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A Review on Integrated IoT-Based System for Real-Time Accident Detection and Smart Ambulance Deployment

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Abstract - Motorcycle accidents are at the forefront of leading accidental deaths among the youth, with a rapid response being crucial for decreasing fatalities. Many current systems fail to meet ability in speedy detection of accidents and accurate reporting. They are also found inefficient in taking an emergency hospital response. The problem above has triggered the research and development of this study, Emergency Request Response and Management System (ERMS), which integrates real-time accident detection, rapid response, and effective emergency management. ERMS employs both vibration and accelerometer sensors, which act in a dual functionality, with AcciDet TracSys detecting sudden changes in motion to ascertain accidents and AcciAddr TracSys sending critical information like location coordinates and details on the accident via GPS. This data is immediately sent and shared with emergency responders and registered person contacts for quick medical help. The system also works with smart ambulances that guide their route using real-time GPS to reduce time. More than other systems, it integrates a coordinated approach that greatly improves the speed of response and increases the probabilities of survival. This paper discusses the working principle of ERMS, methods of detection, and communication, showing how the external world can make roads safer; it saves lives.

***Key Words*:** Real-Time Detection, Immediate Aid, Advanced Ambulance Care.

1.INTRODUCTION

Road safety problem is growing problem all around the world; especially in India where the number of vehicles on the road is growing day by day along with increased number of accidents. India has registered over 21 million vehicles, of which more-than two-wheeler accidents account for more than half of all fatalities. In a day, around 413 lives are lost due to road traffic accidents but a great many of these casualties occur even within the first hour from after the incident, thereby calling for immediate medical assistance. This really can prove productive in addressing the issue through applications in the Internet of Things (IoT). The Internet of Things connects different devices to the internet to share information in real-time. Applications like smart helmets, vehicle tracking, and automatic accident detection systems help emergency responders in reaching to the sites of accidents faster, thus potentially saving lives by considerably shortening the time it takes to get help. This paper deals with detecting accidents with IoT, notifying emergency services, and improving time to respond. It looks into some of the present trends and technologies on IoT and ultimately contributes toward developing more intelligent and safer transport systems that can potentially save lives from accidents.

LITERATURE SURVEY

If an accident occurs, the system sends real-time alerts to the vehicle owner, the driver's guardian, and emergency services, helping to reduce response time and potentially save lives. The system is designed to prevent accidents by tracking things like speeding, traffic signals, and the driver's emotional state. It's adaptable to different vehicle types, making it a flexible and scalable solution. The addition of 5G technology enhances the system's ability to send accurate, fast alerts to nearby hospitals and emergency responders, especially for motorcycle accidents where quick help is critical.

Looking ahead, there are plans to improve the system with features like GPS tracking and real-time location-based alerts, which will make it even more effective. The system also aims to address security concerns and provide continuous monitoring to ensure it's always functional. Overall, this system represents a significant step forward in improving road safety, reducing response delays, and ultimately saving lives.

2. METHODOLOGY

2.1 IoT-Based Accident Detection and Reporting System for Quick Medical Assistance

The initiative intends to solve the difficulties in promptly discovering and identifying accident victims in times of emergency. It might be challenging to offer prompt aid when an accident happens since the victim's identity and whereabouts are frequently unclear. Using Internet of Things technology, this system aims to identify incidents, track down the victim, and automatically communicate pertinent data including the victim's position and personal information to emergency services and appropriate contacts. This facilitates a quicker medical response and helps guarantee the victim receives assistance in a timely manner.

2.2 Integration of Slack and Push bullet for IoT-Based Accident Detection and Notification System

The rider's phone is loaded with the Slack app, which is used to activate and deactivate the system. The Slack API assists in causing the system to react when specific criteria are fulfilled. Another program, Push Bullet, serves as a conduit between desktop computers and mobile devices, making it simple to send messages. The rider's emergency contacts' phones have this app loaded. The Raspberry Pi-powered device has the capacity to store and notify several emergency contacts. Push Bullet uses straightforward scripting to send notifications from the Raspberry Pi to the contacts' cell phones. The Raspberry Pi is configured with access tokens for Slack and Push bulb to provide seamless communication.

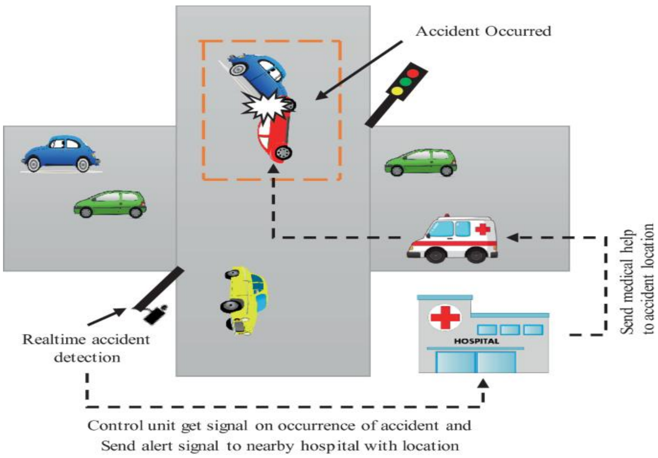


Fig 2.1 Integration of Slack and Push bullet for IoT-Based Accident Detection and Notification System

2.3 Architecture of the Smart Ambulance System

The intelligent ambulance system consists of five distinct layers.

Layer 1: Devices and Interfaces sensors (heart rate, temperature, GPS, accelerometer) installed in ambulances. Emergency response team mobile devices, such as smartphones and tablets. Primary contact interface

Layer 2: Microcontrollers based on Arduino/ESP32 for processing sensor data. RTOS

Layer 3: Sensor data is stored in a centralized database management system (DBMS). Mechanisms for safely storing and retrieving data

Layer 4: Services tracking and monitoring service for ambulances. An alert and notification system is part of an emergency response system (ERS). Integration of the Android app with Telegram for real-time updates Layer.

There are two primary components to the proposed system.

1. Crash detection and tracking is one of them.

2. Tracking and emergency response.

Phase for Crash Detection:

To precisely identify accidents, the ERMS accident detection phase uses a complex multi-sensor technique that integrates data from accelerometers (VC), braking sensors (AB), tilt sensors, flame sensors, and GPS. Every sensor has predetermined criteria that need to be reached in order to identify the occurrence of an accident. The accelerometer specifically monitors gravity force (Grav-force value), which is a sign of an impending accident if it is more than 4. However, there are a lot of false positives when this statistic is used exclusively. In order to solve this, ERMS takes into account more variables, such as speed variation, which is identified by GPS and has a threshold of 2.06 km/s, signifying abrupt and significant changes. In order to provide further proof of an accident, the system also uses microphone input to identify atypical acoustic events, which are defined as sound levels higher than 14dB.

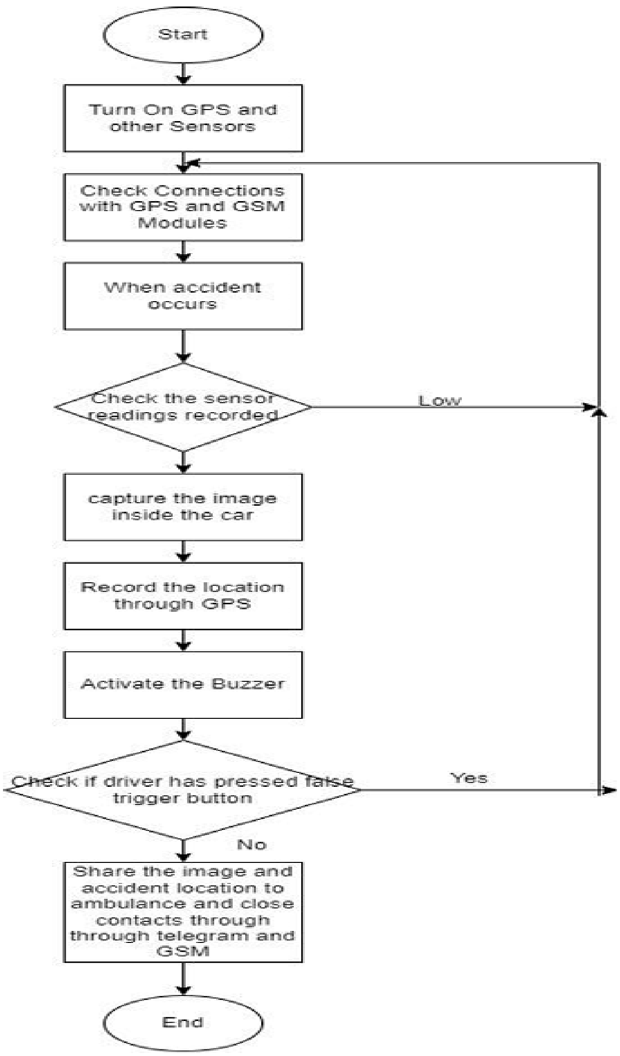
Procedure for detecting crash

Phase of Initialization The accelerometer, tilt sensor, GPS, and camera are all activated by the controller to start the Enhanced Accident Detection System (ERMS). The microcontroller unit and these modules are then connected by the system. Accident Detection: The accelerometer and tilt sensor data are continuously monitored by the ERMS. The system identifies a possible collision if the tilt sensor notices a substantial shift in the vehicle's orientation and the accelerometer records data over the predetermined threshold. position Identification and Alert: The GPS module gives the microcontroller the current position when an accident is detected. The mechanism waits ten seconds for manual deactivation after a buzzer informs the driver.

Driver Response Check: The system returns to its initial setting, presuming that the buzzer was a false alarm, if the driver switches it off within ten seconds. On the other hand, the system verifies an accident has happened if the buzzer is still on. Automated Response: After confirming an accident, the camera takes pictures inside the car, and the system uses a GSM module and Telegram to notify the closest ambulance and primary contacts of the accident site. Emergency Notification: By giving specified contacts and emergency services vital information, such as the location of the accident and its photos, the ERMS guarantees prompt emergency response. In order to quickly identify incidents and start emergency action, the ERMS skilfully combines sensors and communication technology, potentially saving lives.

Start the accident detection system in step one.
Step 2: Activate all sensors by turning them on.
Step 3: Configuring the System All modules should be connected to the controller.
Step4: Detecting Accidents Verify that the accelerometer values are higher than the threshold. Unusual movement is detected by the tilt sensor. An accident is discovered if both are true.
Step 5: Update the location Use GPS to find your present position.
Step 6: Activation of the Alert Turn the buzzer on for ten seconds.
Step 7: Driver Confirmation: Go back to detection mode if the driver turns off the beep. If the buzzer is still on, it is an accident.
Step 8: Accident Verification After the accident has been verified, move on to notification.
Step 9: Communication and Support Activate the camera and take a picture. Give the following primary contacts your location. closest ambulance.
Step 10: The system has finished detecting and notifying accidents**.**

Phase for addressing the Emergency

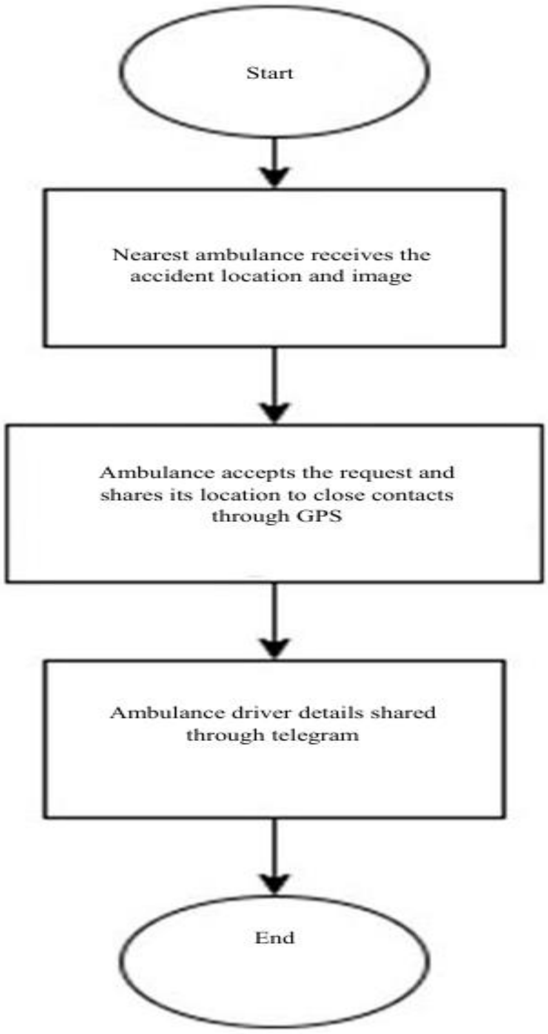


Response and Tracking

To quickly identify accidents and alert emergency services, the Enhanced Accident Detection System's (ERMS) Emergency Response and Tracking Phase uses a variety of sophisticated sensors, such as tilt, accelerometer (AC), vibration (VB), and gyroscope sensors. These sensors are carefully configured to identify values that indicate an accident or readings that go outside of permitted ranges, guaranteeing a timely reaction. The accelerometer detects vibration, shock, and tilt to assess impact severity, and the tilt sensor monitors the vehicle's chassis angle to evaluate safety and stability. Important information for accident reconstruction is provided by the gyroscope, which uses Earth's gravity to determine orientation, and the vibration sensor, which picks up noticeable in-vehicle vibrations. Depending on whether Wi-Fi or GSM modules are being utilized, notifications are sent by Telegram or SMS upon accident detection, guaranteeing real-time communication. GSM modules provide SMS messages as a backup method to get around Wi-Fi coverage problems and ensure continuous connection. Important information including the accident location (GPS coordinates), vehicle orientation, impact intensity, chassis angle, and timestamp are all included in the message. This coordinated strategy guarantees prompt emergency response, cutting down on reaction time and perhaps saving lives. Through the use of several sensors and communication technologies, ERMS offers a complete solution for handling mishaps and improving the efficiency of emergency response. Furthermore, ERMS's automatic notification system minimises human error and guarantees rapid action, while its real-time monitoring features allow emergency services to keep an eye on the vehicle's location and react accordingly. Implementing a flowchart and accident address tracking system to handle the emerging response:

Step 1: Get started, When the Enhanced Accident Detection System (ERMS) detects an accident, the Accident Address Tracking System is activated. In order to guarantee prompt assistance, this initiates the emergency response process and sets off a sequence of automated operations.

Step 2: Ambulance Receives Accident Intimation with Image: When an accident is detected, the ERMS notifies the closest ambulance service, giving them important details like the location of the accident (GPS coordinates) and a picture taken by the in-car camera. Ambulance staff can evaluate the situation using this graphic, calculating the



number of injured parties and possible dangers. Medical teams are better prepared for the accident's severity and response efforts are prioritized thanks to the visual analysis.

Step 3: After getting the call, the ambulance accepts it and shares its location.

Step 4: The ambulance arrives at the scene of the accident The ambulance uses GPS coordinates supplied by ERMS to go to the scene after obtaining the accident location and picture analysis. The ambulance crew arrives, evaluates the situation, administers medical care, and communicates with other emergency services (such as the fire department and police).

Implementation of this system contains 2 stages:

1.Hardware, software, and integration

2.Evaluating the model

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Materials, methods and implementation:

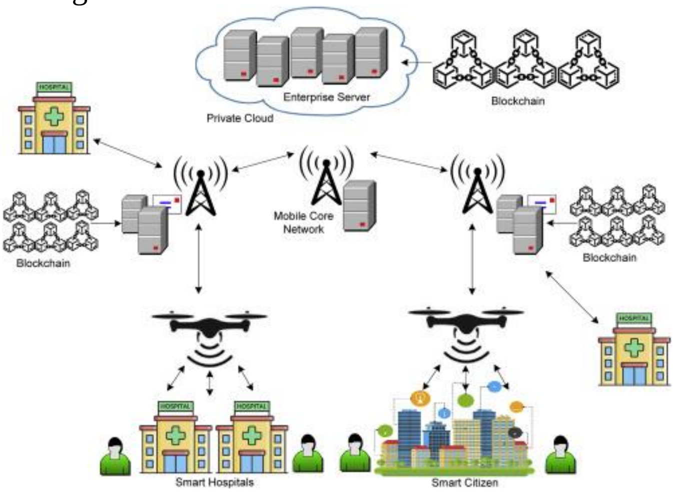
There are two phases to this system's implementation:

1. Integration, software, and hardware
2. Assessing the model Resources, techniques, and execution.

In the case of an accident, the Emergency Request Response and Management System (ERMS) is intended to improve communication and safety. The system uses a variety of hardware and software components to identify accidents and efficiently alert the appropriate parties. A tilt-related sensor is incorporated into the system during the hardware phase to identify accidents. The Microcontroller Unit (MCU), the system's brain, receives a signal from this sensor. After processing the signal, the MCU turns on the alert system. In the event that the alarm is a false alert, consumers can cancel it by pressing a push button built into the design. Emergency personnel need this information in order to arrive at the scene promptly. To make sure the notification reaches the chosen people as soon as possible, the MCU uses Telegram to transmit the GPS data once it has been obtained. The technology is also made to function in places with poor connectivity. The system will immediately switch to SMS notifications in the event that 3G or 4G coverage is unavailable, guaranteeing that the accident location and data are still efficiently conveyed. Hardware, software, and integration are the two primary phases of ERMS implementation, which is followed by model evaluation. The first step involves assembling the pieces and programming the software to make sure everything functions as a whole.

Hardware Components for accident detection

1. Microcontroller (MCU): Processes input from several sensors and instructs actuators to control and coordinate the entire system.
2. GPS Module: Gives location information so the ambulance may effectively route to the hospital and accident scene.
3. 5G/4G Module: Facilitates immediate medical response by enabling real-time communication between the emergency services, hospital, and ambulance.
4. Gyroscope and Accelerometer: Track the ambulance's motion and look for abrupt changes in direction or speed that might point to an accident.
5. Vital Sign Sensors: These devices track vital indicators for patients, including blood pressure, oxygen saturation, and heart rate, giving doctors valuable information.
6. Environmental Sensors: Keep an eye on the ambulance's temperature, humidity, and air quality to make sure patients are in a secure and pleasant setting.



Important software elements:

1. Sensor Data Collection: Compiles information from sensors such as GPS, cameras, and accelerometers.
2. Data Preprocessing: Removes noise from raw sensor data by filtering and processing it.
3.Collision Detection: Identifies unexpected vehicle motion, impact, or abrupt deceleration using algorithms.
4.Event Classification: Determines whether an occurrence was mild or severe by analyzing patterns. **5. Notification System:** Notifies contacts, the driver, or emergency services.
6.Data Logging: Saves crash information for evaluation and enhancement.
7.Cloud & ML Integration: Utilizes machine learning to improve detection accuracy and uploads data for additional analysis.

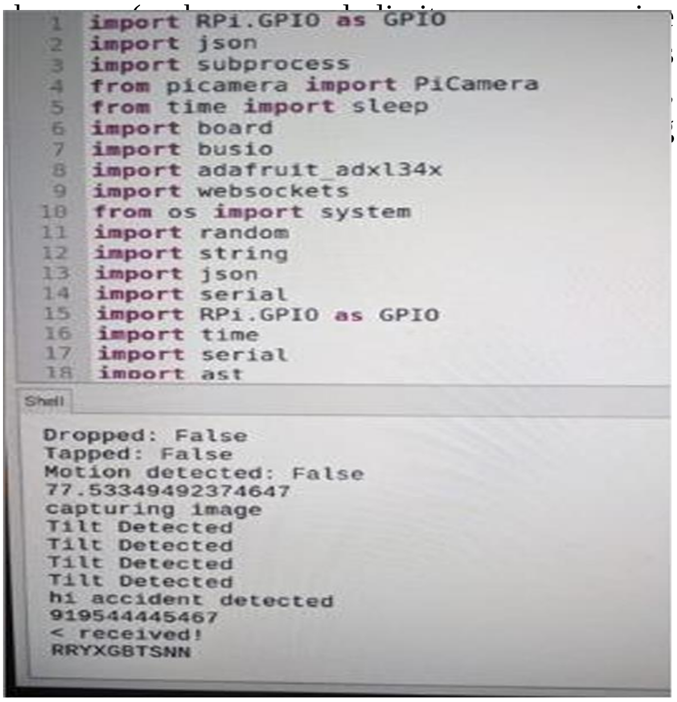
The Internet of Things is an essential part of modern civilization. Both the desire to stay linked to a multitude of devices and the drive for automation are on the rise. Three primary forms of communication occur over the Internet: human-to-human, human-to-machine, and machine-to-machine. The great majority of communication has so far been categorized as either human-to-machine or human-to-human. The Internet of Things is gradually enabling and improving machine-to-machine communication, a crucial interaction type. Apart from its significant influence on academia, industry, government, and society, it is also becoming an increasingly important part of smart cities, smart homes, smart transportation, and smart industrial applications. It is not necessary to use acronyms like IEEE, SI, MKS, CGS, sc, dc, and rms.

Table-1: Predicting the severity of accident through Grav-forces

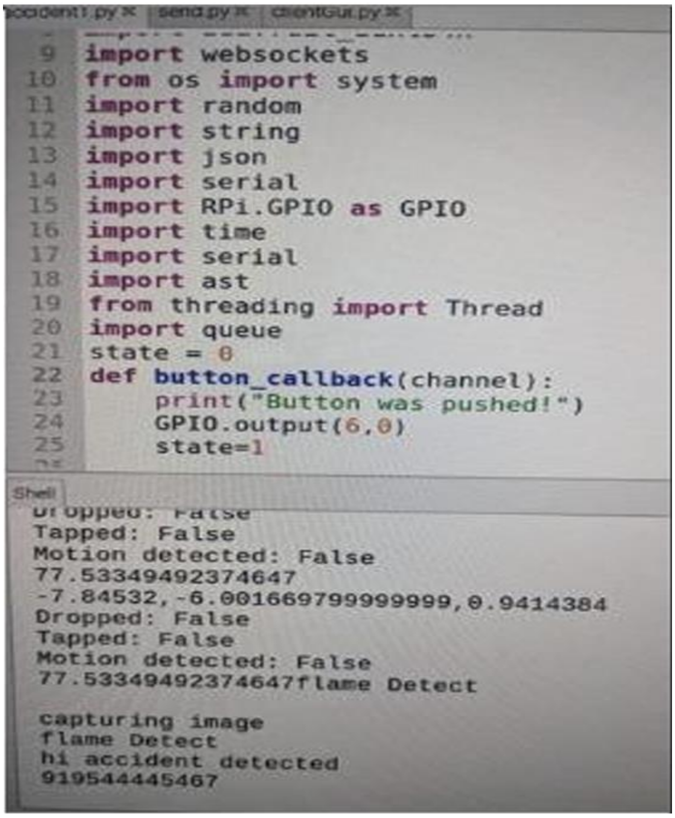
Network	Grav_force	Severity of accident
2G/4G	2 g	No accident
2G/4G	4 g	Minor accident
On/off	15 g	Minor accident
On/off	30 g	Minor accident
On	52 g	Severe accident
Off	60 g	Severe accident

RESULT

To precisely identify and evaluate incidents, the suggested accident detection system makes use of a variety of sensors, such as tilt, flame, grav-force, and GSR (Galvanic Skin Response). In addition to providing real-time tracking of the accident scene and the location of the ambulance, it instantly notifies emergency services. To ensure effective use of resources in minor accidents, customers can manually cancel the emergency call by pressing a button. In order to help prevent accidents, the system also keeps an eye on important factors like the driver's emotional state, traffic signs, and other

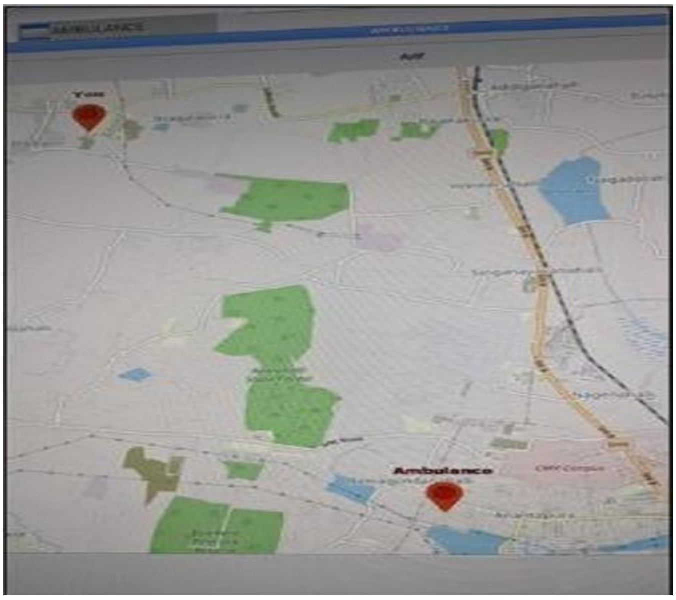


(a) Tilt Detection

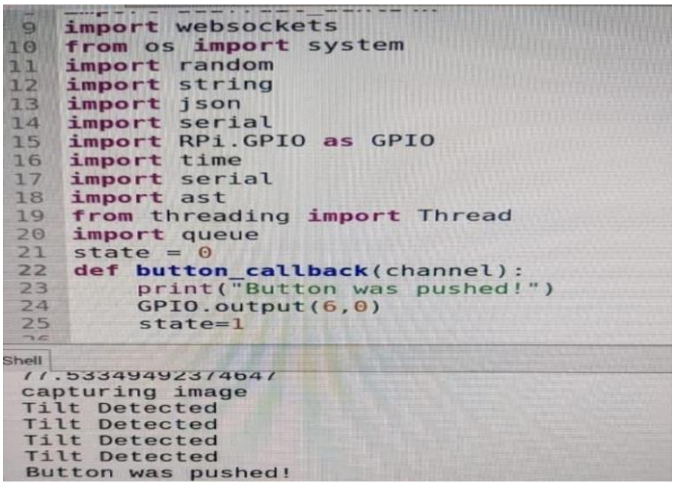


(b) Flame Detection

(c)Notifying the accident occurrence to the nearest ambulances



d) Interface for showing the ambulance and the accident location.



(e) Button pushed to show its a false alarm

3. CONCLUSION

This IoT-based accident detection and prevention system offers a powerful solution to improve road safety. It uses advanced technology, such as sensors to monitor the driver's emotions and detect hazards like road signs and speed breakers. If an accident occurs, the system sends real-time alerts to the vehicle owner, the driver's guardian, and emergency services, helping to reduce response time and potentially save lives.

The system is designed to prevent accidents by tracking things like speeding, traffic signals, and the driver's emotional state. It's adaptable to different vehicle types, making it a flexible and scalable solution. The addition of 5G technology enhances the system's ability to send accurate, fast alerts to nearby hospitals and emergency responders, especially for motorcycle accidents where quick help is critical. Looking ahead, there are plans to improve the system with features like GPS tracking and real-time location-based alerts, which will make it even more effective. The system also aims to address security concerns and provide continuous monitoring to ensure it's always functional. Overall, this system represents a significant step forward in improving road safety, reducing response delays, and ultimately saving lives.

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