Design of the Multifunctional Sensor System for Intelligent Car

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Received: 21 September 2013 /Accepted: 22 November 2013 /Published: 30 December 2013

Abstract: Using the signal-chip microcomputer STC12C5A60S2 as the control core, supplementing with the motor drive module of L29N, an intelligent car integrated with functions of tracking, detecting fires, evading barriers intelligently, measuring distance and wireless communication has been designed. The function of tracking automatically is completed by infrared tube and its control circuits, the function of evading barriers intelligently is utilized by proximity sensor, precise distance is controlled by ultrasonic, and the collision of cars is effectively avoided, fire detection is realized by infrared receiver and smoke sensor MQ-2, the method of extinguishing fire is wind. The PWM technology is used to drive motors, in this way, the speed of the car is controlled flexible and conveniently, increasing wireless transmission module of NRF2401, they can ensure the car runs smoothly on the designated runway. Under the control of the signal-chip microcomputer STC12C5A60S2, each functional module works stably and reliably. Copyright © 2013 IFSA.

Keywords: Multifunction, STC12C5A60S2, Sensor, Method of extinguishing fire, PWM, Wireless transmission.

1. Introduction

With the rapid development of computer, electronic technology and control technology, a wide variety of consumer products present miniaturized, intelligent, multi-functional and other trends. Currently, in the harsh environments of disaster relief, expedition, explosive ordnance disposal and hazardous locations, manual operation mode is still used. With the increasing cars, traffic accidents occur repeatedly, a lot of manpower and financial resources have been wasted. In the intelligent management and automated production, development of the multifunctional sensor system for intelligent car has become necessary and urgent [1]. Therefore, we have conducted the research and design of the multifunctional sensor system for intelligent car, design of the intelligent car will help the development of intelligent car, the realization of the intelligent car will play an important role in the progress of human society and establishment of the harmonious society.

2. Status of Sensors Applied in the Car

With the continuous development and application of electronic technology in the automotive field, electronic degree of cars continuously improves, the traditional mechanical system is difficult to solve this problem, some problems relating to the feature require of cars will be gradually be replaced by...
Sensor is equivalent to the eye, nose, ears and even the skin of human, it can transmit information to the brain of car, and sensor can work reliably in harsh environmental conditions. Therefore, sensor is the core of collecting information and feedbacking information; it has a very important role in cars. Currently, ordinary car is equipped with about a few dozen to hundreds of sensors, luxury car is more, these sensors are mainly located in the engine control system, chassis control system and body control system, but sensors have not been applied in intelligent tracking, processing barriers intelligently, anti-collision and other aspects.

3. Block Diagram of the System

The multifunctional sensor system for intelligent car is mainly made of seven parts [2], which are power module, controller module, the detection module of sensors, the alarm module of sound and light, motor driving modules, ultrasonic ranging module and the module of wireless transmission, the detection module of sensors are mainly consist of infrared tube, proximity sensor and smoke sensor MO-2. The block diagram of the system is shown in Fig. 1.

4. Design of the Main Modules

4.1. Design of the Power Module

The multifunctional sensor system for intelligent car uses two blocks of polymer batteries, they are in series connection, in this way, +7.4 V DC voltage is gotten, it can provide power to the motor driving module. In order to ensure conversion efficiency and reduce energy loss, we use the chip LM2596 to step-down the +7.4 V DC voltage, then +5 V DC voltage is gained, the circuit of power is shown in Fig. 2, the potentiometer is fine-tuned, so that the output voltage is more stable and accurate, it can provide power to STC12C5A60S2, sensors and other modules.

4.2. Design of the Controller Module

The multifunctional sensor system for intelligent car uses the signal-chip microcomputer STC12C5A60S2 developed by STC company as the controller, the chip is fully compatible with the traditional 51 series chips, and its power consumption is lower, its speed is faster, its anti-interference ability is strong, on the basis of the traditional 51 series chips, two output of PWM are added, the PWM speed control of motors can easily achieved [3], the signal transmission is completed by wireless communication. The controller circuit is shown in Fig. 3.

4.3. Design of the Intelligent Module of Tracking and Avoiding Obstacles

Functions of tracking automatically and avoiding obstacles intelligently are achieved by infrared tube
4.4. Design of the Detecting Module of Fire

Fire detection is completed by infrared sensors and smoke sensors MQ-2. Infrared sensor detects fires through infrared ray in air, and MQ-2 achieves early warning by detecting smoke and flammable gases. The physical map of MQ-2 is shown in Fig. 6, the internal structure and peripheral circuit of MQ-2 is shown in Fig. 7 [5]. MQ-2 is consist of heater and gas sensitive element, heater provides necessary environment for gas sensitive element. With the increase of external smoke and flammable gases, the resistance of sensitive element changes, its resistance is related to the concentrations of smoke and flammable gases. A resistor is connected to MQ-2, the analog signal is taken from the middle, the analog signal is input into LM393, and thus detecting fire is realized.

4.5. Design of the Motor Driving Modules

Special motor driving chip L298N is used to drive motor. L298N can achieve positive inversion, brake, PWM speed control and other functions. It is an ideal chip for controlling motors, the driving circuit of motor is shown in Fig. 8. The control of the car is fully completed by programming [6]. Signal power and driving power of L298N is separately, according to the needed, the voltage of the motor can be adjusted, its rotational state code of motor is shown in Table 1.
Table 1. Rotational state code of motor.

<table>
<thead>
<tr>
<th>Motor</th>
<th>Left motor</th>
<th>Right motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pins of MCU</td>
<td>P1.0</td>
<td>P1.1</td>
</tr>
<tr>
<td>Run forward</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Run backward</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Turn right in situ</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Turn left in situ</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Turn right in situ as</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>the center of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>right motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn left in situ as</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>the center of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>left motor</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4.6. Design of the Ultrasonic Ranging Module

Because ultrasound has characteristics of strong implementation, low energy consumption and farther distance spreading in the medium [5], we use ultrasonic ranging module DIP-ME007 to measure distance, the circuit board of ultrasonic ranging module is shown in Fig. 9. DIP-ME007 can quickly and conveniently measure the distances between the car and obstacles, DIP-ME007 has five pins named VCC, trig, echo, out, GND respectively, the output mode of DIP-ME007 is PWM. When VCC, GND are connected well, trig will receive a high level more than 10 μs, a high level can be output from echo. STC12C5A60S2 uses edge trigger, STC12C5A60S2 starts the timer after trigger. When the level is slow, the timer is read, the read time is ranging time, according the flowing formula, we can get the measured distance.

\[ S = \frac{C \cdot t}{2}, \]  

where \( S \) is the distance, \( C \) is the speed of ultrasound, \( t \) is the ranging time. Mobile distance measurement can be realized by the periodic measurements, crash accidents are effectively avoided.

4.7. Design of the Alarm Module of Sound and Light

The alarm module of sound and light relies on cheap colorful LED and music module, the alarm circuit of sound and light is shown in Fig. 10. When dangerous signals, or cars or obstacles are detected, STC12C5A60S2 turns on LEDs through the transistor 9012, meanwhile music module begins to work, alarm signals are sent out.

4.8. Design of the Module of Wireless Transmission

In order to ensure the car can work safely and stably, the module NRF2401 of wireless data
transmission is increased, the circuit of wireless transmission is shown in Fig. 11. NRF2401 is a new RF transceivers device, it operates in 2.4 GHz-2.5 GHz band, it includes frequency synthesizer, power amplifier, crystal oscillator, modulator and other modules. The module contains a variety of low-power mode, and it has automatic retransmission of lost data function, so that signals are received more securely, it can successfully complete data transmission [7].

Fig. 11. Circuit of wireless transmission.

5. Software Design of the System

The software control function of the care is completed by using C language programming, under the help of the power functions of C language, control functions of STC12C5A60S2 are realized, so the entire system can work orderly [8-9]. The main flow chart of the system is shown in Fig. 12.

6. Test and Analysis of the System

According to the actual needs, we build corresponding site, and obstacles, flame and running vehicles are set, let the intelligent car run repeatedly in the test site. According to test results, the car is continually modified, improved until the car better achieve all functions. Relationship between the detection range of the proximity sensor and angles is shown in Table 2, relationship between the detection range and limiting resistors of proximity sensor is shown in Table 3.

Test cases indicate the car can work correctly, it can take appropriate measures to deal with obstacles, after obstacles are detected. But the detection effect of the proximity sensor for obstacle depends on its mounting position and its limiting resistors. Therefore, the proximity sensor should be reasonably placed according to the requirements of the system, and its limiting resistor is adjusted suitably.

Table 2. Relationship between the detection range of the proximity sensor and angles.

<table>
<thead>
<tr>
<th>White ground</th>
<th>Angle (°)</th>
<th>Detection range (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black ground</td>
<td>Angle (°)</td>
<td>Detection range (mm)</td>
</tr>
</tbody>
</table>

Table 3. Relationship between the detection range and limiting resistors of the proximity sensor.

| Operating voltage | Limiting resistor (Ω) | Detection range (cm) |

7. Conclusions

By trying various programs, experiments and repeated debugging of the overall system, the multifunctional senor system for intelligent car can
track automatically, avoid obstacles intelligently, find right path and process obstacles flexibly. It is sensitive to risks caused by spontaneous combustion and flammable gas, and it can eliminate them. The multifunctional sensor system for intelligent car can also effectively prevent the occurrence of crashes. The system has a simple structure, high rate of quantity and high intelligence, so it has the best prospect.

References

[9]. Li Xinke, Gao Chao, Guo Yongcai, He Weihua, Design of sele-tracking smart car based on speech recognition and infrared photoelectric sensor, Transducer and Microsystem Technologies, 30, 12, 2011, pp. 105-108.