The research and development of the vehicle's lateral anti-collision warning system

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Abstract. The car brings modern civilization to people as well as great and startling harm. Especially in recent years, with the development of the expressway and the high speed of vehicles, malignant traffic accidents occurr from time to time, bringing huge losses to people's lives and property. Traffic accidents have become "the first killer" of human beings. In these accidents, malignant large accidents account for a very large proportion, among which the accidents on the highway are the worst, where a few cars or dozens of cars, sometimes even as many as over a hundred cars collide and the casualties are extremely horrible. Therefore, the research and development of active safety devices, for example, anti-collision device of vehicles which is to reduce drivers' burden and errors in judgment will play an important role in improving the traffic safety. Use GPS to measure the current driving speed of the car, and then send the data through the CAN bus to the control processing unit. The main control unit calculates the safety distance and compares it with the actual distance measured by the ultrasonic. After analysis and judgment, the unit give alarm to drivers before a dangerous accident occurs. On the basis of previous studies, anti-interference is designed for the system to improve the instantaneity and reliability of the system.

Introduction

The automobile safety problem has existed since the birth of automobile. With the increase of the vehicle speed and the car ownership, traffic accidents have become more and more serious. Seen from the statistical data of the death tolls in the national automobile traffic accidents, the deaths caused by the automobile traffic accidents rank the first among all kinds of accidents. To sum up, there are the following forms of collision accidents in various traffic conditions: frontal impact, side impact and rear-end and rolling. Considering passengers injuries and property losses caused by the collision, side impact also reaches a relatively high level, only second to frontal crash (Fig. 1). Therefore, research on the side impact of the vehicle is one of the important contents of automobile active safety research and is concerned by automobile manufacturers and research institutions in all the countries throughout the world.

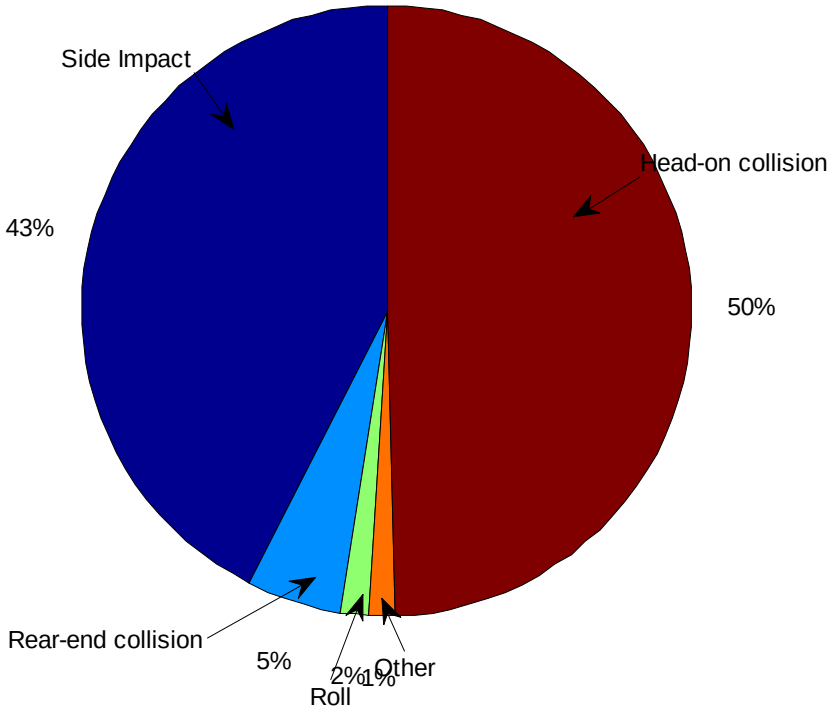

Fig. 1 the comparison of various collision injuries

The systematic overall scheme design and the mathematical model of the lateral vehicle safety distance

Driving on the road, the vehicle is likely to overtake the vehicles in the same direction at any time or be overtaken by those vehicles. In this process, in order to avoid the occurrence of a collision accident, a lateral safety distance must be kept between two cars. The faster the car travels, the bigger the lateral safe distance should be. Because the higher the speed is, the greater the transverse swing of vehicle will be. If the lateral space is too small, a collision accident will occur. In addition, when a vehicle is running, it should keep a certain distance with the highway guardrail.

Drivers prevent such kind of accidents from happening generally by their own experience. When they feel dangerous, they will slow down or change lanes. Car side collision warning system is to help the driver to judge the risk of lateral target and take necessary measures in advance. In this section, through the lateral safety driving model of a running vehicle, the corresponding concept of safe distance is obtained, regarded as a security decision principle.

Through the above calculation, the safety distance of the right and left sides can be obtained when the vehicle is running. In China the width of the current highway lane is 3.75m. The width of a car body is Z. The calculation shows that the lateral safe distance is not consistent with the actual situation, so vehicles cannot overtake. At the same time, in the calculation of the above formula, the vehicle lateral velocity is needed to be measured , but it is difficult to achieve in this system.

Based on the analysis of the above reasons, the minimum lateral safety distance e is known as:

$$e = 0.94 + \frac{v_1 - 40}{200} \quad (2.5)$$

To achieve the basic functions above, vehicle anti-collision warning system shall include at least the following modules. The second function module is the main control module, which is to process the collected various traffic information, calculate it according to a preset program and the algorithm and output control command when necessary; the third functional module is a man-machine interaction unit, including vehicle speed collection and display module and alarm signal output module.

CAN bus theory and its application in the system

Automobile electronic equipment is of various kinds and with different signal characteristics, whose networking technology is different from general computer networks. Reasonable topological structure is very important to optimize network performance, reduce network complexity, increase reliability and reduce cost. In addition to meet the information sharing, the car network system also must satisfy the real-time requirements of the various functional subsystems, so as to achieve comprehensive functions through the exchange of information. It emphasizes the reliability and real-time of network. Automobile network characteristics can be summarized as: short distance communication, simple lines, better sub function modules, high scalability, less complex network and high reliability. The comparison between the characteristics of the vehicle network and the common network topology, shows that the bus structure is the most suitable for the vehicle network system. The vehicle network system design must also consider the following problems:

(1) the electrical and mechanical properties as well as the joint quantity of the joint between nodes and bus.

(2) evaluation and performance detection method of network system and application system.

(3) the fault tolerance and fault recovery.

(4) the time characteristics of real-time control network.

(5) the wiring of installation and maintenance.

(6) the increase of network nodes and update of hardware and software.

CAN bus is a multi master serial communication bus, and its basic design specification requires high bit rate, high resistance to electromagnetic interference and the ability to detect any error. Because the CAN serial communication bus has these characteristics, naturally it is widely applied in the automotive, manufacturing industry and aviation industry. As a kind of remote network communication control mode with advanced technology, high reliability, perfect function and reasonable cost, CAN bus has been widely applied to various automation control system, from the high-speed network to low cost multiplex wiring. For example, in the field of automotive electronics, automatic control, power system, security and prevention monitoring and others, CAN bus has incomparable superiority.

CAN belongs to the serial bus network, whose data are outstandingly reliable, real-time and flexible. The specific features are as follows:

(1) CAN can work in multi master mode manner. Any node on the network can send messages to other nodes at any time initiatively with no distinction of the principal and subordinate. It is flexible and needs no node information such as station address.

(2) The node information in the CAN network can be divided into different priority in order to meet different real-time needs;

(3) The node with lower priority will take the initiative to withdraw from sending while the node with the highest priority will not be affected but continue to transmit data, thus saving a great deal of bus conflict arbitration time, and even in the network with heavy load, paralysis does not appear.

(4) CAN bus can send and receive data by means of point to point, a point to multi points and global broadcast, without special "scheduling".

The design of system software

After designing the hardware circuit, the main function of the system will depend on the realization of system software. Whether the system can reliably work also depends on software design with sophisticated functions, in addition to the rational design of hardware. This chapter will elaborate the required function of the control system, the implementation of main software function and the design scheme of software system.

The software design of this system adopts the top-down design and stepwise refinement method. First, design the main program structure according to the design thought of the structured program; secondly, design the interrupt service routine; thirdly, design subprograms according to the design idea of function modularization and gradually refine each functional module while continue to improve the interrupt service program and the main program; finally, complete the software design.

Assembly language has the advantages of flexible application, the program is easy to be optimized and has close relationship with the hardware system, so it is the most commonly used programming language in MCU, but the assembly language programming has a certain complexity, which means that only being very familiar with the instruction system of MCU and having experience of designing application program in compiled language, can an application program with complex functions be compiled.

Conclusion

The main purpose of the application of automotive lateral anti-collision warning system is to enhance the active safety of automobile. When the vehicle is at a high speed, the collision between the car and lateral vehicle or the guardrail is typical of the traffic accident and the fundamental reason is that there is no enough lateral space between two vehicles. The work of this paper can be summarized as follows:

1. Through the analysis of the actual vehicle driving condition, it establishes a mathematical model of vehicle lateral safety distance. According to the need of the mathematical model, it conducts an overall design of the system. The system is composed of four subsystems including ultrasonic ranging unit subsystem, speed unit subsystem, main control unit subsystem and sound and light alarm subsystem.

2. It uses CAN bus to connect each subsystem and, according to the principle of CAN communication, formulates the communication protocol between subsystems. Through the analysis of the actual application situation of the electronic control unit, it selects the 8-bit microprocessor P89V51 and mc68hc908gz16 as the microprocessors for main control unit and lateral ranging unit. Through the comparison of different ranging methods, ultrasonic ranging is used as the ranging method for the system.

3. After the completion of system software and hardware design, it implements simulation experiment and loading experiment for the system. The experiment shows that the system can completely meet the requirements of system design.

Although the system has been debugged successfully through the experiment, there is still a certain distance to the final productization and functionization. Many shortcomings need to be further solved. It is hoped that the future conditions permitting, the following aspects should be further researched and discussed.

1. The safety distance model needs further improvement. Through the refinement analysis of the forms of collision, a more safety distance model suitable for the complex traffic environment should be established.

2. A more advanced and reasonable device and circuit solutions should be selected to constantly improve the level of the system hardware design and to improve the performance of the system. For example, ARM processor can be adopted to improve the operation ability and speed of the system.

3. Because of the system did not carry on the practical application, the actual driving factors in the process may not be considered and the functions of the software system to achieve are also not comprehensive enough. Therefore, the software needs to be further improved.

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