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Design and Analysis of an Intelligent Car Based on Multiple Platforms

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Original Research Article

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Abstract: This design applies a STC89C52RC single chip microcomputer (SCM) as a main control chip, and uses the information of road surface transmitted from sensing modules like cameras, infrared sensors and ultrasonic sensors to monitor and identify obstacles and adjust the driving directions of an intelligent car, thereby realizing the functions of velocity measurement and obstacle avoidance. The preliminary experiment of exploring the intelligent car shows that this designing scheme is valuable to refer and apply to some extent.
Keywords: Single chip microcomputer; multiplea platforms; driving circuit.

INTRODUCTION

Intelligent car is a robot system that can perceive the environment and its own state through sensors, and achieve the goal of autonomous motion in complex environment with obstacles, so as to complete certain operation functions. Its system design is based on automotive electronics, and covers many creative designs, such as mechanical, electronic technology, sensor technology, control and so on [1].

This design applies a STC89C52RC single chip microcomputer as a main control chip, and uses the information of road surface transmitted from sensing modules like cameras, infrared sensors and ultrasonic sensors to monitor and identify obstacles and adjust the driving directions of a intelligent car, thereby realizing the functions of velocity measurement and obstacle avoidance.

Design requirements and systematic mechanism

Design requirements

The requirements of the intelligent-car designing mainly contain the following specific features: wireless remote control, automatic tracing, automatic obstacle avoidance, video surveillance and velocity measurement. In terms of these technical requirements, the design idea is based on a STC89C52RC SCM to install devices of an infrared sensor, a WIFI module, a camera, a photoelectric sensor and a speed sensor on the car so as to conduct real-time measurement of the data like speed, position and operating status of the car. After receiving these measurements, the SCM will process data so that to finally achieve intelligent control to the car according to various detected results [2-3].

Systematic mechanism

The designing scheme about the intelligent control of the smart car proposed in this paper can be achieved by the STC89C52RC SCM. The start-up and reset of the car is manually operated, and the running of the car is controlled through a mobile terminal system. In the course of driving, the STC89C52RC SCM will control the car so as to collect video data, display videos, regulate the speed and avoid obstacles. During the driving process, infrared photoelectric sensors are equipped on the right and left sides in front of the car to detect the obstacles ahead of it. And through the control of the SCM, the automatic obstacle-avoidance function of the system can be realized. The combination of an ultrasonic sensor with coded discs is applied to measure the motor speed in order to achieve the measurement and adjustment of the car speed. Moreover, in the driving process, the SCM processes the data from the camera and transfers them to the mobile terminal. The tracking module adopts an infrared receiving module IR1838, which enables the car to independently identify black guiding lines, so that to realize fast and stable line hunting according to the black lines of the tracking module[4].

Hardware design

Designing scheme of the systematic structure

The main control chip of the intelligent car is a STC89C52RC SCM, and the whole system is divided into the following modules: host computer systems of Android, IOS and PC, a voltage-regulation circuit module, a controller module, a direct current motor module, a drive module, a tracking module, an obstacle-avoiding module, a speed-measuring module, a WIFI module and a camera module. The overall frame diagram of the hardware is shown in Figure 1.

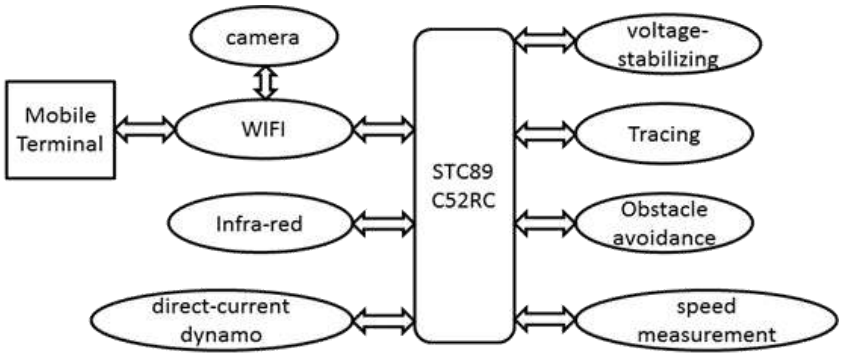

Fig-1: The structure diagram of the system

The STC89C52RC SCM and its peripheral circuit

The SCM, STC89C52RC, is a CMOS 8-bit microcontroller with low power dissipation and high performance. It also possesses an 8K programmable Flash memory in the system. The SCM is equipped with a classic MCS-51 core, but a number of enhancements have been made, so that the chip can have some features that are not available to the traditional 51 SCM. The key features are an 8K bytes Flash, a 512 bytes RAM, a 32-bit I/O port line, a watchdog timer, a built-in 4KB EEPROM, a MAX810 reset circuit, three 16-bit timers/counters, four external interrupts, a 7-vector and 4-level interrupt structure (compatible with the traditional 51-type, 5-vector and 2-level interrupt structure) and a duplex USART. In addition, the stc89c52 can be reduced to a 0Hz static state to conduct logic operation, which supports two kinds of software and allows selecting the power-saving mode. Under the idle mode, the CPU stops working, but the mode allows the RAM, timers/counters, serial ports and interrupts to continue working. In the power-down protection mode, the RAM content is saved, the oscillator is frozen, and all the functions of the SCM are stopped until the next interrupt or the reset of the hardware. The maximum operating frequency is 35MHz on the basis of the optional choices of 6T and 12T.

Module design

The obstacle-avoidance module. In the designing scheme, a HC-SR04 ultrasonic module is applied to achieve obstacle avoidance, and it is also able to provide a non-contact distance sensing function in the range of 2~400cm with the accuracy of 3mm which is as high as to meet the systematic requirements with strong anti-jamming performance. The function is also useful in identifying whether an obstacle is a hump on the ground or a barrier that is unable to be getting through. Meanwhile, this module consists of an ultrasonic transmitter, a receiver and a control circuit.

The tracking module. This design selects an IR1838 infrared probe to apply the infrared detection method, that is, to take advantage of the different reflective properties when infrared rays radiate on physical surfaces in different colors. In the process of driving, the probe constantly emits infrared lights to the ground, and when the ground is white, the infrared lights will be diffused and the reflected lights will be received by the receiving tube on the car. If the infrared rays radiate on a black line, they will be absorbed, and the receiving tube cannot receive any signal. Under these circumstances, through using LM324 as a comparator to collect high and low electrical levels, the detection of signals can be achieved.

The velocity measurement module. An ultrasonic sensor, which consists of a transmitter and a receiver, is chosen in this design. The SCM controls the transmitter to send a pulse with the frequency of 40 kHz and starts timing at the same time. When encountering a nearest obstacle, the pulse will be reflected back to the receiver, and at the end of the timing, the distance can be calculated by the time span between the sending time of the pulse and the time that it is received, and then be further converted into speed.

The camera module. The design applies an UVC camera which connects with a gl-inlet router through an USB interface. After installing a driver and video monitoring software, video signals can be transferred by the WIFI function of the gl-inlet router.

Software design

The software of this system applies a modular construction and is composed of a main program and several subroutines of setting the orientation of the camera, controlling the running of the car, displaying the car speed and collecting and showing videos (Figure 2). However, the main function of this software is to collect and control the signals from the sensors and the camera. And the buttons of moving forward and backward and turning left and right as well as the speed-control buttons on a TV enable the car to avoid obstacles flexibly. Meanwhile, the software also plays a role in the functions like making initial programming for the SCM.

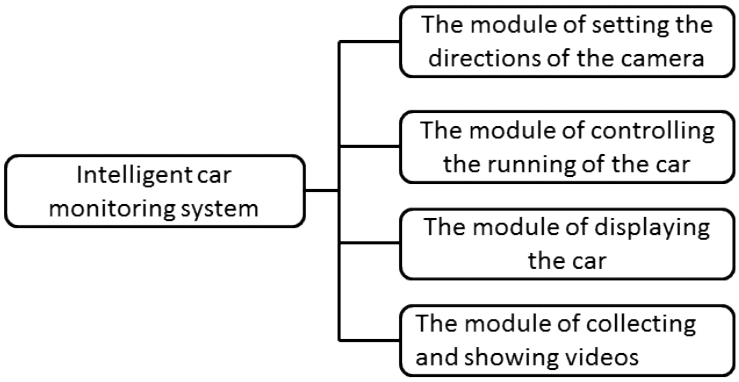

Fig-2: Software modular structure

System testing and performance evaluation

In this paper, the system design is based on the principles of SCMs, sensors and cameras. Through considering the STC89C52RC SCM as the main control chip, adopting a L293D and a 12V direct current motor as the drive elements and conducting software programming, a infrared obstacle-avoiding car with a complete set of construction, modular functions and relatively more flexible reaction is manufactured. After testing the obstacle avoidance of the car, it is proved that this car is capable of avoiding obstacles and finishing the expected avoiding moves greatly. Meanwhile, the car can run quickly and avoid obstacles sensitively with good effect and running stability.

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