SafeRide: IOT Based Helmet System for Rider safety with integration of ThingSpeak

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***Abstract*—This research proposes the development of a Smart Helmet system utilizing Internet of Things (IoT) technology to enhance the safety of bike riders and reduce road accidents. The system addresses prevalent issues such as non-compliance with helmet usage and reckless driving behaviors, particularly under the influence of alcohol. Through IoT integration, it incorporates sensors to detect real time location of the driver and alcohol consumption, ensuring driver's safety and surveillance. Additionally, in the event of an accident, the system promptly notifies registered contacts with the precise location, facilitating timely assistance. The Smart Helmet system has broad applications in promoting road safety, including urban transportation, motorcycle rental services, racing events, law enforcement, and personal use, providing proactive measures to mitigate risks and minimize human losses associated with motorcycle accidents.**

***Index Terms*—ESP32, Platform IO, ThingSpeak, SIM808, NEO-6M, ADXL335, MQ-3**

I. INTRODUCTION

It's widely known fact that motorcycles and bicycles hold a strong appeal for many young individuals, often surpassing the allure of traditional four-wheeled vehicles. However, alarming statistics from surveys indicate a troubling trend: a considerable number of riders choose to forgo wearing helmets, seemingly oblivious to the serious risks and potential repercussions. Here we can see that most of the people are avoiding and breaking traffic rules, thus in order to resolve this issue we came up with an innovative technology which is a microcontroller-based Smart Helmet System. This innovative system provides users with real-time alerts, significantly mitigating potential risks and minimizing adverse outcomes. Our primary motivation behind this technological advancement is to enhance safety measures and reduce human casualties, ultimately prioritizing user well-being. Majority of the road accidents are taking place due to variety of reasons and that include the negligence while driving, improper age limitation to young, aged people to drive vehicles and the mostly it comes to when not wearing helmet while driving the bikes or two-wheelers, due to such choices it can have dire consequences, ranging from immediate fatality to long-term disabilities.The entire system, incorporating a range of sensors, is streamlined and simplified through the use of ESP32, leveraging its versatility and capabilities. To detect the presence of alcohol breath, an alcohol sensor is mounted in the driver's helmet close to the mouth. At the same time, it is tracking the location of the rider in real time using GSM and GPRS setup.

II. PROPOSED SYSTEM

The proposed smart helmet system integrates GPS technology to track the rider's precise location in real-time, enhancing safety measures and enabling swift assistance in case of emergencies. Moreover, the system incorporates an alcohol sensor to monitor the rider's intoxication level, preventing engine activation if the limit is exceeded. In the event of an accident, the system triggers an alert and sends notifications to registered contacts, including a Google Maps link pinpointing the exact accident location for immediate response. Facilitating remote accessibility and portability, the system seamlessly integrates with ThingSpeak, a cloud-based IoT platform, enabling centralized monitoring and control from any location with internet connectivity. This integration ensures that critical data, including GPS coordinates and sensor readings, can be accessed and analyzed in real-time, enhancing overall safety and security for riders. The primary drawback of conventional helmets is their limited ability to provide adequate protection in all accident scenarios, as they may fail to mitigate more severe impacts, potentially resulting in injuries. However, integrating an emergency information system powered by a microcontroller and GPS module can significantly enhance safety measures and potentially save numerous lives. This innovative solution addresses the limitations of conventional helmets, providing comprehensive protection and reinforcing compliance with traffic regulations.

III. SYSTEM DESIGN

A. ESP - 32

The ESP32-WROOM-32 is a powerful Wi-Fi and Bluetooth microcontroller module developed by Espressif Systems.

- Processor: The ESP32-WROOM-32 features a dual-core Xtensa LX6 microprocessor, which operates at up to 240 MHz. This dual-core architecture allows for efficient multitasking and handling of multiple tasks simultaneously.
- Wireless Connectivity: One of the key features of the ESP32-WROOM-32 is its built-in Wi-Fi and Bluetooth capabilities. It supports 2.4 GHz Wi-Fi 802.11 b/g/n and Bluetooth v4.2 BR/EDR and BLE (Bluetooth Low

Energy). This makes it suitable for a wide range of IoT (Internet of Things) applications requiring wireless connectivity.

- Peripheral Interfaces: The module offers a variety of peripheral interfaces, including SPI, I2C, UART, I2S, PWM, and ADC. These interfaces allow for easy integration with various sensors, displays, and other external devices.
- Memory: The ESP32-WROOM-32 comes with a generous amount of memory for storing program code and data. It typically includes up to 520 KB of SRAM and up to 448 KB of ROM for program storage.
- Security Features: Security is an essential aspect of IoT devices, and the ESP32-WROOM-32 provides several security features to protect data and communications. It includes hardware-accelerated encryption (AES, SHA-2, RSA), secure boot, and flash encryption to safeguard against various security threats.
- Low Power Consumption: Despite its powerful features, the ESP32-WROOM-32 is designed to be energy-efficient, making it suitable for battery-operated and low-power applications. It offers various power-saving modes, including deep sleep, which minimizes power consumption during idle periods.
- Development Environment: Espressif provides comprehensive development support for the ESP32-WROOM-32 through its ESP-IDF (Espressif IoT Development Framework) and Arduino IDE. These development tools offer libraries, examples, and documentation to facilitate the development of IoT projects.

TABLE I
ESP-32 Features

Sr.No.	Features
1	Dual-core Tensilica LX6 microprocessor
2	Up to 240MHz clock frequency
3	520kB internal SRAM
4	Integrated 802.11 BGN WiFi transceiver
5	2.2 to 3.6V operating range
6	2.5 µA sleep current under hibernation
7	32 GPIO
8	10-electrode capacitive touch support
9	Hardware accelerated encryption

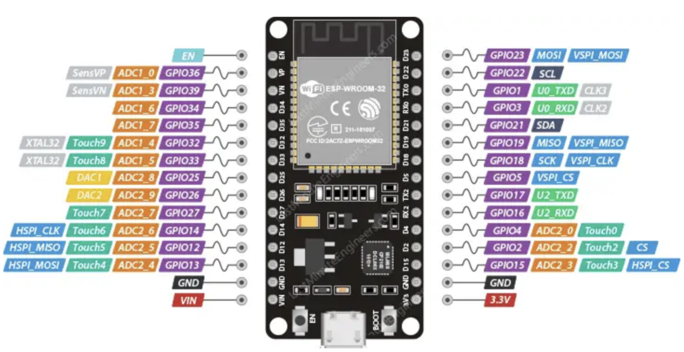

Fig. 1. Esp32 micro-controller [1.]

B. MQ - 3

The MQ3 alcohol gas sensor is a module used for detecting alcohol, CH4, benzene, gasoline, hexane, CO, and LPG. It has a sensitive material SnO2 for alcohol gas detection, with lower electrical conductivity in the fresh air. It is a semiconductor alcohol gas sensor that detects or monitors the presence or absence of alcohol. It is also known as chemi-resistors because sensing of the sensitive material depends on the resistance change when the sensor is exposed to alcohol gas. When the sensor is pointed closer to the alcohol gas, the SnO2 conductivity increases. The increase in sensor conductivity is directly proportional to the alcohol concentration. Therefore, the alcohol concentration is measured by any microcontroller very easily. The MQ3 alcohol gas sensor is very fast and has a high sensitivity to alcohol, smoke, and gasoline. An Alcohol detector can be made using this alcohol sensor. For this project, the threshold value is kept at 1020 for alcohol detection.

TABLE II
Sensor Specifications

Parameter	Value
Concentration	0.05 mg/L $\sim$ 10 mg/L Alcohol
Operating Voltage	5V $\pm$ 0.1
Current Consumption	150mA
Operation Temperature	-10°C $\sim$ 70°C

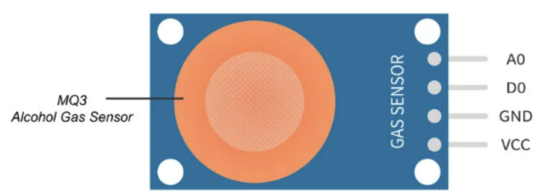

Fig. 2. Gas sensor (ethanol) [2.]

C. ADXL-335

It is an electromechanical device which is used to measure acceleration forces and the forces will be static or dynamic forces. An accelerometer will measure the vibration of the material and it is employed to continuously monitor the head inclination of the rider and position of the helmet and helpful for calculating the likelihood of accidents.

The ADXL335 is a compact 3-axis accelerometer, designed for low-power applications. With ±3 g full-scale range, it measures acceleration along the X, Y, and Z axes. Each axis represents a different direction of movement: X (Roll) for side-to-side, Y (Pitch) for forward-and-backward, and Z (Yaw) for up-and-down. Outputting analog voltages proportional to acceleration, it offers a sensitivity of around 300 mV/g. The sensor's bandwidth ranges from 0.5 Hz to 1600 Hz, suitable for various applications including tilt sensing, motion detection, and vibration monitoring. The threshold values of positive x, positive y and positive z direction be as follows 1.5, 1.5, 1.5 and similarly in negative direction it is as follows -1.5, -1.5, -1.5 respectively for accident detection.

TABLE III
SENSOR SPECIFICATIONS

Parameter	Value
Supply Voltage	2.8V to 3.6V
Current Consumption	320µA
Sensitivity	300mV/g
Bandwidth	3Hz to 5kHz

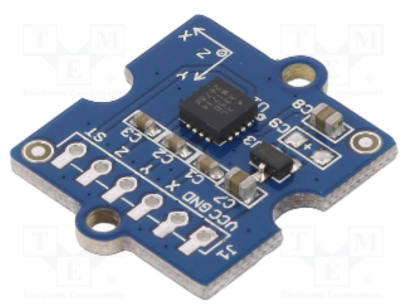

Fig. 3. Accelerometer (3-AXIS) ADXL335 [3.]

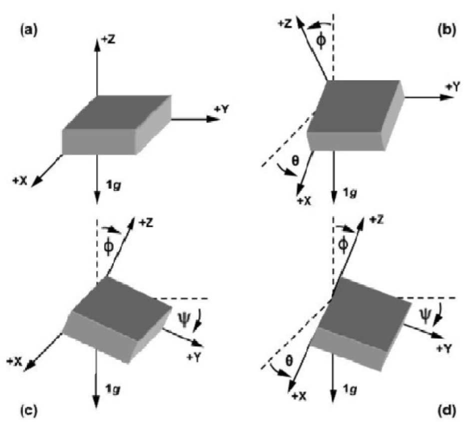

Fig. 4. Roll (X), Pitch (Y), Yaw (Z) representation [3.]

D. NEO - 6M

NEO-6M GPS module is designed and developed by u-blox. This is very small but it packs a lot of features. It can track up to 22 satellites over 50 channels while consuming only 45mA of current and has an operating voltage of 2.7V to 3.6V. One of the most interesting features of this module is its power-saving mode. This allows a reduction in system power consumption. With power-saving mode on, the current consumption of the module reduces to 11MA only.

– A small LED that is used to indicate that the GPS module is able to communicate with the satellites.
– No blinking – it is searching for satellites.
– Blink every 1s – Position Fix is found
– Antenna: The module comes with a -161 dBm sensitive patch antenna that can receive radio signals from GPS satellites. You can connect the antenna to a small UFL connector which we have mentioned in the parts marking section of this article.

The system calculates real-time latitude and longitude coordinates, providing accurate location data. These coordinates are then transmitted to the ESP32 for further processing and utilization.

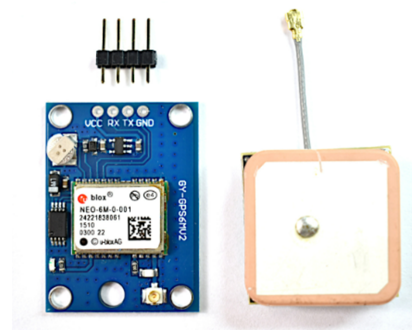

Fig. 5. GPS module for position tracking [4.]

E. SIM 808

SIM808 module is a GSM and GPS two-in-one function module. It is based on the latest GSM/GPS module SIM808 from SIMCOM, supports GSM/GPRS Quad-Band network and combines GPS technology for satellite navigation. The latest firmware support bluetooth function. You can use all AT commands for BT functions right now. Please see Download at the bottom. It features ultra-low power consumption in sleep mode and integrated with charging circuit for Li-Ion batteries, that make it get a super long standby time and convenient for projects that use rechargeable Li-Ion battery. It has high GPS receive sensitivity with 22 tracking and 66 acquisition receiver channels. Besides, it also supports A-GPS that available for indoor localization. The module is controlled by AT command via UART and supports 3.3V and 5V logical level. A sim card has to be put inside the sim card slot in the modem thus, enabling it to send and receive messages from registered mobile phone numbers.

F. ThingSpeak IOT Platform

ThingSpeak platform, which is cloud-based IoT platform providing easy access to device data from anywhere with internet connectivity. Its user-friendly interface allows for simple configuration, visualization, and customization of data representations. Integration with external services via its API enhances its functionality for various IoT applications. It was created by MATLAB.

Fig. 6. SIM 808 module for GSM based communication [5.]

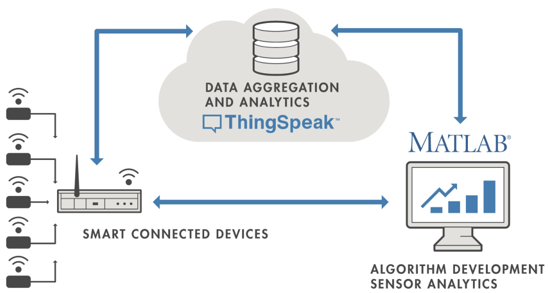

Fig. 7. ThingSpeak Block Diagram [6.]

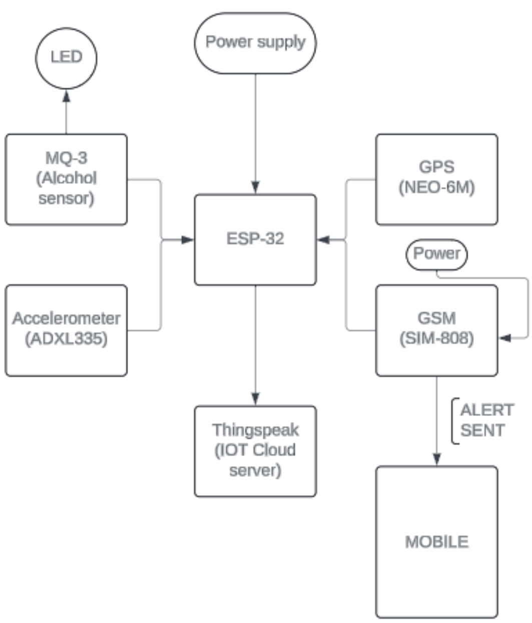

Fig. 8. Smart Helmet System - Block Diagram

IV. Implementation

The project implementation revolves around utilizing the Platform IO IDE, an extension of Visual Studio Code, to streamline development. It kicks off with parameter initialization, primarily configuring serial communication for both the GPS module and SIM808 module. Hardware Serial1 is designated for the GPS module (TX2: 17, RX2: 16), while Software Serial is employed for the SIM808 module (TX: D23, RX: D22). This ensures seamless communication with both modules, crucial for acquiring location data and enabling SMS alerts.

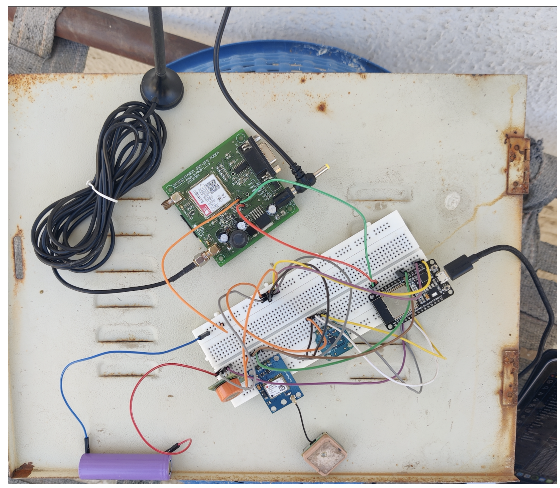

Fig. 9. Hardware Implementation on bredboard

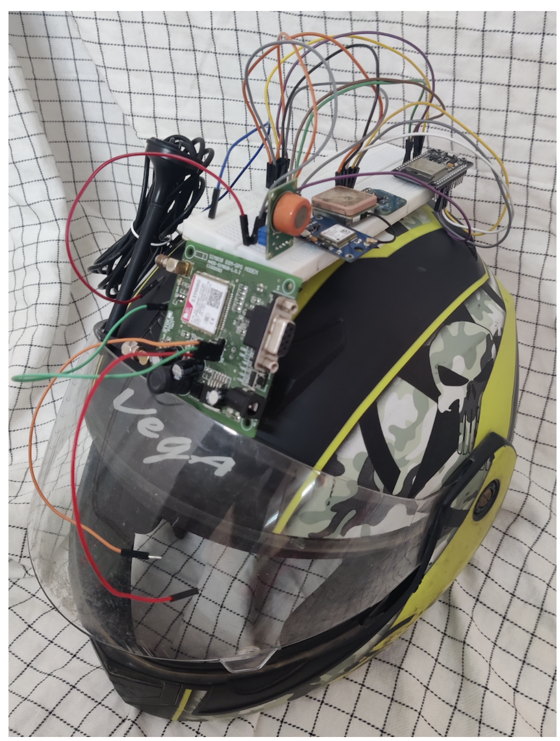

Fig. 10. Smart Helmet System

Transitioning into operational setup, the ESP32 is configured in station mode, establishing a link to a local WiFi network by defining the necessary credentials. Additionally, the project integrates with the ThingSpeak IoT server, leveraging its API key for data transmission. This integration forms the backbone of remote accessibility, enabling real-time monitoring and data analysis.
Sensor integration plays a pivotal role in the project's functionality. Pin assignments are made for various sensors, notably the alcohol sensor (D35) and the accelerometer (X: D32, Y: D33, Z: D34). Accompanying these assignments are threshold values critical for accurate sensor readings. Furthermore, calibration values for the accelerometer are established to ensure precise data interpretation.
In the execution phase, the project continuously collects sensor data within the main loop. This includes GPS location tracking, alcohol sensor readings, and accelerometer data. Every ten seconds, this aggregated data is transmitted to the ThingSpeak platform, facilitating ongoing monitoring and analysis.
An additional layer of safety is incorporated through the alcohol sensor. If the sensor detects a value surpassing the predefined threshold, an LED is activated momentarily to alert the driver. This proactive measure aims to mitigate potential risks associated with impaired driving.
If an accident is detected based on accelerometer thresholds, an SMS alert is triggered. This alert contains vital information, including latitude, longitude, and a Google Maps link, providing immediate assistance to the driver or relevant authorities.
Overall, the project orchestrates a seamless integration of sensors, data transmission to ThingSpeak, and accident detection functionalities within an IoT framework. Its comprehensive approach to safety and monitoring underscores its potential impact in enhancing driver security and promoting responsible behavior on the road. The corresponding workflow is shown in figure 11.

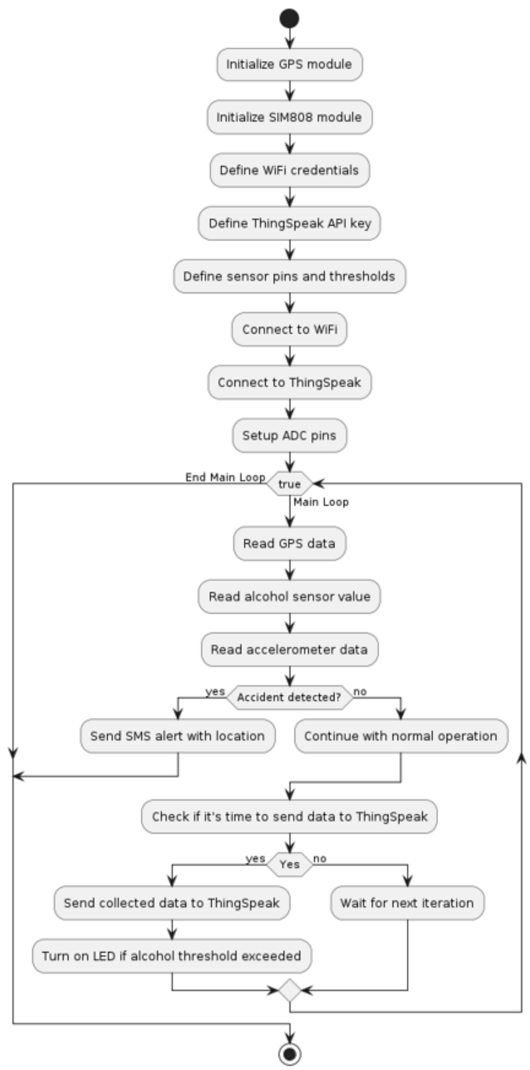

Fig. 11. Work Flow

V. Results

The results are showcased on the ThingSpeak IOT platform and are updated after every 10 seconds on it. Here for the project, Platform IO IDE is used for software development of the project and to confirm that its data is sent on to the server, output on the serial monitor can be seen in the figure 12.

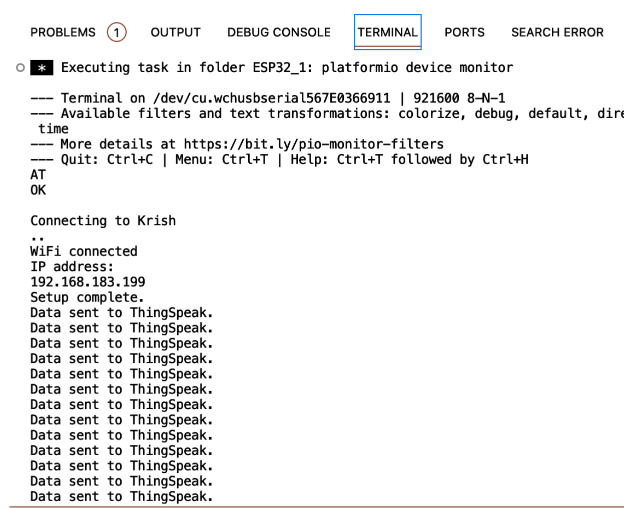

Fig. 12. Serial Monitor Output on Platform IO

Various fields display data collected from the integrated sensors in this project. These fields include:

- GPS Latitude: This field shows the latitude coordinates obtained from the GPS module. It provides real-time information about the device's geographical location.
- GPS Longitude: This field displays the longitude coordinates obtained from the GPS module. Like the

latitude field, it offers real-time data on the device's exact location on the Earth's surface.

- Alcohol Sensor Value: This field indicates the analog value read from the alcohol sensor. It helps monitor alcohol levels in the surrounding environment, which could be crucial for safety applications.
- X-Axis Acceleration: This field shows the acceleration value along the X-axis obtained from the accelerometer. It provides insights into the device's motion or orientation changes along the horizontal axis.
- Y-Axis Acceleration: Similar to the X-axis acceleration field, this one displays the acceleration value along the Y-axis. It helps track motion or orientation changes along the vertical axis.
- Z-Axis Acceleration: This field indicates the acceleration value along the Z-axis. It provides data on motion or orientation changes along the depth axis.

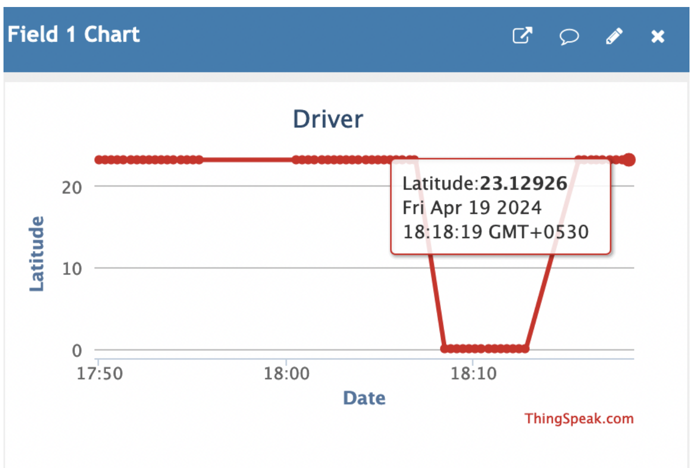

Fig. 13. Latitude (Location)

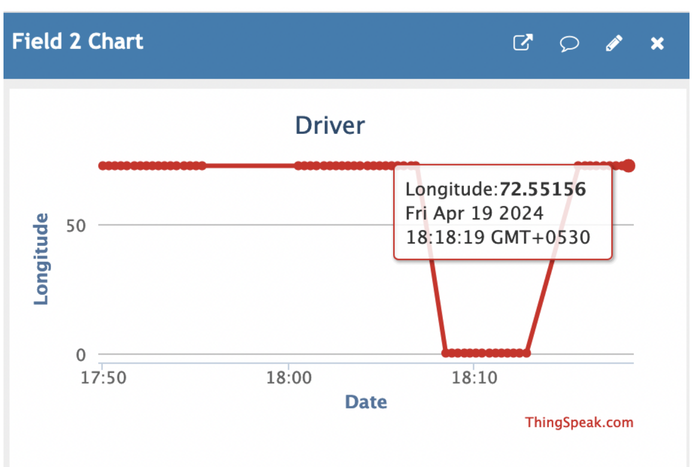

Fig. 14. Longitude (Location)

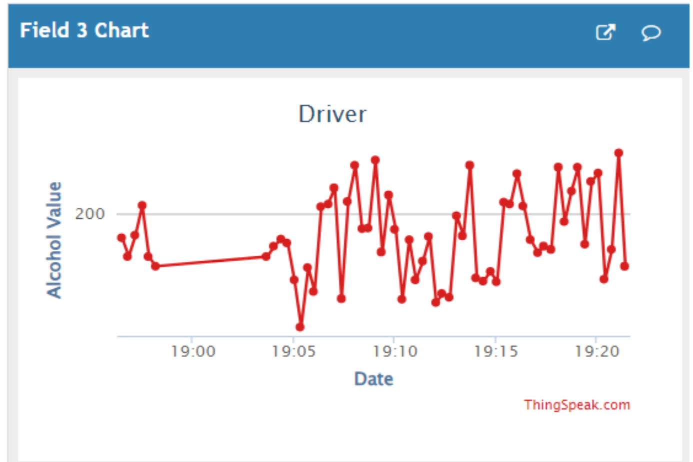

Fig. 15. Alcohol sensor reading

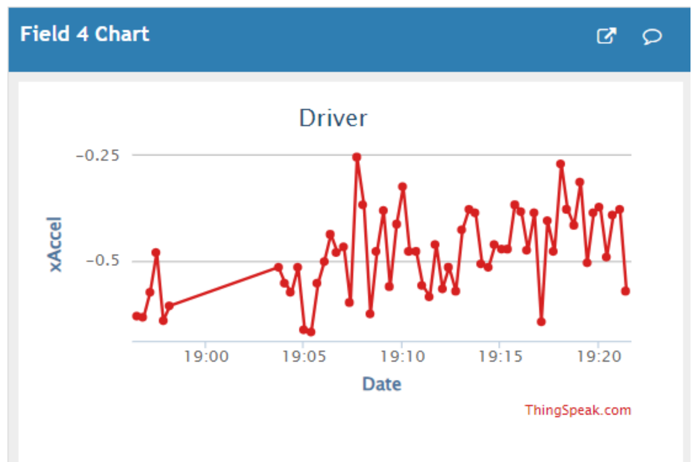

Fig. 16. X - axis

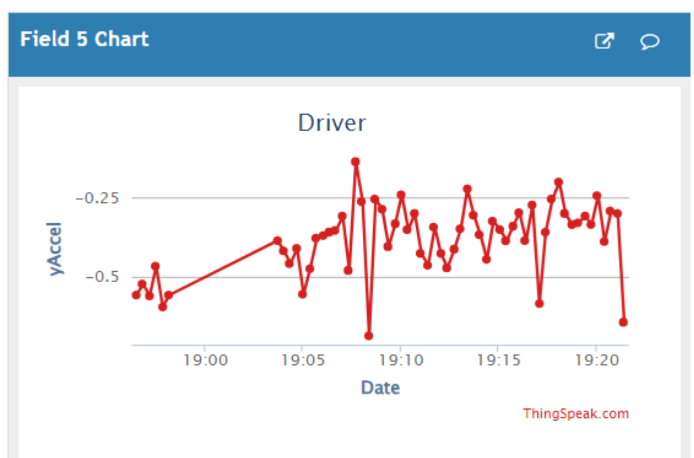

Fig. 17. Y - Axis

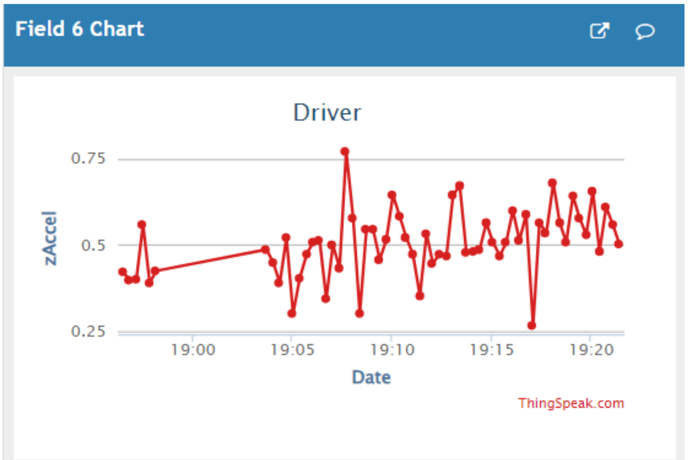

Fig. 18. Z - Axis

Also, upon accident detection alert message is instantly sent to the registered contact number with information about the latitude and longitude of the driver, with it Google Maps link is also attached. Look at the corresponding outputs in the figure 19 and 20.

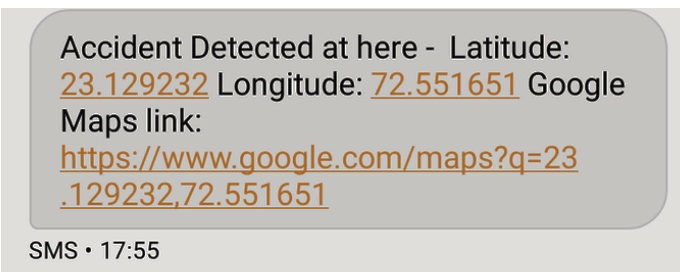

Fig. 19. Alert Message sent to registered number

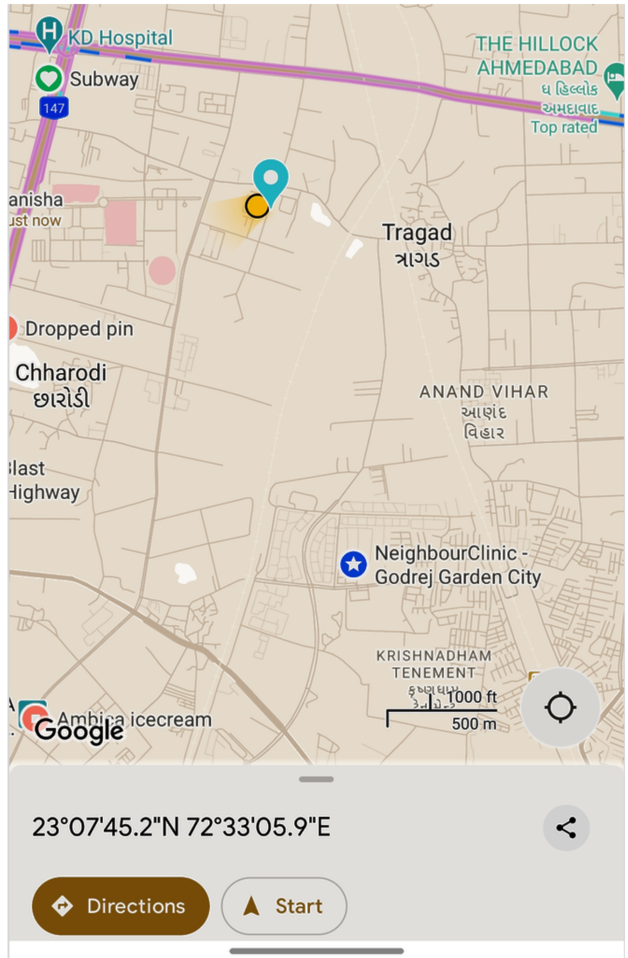

Fig. 20. Location of the accident - (Google Maps link)

VI. Future Scope

This smart system offers room for numerous additional features to enhance its functionality. With further development, this prototype has the potential to be transformed into a market-ready product. The future scope of the project includes enhancing accident detection by incorporating a buzzer within the helmet. Upon meeting accident thresholds, the buzzer will be triggered to alert nearby individuals. Additionally, a button feature on the helmet will allow the driver to prevent false accident alerts by pressing it within a stipulated time frame and the buzzer would be disabled. Additionally, integrating a calling feature into the helmet, complete with a microphone and speaker, facilitates communication during emergencies. This system allows for hands-free reception of calls, further enhancing its utility in critical situations. Moreover, the implementation of an AI assistant within the helmet, activated by voice commands, will provide navigation assistance to the destination. These advancements aim to enhance safety and communication capabilities in the smart helmet system.

VII. Conclusion

In conclusion, the integration of real-time GPS tracking and accident detection with alcohol sensing capabilities in a smart helmet marks a significant advancement in ensuring road safety. By providing instant alerts to both the wearer and designated contacts on their phones, this technology has the potential to mitigate the risks associated with impaired driving and accidents, thereby saving lives and preventing injuries. As we continue to innovate in the realm of wearable technology, such advancements demonstrate our commitment to leveraging technology for the greater good of society.

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