Design and Research of Automotive Intelligent Avoidance Control System

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ABSTRACT : *With the rapid increase of the number of vehicles in the world, collision accidents are increasing year by year. Automobile intelligent collision avoidance control system can effectively ensure the safety of vehicle driving. Combining with the traditional infrared ranging principle, a vehicle avoidance control system based on DSP and infrared high-speed ranging module is proposed. The function design and key hardware circuit design are completed. Through the debugging of the system, it can be seen that the measurement accuracy of obstacles fully meets the control requirements. The system has reliable function, low cost and good stability, and has good application prospects.*

KEYWORDS -*automobile collision avoidance; control system; infrared ranging; DSP*

I. INTRODUCTION

With the increasing number of automobiles in the world, the incidence of road traffic accidents remains high, which has become a serious social problem [1]. Under some bad driving conditions, it is particularly prominent, such as bad weather, speeding, fatigue driving, etc. At present, the improvement of safe driving performance is still one of the most critical issues in the field of automobile research and development. In order to reduce the probability of vehicle collision accidents, scholars at home and abroad have carried out in-depth research on emergency collision avoidance system [2], and gradually got good development and application in the field of civil vehicles. Many automobile manufacturers mainly design collision avoidance system based on cameras, radar and other equipment, focusing on avoidance under low speed conditions, that is, using braking mode to prevent collision control, which is conducive to the driver's immediate response to emergency braking. However, in complex road conditions, this method cannot fully meet the requirements of drivers. For this reason, more and more researchers use laser, ultrasonic or infrared to collect obstacle signals around vehicles, and design intelligent avoidance or obstacle surmounting system to provide necessary early warning information or control signals for drivers [3]. Considering reliability and cost-effectiveness, an intelligent vehicle avoidance control system based on infrared ranging method is proposed, which can effectively solve the traffic inconvenience caused by fog and other bad weather, and has significant advantages in judging medium-distance obstacles.

II. WORKING PRINCIPLE OF THE SYSTEM

2.1 Infrared ranging

The intelligent vehicle avoidance function designed in this paper is based on the principle of infrared ranging [4]. Generally, the basic requirement of infrared ranging is the function of infrared transmitting and receiving, and the distance of obstacle avoidance can be calculated by the transmission time of infrared ray. Because of the large number of wireless signals in the environment, it is necessary for the system to set a specific infrared light frequency to avoid being confused or interfered by other signals.

However, conventional infrared ranging devices are only suitable for short distances, which greatly limit the function of the system and the safety of the vehicle. Therefore, the system uses a specific infrared sensing device, as shown in Figure 1. Its basic structure includes infrared emitter, receiving control terminal and signal input/output port. In addition, the infrared emitter is required to have a large power, not only to ensure the reliability of the measurement, but also to enhance the anti-interference ability of the signal. For the input/output module of the signal, standard voltage is needed to facilitate the calibration of distance accuracy.

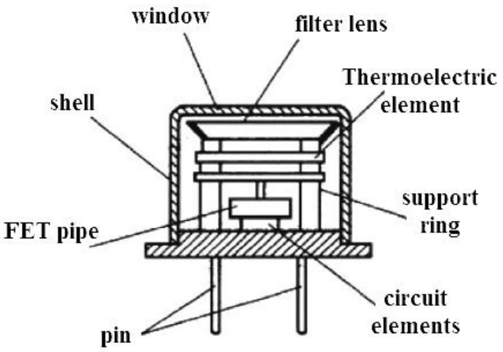

Fig.1 Internal structure of infrared ranging controller

2.2. Functional design

In order to improve the exploitability of the system [5], DSP2812 is used as the core processor of the vehicle avoidance control system. The basic functions of the designed system include: (1) the distance display of the nearest obstacle, the measurement deviation of the driving speed above 60 km/h is less than 5%, the measurement deviation of the driving speed within 20-60 km/h is less than 2.5%; the measurement deviation of the driving speed within 20 km/h is less than 1%; (2) the alarm value of the distance of the obstacle can be set according to the requirements, and the sound-light alarm can be carried out; (3) the measurement deviation of the driving speed within 20 km/h is less than 1%. Good interaction, easy to upgrade the system hardware; (4) stable communication, strong real-time. In order to further enhance the reliability and safety of the system, GPS and infrared high-speed sensors are used together, and the system is modularized. This can make the intelligent avoidance control system have better application effect in the safe driving of automobiles.

According to the function type, the sub-modules of the system mainly include infrared high-speed ranging module, display module, alarm module, JTAG interface module and SPI interface module. Among them, JTAG interface module provides program debugging, upload and download ports, and can upgrade the software system through RS232. According to the principle of function, infrared ranging function is controlled by DSP2812. When the system is started, DSP2812 receives instructions from the host computer or driver for real-time ranging. The sensor will output the transient voltage signal during the infrared transmission to reception, and the controller will recognize it after A/D conversion. DSP2812 obtains the distance of the target obstacle through data processing, and plans the best obstacle avoidance route through the specific algorithm in the software.

In the course of driving, the position and posture of the vehicle belong to the dynamic change, which results in the angle deviation of infrared ranging. For this reason, the mechanical base of the high-speed infrared sensor is set as a two-dimensional workbench, and the workbench is rotated within 180 degrees by two stepper motors. The range of motion is set to 250mm. Although the workbench mainly realizes the change of sensor's position and state with relatively low precision requirement, in order to ensure its stability, it is necessary to design the driving circuit.

III. System Design and Debugging

3.1. Key circuit design

In the reliability design of the system, besides the optimal selection of hardware, the driving mode of the mechanical base of high-speed infrared sensor equipment and the A/D conversion process are also required to be emphatically designed. For this reason, the driving circuit and A/D conversion circuit of the two-dimensional worktable are designed as shown in Fig. 2 and Fig. 3 respectively.

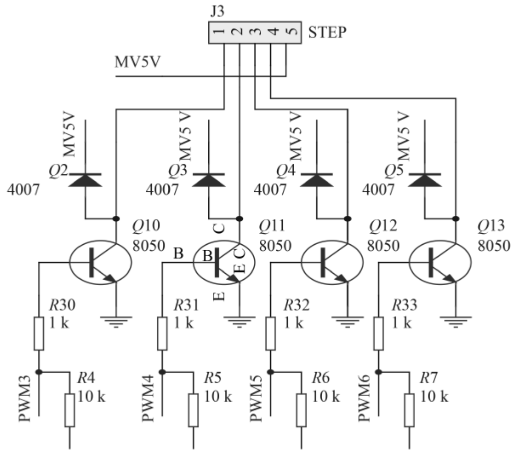

Fig.2 driving circuit of two-dimensional workbench

As can be seen in Fig.2, J3 is an external expandable motor interface. Stepper motor adopts automatic control mode and control instructions are directly recognized PWM signals. However, it needs to be amplified by triode 8050, and voltage protection function is performed according to diode 4007. As can be seen in Figure 3, in the process of A/D conversion, signal acquisition is mainly realized by ADC0804Q and transmitted to the controller DSP2812. A/D converter ADC0804 is a typical 8-bit, 1-channel analog-to-digital converter with output voltage of 0-5V. It has significant cost-performance characteristics and is suitable for relatively low precision requirements[6].

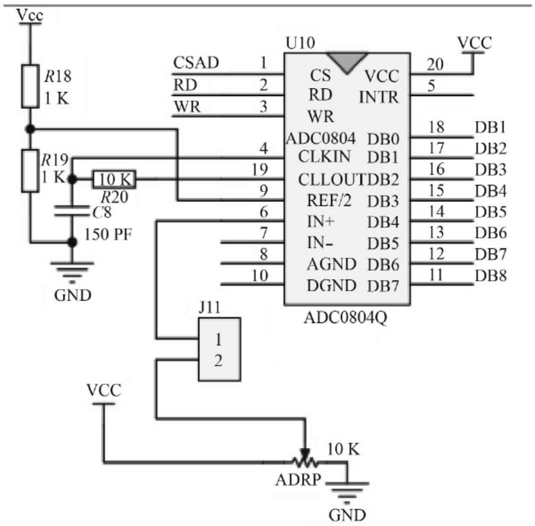

Fig.3A/D conversion circuit

3.2. System debugging and testing

After the hardware design is completed, continuous debugging is needed to achieve the ideal working state. In the process of system debugging, the following problems are found in the hardware of the system: (1) For power devices, there are some design defects in the driver part; (2) Communication interference. For the above problems, the system adopts the following optimization schemes: (1) Adding isolated power supply in the power circuit of driving circuit can effectively avoid the influence of power line and increase the safety and reliability of driving circuit; (2) Data communication adopts CAN bus mode, and the power supply voltage is changed to 12V, when the voltage generated by communication line is changed. When the reduction is less than 5V, it can still maintain strong communication intensity.

After the system debugging, the accuracy test is carried out during the vehicle driving process [7]. Set obstacles in the open area, and calibrate vehicles and obstacles. At different speeds, the distance between vehicles and obstacles is measured at special locations. Finally, the deviation between the actual distance and the measured distance is obtained as shown in Tab.1. It can be seen that the system has high measurement accuracy and fully meets the functional design requirements.

Tab.1 Measurement error analysis

Speed / $km \cdot h^{-1}$	Actual distance /m	Measuring distance /m	System deviation /%
5	20	20.13	0.65
10	20	20.15	0.75
25	20	20.33	1.65
45	20	20.48	2.4
80	20	20.39	1.95
100	20	20.63	3.15

IV. CONCLUSION

The intelligent vehicle collision avoidance control system designed in this paper can greatly reduce the incidence of vehicle collision, and has important significance for safe driving. Because the whole system is based on the principle of infrared ranging, it is very suitable for heavy fog, heavy rain, night travel or other low visibility driving conditions. In addition, the system fully takes into account the accuracy and reliability of measurement, meets the functional design requirements, has strong scalability, and provides a good foundation and prerequisite for later development or upgrading.

V. Acknowledgements

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