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Real-Time Car Crash Detection and Notifier Using GPS Module and IoT

Muhammad Luqman Hakim Abu Seman[1], Noraisah Sudin[2]*

[1] *Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering University Tun Hussein Onn Malaysia (UTHM), Parit Raja, 86400, MALAYSIA*

*Corresponding Author: noraisah@uthm.edu.my
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Abstract

With the increasing number of vehicles in Malaysia year by year, accident can occur to anyone no matter how safely the person drive, the other driver might be the cause of the accident and some even have the misfortune that nobody knows that the person get caught in accident and probably need a few days before being found. With the help of this project, it will instantly notify the family members of the victim that their beloved one gets caught in an accident and can let them reach the victim as soon as possible. This project makes use of IoT concept where it sends data through the internet. With the help of ESP32 microcontroller, that makes the data transmitting possible along with the GPS Module Neo-8M to point to the accident location. The collision sensors and the gyroscope sensor MPU6050 act as the input device for the main device. The main function of collision sensors is to detect any potential vehicle(car) crash, while gyroscope sensor MPU6050 is used to detect the orientation of the vehicle whether it is in normal orientation or otherwise. Then, the accident location will be displayed on the mobile application which has been developed in this project as well. The evaluation on the accuracy of the GPS module in pointing out the location of the accident location also has been conducted in four different environments, in an open area, inside the building, between high-rise building and wooded area. Based on the results obtained, it is shown that the accuracy of the GPS module in an open area is accurate meanwhile in other environments, a slight error occurred where the highest approximate value is five meters off from the location in real time.

1. Introduction

In the world nowadays, people need to travel to different places a lot either for work purposes or just to have fun travelling with families and friends or alone. In Malaysia, most of the population used personal vehicle to travel from places to places since citizens in Malaysia prefer to use their own personal vehicle more than the public transport itself. Of course, vehicle accidents are something that can happen to anyone anytime which is unexpected and sometimes if the victim is not lucky enough, it would take a few days for other people to find the victim or even knows about the accident especially the family members of the victim. We can see in a few news regarding these case for example the first news about a man missing and was found later after two days in a bush following an accident. In another two cases, families were unaware that their members had been in an accident. These cases are the main reason that this project gets into action.

With the help of the Real-Time Car Crash Detection and Notifier using GPS module and IoT, the family members of the victim can instantly know that their other family members caught in an accident and immediately reach location of the accident through the designed mobile application inside their smartphone. This system can also help in the search and rescue mission for the victims.

2. Methodology

In the proposed system, ESP32 has been used as the microcontroller that is responsible to process the input and the output of the project because of its capabilities to connect with Wi-Fi and work with internet for IoT-based systems [1]. The ESP32 microcontroller is connected to the four collision sensors, gyroscope sensor MPU6050, and GPS Module Neo-8M. The output data from the ESP32 microcontroller can be seen in the mobile application that is developed using MIT App Inventor and the data is stored inside the Blynk cloud. The block diagram of this work is presented in Fig. 1.

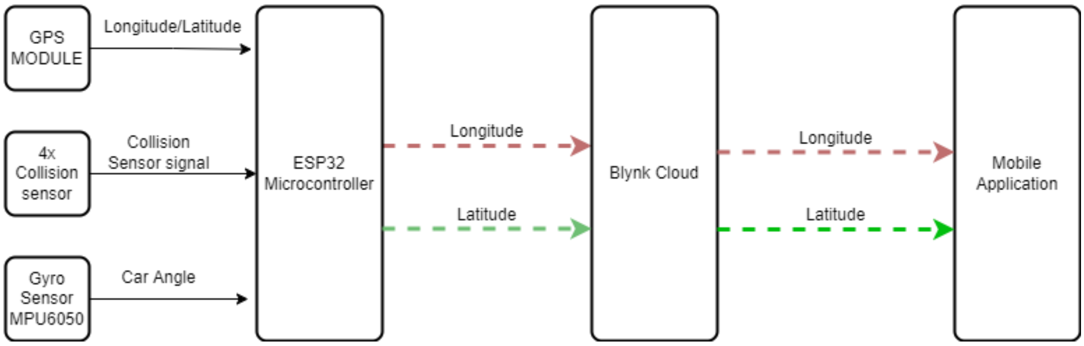

Fig. 1 *The block diagram of the system*

Fig. 2 shows an overview of the program flowchart of the system will initialize all the sensors and the GPS Module and after that it will wait until the system is connected to the internet and when the system is connected to the internet, the Blynk cloud will be online and ready to store the Longitude and Latitude data from the ESP32 microcontroller. Next the collision sensors will be on standby mode while the gyroscope sensor MPU6050 starts calibrating and then reading the car angle to know the orientation of the car. After that, whenever one of the sensors is triggered, the GPS Module extracts the longitude and latitude data and the ESP32 Microcontroller sends the data to the Blynk cloud [2]. Each data is sent to their designated virtual pin where the longitude data is assigned to virtual pin V1 and latitude data is assigned to virtual pin V2. Finally, the location of the car will be displayed on the mobile application for the victim's family member to see and navigate to the accident location.

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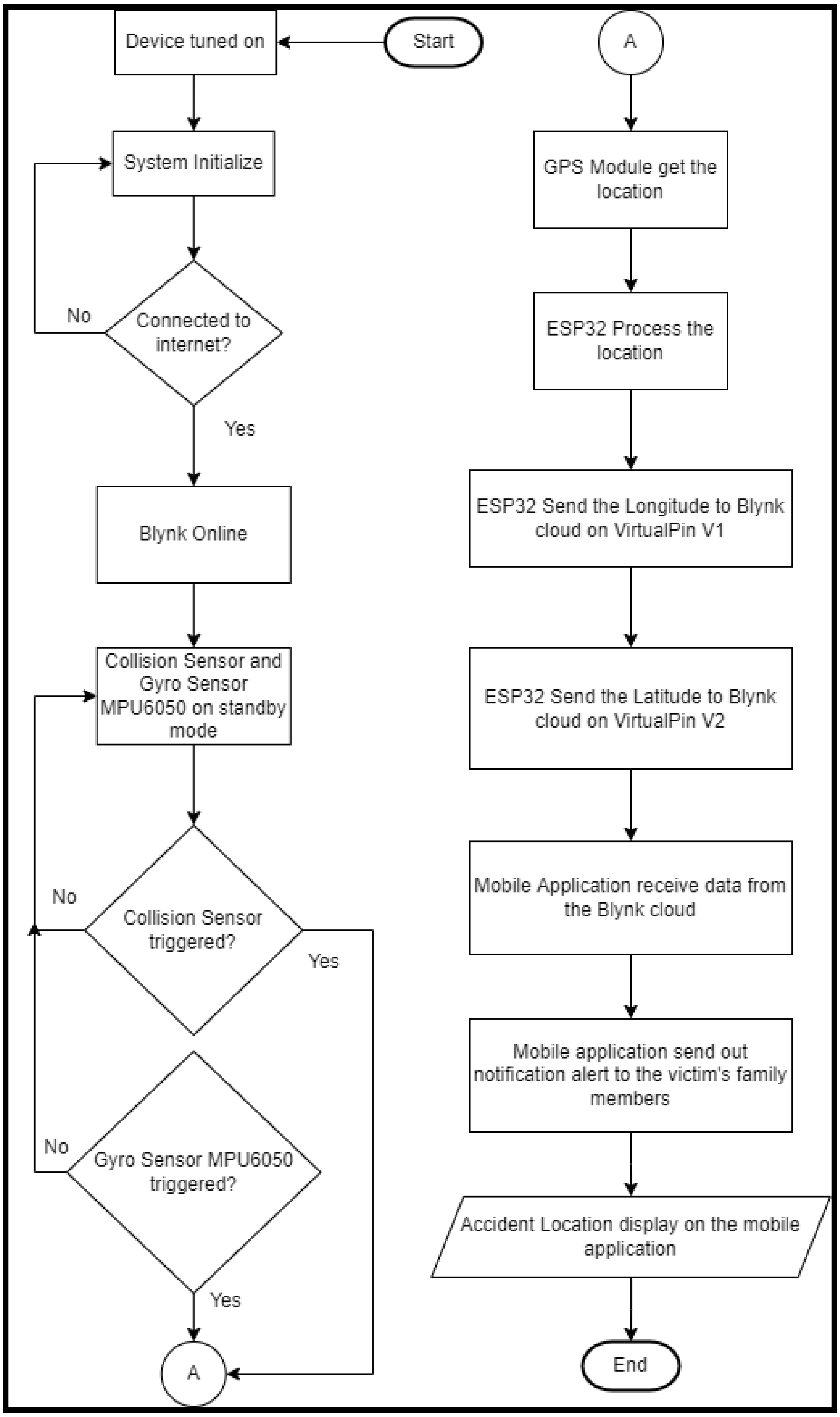


Fig. 2 *Flowchart of the system*

2.1 Hardware and Software Requirements

2.1.1 Hardware Requirements

Table 1 lists all the components needed for this project. And Fig. 3 shows the circuit diagram of the project

Table 1 *List of components and their function*

No	Component	Function
1	ESP32	Primary Microcontroller
2	GPS Module Neo-8M	For locating the accident location
3	Gyroscope Sensor MPU6050	For reading the car angle and determining the car orientation
4	Collison Sensor	For detecting any impact on the car

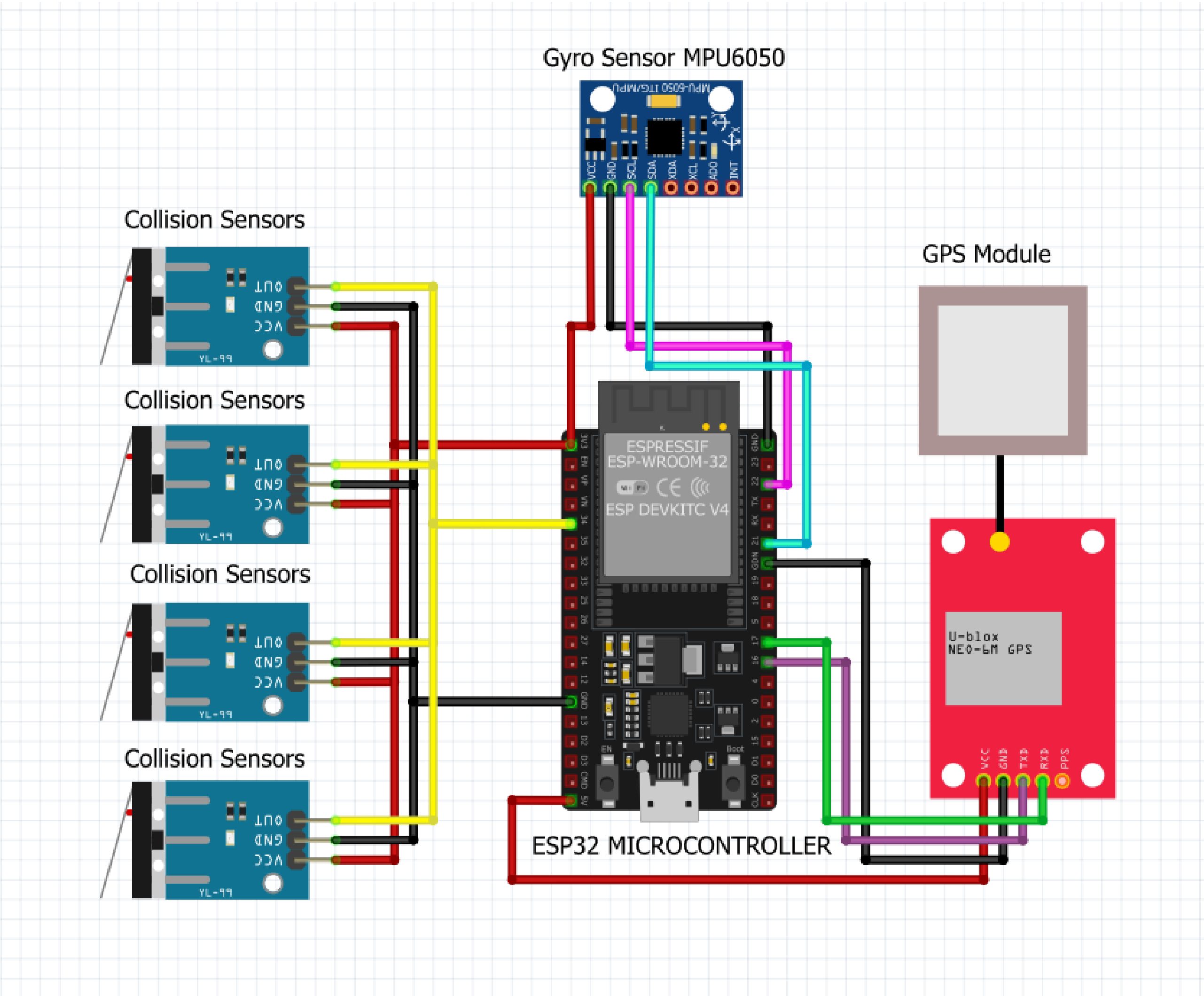


Fig. 3 *Circuit Diagram of the project*

2.1.2 Software Requirements

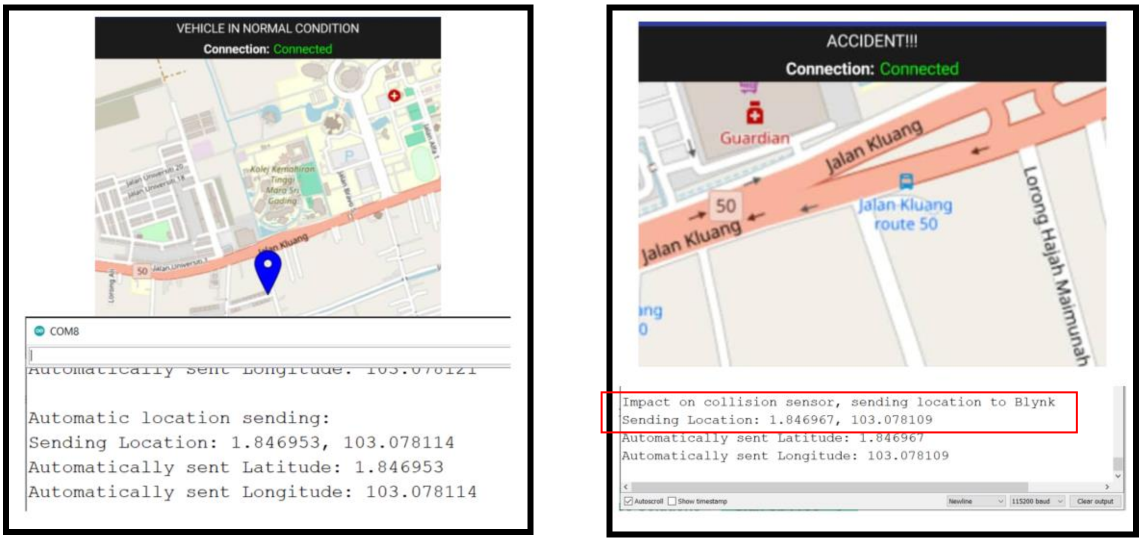
Table 2 shows the software requirements for the project and what is the purpose of the software in the project development.

Table 2 *Software requirements and the purpose*

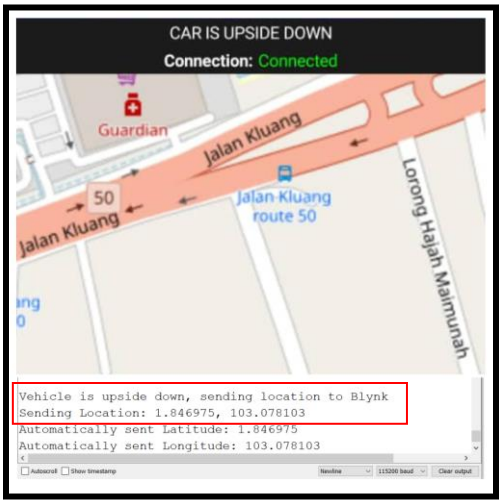
No	Software	Function
1	Arduino IDE	For programming the code and uploading the code into the microcontroller
2	Blynk Cloud	For storing data from the ESP32
3	MIT App Inventor	For developing the mobile application

3. Results and Analysis

From Fig. 4(a), the result shows that the car is in normal condition where no collision or abnormal orientation is detected which is why the text message at the very top of the mobile application show the message "VEHICLE IN NORMAL CONDITION". In Fig. 4(b), the output illustrated in the mobile application is when the collision sensor is triggered, when the ESP32 microcontroller detect that the input is coming form the collision sensor, it sends the data to the Blynk cloud and that is how the message "ACCIDENT!!!" appear at the top of the mobile application. Lastly on Fig. 4(c), the output shows on the mobile application is when the gyroscope sensor MPU6050 is the one that triggered because it sense that the car is in abnormal orientation, when the ESP32 microcontroller received the input from the gyroscope sensor MPU6050, it sends the different output to the Blynk cloud and then the mobile application display the text message "CAR IS UPSIDE DOWN" at the top of the mobile application.



(a) (b)

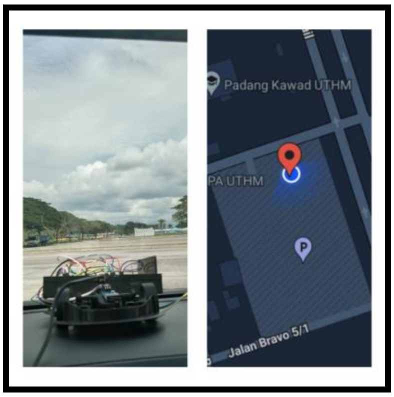


(c)

Fig. 4 (a) *Car in normal condition (b) Car crashing output (c) Car in abnormal orientation*

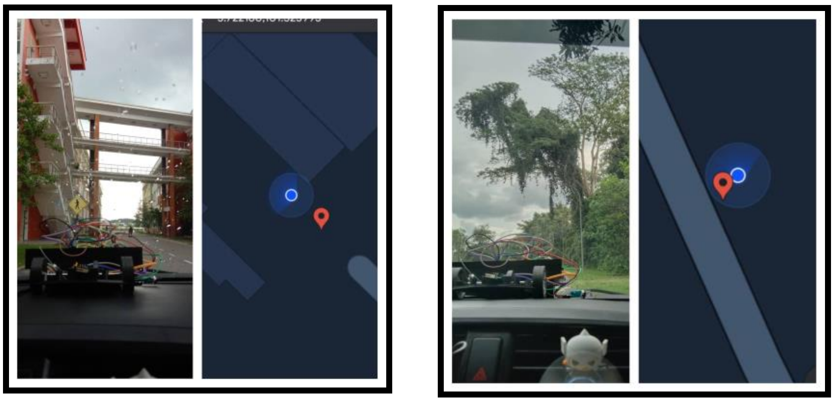
3.1 Analysis On GPS Accuracy

In this project, the first analysis that has been made is on the accuracy of the GPS Module to point the accident location, the testing has been made in three different environments. Firstly, the test is conducted in an open area as illustrated in Fig. 5(a) and the output shows that the location is accurate because there is no disturbance on the GPS signal. In Fig. 5(b), the GPS accuracy is tested inside the building where the GPS signal is blocked by the roof. In Fig. 5(c), the GPS accuracy is tested between high-rise buildings where the GPS signal is disrupted by the building at the left and right of the device. Lastly the accuracy of the GPS module is tested in a wooded area as in Fig. 5(d) where the tree around the road will be the one disrupting the GPS signal. The result of the analysis can be seen in Table 3.



(a)

(b)



(c) **(d)**

Fig. 5 (a) *GPS accuracy testing in an open area* (b)*GPS accuracy testing inside building (under roof)* (c) *GPS accuracy testing between high-rise building* (d) *GPS accuracy testing in wooded area*

Table 3 *GPS Accuracy Analysis Result*

No	Condition	GPS Accuracy (how far the location is away from the device
1	Open area	Location is accurate with the real time location
2	Inside the building (under roof)	Approximately 5 meter off from the device location
3	Between high-rise building	Approximately 3 to 4 meters off from the device location
4	Wooded Area	Approximately 1 to 2 meters off from the device location

3.2 Analysis on Gyroscope Sensor MPU6050 Accuracy on determining Vehicle Orientation

In this section, it will show the analysis on the accuracy of the gyroscope sensor MPU6050 in terms of determining the orientation of the car to see if the car is in normal position or abnormal position such as lying on the side or turning upside down [3] [4] [5]. In Fig. 6, the output on the serial monitor does not show that the car is in abnormal orientation even when the car is slightly tilted to the side, this is because of the road surface that sometimes makes the car to be slightly tilted, does not mean that the car involves in an accident. However, in Fig. 7, the output on the serial monitor shows that the car is not in normal position and from the picture taken, the car is upside down which means that the car got involved in an accident. This means that the gyroscope sensor MPU6050 is able to determine the orientation of the car accurately without any problem to make sure that the victim's family members do not receive a false alarm from the device.

Fig. 6 *Car in normal position*

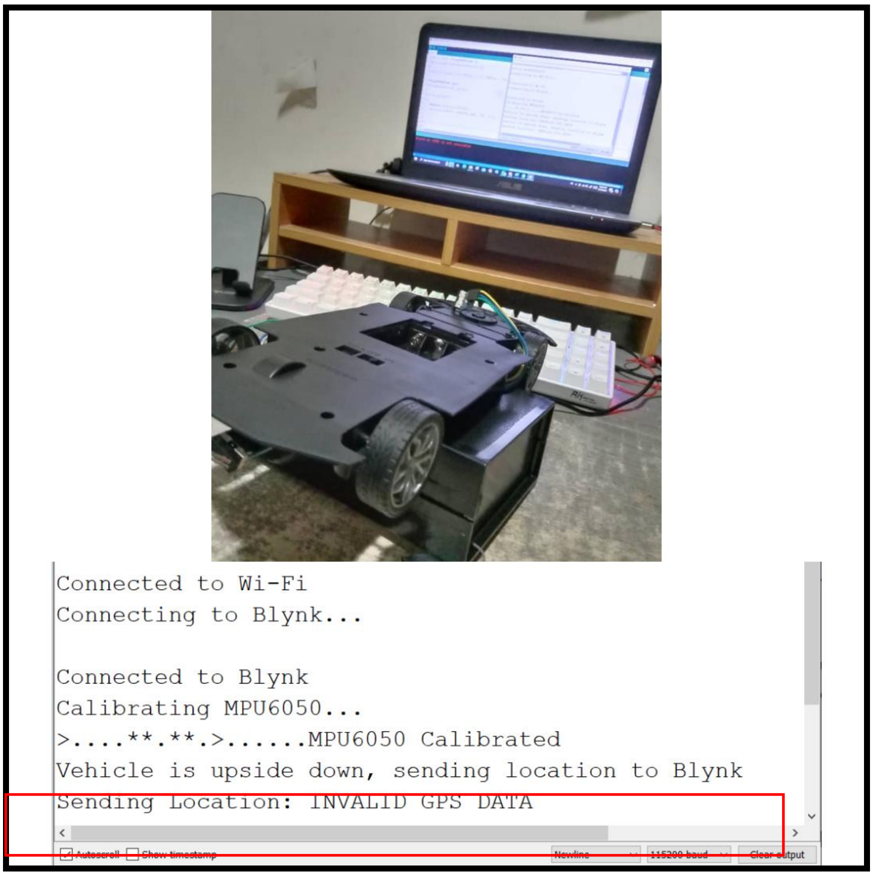


Fig. 7 *Car is upside down*

4. Conclusion

To summarize, this project successfully achieved its objectives by detecting and notifying accident locations using a mobile application. The system integrates the ESP32 microcontroller, collision sensors, gyroscope sensor MPU6050, and GPS Module Neo-8M to collect and transmit data to the Blynk cloud, enabling family members to access the accident location in real time via a mobile app. The functionality and accuracy of the sensors and GPS module were tested and demonstrated reliable performance under various conditions. However, the project has several limitations, including GPS accuracy being affected by environmental factors like buildings or wooded areas, dependency on internet connectivity through the Blynk cloud, the mobile application developed using MIT APP inventor is only compatible with android device [6] [7], and the gyroscope sensor requiring calibration to avoid drift. Additionally, the 3D-printed case may lack durability against extreme impacts or water submersion. These limitations highlight areas for future improvement, such as upgrading the GPS module, developing the mobile application using Google Flutter to make it compatible with android and IOS devices, enhancing the casing for better durability, incorporating offline functionality, and refining the gyroscope calibration process to enhance system reliability.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Luqman Hakim Abu Seman;* ***data collection:*** *Muhammad Luqman Hakim Abu Seman;* ***analysis and interpretation of results:*** *Muhammad Luqman Hakim Abu Seman;* ***draft manuscript preparation:*** *Muhammad Luqman Hakim Abu Seman, Noraisah Sudin. All authors reviewed the results and approved the final version of the manuscript.*

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