

## Bus Passenger Safety Protection System

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**Abstract.** At present, bus is a kind of transport that people choose with high frequency, Therefore, the safety of buses has become an important concern of the public. Now the use of airbags and ABS has had some effect, but it has not effectively reduced the casualties of passengers in bus accidents. Due to the large space of the bus, the airbag is difficult to operate, and there is a lack of centralized control and automatic trigger safety protection system for passenger cars, it is difficult to guarantee the safety of passengers when the bus is hit or overturned. The bus passenger safety protection system came into being. It is a system that can automatically trigger and control the operation. It can detect the occurrence of accidents, judge the state of the vehicle, automatically open the escape door according to the state of the vehicle, and finally open the warning light to warn other vehicles. The major functions include accident detection device, judgment and automatic control system, front end buffer energy absorber, safety escape door and warning light structure.

### Introduction

**Research Background.** Bus passenger safety protection system in the present moment is missing or incomplete, the airbag in the application of small cars, due to the space is large in the bus, the role of airbags will be greatly reduced, so you need to rely on other buffer device to reduce the impact, considering the driver and the passengers should give a short reaction time and vehicle deceleration time, using honeycomb + shock absorber buffer device of energy absorption. In addition, due to the lack of control systems that can be automatically detected by the bus and triggered by safety devices, it will be very difficult for passengers to escape by themselves if the driver lacks driving experience or is in a difficult state to move.

Since 1980s, MCU has developed from 4 - and 8-bit MCU to 300M high speed MCU [1]. Aiming at the problem of bus's lack of automatic protection system, based on the high-speed processing of single chip microcomputer and accurate detection of sensor, this paper designs bus passenger safety protection system by taking automatic control system as the research object and adopting closed loop control technology.

**Research Meaning.** It is necessary to study the safety protection of bus passengers because of its large capacity and certain safety risks. Each protection device operates automatically according to the event and the program of single chip microcomputer, which to some extent reduces the operating burden of the driver when the safety accident occurs. The shock absorbing energy structure of honeycomb + shock absorber not only reduces the impact force, but also provides enough time for the system to complete the whole control. The single chip microcomputer is used as the control and processing center, and each sensor works together to improve the efficiency of the safety protection system. According to the above, it can improve the safety factor of the bus and reduce the casualties when the accident occurs.

**Research Status.** For the first time, the bus passenger safety protection system adopts the single-chip microcomputer-based automatic control system that is applied on the bus, and with various sensors and front-end energy absorbing structure, it realizes automatic detection and response to accidents. Nowadays, the use of the use of single-chip computer and its peripherals and sensor has been extended to all fields, and the STM32 MCU has rich model, very many peripherals, good real-time performance, outstanding power control, the advantages of the lower cost of development, with sensors play a great role in modernization project, combined with a reasonable mechanical design, circuit design and components design, the logical relationship between event

detection can realize accurate and fast trigger deceleration circuit, after the vehicle stop automatically open the security doors.

In the current approach of dealing with safety accidents, demand for the ability of the driver is extremely high, although the safety protection system based on single chip microcomputer doesn't mean that the ability requirements for drivers are optional, but it does reduce the pressure on drivers in the face of safety accidents. In a very short reaction time, the driver can be operations, and focus on the vehicle direction control.

About the bus door, is not implemented in the vehicle stopped automatically open, is restricted by passengers to press the emergency button to open, MPU6050 nor applied in detection of bus rollover, the above safety devices also does not implement a set of automatic, triggered a coherent system, thus by these devices and their logical relationship can constitute an automatic control system based on STM32, which in turn depends on the structure of the single chip microcomputer continuously optimized and the continuous development of embedded microcontroller system.

## Related Technology Research

**SCM technology.** There are many types of single chip microcomputer. STM32F4 series of single chip microcomputer is adopted in this project. This series of single chip microcomputer has many advantages. Based on ARM® Cortex™ - the M4 kernel, ART technology makes program zero wait for implementation, improve the efficiency of the execution of a program, the most extreme Cortex - the performance of the M4. At the same time, the adaptive real-time accelerator can fully release the performance of the cortex-m4 kernel. Programs running in flash can achieve performance equal to zero wait periods when the CPU is operating at all allowable frequencies (less than or equal to 168MHz). STM32F4 series microcontrollers are integrated with single-cycle DSP instructions and FPU to improve the computing capacity and enable some complex calculations and control. Its features of high processing capacity and high computing speed can meet the matching of the neutralization sensor in this project and effectively achieve the desired objectives. At the same time, MCU is developing to CMOS, intelligence and large capacity [2].

This project mainly USES the I/O part of single chip microcomputer and AD conversion function. Among them, I/O port can realize the input and output of multi-channel PWM wave by configuring advanced timer TIM1 and TIM8 and enabling timer channel, which can indirectly detect motor speed, and then carry out real-time detection and real-time control of speed. In STM32, the maximum conversion frequency of AD is 14MHz, and there are 16 conversion channels [3]. Through AD conversion function, the single chip receives the signal of collision sensor and MPU6050, A 6-DOF IMU Sensor MPU 6050 was employed to generate data as a comparison with set point [4], realizing the reception of collision and side flip signals, and then with the input and output of PWM wave, realizing the opening of safety door and warning light after the deceleration and stop in the case of collision and side flip. When the number of pins of a single chip is not enough, the communication between multiple single chips can be realized through the IIC protocol, which makes the processing efficiency higher.

**Sensor technology.** The MPU6050, which is used for lateral flip detection, is the world's first integrated six-axis motion processing component, with a three-axis MEMS gyroscope, a three-axis MEMS accelerometer, a digital motion processing engine (DMP) and an auxiliary I2C port (often used to extend the magnetometer) for third-party digital sensor interfaces. The MPU6050 has a 16-bit analog/digital converter (ADC) that converts triaxial gyroscope and triaxial accelerometer data into digital output. Using the built-in DMP of MPU6050, the attitude calculation of the carrier is realized, which not only simplifies the code design, but also reduces the burden of MCU. MCU does not have to carry out the attitude calculation process, so that it has more time to deal with other events and improve the real-time performance of the system [5]. At the same time, MPU6050 has a programmable low-pass filter, which can be used to filter the sensor data. By filtering, the waveform is more stable and accurate, that is, the single-chip microcomputer will accurately capture the abnormal tilt of the car body, the algorithm is easy to implement and can be embedded into the embedded system [6]. Collision sensor is divided into collision intensity sensor and collision

protection sensor. The collision intensity sensor is used to detect the impact degree of the car. The sensor can be divided into left anterior collision sensor, right anterior collision sensor and central collision sensor. Collision protection sensor is used to prevent false deceleration or false opening of safety door, also known as safety collision sensor or detection collision sensor.

Therefore, collision detection is realized by using collision sensor or ultrasonic distance measurement module. Collision sensor outputs low level when collision occurs and high level when no collision occurs. Then, potential level is detected through the I/O port of single chip microcomputer to realize the detection of collision conditions. Receiving low power at ordinary times means collision, otherwise this I/O is always in a high level state. In addition to collision and rollover detection, flame sensor and smoke sensor can be added to check the safety status of the vehicle. Collision sensor and MPU6050 together constitute the accident detection system, which is accurate and efficient.

## System Architecture

**Shock absorbing function.** The structure of energy absorbing buffer adopts honeycomb structure. Honeycomb structure is the best topological structure covering two-dimensional plane, which has the characteristics of high strength (especially honeycomb sandwich structure) and material saving. The carrying capacity of honeycomb is directly proportional to the density of honeycomb, that is, the greater the density of honeycomb, the higher the carrying capacity [7]. Honeycomb polyculture structure has better anti-collision performance, and the material utilization during the collision process is also higher [8]. With the shock absorber, this structure has better performance than the normal buffer structure, which can extend the operation time of the motor controlled by the single chip microcomputer to a certain extent, and guarantee the working efficiency of the sensor and the single chip microcomputer.

**Control system.** The control system is composed of STM32 microcontroller, motor, collision sensor, MPU6050, etc. STM32 is located in the core of integrated circuit, collision sensor is reasonably distributed around the car body, MPU6050 is located on the horizontal surface, motor is located in a reasonable position of the control security door, and the layout of the microcontroller and its control part should be reasonable. The I/O port required by the single-chip computer will not be occupied, and the I/O port level will not always be raised or lowered due to circuit problems, while ensuring that the sensor can transmit signals at high and low levels or MPU6050 data output without serious interaction. Since the motor will produce the reverse electromotive force at the moment when the motor stops working, the PWM wave duty ratio can be adjusted to slow down or adopt dead zone control, or the method of optocoupler isolation can be adopted to prevent the chip of the single chip from burning down. The above constitutes a control system.

**Automatic escape door.** The safety escape door is located on the side wall of the vehicle and the tail of the vehicle. After the sensor detects that the vehicle is about to stop, the single-chip computer controls the steering gear to open the safety door quickly to ensure the safety of passengers.

**The warning device.** When the safety door of the vehicle is opened, the single chip will control the circuit to trigger the warning light, which will be used to warn the traffic vehicles and prevent the occurrence of subsequent accidents. When the vehicle is seriously damaged, the standby power supply can be used for power supply, and the standby power supply is also controlled by the single chip microcomputer [9].

## Summary

Driving safety is mainly affected by the factors of the driver's own problems, due to the imbalance between the psychological and physiological state of the driver resulting in a large proportion of safety accidents [10]. This design realizes the bus automatic detection of safety accident, and realizes the automatic control of safety protection device through the system controlled by single chip microcomputer. Automatic control technology has been widely used, we can use it to produce, but also to protect human beings. The system has a lot of room for improvement, such as detecting the

internal environment of the vehicle with more accurate and sensitive sensors, or automatically alerting the vehicle after an accident via the Internet. At the same time, SCM can be connected to the Internet, so that it plays a greater role in the era of interconnection of things, such as the realization of Internet alarm for help [11]. It is hoped that through this system, the application of automatic control system in safety protection can be promoted, so that passengers will not be trapped in the accident and have a higher probability of survival.

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