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Design and Implementation of a Vehicle Parking Positioning Assistant Device

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Abstract. At present, it is difficult to grasp the distance behind the vehicle when reversing vehicles, especially ultra-long and ultra-high vehicles, and there are some potential safety hazards. In order to solve this potential safety hazard and enable vehicles to park in garage more quickly and accurately, this paper designs and implements an ultrasonic ranging and parking positioning auxiliary device based on STC89C52 microcontroller. Main work: First, the overall scheme design of the device is completed. Then, the hardware circuit design and software design of the device are completed, and the hardware circuit composition, software design thinking and working principle are elaborated. Finally, through continuous testing, a large amount of data is collected and the applicable distance range and reliability of the device are analyzed. The test results show that the device can be applied to the auxiliary positioning of large vehicles with good operability and positioning accuracy, and can satisfy the requirement of reversing the vehicle into the garage.

Introduction

Parking aids for vehicles have undergone several generations of development, each with its own characteristics. The first generation of reversing horn: little beep will repeat the broadcast as long as reversing, but it does not provide distance information to the driver and is of little help to the driver. Second Generation Buzzer: Sound alarm when the reversing distance reaches the preset value. This is the start of reversing radar, which can remind the driver to grasp the reversing distance. However, the man-machine interaction is poor, and the driver cannot know the specific digital information, which is not convenient for judgment. The third generation of digital band display: it can display the distance information measured by the sensor on the digital tube, which realizes interaction, and integrates the digital and band, and can display distance and remind whether it is a safe distance. The fourth generation LCD display: LCD display is similar to digital tube, but LCD dynamic display is a leap. As long as the vehicle is started, the LCD panel will display the vehicle graphics and the distance to the surrounding obstacles. Fifth generation magic mirror reversing radar: rearview mirror and reversing radar are integrated. It can be used as a rearview mirror to observe and also as a display of reversing radar. It can realize accurate measurement within 2m and is easy to install. It is directly installed with rearview mirror and has voice broadcasting function. The sixth generation automatic parking system: according to the ground marking and the surrounding environment, the vehicle-mounted computer measures the distance and angle of the surrounding obstacles with the radar probe installed on the vehicle body, collects the environmental pictures through the cameras around the vehicle body, and then plans the optimal process through the vehicle-mounted computer system to automatically park the vehicle in place.

At present, ultrasonic wave is still the best sensor for reversing distance measurement. The development trend in the future is toward human-computer interaction. Single chip computer calculates the distance through sensors. Distance information should be displayed through various means such as digital, image, video, language, etc. It is more convenient for drivers to check. For large vehicles, wireless transmission should also be considered to process and display the data in a unified way.

Overall Scheme Design

This paper mainly aims at the difficulty in grasping the distance behind the car when reversing into garage. in order to avoid the occurrence of vehicle accidents, it provides reliable basis for drivers and commanders to park the vehicle at the designated position accurately. Therefore, the functions of the parking positioning auxiliary device include:

(1) The device is easy to carry and install.

(2) Suitable for various environments, different alarm distances can be set.

(3) In the process of parking, help drivers and commanders to grasp the distance, that is, display the distance.

(4) The distance between vehicle and obstacle can be measured.

(5) When the distance reaches dangerous distance, the device can alarm in time.

Overall design ideas: Firstly, SCM(Single chip microcomputer)module is used to control the transmitting and receiving circuit of the ultrasonic module HC-SR04 and to process the data. Then the data is displayed by digital tube. At the same time, the dangerous distance is judged and buzzer alarm is given.

In terms of hardware, according to the function of the device, the structure of the auxiliary device must have the ultrasonic module, the SCM control unit, the display circuit and the alarm circuit. The structure block diagram of the auxiliary device is shown in Fig.1.

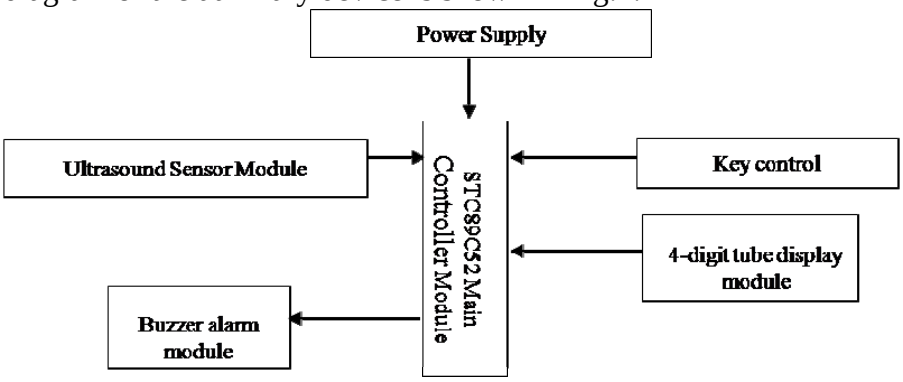

Figure 1. Framework of ranging alarm system

In terms of software, the system software design adopts modular design, mainly including main program design, distance calculation subprogram, interrupt service subprogram, key setting subprogram, display subprogram, delay subprogram and alarm subprogram design, etc. The main program is the core of the whole program design. Its main function is to call each subprogram to calculate and control them to complete their respective functions. Interrupt service subprogram and delay subprogram are mainly used to judge the transmission time, reception time and delay time, so as to avoid straight beam trigger caused by direct transmission of ultrasonic wave from transmitter to receiver. The distance calculation subprogram is to calculate and measure the distance between the sensor and the target object. Show subprogram is to show the calculated results; Alarm subprogram is an alarm when the vehicle enters the danger close.

Hardware and Software Design

Selection of SCM

STC89C52 produced by STC Company is selected in this device. It is a low power consumption, high performance CMOS 8-bit microcontroller. The pin diagram is shown in Fig.2.

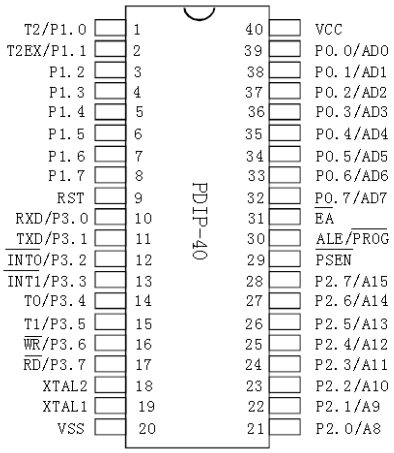

Figure 2. Pin diagram of STC89C52

Main Control Module

The main control minimum system circuit is shown in fig.3. The following devices are used in this design: STC89C52, ultrasonic sensor, key, four-bit digital tube, buzzer and other SCM peripheral application circuits. Three keys are used in the circuit, one is setting key, one is adding key and one is subtracting key. The overall design of the hardware circuit is shown in fig.4.

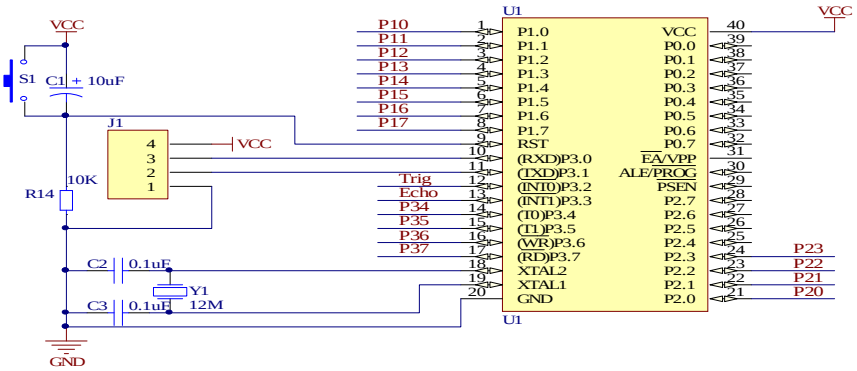

Figure 3. Circuit diagram of main control minimum system

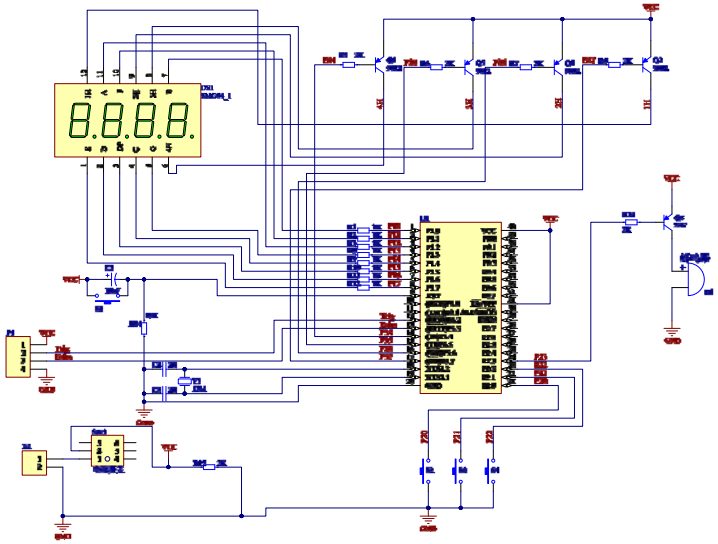

Figure 4. Circuit diagram of ranging alarm system

Ultrasonic Ranging Module

At present, the commonly used ranging sensors are laser ranging sensor, infrared ranging sensor and ultrasonic sensor. Although laser sensor is an ideal choice, but its price is relatively high, and its security is not high enough. In addition, in the course of driving, the ultrasonic sensor has strong anti-interference ability and short response time, so this paper chooses the ultrasonic sensor as the sensor probe of this design.

The existing HC-SR04 ultrasonic is used in the ultrasonic ranging module. The module can provide a non-contact distance sensing function of 2cm-500cm, and the ranging accuracy can reach up to 3mm.

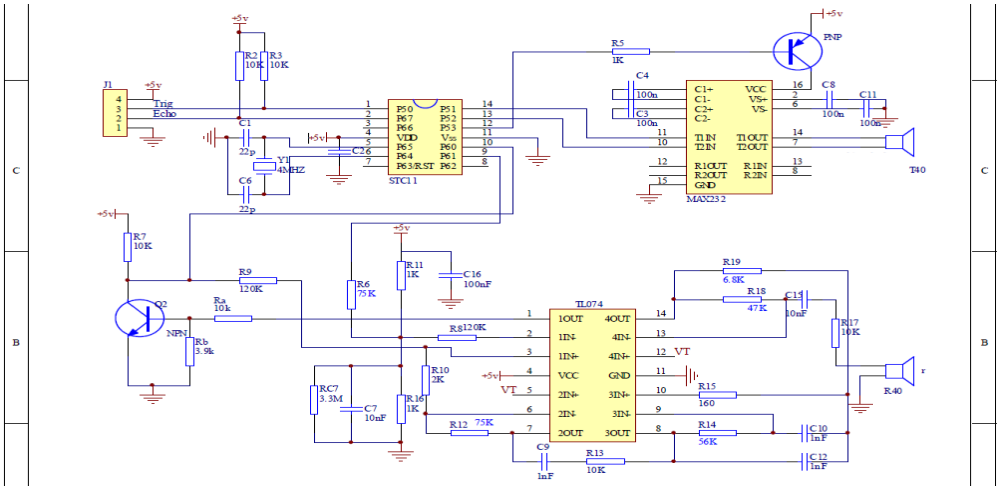

Figure 5. Circuit diagram of HC-SR04

Software Design

The software design of the device is programmed in C language, and Keil C51 is used as the development software. The software integrates programming and simulation debugging. It can be programmed in C language and assembly language, and the development environment is good. In order to improve the reliability of the device and the execution efficiency of the program, modular design is adopted for the device according to the functional requirements, and the program flow chart of each module is designed to simplify the programming and improve the execution efficiency.

Testing Experiment and Result Analysis

Static Ranging

The parking positioning assistant device designed in this paper is placed next to the tape ruler, moving the device to a certain distance, reading the numerical value displayed by the digital tube as shown in Fig.6, and recording it, as shown in Tab.1.

Table 1. Static Measurement Data Table

Tape indicator (CM)	Measured value (CM)	Tape indicator (CM)	Measured value (CM)	Tape indicator (CM)	Measured value (CM)	Tape indicator (CM)	Measured value (CM)
1	2	17	17	50	48	90	88
3	3	19	18	55	53	95	92
5	5	21	21	60	58	100	97
7	6	25	24	65	63	150	147
9	9	30	30	70	68	200	197
11	11	35	34	75	72	250	247
13	13	40	39	80	77	300	298
15	15	45	44	85	83	315	315

As can be seen from the above table, the measured data of the auxiliary device designed in this paper still have certain errors with the actual values, but the device plays an auxiliary role when used for parking and positioning. At the same time, all errors in the table are basically within 5CM, which does not have much effect on maintaining a safe distance between vehicles and obstacles, so static measurement errors can be ignored.

Dynamic Measurement

The completed auxiliary device will be dynamically measured in the garage, as shown in Fig.7.

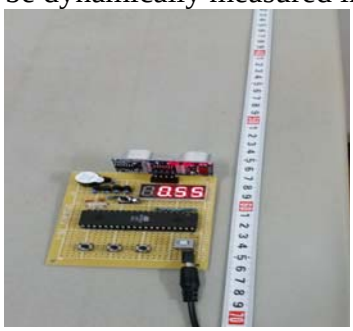

Figure 6. Static measurements

Figure 7. Dynamic Testing

Conclusions

The vehicle parking and positioning auxiliary device designed in this paper is mainly based on 89C52 SCM control core, and it is a display alarm device mainly based on ultrasonic ranging. Through the analysis of the theory and the actual situation, the design scheme of the device is basically feasible. It realizes SCM as the main control core, collects data through ultrasonic sensors, and the SCM control

core quickly calculates the distance from the obstacle and displays the result through a digital tube. At the same time, the buzzer is used to sound an alarm, thus achieving the purpose of assisting the vehicle to reverse into the garage.

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