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Design and Implementation of a Van Rollover Early Warning System Based on Microcontroller

Xiaobin Wang[1], Shaoqian Yu[2], Chen Zhang[3]
University of Delaware, Newark, USA[1],University of Delaware, Newark, USA[2],University of Delaware, Newark, USA[3]
Wangxiaobinm@delaware.edu[1], yushaoqian@delaware.edu[2], zchengZ@delaware.edu[3]

Abstract: In comparison to other vehicles, vans exhibit a lower rollover stability limit due to their substantial mass and elevated center of gravity. To enhance transportation safety and mitigate traffic accidents, it is feasible to incorporate a design that provides early warnings when critical thresholds are surpassed. This can be achieved by continuously monitoring the inclination and speed of the vans in real time.

Keywords:SCM; Hall speed module; 1602 liquid crystal display module; Gyroscope module.

1. Introduction

Because of the characteristics of large mass and high center of gravity of vans, the probability of rollover accidents is greatly increased. Van-rollover has gradually become a hot research issue in the field of active vehicle safety. Mainly focusing on rollover warning, passive safety technology, active safety technology, etc, the research of anti rollover in foreign countries started earlier. Time to rollover (TTR) was used as the criterion of rollover risk in the rollover warning system proposed by Huei Peng and Bo chiuan Chen. TTR was defined as the time fromthe current time to the time of vehicle rollover. Based on the simplified vehicle dynamics model, this early warning method can predict the time of vehicle rollover, which has good real-time performance. Based on the simplified vehicle dynamics model, this method can predict the time of rollover in real time. The research of anti rollover in China is still in the initial stage, and theresearch focuses on theoretical analysis, the research on anti rollover control is less, and the actual product development for anti rollover control is less. Due to the lack of special testing sites, the theoretical research is seriously out of line with the real vehicle verification.

2. The Design of the Scheme

The design consists of STC89C52 microcontroller circuit , hall speed module circuit ,LCD1602 liquid crystal display circuit , gyroscope MPU6050 module circuit ,1 bit button circuit , motor control circuit , buzzer alarm and power supply circuit, as shown in Fig. 1.

3. The Design of Hardware Circuit

3.1. STC89C52 Minimum System Design

STC89C52 is a kind of low power consumption and high performance cmos 8-bit microcontroller produced by STC Company. It has the following main features: 8K byte system programmable Flash memory; 512-byte data storage space; Storage space with 4K byte EEPROM inside; serial port to download directly.

STC89C52 minimum system works normally through reset circuit, power circuit and clock circuit. The principle diagram of the microcontroller's minimum system is shown in Fig. 2.

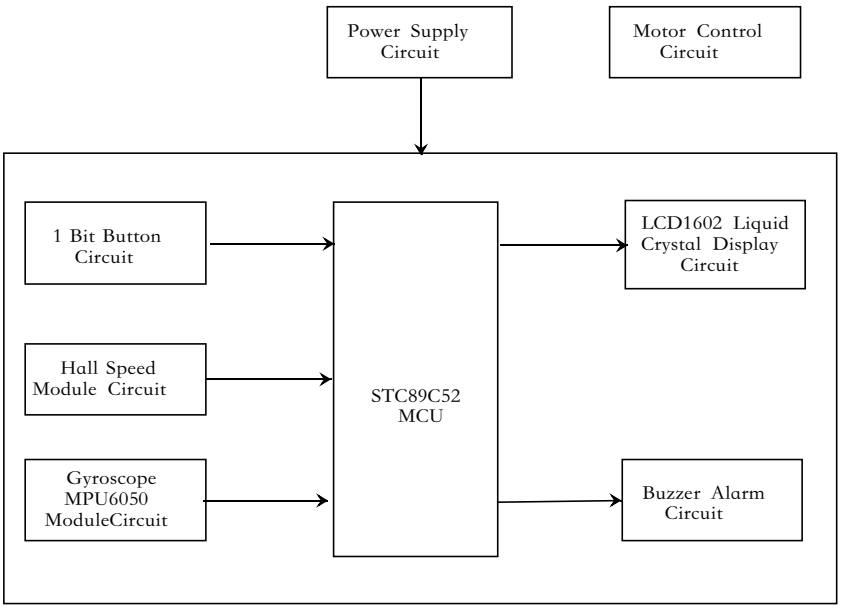


Fig 1. The design of the scheme

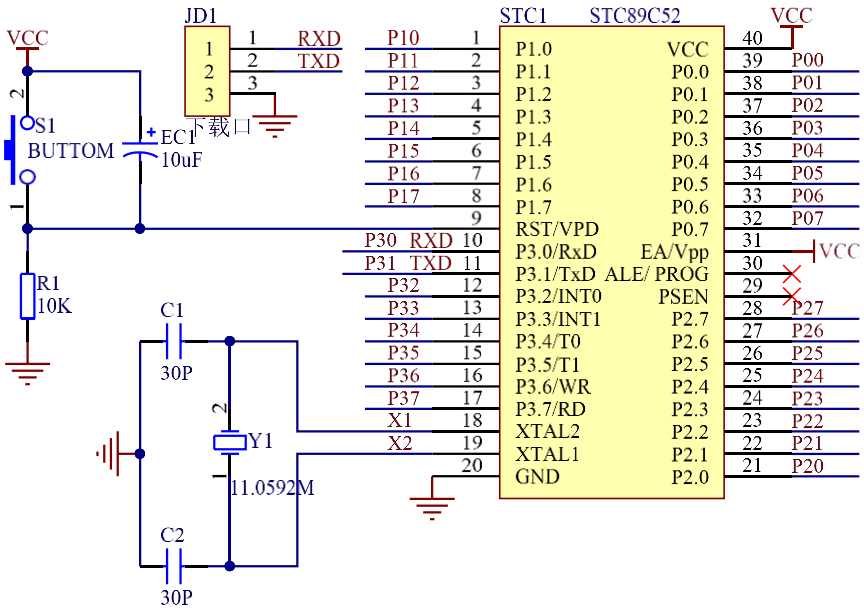


Fig 2. STC89C52 minimum system schematic diagram

3.2. 5V Power Circuit Design

The main power supply of this design is 5V DC power supply, which is simple and stable. The red LED lamp is used as the indicator of whether the system has power. The resistance is 1K, which is used to protect the LED lamp and prevent the LED lamp from burning due to excessivecurrent. SW is a self-locking switch. When the switch is pressed, the power supply is 5V DC output, and the red light is on. When the switch is pressed again, the system has no power output and the red light will be off. As shown in Fig. 3.

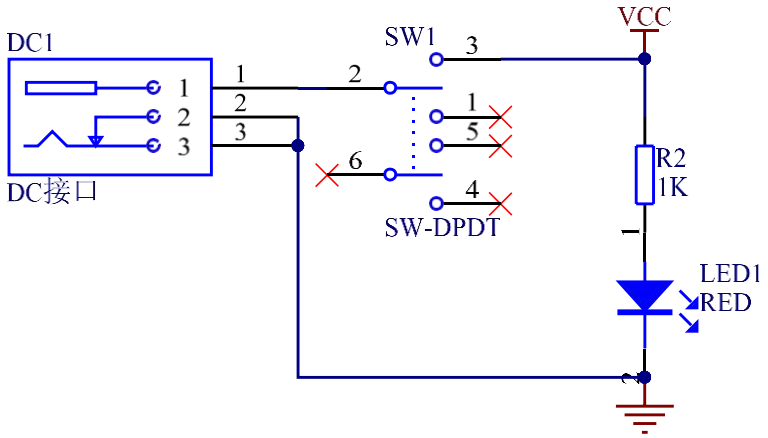


Fig 3. 5V Power Circuit

3.3. Circuit Design of LCD1602 Liquid Crystal Display Module

This design uses character display. The LCD1602 liquid crystal display is used as a display device to output information. The power consumption of the LCD module is lower than that of the traditional nixie tube. It is exquisite and compact, and does not need additional driver circuit.LCD1602 can display two lines of sixteen Chinese characters, and its schematic diagram is shown in figure 4.

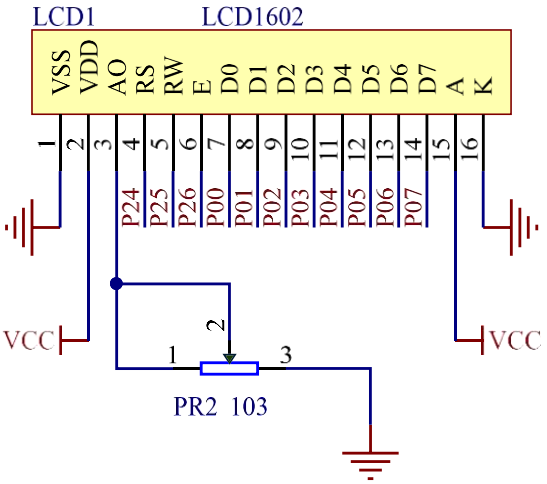


Fig 4. LCD1602 schematic diagram of liquid crystal display circuit

3.4. Circuit Design of Hall Sensor Module

Hall sensor module is designed based on Hall element a3144. By comparing the value of Hall sensor with the voltage value of potentiometer, it can output high and low level directly, the signal is clean, the waveform is good, and the driving ability is strong. A3144 Hall sensor module has small volume, high sensitivity, fast response, good temperature performance, high accuracy and high reliability. Hall sensor USES LM393 wide voltage comparator to ensure more stable pulse signal output. The internal circuit diagram of hall sensor module is shown in Fig. 5.

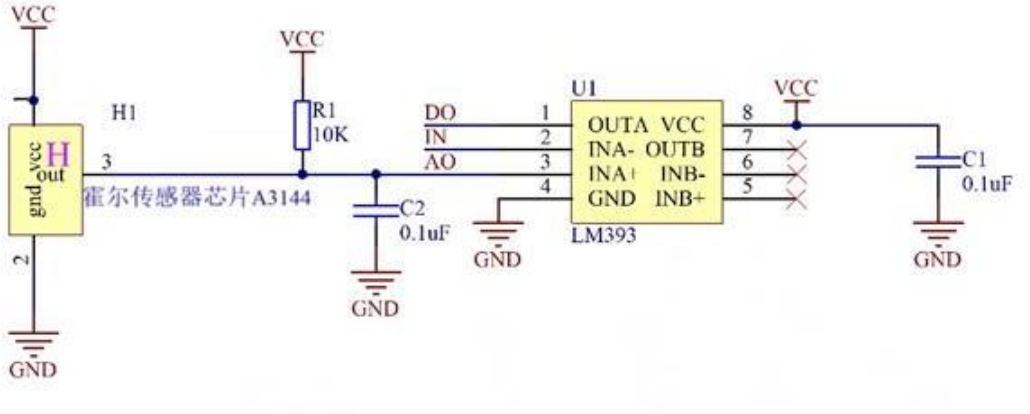


Fig 5. Internal circuit diagram of the module

3.5. Key Circuit Design

In this design, the pin controlled by the button MCU is high level by default. After the button is pressed, the related pin becomes low level. So as to realize manual input and switch vehicle mode.The circuit schematic diagram is shown in Fig. 6.

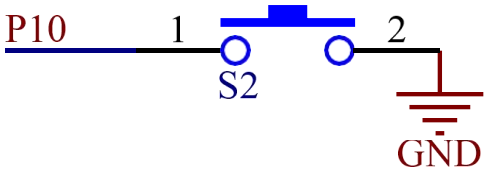


Fig 6. Schematic diagram of button circuit

3.6. 5V Dc Motor Speed Control Circuit Design

In this design, analog circuit can adjust the speed of motor. After the system is powered on, adjust the potentiometer PR according to the power switch to realize speed regulation. The voltage distributed to the motor changes between 0-5V. The motor speed can be adjusted by changing the voltage. Schematic diagram of 5V DC motor speed regulating circuit is shown in Fig. 7.

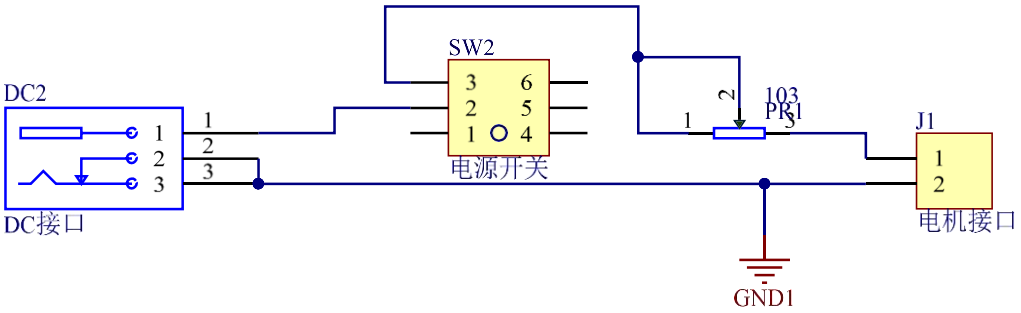


Fig 7. Schematic diagram of 5V DC motor speed regulating circuit

3.7. Design of MPU6050 Tilt Angle Sensor Module Circuit

This design chooses mpu6050 module to detect the object state. This module has high stability and precision. Accurate angle can be obtained at any position. The high and low level of the input and output of this module is 3V to 5V, which can be directly connected with the serial port of the single chip microcomputer, but can not be directly connected with the nine pin serial port of the computer. The interface schematic diagram of the module is shown in Fig. 8.

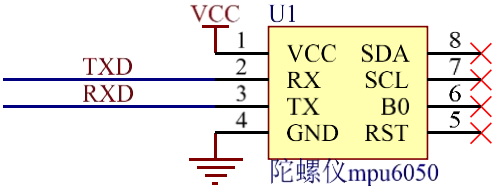


Fig 8. Schematic diagram of sensor interface circuit

3.8. Alarm Circuit Design of Buzzer

The alarm module used in this design is a 5V buzzer module driven by a triode. Only the pin is low level, the buzzer will beep and alarm, and it will not beep if the pin is high level. The current limiting resistor plays a protective role. The schematic diagram is shown in Fig. 9.

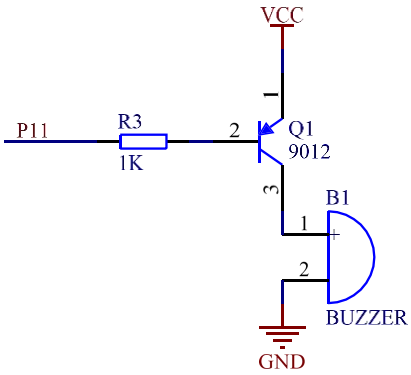


Fig 9. Schematic diagram of buzzer alarm circuit

4. The Design of System Software

In this design, the MCU development environment is keil uvisin4. The program language adopts the higher readability and portability of C language programming. The system operation flow chart is shown in Fig. 10.

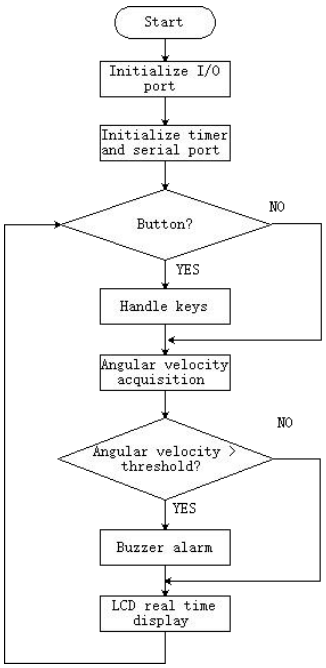


Fig 10. System operation flow chart

5. System Debug and Test

After testing, if the speed exceeds 3m / s, the buzzer will give an alarm; if the left and right rollover and the back and forth rollover amplitude are plus or minus 15 degrees, the buzzer will also give an alarm. The system test is normal. When the speed reaches 2.4m/s, the buzzer will not alarm, as shown in Fig. 11 below.



Fig 11. System test diagram

6. Conclusion

In this project, the real-time speed of the van is detected by Hall sensor, and the angle of x-axis and z-axis of the vehicle is detected by gyroscope. According to different types of vehicles, the maximum speed value and the angle threshold of rollover can be set to realize alarm and reminder, so as to reduce the occurrence of accidents.

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