching aid to many disciplines teaching. The educational robot platform is composed of the parts shown in Figure 1, It is divided into two parts, software and machinery, in which the software part is an integrated programming environment of the computer software, used to carry out educational robot control program design; The mechanical part includes the basic components, transmission parts, power components, controllers and sensors, etc. Using these mechanical components, the user can according to their own ideas, freely combined into a wide range of robot system[1]. In order to enrich the educational function of the robot, the design of this article uses ultrasonic sensors, infrared tracking sensor and the existing mechanical components, combined into a Educational robot which can autonomous obstacle and avoidance tracking. The design of the educational robot is a smart car for the mechanical ontology, the car can be in accordance with the user set the trajectory of the road to walk correctly and to avoid obstacles[2].

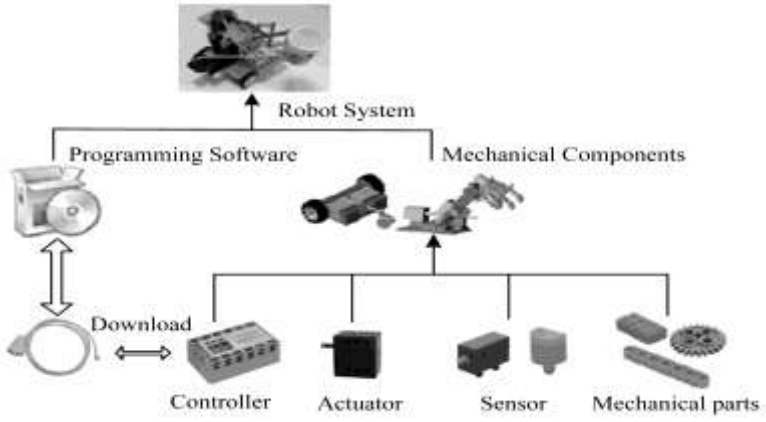

Figure 1 Composition of educational robot

II. THE DESIGN FOR SYSTEM HARDWARE

2.1 Overall Design

The design of the robot controller is based on STM32F103VET6 as the main control chip, the car through the ultrasonic ranging to get the distance of the obstacle display distance and the real-time motion of car on the serial screen.controller according to the feedback information, judging and adjusting the vehicle speed and direction, to avoid obstacles, the car will continue to advance tracking. The design of the intelligent car is mainly composed of a controller, DC motor, tracking and ranging sensor and the car body. The circuit module of the controller mainly includes the minimum system circuit, the serial port screen module, the motor drive module, the sensor interface module and the USB download circuit. The overall composition of the system is shown in Figure 2[3-5].

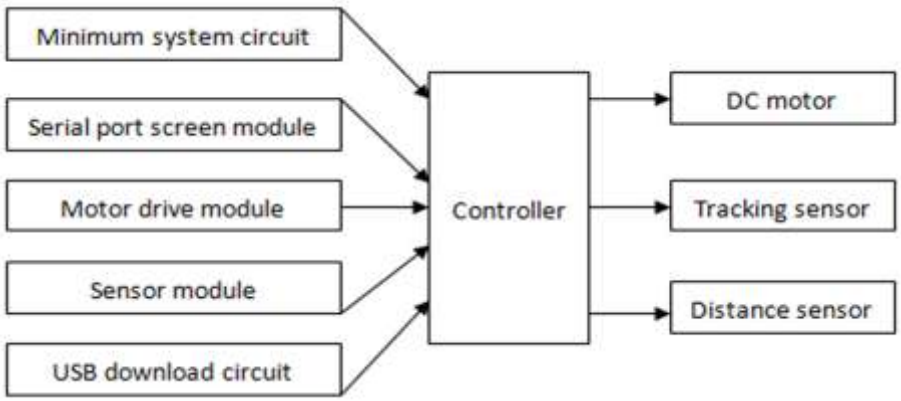

Figure 2 System structure

2.2 Master Chip

The controller uses STM32F103VET6 as the control chip, is the car's brain. STM32F103VET6 is a 32 bit high performance and low power the stmicroelectronics production of the micro controller, the kernel for the Cortex-M3, the clock frequency is up to 72MHz, 64KSRAM, 512K with large capacity FLASH space, with up to 100 pins, Chip with serial port, IIC, SPI and other high-speed communications, to provide an efficient solution for many embedded control applications, it has the characteristics of simple control, convenient and fast.

2.3 Motor Drive Module

This paper uses two DC motor drive to achieve the car's forward, backward, left and right steering and so on. The two motors control the left and right wheels of the car. The car's steering is achieved by controlling the left and right wheel speed, when the speed of left wheel is higher than the right wheel when the car to the right, and the car to the left in contrast.The running speed of the car is controlled by the PWM speed regulation method,The timer output pin of ARM chip output a series of fixed frequency square wave to drive motor,to change the timer output by programming ARM chip duty cycle of the square wave can change the average voltage applied to the motor, thereby changing the motor speed. Two motor speed of the rear wheel can be achieved with the car forward, backward, turning and other functions[6].

For ordinary DC motor have a high speed, difficult to control the torque is small, but the design of the car speed should be controlled, the requirements of the motor speed is not too fast, and the DC motor can overcome the shortcomings of common DC motor.The motor driver chip select the dual channel H bridge motor driver DRV8833. it is simple to connect, support 2.7-10.8V wide power supply voltage, the maximum output current is 4A, which is an essential tool for smart car. The motor circuit is shown in Figure 3.

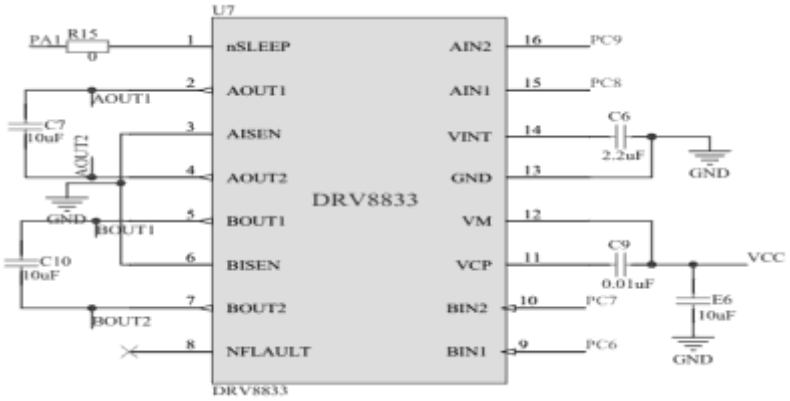

Figure 3 Motor circuit

2.4 Tracking Module

The tracking module uses infrared tracking sensor to identify paths on the road. The four tracking sensor are orderly arranged in the front of the car at the bottom (Fig. 4), the distance between two sensors are 2cm, the difference color between black paths and white ground is great,the sensor receives the reflected light intensity is different between them. So, we can according to the detected black phototube to determine the direction of the car.

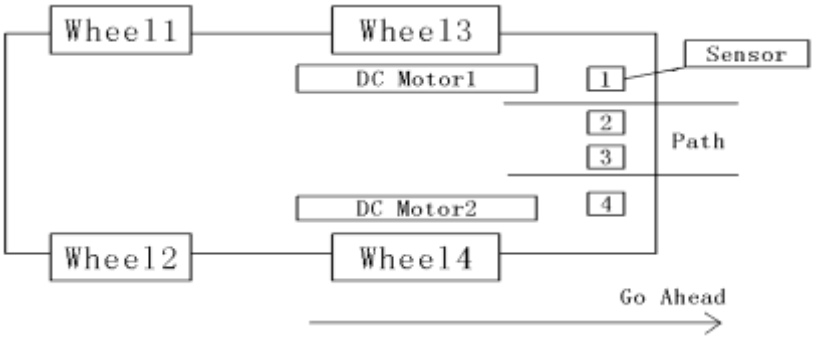

Figure 4 Distribution of tracking sensor

The relationship between Car motion state and four output tracking sensor showns in table 1.

Table 1 Motion state logic table of car

Car motion state	Sensor1	Sensor2	Sensor3	Sensor4
Severe left	1	1	0	0
Left	0	1	0	0
Middle	0	1	1	0
Right	0	0	1	0
Severe right	0	0	1	1

When the emitting diode in tracking sensor in conduction,it emits infrared, infrared reflected from the object(path) reflected to the receiving tube, it will make the resistance between receiving tube collector and emitter becomes low, the comparator output is low after LM339,the signal of input will send to ARM chip to analysis. When the infrared on the path, the light reflected to receiving tube will reduce,the resistance between collector and emitter of receiving tube will become greater that will make the output with high-level[7-8].So,The software of the controller can accurately determine whether the position of the car is off track by judging the level of the received level.

2.5 Obstacle Avoidance Module

The function of obstacle avoidance module is to slove problem that tracking car can not moving when obstacle before the car.The design of module adopt ultrasonic sensor to detect obstacle and have a obstacle avoidance algorithm makes the car can steer clear of obstacles to move forward. Using US-100 ultrasonic sensor as the detecting element to detect obstacles ahead,It can provide 2cm-450cm non-contact distance sensing function, the ranging accuracy of sensor can reach 3mm and with high accuracy and strong anti-jamming performance to meet the requirements of the system.It can judge the distance between obstacle ,the module includes an ultrasonic transmitter, receiver, and a control circuit[9].

At the front of the bottom of car have installed ultrasonic sensor, when the controller detect obstacles on the track, if the distance between the front and the obstacle is less than the set value, the car will slowed down. And then the car began to turn right, go along the obstacle, because of constraints of the size of the obstacle in advance, thus ensuring the car along the obstacle avoidance process will encounter obstacles. When sensor detected paths again, the car began to adjust the trajectory,and to continue tracking, the car will around obstacles and continued along the path in the end.

III. THE DESIGN FOR SYSTEM SOFTWARE

3.1 Main Program Module

The program using with keil uVision5,the main program included initialization system, obstacle avoidance function, tracking function, motor control and serial screen program.The main function of the program is to initialize each function module, at the same time, the corresponding configuration of the ARM initialization. The car began to enter the circulation mode, constantly scanning the state of I/O for sensor when it is connected with the controller, once detected the signal of I/O port has changed, the implementation of the corresponding judgment procedure, corresponding to the output PWM wave to control the DC motor to control the operating state of the car. The main program flow chart is shown in Figure 5.

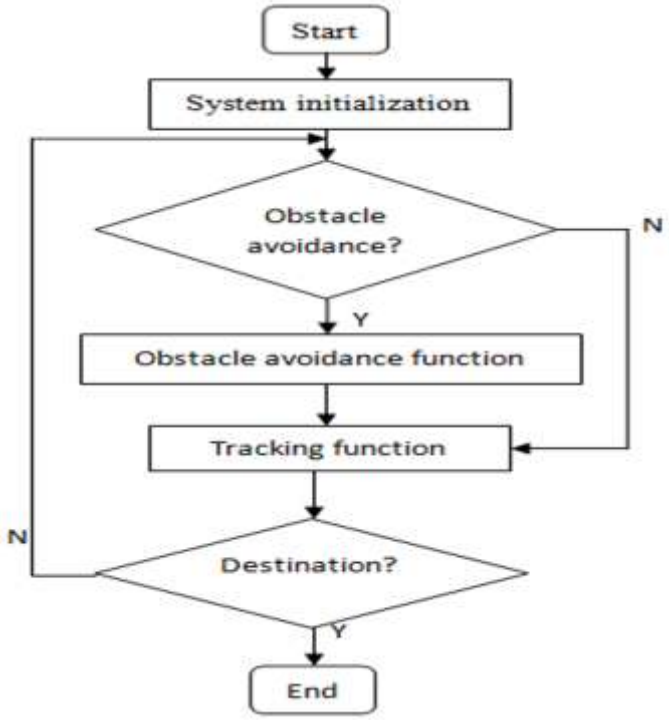

Figure 5 Flow chart of main program

3.2 Tracking Module

When the car entered the tracking mode,the ARM chip will have a real-time detection of level state for corresponding to I/O port,and through the judgment processing program execution to determine the operating state of the car,and then the corresponding execution forward, turning left and right operation, tracking procedure is shown in figure 6

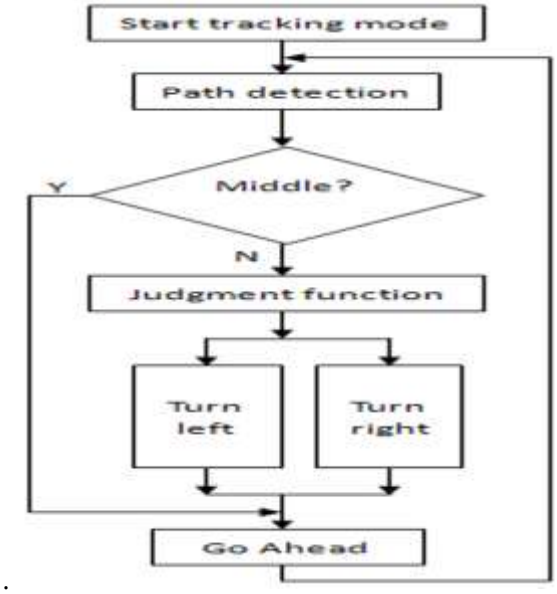

Figure 6 Flow chart of tracking

3.3 Obstacle Avoidance Module

When the car entered the obstacle avoidance mode, ARM chip have a real–time detection of the date for ultrasonic sensor, and through the comparison of judging distance and safety distance data, to determine the operating state of the car, and then the corresponding execution deceleration, turn left, bypass, before operation, obstacle avoidance program flow as shown in figure 7.

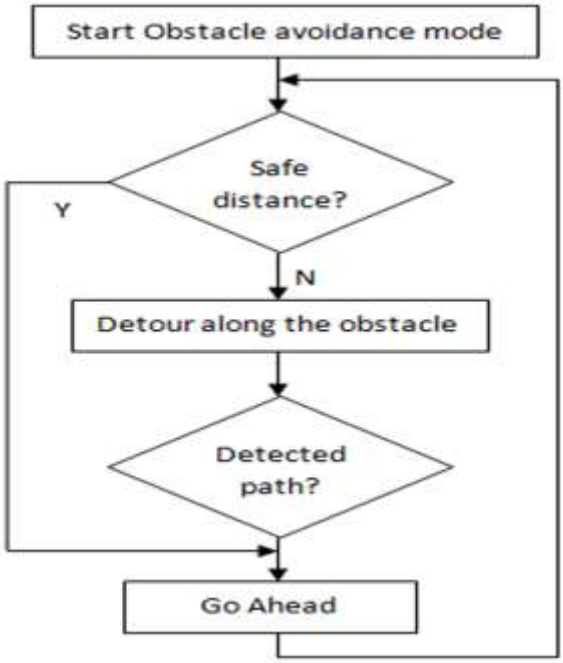

Figure 7 Flow chart of obstacle avoidance

IV. EXPERIMENTAL RESULT

According to the design of this article make the robot car of tracking and obstacle avoidance,through the actual test results show that: the car hace a smooth running process and did not deviate from the experiments in the process of turning arc,speed can be adjusted through the program, it have a stability performance. In order to clearly show the advantages of the robot car designed in this paper, we designed the following three kinds of car:

（1）car1：the car of this article, 4 tracking sensor, using PWM speed control

（2）car2：3tracking sensor, using PWM speed control

（3）car3：3tracking sensor,no PWM speed control

There are have a compare between speed, tracking and obstacle avoidance, as shown in table 2. compared to the car 2 and car 3, the stability of car 1 has been greatly improved.

Table 2 Experimental result

Car name	Experiment times	Speed（cm/s）	Failure of obstacle avoidance times	Off track times
Car1	10	13	0	0
Car2	10	13	1	2
Car3	10	12	1	3

V. CONCLUSION

In this paper, according to the design of hardware and software for smart car, realize the control of the car, to avoid obstacles and intelligent tracking route.In the design of the software part uses the modular design idea, in order to facilitate the software revision, the management as well as the transplant.The experimental results show that the car using ultrasonic sensor US-100 to measure the distance of the obstacle,the obstacle avoidance control effectively, using infrared tracking sensor to detect the track line on the road.The car can running according to the predetermined trajectory, at the same time in the operation process, the software on the ARM chip to judge the operation status of the car, but also to change the speed of car by PWM.

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