Automatic Vechicle Detection And Rescue system

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ABSTRACT

Human loss by road accidents has been a devastating issue, which possess negative implications on the socioeconomic development of the societies. Most developing countries are recording higher volumes of fatalities whenever a road accident occurs due to the lack of a proper and quick system that reports accidents to the emergency services for an immediate rescue. Moreover, the chances of survival of any casualty of an accident is mostly dependent on how quick the emergency medical services arrive at the scene and quickly reaches the nearest hospital with the victims for treatment. However, these emergency vehicles are sometimes delayed by heavy traffic en route to and from the accident scene. This paper introduces a robust automatic vehicle accident detection and alert system, which uses an accelerometer to detect the tilting and the crashing of the vehicle, sends the Global Positioning System (GPS) location of the accident scene to intended security, medical and family contacts. The proposed design achieved a turnaround response, which is faster than conventional rescue system without these features. Hence, saving more lives as possible through technology.

Keywords — Emergency Medical Services (EMS), Global Positioning System (GPS), Global System for Mobile Communication, Internet of Things (IoT).

I. INTRODUCTION

Road transport is increasingly popular in the world. However, road accidents especially in cities and towns are rapidly increasing to an uncertain level, which is devastatingly affecting the socio-economic development of people. The effects include the huge costs of losing livelihoods, leaving families destitute, and infrastructural damage costs and losses. Measures to prevent human loss whenever an accident occurs are among the top priorities to be addressed in this paper. Most governments in all these developing countries, including the government of South Africa, are embarking on a vision to work on the best way possible to reduce the occurrence of these road accidents by raising awareness and offering efficient road safety lessons. Realistically, in most cases, accidents occur unexpectedly or mistakenly thus the main challenge has been timeliness in reaching the victims involved in an accident and taking them to the hospital for treatment. This problem is normally caused by the provision of late reports or even the conveyance of insufficient information about the accident including the location of the scene to the emergency services or rescue authorities [1]. Hence there is a greater need to introduce and establish an internet of things (IoT) related automated system used to detect an accident, notify the nearest emergency services to offer immediate medical services to the victims, and promptly notify the immediate family member of an effective.

II. METHODOLOGY

The automatic vehicle accident detection and rescue system proposed in this work is shown in Fig. 1. It is a compact IoT-based system, and operates at a low-cost in saving human lives. The automatic vehicle accident detection is an IoT-based project divided into 4 main subsystems namely the accident detector subsystem, Emergency Medical Service (EMS) subsystem, ambulance/EMS vehicle subsystem, and traffic light subsystem[2].

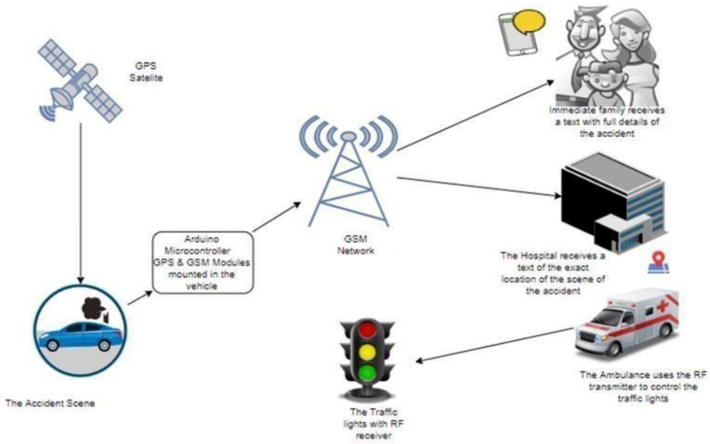

Figure 1: Overview of the automatic vehicle accident detection and rescue system

A. The Accident Detector Subsystem

The accelerometer sensor, buzzer, 16 x 2 LCD, GPS, and GSM modules are mounted in the vehicle making up the accident detection unit as shown in Fig. 2.

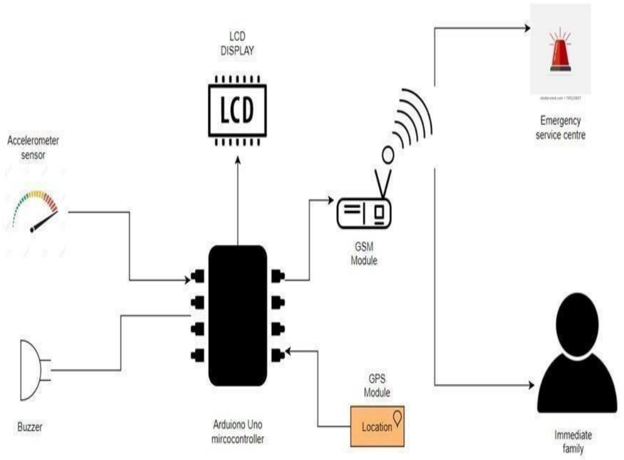

Figure 2: Architectural design for the accident detection and notification segment

An MPU-6050 3 Axis Gyro accelerometer sensor was used in this work. The accelerometer detects the crash by measuring the vibration caused during an accident, if it exceeds the threshold value then a signal is sent to the Arduino microcontroller to actuate the notification process[4]. In addition, this sensor detects if the vehicle has fallen into the 3D real axis. The orientation of the accelerometer is shown in Fig. 3.

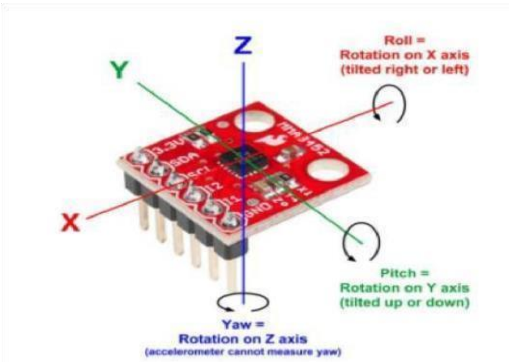

Figure 3. The orientation of an accelerometer

The accelerator is only activated to send forth a signal to Arduino if the angle rises in the X and Y axes go beyond 80 and 70 degrees respectively measure from its zero-degreed original position. It sends a HIGH signal to the Arduino microcontroller to initialise the detection and reporting system. When the Arduino Uno microcontroller receives any signal from any of the above-mentioned sensor, the buzzer rings to confirm the detection of the accident. The Arduino controller then asks the GPS module to collect the latitude and longitude data of the scene of the accident from the GPS. The design also made use of an Nrf24l01 Module for transmitter and receiver, SIM800L GSM Module with inbuilt helical antenna, and another port for a PCB antenna. A full detailed text message with the exact location of the accident is instantaneously sent to the Emergency Medical Service Centre and the immediate family member with the phone number registered in the system using the low-cost GSM network. The reset button has been incorporated to account for minor and false detections[5].

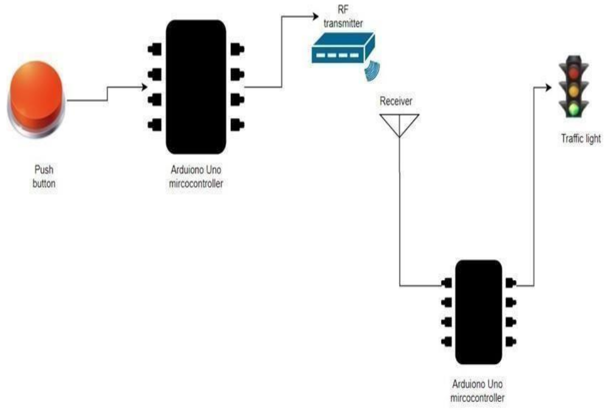

Figure 3: Architectural design for the traffic controller

III.RESULTS AND DISCUSSIONS

Various conditions were created so to examine how the subsystems perform in real-world environments. Analyses were provided to examine if the results obtained are in line with our expectations and the project's specifications. A. Tilt Measurement Test An experiment was carried out to examine the tilt angles measurements by the accelerometer sensor thus setting threshold values for accident detection. An accident is assumed to have occurred whenever the threshold values of 80 degrees in the x-axis and the 70 degrees in the y-axis are reached and/or surpassed. Table I shows the number of attempts performed so to investigate the performance of the tilt sensor. The accelerometer sensor met the expected result of displaying the measured angle with a very small error deviation. This error could have been caused by a systematic error in manufacturing[2].

Attempt	Direction	Actual Angle measured by the protractor (degrees)	Angle displayed by the LCD (degrees)	% Error
1	Left	55	54.12	0.016
	Right	66.44	65.01	0.022
2	Left	88.10	87.22	0.010

	Right	65	64.480	0.008
3	Left	100	99.50	0.005
	Right	120	119.12	0.007
4	Neutral	0	0	0.000

TABLE I. Tilt Sensor Angle Analyses

Therefore, the tilt sensor shall detect an accident when a car tilts at 80 degrees or more in the x-axis, thus it shall send a HIGH signal to the Arduino to start the reporting process. On the other hand, if 70 degrees is reached or surpassed in the y-axis the reporting system shall be initialised as well. These angles were set as thresholds so to compensate for the alignment of the vehicle in hilly places and uneven ground. B. GSM Configuration Test The performance of the GSM in sending text messages to 3 different networks namely Cell-C, MTN and Vodacom was also conducted. The text messages received on 3 chosen networks from a GSM module is shown in Fig. 4 and the response time experienced is shown in Table II. The initial step of configuration was successful as the LED of the GSM module blinked every 3 seconds. From the GSM tests shown above, the response time was varying, but remained within the expected range. This was due to the difference in operational performance of different network providers at different locations. The GSM used in this experiment performed extremely well as it sends a text message within seconds, this supports the objective of this project to notify the emergency department and the immediate family member registered in the system[6].

C. GPS Configuration Test

The results presented in Table III showed infinitesimally error due to deviation in the manufacturing methods of the mobile GPS and the Ublox Neo GPS. The inbuilt antenna facilitated a fast and efficient communication between the module and the satellite in extracting the actual location of any of the tested places in terms of the longitude and latitude results obtained. The objective of locating the scene of the accident using this GPS module was successfully met, as the GPS is supposed to communicate with the Arduino microcontroller by sending it the exact location of the accident scene immediately upon detection. D. RF Communication Test The RF transmitter was used to light the LED lights connected with an RF receiver circuit. The results from the experimental circuit were shown in Table IV and are satisfactory[4]. Each push-button action actuated the desired output of the corresponding LED light in a very short period. The Arduino at the transmitter side keeps track of the status of the push button switches. As the switch is pressed a HIGH logic signal is recognised at the analogue inputs of the microcontroller, which encodes the data in preparation of the transmission. The Arduino then propagates the required data to the analogous light on the other circuit on the receiver side in which the particular switch is pressed. The RF receiver receives the propagated data from the transmitter and decodes the data thus effecting a HIGH signal on its pins resulting in the lighting and the switching OFF of the LEDs. As the distance between the RF transmitter and receiver increases, the action was delayed. However, if beyond 100 m, it was dysfunctional according to the device datasheet. E. General

Performance of the Overall System[3].

Figure 6: Alert message format

For instance, we assumed that the accident has occurred on 10 Cranswick Road in Sandton. The Emergency Centre use the reported longitude and latitude values so to identify the scene of the accident on Google Maps thus identify the nearest hospital for immediate medical rescue as shown in Fig. 7.

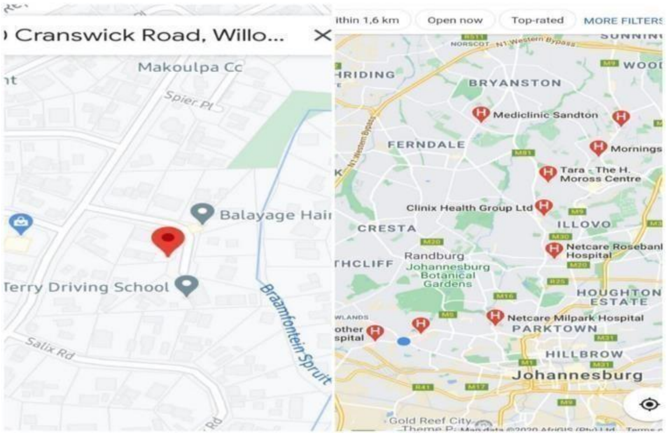

Figure 7: Google Maps used to identify the nearest hospital for immediate rescue

D. Comparison of existing and proposed method

Feature	**Existing Method**	**Proposed Method**
Detection Technology	GPS, Accelerometer	GPS, Accelerometer, AI-based image recognition, IoT sensors
Communication Technology	GSM, SMS	GSM, SMS, 5G, Cloud-based communication
Accuracy	Moderate	High (due to AI and additional sensors)

Response Time	Moderate	Fast (due to real-time processing and advanced communication)
Energy Efficiency	Moderate	High (optimized algorithms, low-power sensors)
Integration with Emergency Services	Manual (requires human intervention)	Automatic (direct integration with emergency services)

IV. CONCLUSION

A portable and compact accident detection and alert system which is cost effective was successfully designed and implemented. The system detects accident whenever the set threshold values are surpassed and alerts the emergency responsible authorities and registered next-of-kin within a maximum of 4 seconds. The developed traffic light controller can be applicable to ambulances, fire brigades and other emergency or priority vehicles/convoy. The overall performance of the accident detection and rescue system would help to save the lives of many accident casualties. A reset button has been incorporated so to disengage the system even in situations that a minor accident occurs so to prevent a wastage of resource especially from the Emergency Centre and reduce panic from the family members. In addition, the operation range need to be maintained within 100 m radius of the traffic light so enhance the good operation of the RF communication. If the driver presses the push button outside the operational range, then no signal shall be transmitted. Finally, interference of the RF signals from other devices might hinder the smooth operation of the wireless RF communication system.

The shortcomings of this system are the unpredicted error of false detection at rare cases and the interruption of the RF communication by interference. However, we recommend in future work the use of LoRa transceivers, which supports wireless communication of longer ranges. More so, it is recommendable that this system be improved so to instantaneously shut down the motor vehicle engine upon accident detection for safety reasons of the victims of the accident and also incorporate the ultrasonic sensors which in instances of a possible head-on collision could help to minimize losses of human lives.

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