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Accident Broadcasting Alert and Notification System for Motorcyclists

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Abstract:

Malaysia is reported to be the highest country in ASEAN that has road fatality risk by an International Association of Traffic and Safety Sciences (IATSS) research article. There were more than 50% of the road accident fatalities involving the motorcyclists. According to this study, thepolice and emergency department in a hospital may not be able to promptly notify the victim's closest family member due to the absent of emergency contact details left by the victim during the accident. Moreover, as compared to other vehicles users who can easily obtain "accident reported ahead" sound alert via Waze application or GPS device; other motorcyclist riders who have not been through the accident area would not be aware with any accident ahead. To address these limitations, an innovative project that considers GSM technology, GPS application with an accident detection system via force/pressure sensor shall be included on the motorcyclist's helmet using the latest and trending technology, IoT. When the sensor data exceeds maximum limit of pressure then RF will broadcast to the nearby rider within 150 m with the accident occurrence via recorded voice and GSM module automatically sends message family members. It is anticipated that the project development would be able to reduce the number of accidents involving motorcyclists and ensure the victims' closest family member be informed with the location of motorcyclist as he/she are involving in any accident.

Keywords: *Smart helmet, GPS, GSM, accident detection, IoT*

I. INTRODUCTION

Due to heavy traffics in Malaysia, motorcycle has become one of the dominant transport modes for Malaysians. As shown in Figure 1, IATSS research article entitled "Motorcycle fatalities in Malaysia" has reported that 60% of road accident fatalities are involving motorcycles[1]. These statistics shows that motorcycles become the major contributor in road accidents with no sign of declining in the future.

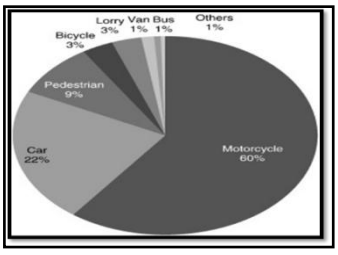

Fig. 1. Fatality distribution by various mode of transports. Adopted by permission from [1]

Other vehicles' users could easily get notified with any minor collisions or accidents via trending devices such as GPS navigation device and mobile application such as Waze. However, motorcyclists are unable to use such devices and mobile applications when riding on the road due to wind flow and safety. Therefore, motorcyclists are unaware of any accidents that occurred ahead.

Besides that, authorized parties such as police or hospital may need to perform "call for relatives" in the newspapers or televisions news when they failed to contact the motorcyclist's next of kin. This scenario may happen since the authorities are unable to get emergency contact details from the victims who are unconscious or found dead.

There were several innovative works on smart helmet as proposed by researchers in [2]-[6] where an improvement in terms of innovation applications

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were included on the motorcyclists' helmets to reduce the number of accidents involving motorcyclists and ensure the victims' closest family member be informed with the location of motorcyclist when he/she has involved in accident. For instance, smart helmet invention proposed in [2] used GPS to trace the location of the bike just in case if accident happens. However, there is no alert notification send to the nearby riders for other riders' awareness on nearby accident.

On the other hand, a smart helmet proposed in [3] was solely depends on a vibration sensor to detect an accident when the rider has felt and hit the ground. This might not be effective because the sensor will easily activate the accident notification system in the helmet regardless with any detected vibrations. Next, another smart helmet invented by [4] uses a flex sensor to check whether the rider is wearing the helmet or not. This is to reduce the chance of serious accident for motorcyclist especially when the rider is drunk. Lastly, an IoT based smart helmet in [5] uses GPS and wireless fidelity (WiFi) to alert the emergency response team such as hospital for ambulance service to the accident location. However, the system operation is only possible if there is Wi-Fi accessibility at the accident location.

This paper will address the limitations found in the above-mentioned inventions of smart helmet as listed in the following project objectives:

i) to develop a fall detection system during accident for motorcyclists by using force sensitive resistor (FSR) and accelerometer.

ii) to send a message alert to the next rider within the estimated range with the accident occurrence via recorded voice notification.

iii) to report the motorcyclist's closest family member with the accident location via SMS notification

II. METHODOLOGY

The block diagram for the project is shown in Figure 2. The input readings will be taken from a FSR sensor and accelerometer. The FSR is used to detect whether the motorcyclist is wearing the helmet or not. Meanwhile, an accelerometer is used to identify the accident occurrence. This two sensor units would be the inputs for the Arduino as the system process to activate the proposed motorcyclist accident detection and notification system via GPS, GSM and RF-UART-433 with maximum of 150 meters range.

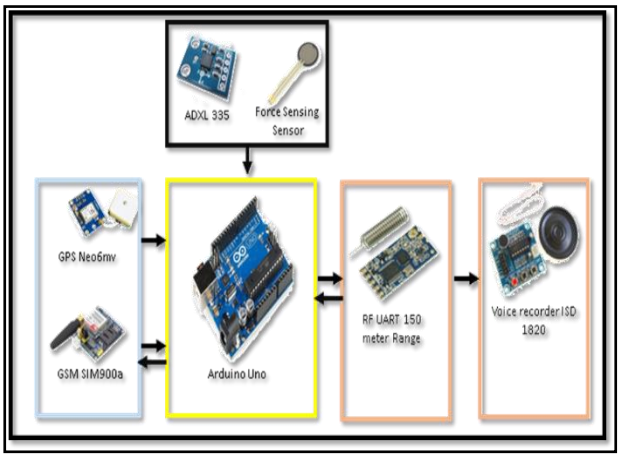

Fig. 2. Project block diagram

The system operational flowchart for the project is shown in Figure 3. The occurrence of an accident will be considered as TRUE when two conditions are met.

An accelerometer of ADXL 335 is used to measure the acceleration force. If all of the three axes (X-, Y- and Z-axis) of the accelerometer are in HIGH condition, the FSR sensor will measure the force pressure as absorbed by the helmet during the fall or accident cases. A threshold value will be set to 600 and whenever the FSR reading exceeds this threshold value, the system will wait within one minute to allow the motorcyclist who had involved in an accident to disable the accident detection and notification procedures.

However, if the system does not receive any system termination by the motorcyclist who had involved in an accident (in a case of the victim is severely injured or unconscious),the GPS module will be activated. Therefore, the longitude and latitude of the accident location could be identified. This information will be used by the GSM module to notify the victim's closest family members via SMS.

The proposed system will further transmit the accident alert notification to the nearby riders that reside within 150 meters range via a standard recording audio message. The transmission of the accident alert notification based on the audio message is possible via RF module called UART-433. Another smart feature is the push button on the helmet that could be simply pushedand activate the RF module for sending the accident alert notification audio message to other nearby riders within 150 meters range.

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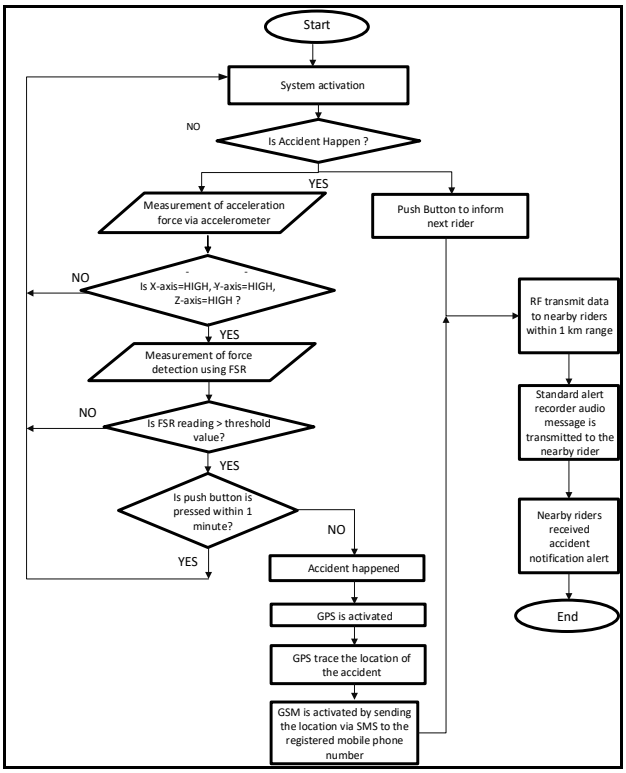

Fig. 3. Project operational flowchart

Figure 4 depicts the circuit diagram of the proposed systemdesigned usingFritzing Software. Fritzing is a software program to design the circuit before it could be translated into prototypes or real product. It presents the circuit in breadboard view, for easier visualization of the assembled component.. Thus, all of the components could be properly mounted inside the helmet.. Furthermore, the required power supply could be estimated for each component without any damaged to the module. The pin of microcontroller would be easier to configure to define the input and output of the system.

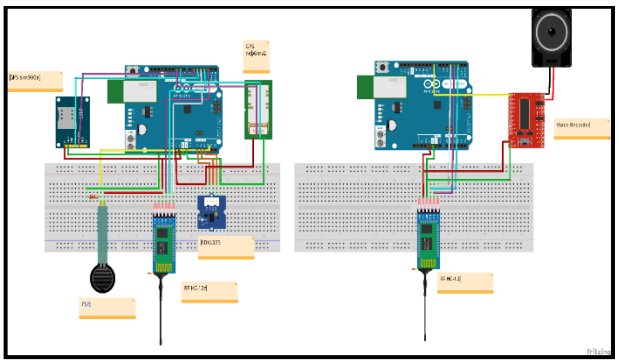

Fig. 4. Circuit diagram usingFritzing software

Fig. 5.A complete circuit mounted inside a helmet

Since the project focuses on the accident detection and notification for motorcyclists, all of the described components in Figure 2 were mounted inside a helmet unit as portrayed in Figure 5. Specifically, FSR is placed inside the helmet at the upper part of the helmet where the pressure from wearing a helmet is easily detected by the sensor. The accelerometer will also be mounted inside the helmet to measure the rider's acceleration speed of moving. The system power supply using battery is placed nearby the Arduino.

Meanwhile, one push buttons are placed outside and on the right side of the helmet to terminate the GSM via SMS of calling assistance. A speaker attached to a standard recorder alert audio message is placed inside and on the left side of the helmet. The RF transmitter circuit is placed inside the helmet while the transmission antenna ofGSM and GPS are located outside the helmet to ensure the transmission data is stable.

III. Results and Discussion

A. *Motorcyclist Fall Detection.*

The analysis of the pressure and vibrationfor the falling classification could be observed using the graph as illustrated in figure 6.. The line graphs shows the total pressure of idle condition, while riding and during accident between number of data tested by FSR.

It can be seen that the total pressure of idle condition is constant to zero that represent no pressure inside the helmet due to the rider do not wear the helmet. However, the total pressure for while riding is relatively increased, slightly between 300 to 600 due to the rough terrain that gives a little pressure inside the helmet during riding condition. During an accident, the graph will be increased sharply as the strong impact inside helmet is reported to be between 600 to 900. Overall, these three conditions of pressure are varies according to the situation of the riders.

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Meanwhile, Figure 7 shows the shock strength of idle condition, while riding and during accident between number of data that have been tested using Accelerometer ADXL335.

It can be seen that the total acceleration of the "Idle condition" is at low vibration due to the static condition of the helmet or when the rider did not wear the helmet. However, the total acceleration for "While riding" is relatively increasing slightly between ± 20 related to the rough terrain that give a little vibration to the helmet. During to an accident, the graph will be increased sharply as the strong impact to the helmet is between ±120. Overall, for these three conditions of shock strength are varies according to the situation of the riders

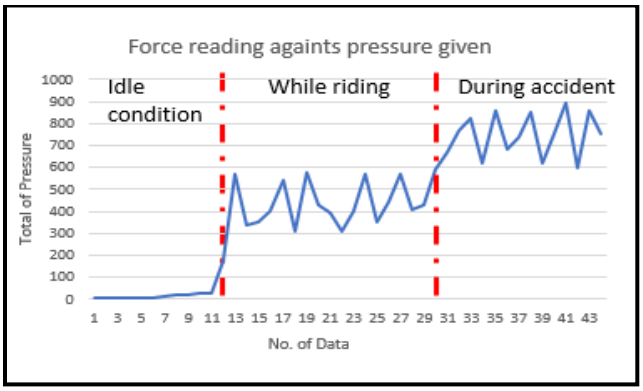

Fig. 6. Force reading against a given pressure

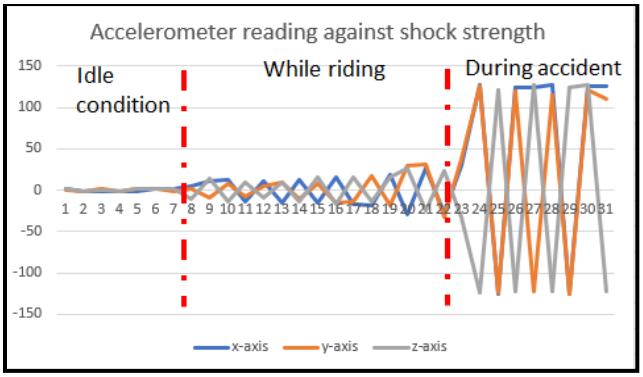

Fig. 7. Accelerometer reading against shock strength

B. *Accident Notification for Nearby Riders*

A wireless serial port communication module is used to notify the nearby rider regarding a motorcycle accident. Figure 8 shows the successful maximum range of communication during the experiment. The RF antenna was able to communicate in the range of 150 meters within the accident radius. The distance of 150 meter is the best distance to notify the nearby rider about an accident to avoid the unnecessary information give to the other riders that are located far away from the accident location. In addition, for road that has a lot of curve is high potential to infringement each other where the riders are unaware of any accident happened ahead since they are unable to use Waze and GPS navigator all the time. Figure 9 shows the overall prototype view of the proposed smart helmet for both victim and nearby riders.

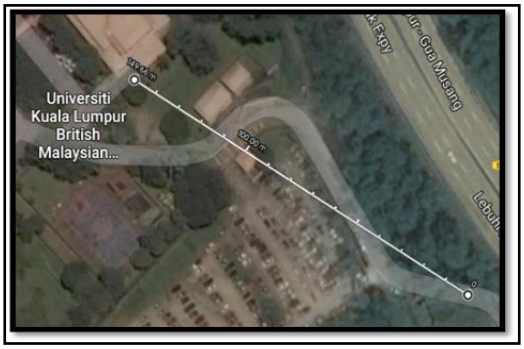

Fig. 8. Range distance of RF module using Google Maps

Fig. 9. Two helmet with communication system

C. *Accident Notification for Motorcyclist Contact Person*

GSM is use to notify the motorcyclist's closest family about an accident via SMS.

Figure 10 shows the text of accident notification received by the registered mobile phone number as retrieved from the proposed system in the victim's helmet . The text message contains the location of the accident in which the recipient could just click on the link and the mobile phone will directed the link to the accident location via Google Maps view as shown in Figure 11.

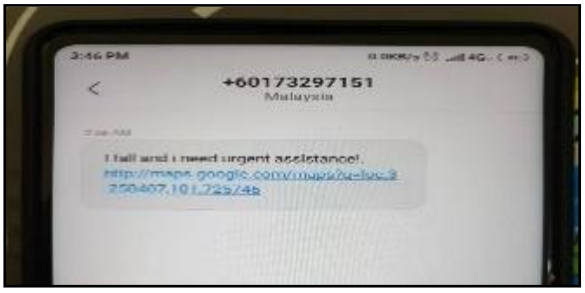

Fig. 10. The text of accident notification received by the victim's contact person

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Fig. 11.The direction to the accident location

IV. CONCLUSION

As the conclusion, a smart helmet for motorcyclist accident alert and notification via GSM and GPS is developed by mounting a Radio Frequency (RF) transmitter and receiver system on an existing of motorcyclist's helmet. Both FSR and accelerometer were used for motorcyclist fall detection. The results presented in Section III show that all of the project objectives were successfully achieved.

This project could benefit the society by decreasing the number of road accident. Firstly, it will enable a prompt accident notification to the love ones. As the victim family, it is important to receive an information about the status of the victim especially in major injured. This is to avoid from any delayed feedback from the victim's family when the respective authorities failed to immediately get the emergency contact details of the victims. World Health Organization (WHO) and the Association for Safe International Road Travel [7] stated that many victim's family members had responded to the shock that shattered a seemingly ordinary day with disbelief, denial, panic and rage.

Secondly, the project development would be able to prevent other riders from getting involved in the same accident when the other riders were unaware of any accident ahead especially on tight corners during dark and glomming weather with potential to collide to an accident. This is because motorcyclists are unable to use navigator apps and mobile apps all the time while riding. Besides, this will encourage an immediate help among fellow riders.

Basically, this development of accident broadcasting alert and notification system for motorcyclist have a huge market potential. This system can be commercialized through any collaboration between the manufacturer as one of the initiative to standardize the accident detection and notification system in Malaysia. Furthermore, collaboration from telecommunication network provider would be great by contributing an unlimited free SMS on the accident notification to the registered mobile phone number of the victim's contact person.

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