Evolution in Electrical and Electronic Engineering Vol. 4 No. 1 (2023) 195-202

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Vehicle Accident Detection System using Accelerometer

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DOI: https://doi.org/10.30880/eeee.2023.04.01.023
Received 16 January 2023; Accepted 06 February 2023; Available online 30 April 2023

Abstract: Generally, road lane design and heavy traffic control accidents still happen significantly despite the presence of so much contemporary equipment in vehicle design. Because no medical facility was accessible at the appropriate time and location in the majority of accidents, people died. Thus, this paper intends to lowering this risk factor using an automatic accident detection system. Using a microcontroller technology like the ESP32 NodeMCU, any accident can be detected automatically. A vehicle's tilt or vibration during an accident is detected using the MPU6050 detector that is connected to the MPU 6050. The Global Positioning System (GPS) module tracks the accident's location and the GSM module sends SMS/message to a predetermined number. By utilising the GPS and sensors, this automatic tracking system can help track and locate the precise location of any vehicle that has been in an accident. This project's outputs include a piezo buzzer, LCD, and LED (green and red). Except for the LED (green), all results are used to alert the surrounding area when a traffic accident occurs. The 6V PV solar panel used in this project absorbs solar energy, converts it to electricity, and charges the Li-on 18650 3.7V battery with a capacity of 2000 mAh and increases the voltage to 5V as an output, which will be used as a power supply for the ESP32 in this project. Furthermore, the current findings show that the system able to identify accidents and send SMS/messages and the location to a predetermined number by putting all the systems in the junction box.

Keywords: Accident Detection, ESP32 Microcontroller, GPS Module, GSM Module, and Accelerometer (MPU6050)

1. Introduction

Up to 3,000 fatalities and millions of injuries or disabilities are reported by the World Health Organization each year as a result of motorcycle accidents [1]-[4]. According to 2019 statistics, Malaysia ranked first among ASEAN countries in 2013, with roughly 6,915 deaths. Motorcycle

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accidents are more common in Malaysia, and most result in death. The number of accidents reported in 2017 was 533,875. In 2019, the proportion of instances increased by 33,641, bringing the overall number of cases to 567,516 in 2019, representing a 6.3% increase over the total number of incidents involving other types of vehicles [2]. In today's Malaysia, many accidents occur, with motorcyclists responsible for most of them. Mistakes do happen, but they are rarely identified promptly. The individual may die if the accident is not recognized within a specific time. There might be no witnesses if the accident occurred in a limited or quiet place, making it challenging to locate.

This project's purpose is to develop a system that can quickly detect a motorcycle using its location and track it in real time. The GPRS and GSM networks are used to deliver warning signals, and longitude and latitude information can be used to pinpoint the accident's exact location before being relayed to the relevant authorities. Accelerometers, which are motion and orientation sensors, are built into this system. So that all information about the motorcycle's orientation and movements may be viewed. Additionally, using the GPRS network, this technology can determine the site of an accident and promptly notify the authority or person of our choice. As the event happens, there are additional opportunities to locate the person and determine whether they are still alive. These two approaches, when combined, can provide a full answer for preventing an accident happen without knowing.

2. Methodology

2.1 Operation of The System

In this design, a GPS receiver and GSM module are utilised to control the entire process using Esp32. The vehicle's location is discovered using a GPS receiver, and an SMS alarm is sent using a GSM module. MPU6050, an accelerometer, is used to detect accidents or rapid changes in any axis. The system status is also shown on an LCD 16x2. The system is ready to operate after uploading the code to the Esp32. If the accelerometer's axis value has changed unexpectedly, the Arduino has notified the GSM module to look for accidents. Arduino reads the data from the GPS module and uses the GPMRC String to extract the coordinates. The angle is shown continually on LCD. However, when an unexpected vibration happens, the GSM only sends an SMS to the designated number, such as the police, ambulance, or a family member, with the location coordinates of the accident site. Using AT instructions, the GSM module may speak with the network. The initialization of the GSM and GPS modules is the primary need for this circuit. The system can function to produce the intended results once they have been configured appropriately.

2.2 System Block Diagram and Flowchart

Figure 1 shows the system block diagram while the system flowchart is illustrated in Figure 2. To detects the occurrence of the accident with the help of a 3-axis gyroscope and 3-axis accelerometer, an accelerometer MPU6050 sensor is employed. Vehicle position is determined using the GPS module of the Global Positioning System. The Esp32 Microcontroller receives the angle and location data from these sensors. To send an alarm message to a predetermined mobile phone, utilize the GSM SIM900A module. The LCD is also connected to Arduino to display the location.

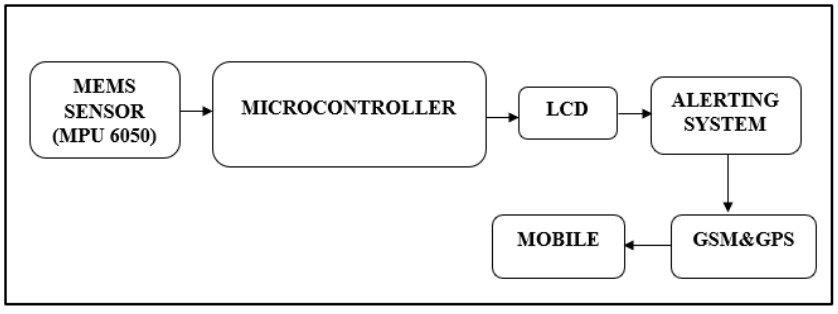

Figure 1: Block Diagram of Proposed System

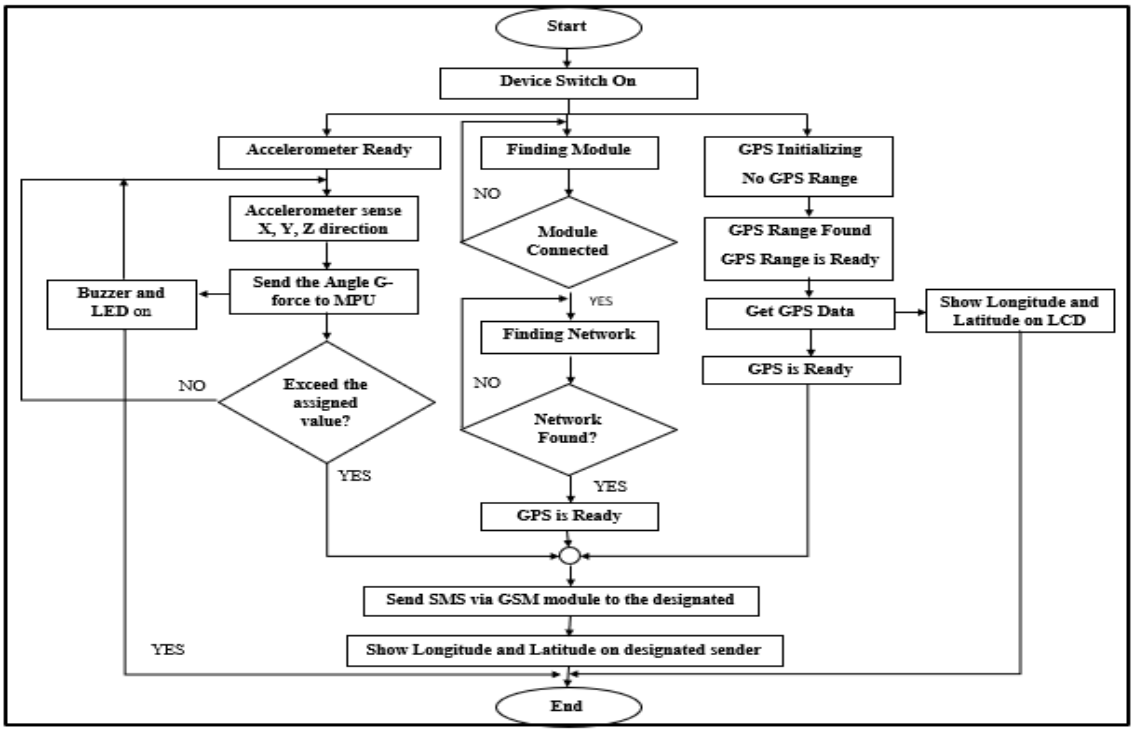

Figure 2: System Flowchart

3. Results and Discussion

The section will discuss the outcomes that the project is supposed to produce to accomplish its goal, which is the accident detection system send notification to the family via SMS. The investigation focuses primarily on the 3-axis Accelerometer and 3-axis Gyroscope, which determines the fault at which the sensor is triggered and can detect an accident. As a result, the project needs to be carried out so that will can get a fault on how the accident occurred. The buzzer serves as an alarm and the LED functions as a warning lamp. When the program is on the green led will light up, and the GPS module and GSM module will be initialized and get the signal and also display on the LCD. There is a LED light that serves as a warning lamp, an alarm buzzer, an MPU6050 sensor that detects the occurrence of motorcycle accidents, and a GSM module with the Telco card UMOBILE number 01162148900 to send SMS and GPS to locate the location. The buzzer will be ringing, the LED will light up, and the specified person will be informed of the accident occurs and the location of the accident via the GSM module and GPS module when the MPU6050 detect the accident.

3.1 Connection Testing

There are four individual tests before connecting the overall circuit design, which is reading data from MPU6050, location data reading from GPS Module, sending SMS message by GSM SIM900A Module, and display on LCD. GSM 900a, LCD, piezo buzzer, switch, MPU6050, male-to-male and male-to-female jump wires, and resistors of 100 ohm and 220 ohms are the components utilised. Figure 3 shows the connection of the prototype system.

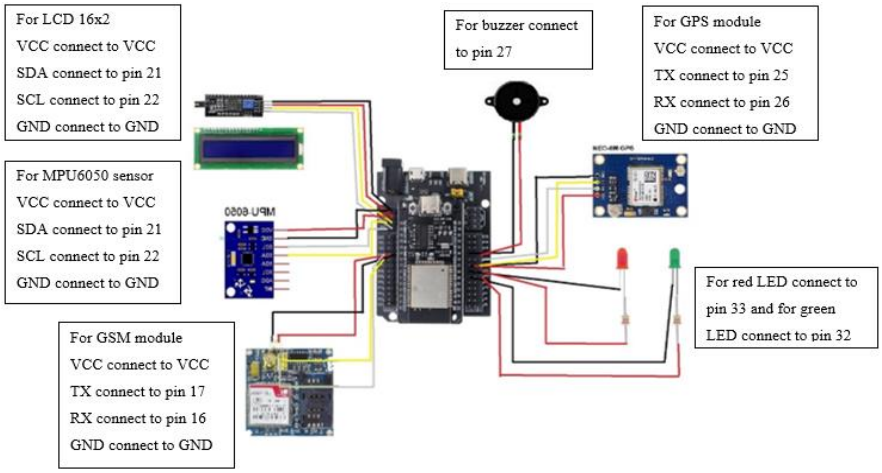

Figure 3: Connection of Proposed System

3.2 Displaying on LCD

Figure 4 shows the connection to displaying on LCD. Additionally tested are the LCD and Esp32 interface. The four-bit mode is used to control the 16 x 2 LCD display. The switch in the project is linked to both the VCC and the ground. This supply covers every component. When the switch is turned ON, the LCD will be displaying the word “GSM and GPS module Init” and when the GSM and GPS get the signal LCD will display the word "GSM and GPS signal ready". After the MPU 6050 detects the accident, the word “Collision detect” will be displayed on the LCD.

Figure 4: LCD Test

3.3 Sending SMS message by GSM SIM900A Module

Figure 5 shows the connection GSM SIM900A Module to send the SMS message by using the AT commands described in Table 1 GSM module is tested.

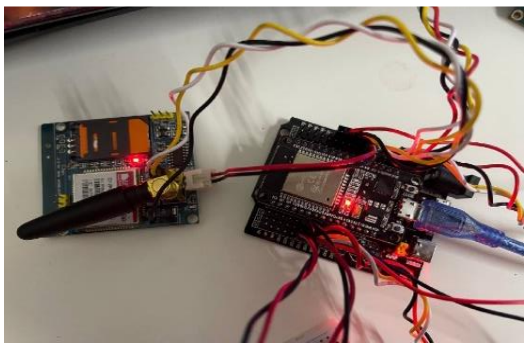

Figure 5: GSM Test

Table 1: GSM Module

Commands	Description
ATA	Answer Command
ATD	Dial Command
AT+CMGS	Sent SMS message
AT+CMGF	Select SMS message format
AT+CBMI	New SMS message indication
AT+CPIN	Check Pin

3.4 Connection all component

Figure 6 shows the final connection of the system. When each test is passed, the devices are carefully linked, and the entire program is uploaded to the Esp32 platform. For accident detection, the maximum limit acceleration is established. When the MPU 6050 detects the occurrence of the accident with the help of a 3-axis gyroscope and 3-axis accelerometer, the piezo buzzer will sound, and the LED will turn on. When the MPU6050 not detects, the buzzer and LED will then switch off.

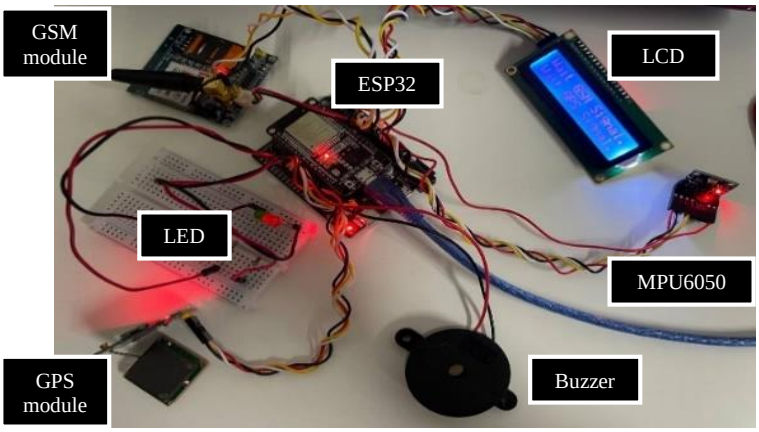

Figure 6: All Component Test

3.5 Connection with Solar Charging

Generally, solar energy generates from solar panel and supplies to micro controller. It analyse the input and output of the system. The function of solar panels is to gather that energy and convert it to electricity to bring power to our project. Figure 7 shows the connection with solar charging. This configuration charges the battery as well as supply power to the circuit when the solar cell is producing energy. At night, the charge circuit is disconnected and the battery is used as the power source for the circuit.

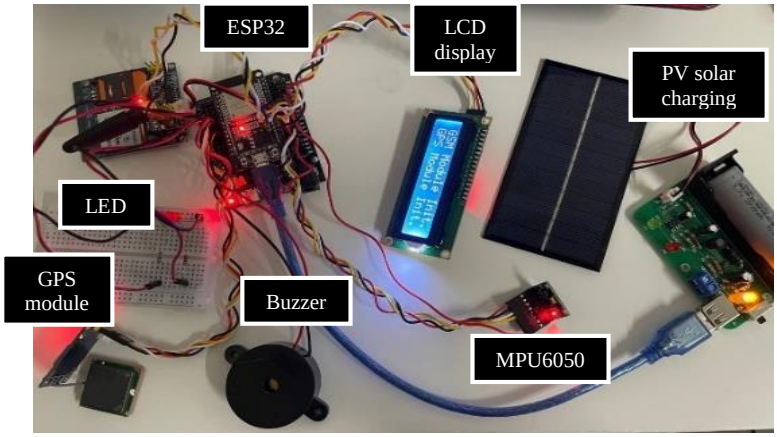

Figure 7: Solar Charging Test

3.6 The notification messages

The communication technology utilised was GSM 900a, and the GPS module transmits the data in NMEA format, which may use to pinpoint the disaster's precise location. SMS messages are sent to specified people via the GSM. When an accident occurs, the designated person will receive a notice stating that "Collision sensor has been activated at Position https://www.google.com/maps/place" and will be aware of the location of the motorbike and be able to take appropriate action. Figure 8 shows the notification message on the user mobile.

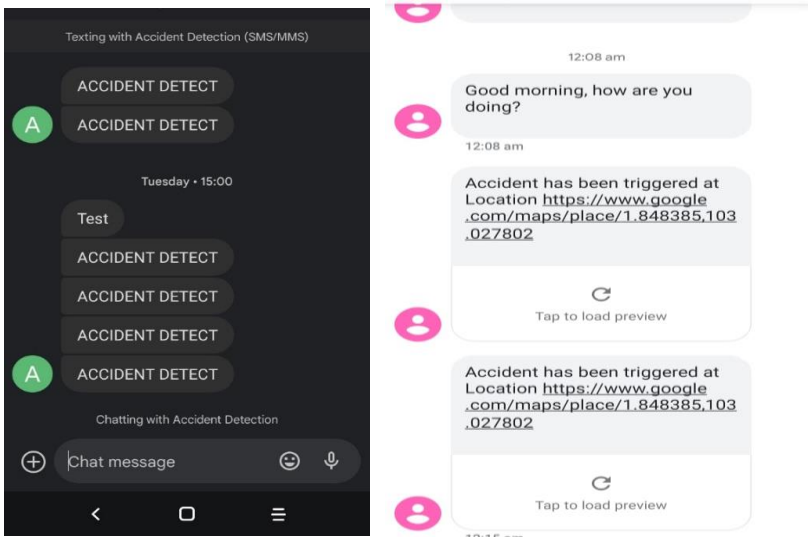

Figure 8: Notification on Mobile

3.7 System performance analysis

The prototype will be linked to an LED light and buzzer. The LED will light up when the MPU 6050 detects the occurrence of the accident with the help of a 3-axis gyroscope and 3-axis accelerometer, and the buzzer will sound. It was timed how long it took the LED to turn on and the buzzer to sound. Time spent by GSM and GPS receiving a signal and sending SMS and location has also been noted. The system performance analysis for the time taken to the output is shown in Table 2.

Figure 9 shows the graft analysis time taken to the output. The graph indicates that there were connectivity issues on the initial try, which made it take some time to react. Due to a connection-related GSM issue, the second, fourth and sixth responses are delayed. The fifth and eighth responses are almost the same which wait quite a while also because of the interference signal. Successfully responding

within the allotted time is the third and seventh attempts because the GSM and GPS modules did not interfere with the signal and the recorded duration was no longer than 20 seconds.

Table 2: The Analysis Time Taken of Project

Attemp test	Time taken (s)		
	LED light up	Buzzer ring	GSM and GPS received signal and send SMS
1	17	20	24
2	15	17	25
3	10	14	20
4	15	17	25
5	13	15	23
6	14	13	26
7	10	10	18
8	14	16	22

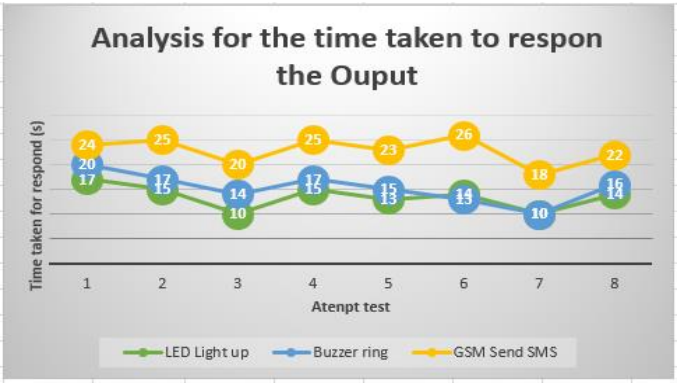

Figure 9: Graph Analysis Time Taken

3.8 Analysis of Solar Charging

Table 3 shows the voltage across the solar panel at various times on a day. The following readings were taken on Jan 2023. Figure 10 indicates that the highest average voltage is between 12:00 and 3:00 PM. The outcome also demonstrates that the generated voltage was more than 5V throughout the entire tested period. indicating that the battery can receive charge from the PV module.

Table 3: The Voltage Across Solar Panel

Time	Max. Voltage (V)
9am	4.73
11am	4.85
1pm	5.02
3pm	4.95
5pm	4.75

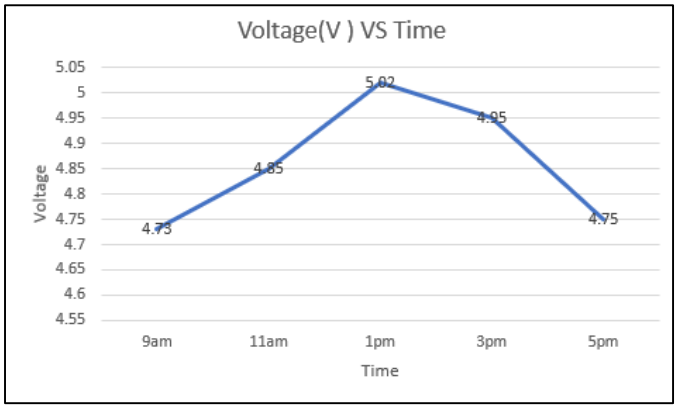

Figure 10: Graph Voltage VS Time

4. Conclusion

This project aims to develop and build a prototype with automated accident detection. The prototype has already accomplished the first and second objectives by detecting when an accident occurs using an MPU6050 sensor and delivering an alert with the location of the motorbike using a GSM and GPS module. Additionally, this project is completed when it can be powered by PV solar charging. The third objective was also achieved when the system's effectiveness was demonstrated with eight sensor detection attempts and sending the notification to priority individuals in this project. Many individuals require this product because they want to be safe and take measures when riding a motorbike. As a result, the producer may need produce this prototype in large quantities.

5. Acknowledgment

The authors would also like to thank the Faculty of Electrical and Electronic Engineering, University Tun Hussein Onn Malaysia for its support.

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