Journal of computer science and software applications
https://www.mfacademia.org/index.php/jcssa
ISSN:2377-0430
Vol. 4, No. 8, 2024

Development of a Near-Infrared Detection System for Real-Time Monitoring and Prevention of Drunk Driving

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Abstract:

The rapid growth of China's automobile industry has intensified concerns over transportation safety, particularly the issue of drunk driving. Despite the implementation of stringent policies over the past decade, cases of drunk driving continue to rise, with over two million incidents recorded annually. Current detection methods, including blowing tests and blood tests, face challenges related to accuracy, efficiency, and public acceptance. To address these limitations, this study proposes a near-infrared-based, non-invasive alcohol detection system designed for real-time monitoring of drivers' blood alcohol concentration (BAC). The system utilizes near-infrared technology to detect BAC and activates audible and visual alarms when levels exceed preset limits. It also transmits vehicle and driver information to a designated mobile phone number for prompt intervention. This low-cost, automated system offers significant advantages in convenience, accuracy, and practicality, with the potential to reduce drunk driving incidents and optimize police resource allocation. Widespread adoption of this system could transform alcohol detection practices, enhancing road safety and minimizing traffic-related fatalities.

Keywords:

Near-infrared; Single-chip; Alcohol Detection; Drunk Driving.

1. Introduction

In recent years, with the growth of the Chinese economy, the automobile industry continues to expand. More and more motor vehicles are driven on the road, which seems to be convenient for people to travel around.

However, a controversial topic about paying more attention to the safety of transportation never fails to attract public attention. China has promulgated the policy of drunk driving for ten years, and the number of drunk drivers has decreased. On the other hand, with the development of transportation, the amount of motor vehicles has increased by nearly two hundred million and drivers have reached three hundred million.

Consequently, drunk driving cases are increasing dramatically. More than two million cases of drunk driving are investigated and punished nationwide every year. ‘Crime of Drunk Driving’ has become the top crime across the country. Addressing the drunk driving problem is a long process, which needs consistent efforts. Thus, curbing and avoiding drunk driving effectively is also one of the most popular research methods in the field of automobile safety.

As a result, one of the study hotspots in the field of car safety is the ways to successfully control and avoid drunk driving. Currently, blowing tests and blood testing are the primary methods of detecting drunk driving in China and around the world.

Blowing tests evaluate the degree of chromium ion conversion according to the spectral wavelength of the resulting solution, and they are the most prevalent roadside detection method for drunk driving in China and around the world. As an internal standard substance, a specific group of tert-butanol will be added to the blood during the blood test. The alcohol content is calculated using the peak area of the alcohol and tert-butanol after they have been volatilized and identified by gas chromatography.The blow test is not as exact as the blood test, but it is more convenient and faster.

The blood test is not commonly utilized as a detection method. It is only carried out at the hospital when the party disagrees, which can easily lead to psychological resistance on the part of the party. Furthermore, blood tests and blood tests rely on manual inspection of traffic cops, and the increased workload and waste of the police force are also uncertain.

Near-infrared detection is advantageous in terms of convenience, speed, non-destructiveness, continuity, and accuracy. This research proposes a surveillance system based on near-infrared non-invasive human detection technology to help prevent the occurrence of drunk driving accidents. This system monitors the blood alcohol content of the driver in real-time. And if the data is abnormal, it will give an audible and visual alarm. At the same time, the vehicle information will be synchronously sent to the set mobile phone number.

2. Overall System Design

This design is an alcohol detector using STC12C5A60S2 single-chip embedded system. It is mainly composed of a gravity sensor, infrared detection circuit, LCD touchscreen display, sound and light alarm, analog-to-digital converter, and single-chip microcomputer.

When the driver sits in the driver's seat, the gravity sensor located under the driver's seat begins to detect the weight signal on the driver's seat. After the signal is conditioned, it is converted into an analog electronic signal and then converted into a digital signal by an A/D converter, and then sent to an infrared detection circuit. The infrared detection circuit is divided into a signal acquisition circuit, a filter circuit, and a signal amplification circuit. After the signal data is collected, filtered, and amplified, it is processed by a single-chip microcomputer and peripheral circuits. If the value reaches the set threshold, the alcohol concentration will be displayed on the LED. Simultaneously, the alarm starts. And sends information such as the location of the vehicle license plate to the stored mobile phone number through the SIM module.

The overall block diagram of the hardware circuit part of the overall system is shown in Figure 1.

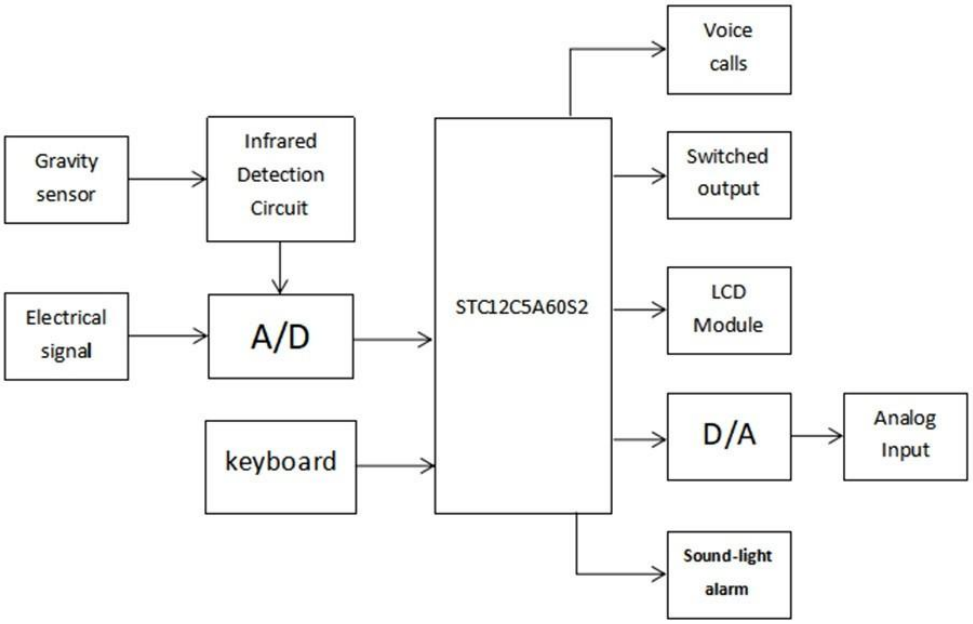

Figure 1. System design

3. The Hardware Design

The schematic module includes a gravity module, a display module, a voice module, an audible and visual alarm module, a keyboard, and an analog-to-digital conversion module.

The ADC module adopts the chip ADC0809, ADC0809 is a sampling frequency of 8 bits and the principle of successive approximation of the analog to digital conversion device. The following is the ADC0809 working principle and pin diagram introduction. It has an 8-channel multiplexer switch inside and it can only select 8 single-break analog input signals in A/D conversion according to the address code latch decoding signal.ADC0809 is composed of an 8-way analog switch, an address latch and decoder, and an A/D converter. And a three-state output latch. The multiplexer switch is optional for 8 analog channels, allowing 8 analog inputs to be time-shared, and sharing the A/D converter for conversion.

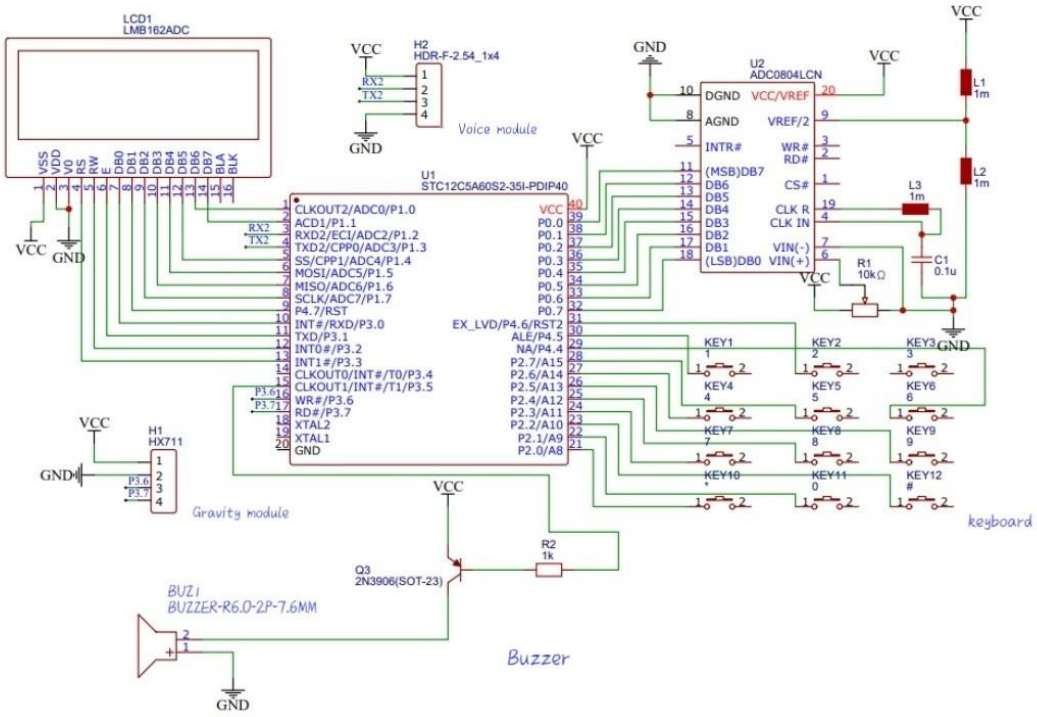

Figure 2. Hardware design

4. The Software Design

4.1 General Software Design

Software according to the system function is designed by modular programming, the main flow of the controller is shown in the figure.

It can detect if there is someone in the driver's seat, the amount of alcohol in the blood, and whether the alcohol content is above the limit. After that, the alcohol content is displayed on the screen, a sound-light alarm is selected on whether the alcohol content exceeds the standard. After the system is powered on and stable enough to work, each module initialization and automatic measurement. The voltage information of the gravity sensor is collected and compared with the set weight range. If the weight value is less than the set range, the system enters on standby. If it is at or above this range, the next step is to detect alcohol concentration by infrared ray. The collected information will be compared with the set data. If it is higher than the set data, the sound-light alarm will be made, the reservation number will be dialed and the alcohol concentration will be displayed. Otherwise, only alcohol concentration will be displayed. According to the requirements of different functions of the detection system, it consists of modules with alcohol detection, operating voltage setting, and sampling data upload.

As shown in Figure 3.

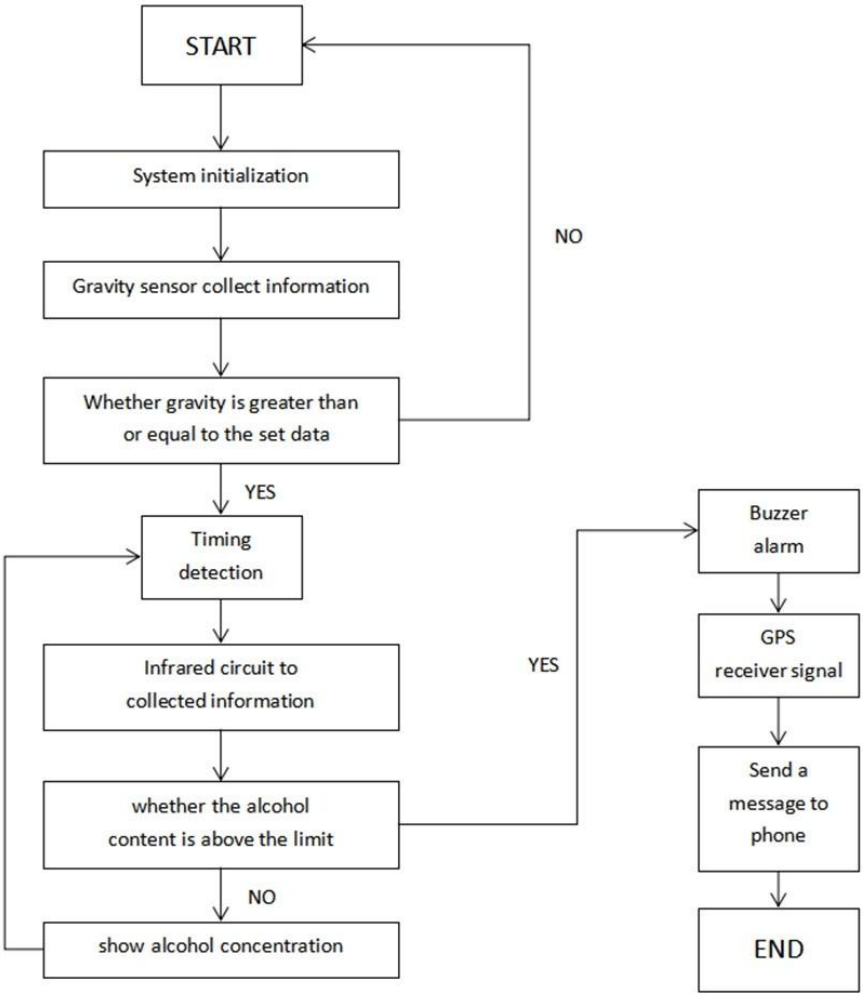

Figure 3. Software design

4.2 Concentration Detection Program

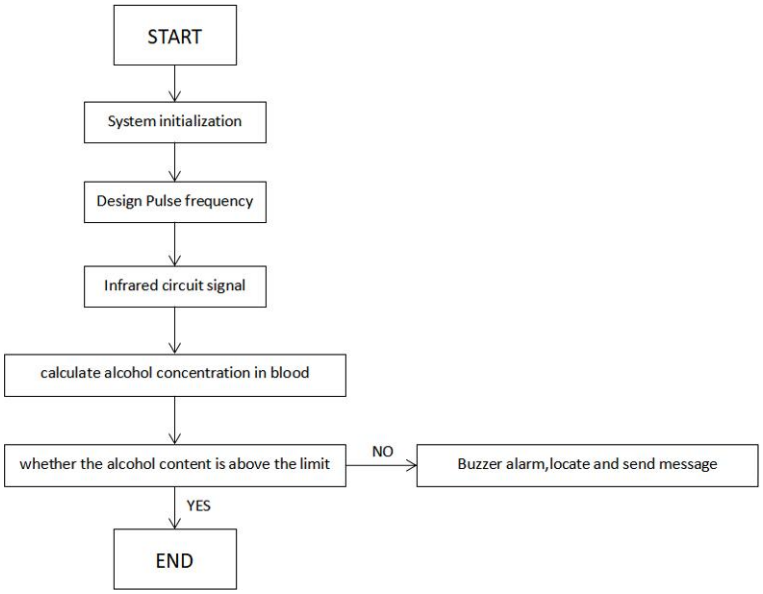

Figure 4. Concentration detection program

The flow of the concentration detection program is shown in Figure 4.

The concentration detection program detects the alcohol in the blood through the sensor composed of an infrared emitting tube and receiving tube. The obtained signal is filtered and amplified into the single-chip microcomputer STC12C5A60S2 for data processing, and the detection result is obtained. If the amount of alcohol in the blood exceeds the preset standard, the driver will be immediately warned and the danger information will be relayed to the main system. If not, the safety information will be relayed to the main system for continued use.

5. Summarize

The alcohol detection system is intended to decrease and prevent drunk driving. The blood alcohol concentration is determined using a near-infrared beam. If the inebriated individual is determined to be a driver and the alcohol content is higher than the preset limit, the system will automatically broadcast the voice while the screen flashes to display the alcohol concentration. And use the mechanism to deliver information to the chosen mobile phone number. The system has the benefits of automatic detection, low cost, and ease of use. If everyone can use it, it will reduce drunk driving behavior by detecting alcohol when getting in the car and saving unnecessary police time.

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