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Accident Detection and Location-Based Alert System using IFTTT Server for Enhanced SMS Notification without GSM Module Dependency

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ABSTRACT

Road accidents are a leading cause of fatalities worldwide, emphasizing the need for an efficient accident detection and alert system. This paper presents an IoT-based automatic vehicle accident detection and alert system that ensures rapid emergency response. The system integrates the NEO-6M GPS module for real-time location tracking, the MPU-6050 accelerometer to monitor vehicle motion and detect sudden impacts, and the NodeMCU ESP8266 microcontroller for processing and communication. A predefined threshold is set for acceleration and orientation changes, and if the detected values exceed this threshold, the system triggers an alert. Using the IFTTT server, automated notifications and calls are sent to nearby hospitals, emergency contacts, and authorities, providing precise accident location details. The system ensures real-time monitoring, minimizes response time, and increases the chances of saving lives. This cost-effective and efficient solution leverages IoT technology to enhance road safety and emergency response systems [3]. Experimental results demonstrate the reliability of the proposed system in detecting accidents accurately and sending timely alerts. Future enhancements include integrating additional sensors for improved accuracy and incorporating AI-driven analytics for predictive accident prevention.

INTRODUCTION

Road accidents are a major global concern, often resulting in severe injuries and fatalities due to delayed emergency response. According to the World Health Organization (WHO), thousands of lives could be saved annually if medical assistance reached accident victims in a timely manner. Conventional accident detection systems rely on manual reporting or GSM-based alerts, which can be unreliable due to network issues [1], high costs, and communication delays. To overcome these challenges, this research presents an IoT-based Automatic Vehicle Accident Detection and Alert System that ensures real-time accident detection and instant emergency notifications [12][13][16]. The basic work function of our proposed system is shown through a block diagram in figure 1.

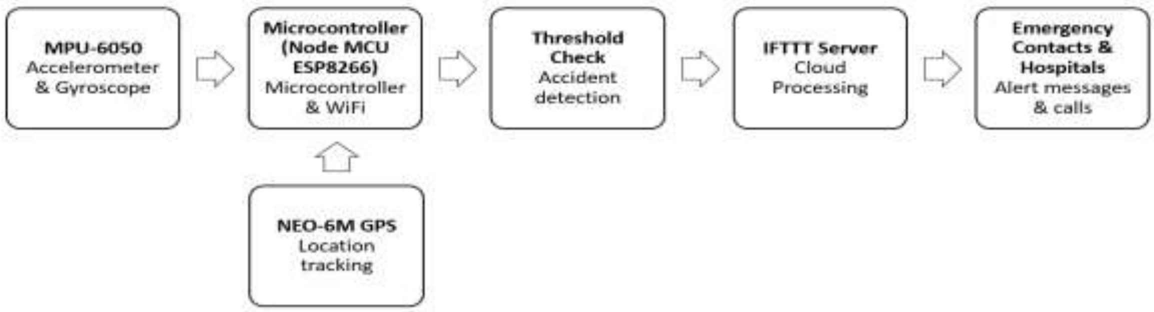

Fig. 1-Block diagram of proposed system.

The proposed system integrates MPU-6050 accelerometer and gyroscope, NEO-6M GPS module, NodeMCU ESP8266 microcontroller, and IFTTT cloud-based automation for rapid accident detection and alert transmission [7]. The MPU-6050 sensor continuously monitors vehicle motion, detecting sudden acceleration changes, tilts, or impacts that exceed a predefined threshold. If an accident is detected, the NEO-6M GPS module retrieves precise location coordinates, which the NodeMCU ESP8266 transmits to the IFTTT server via Wi-Fi. The IFTTT platform then triggers automated SMS alerts and emergency calls to nearby hospitals, emergency responders, and designated contacts, ensuring a fast and efficient response.

Unlike GSM-based systems, this Wi-Fi-enabled IoT approach eliminates network dependency, reduces costs, and ensures real-time communication. The system's high accuracy, automation, and minimal human intervention make it a cost-effective and reliable solution for road safety. This paper discusses the system's architecture, working principles, and performance evaluation, demonstrating its potential to enhance emergency response efficiency and reduce accident-related fatalities [17][18][19].

Working Principle

The automatic vehicle accident detection and alert system identifies road accidents in real-time and notifies emergency responders immediately [6]. It employs IoT-based components, including the MPU-6050 accelerometer and gyroscope sensor, NEO-6M GPS module, NodeMCU ESP8266 microcontroller [15], and IFTTT server, for automated alerts. Unlike GSM-based systems, this design eliminates high costs, network dependency, and signal interference, using Wi-Fi-based communication for reliable and cost-effective emergency response. The system has explained through a flow chart, shown in figure 2.

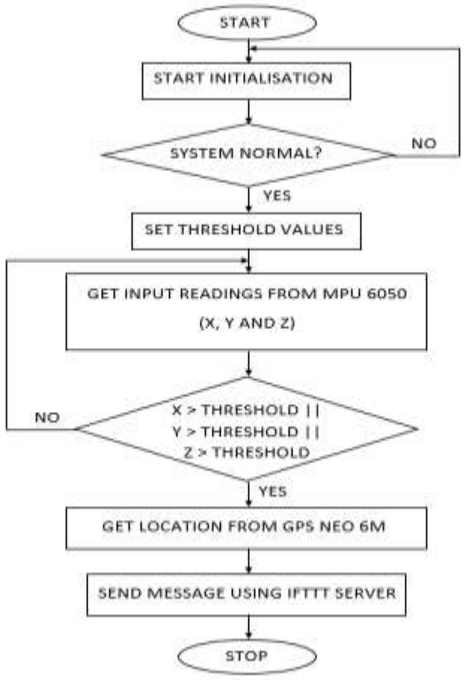

Fig.2- Flow chart of proposed system.

MPU-6050 Accelerometer and Gyroscope continuously monitors vehicle motion, acceleration, and orientation. Detects abrupt changes exceeding a predefined threshold, indicating a possible accident. The MPU6050 provides raw accelerometer values in X, Y, Z axes. The resultant acceleration is given by:

$$A_{\text{resultant}} = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

Where, A_x, A_y, A_z are accelerometer readings in g (gravity units),$A_{resultant}$ is the overall acceleration magnitude. The gyroscope readings from MPU6050 give angular velocity (ω_x, ω_y, ω_z) in degrees per second. The resultant angular velocity is:

$$\omega_{\text{resultant}} = \sqrt{\omega_x^2 + \omega_y^2 + \omega_z^2}$$

NEO-6M GPS ModuleRetrieves precise accident location (latitude and longitude) to assist emergency responders.The velocity (V) is computed using GPS coordinates at two different timestamps:V = d/t, where: d = Haversine distance between two GPS coordinates, t = Time difference between the readings. The Haversine formula for distance (d) is:

$$d = 2R \cdot \arcsin\left(\sqrt{\sin^2\left(\frac{\Delta\phi}{2}\right) + \cos(\phi_1)\cos(\phi_2)\sin^2\left(\frac{\Delta\lambda}{2}\right)}\right)$$

Where: R = Earth's radius (6371 km), ϕ_1, ϕ_2 = Latitudes (in radians), λ_1, λ_2 = Longitudes (in radians), $\Delta\phi = \phi_2 - \phi_1$, $\Delta\lambda = \lambda_2 - \lambda_1$.

NodeMCU ESP8266 MicrocontrollerProcesses sensor data, verifies accident occurrence, and sends alerts via Wi-Fi.IFTTT Server for Automated Alerts and executes predefined actions upon accident detection by sending SMS or emails to emergency contacts [5][10][11]. Also it triggers emergency calls to nearby hospitals and notifies emergency responders, police, and family members. The proposed method continuously monitors acceleration, tilt, and impact forces.Accident will be sensed when values exceed the threshold.Immediately location will be tracked via NEO-6M GPS module and an alertsignal via Wi-Fi through the ESP8266 microcontroller will be raised. The main advantages of our proposed work is that the system operates effectively in remote areas without the need for mobile signals, ensuring continuous functionality, i.e. it eliminates the need for SIM cards and subscription fees, reducing operational costs [14]. This system also provides instant notifications through cloud-based automation, enabling quick response times. This IoT-driven system significantly enhances road safety by ensuring rapid emergency responses and reducing fatalities [4][8][9].

RESULT ANALYSIS

The result was analysed through Matlab simulation, where 2 graphs of Acceleration vs. Time and GPS Location and Response Status was formed (Shown in Fig 3). The graphs generated from the accident detection system visualize how the GPS module, accelerometer sensor, and IFTTT server work together to detect accidents based on acceleration changes and location tracking.

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Graph 1: Acceleration vs. Time (with Alert Highlights)
This graph represents acceleration values (X, Y, Z components) plotted over time:
X-axis acceleration (circles)
Y-axis acceleration (squares)
Z-axis acceleration (triangles)
Key Observations:
At t = 10s, acceleration remains within normal limits.
At t = 20s, acceleration spikes sharply (X = 9.50 m/s^2, Y = 7.00 m/s^2), triggering an accident alert.
At t = 21s, the alert remains active, but no duplicate IFTTT request is sent.
At t = 30s, acceleration returns to normal, meaning no alert is triggered.
At t = 40s, another sharp acceleration change (X = -8.50 m/s^2, Y = -6.50 m/s^2) triggers a second accident alert.

Conclusions from Graph 1:
Accidents are detected when acceleration values exceed a set threshold.
Alerts are triggered by sharp acceleration changes (e.g., 20s and 40s).
Duplicate alerts are avoided, ensuring the system does not send redundant notifications.

Graph 2: GPS Location and Response Status
This graph plots GPS coordinates (Latitude & Longitude) vs. Time to track the system's position.
Markers Indicating Responses:
Green Marker (Buzzer ON): Indicates buzzer activation at t = 20s and t = 40s.
Blue Marker (IFTTT Sent): Shows when an IFTTT request was sent at the same timestamps.
Key Observations:
GPS location is recorded only after an accident is detected.
Coordinates remain almost unchanged, suggesting either a fixed monitoring system or a slow-moving vehicle.

Conclusions from Graph 2:
IFTTT requests are sent only after an accident is confirmed (t = 20s, t = 40s).
Buzzer activation alerts nearby people for immediate local response.
GPS coordinates provide emergency responders with precise accident locations.
Final Summary
The system successfully detects accidents using accelerometer data, activates a buzzer for local alerting, and transmits real-time location data via IFTTT. By preventing duplicate alerts, the system ensures efficient and non-redundant notifications, making it a reliable IoT-based accident detection system for smart vehicle safety.

Fig.3- Result analysis using MATLAB simulation

Table 1- Recorded Result

Time (s)	WiFi Status	GPS Location	Acceleration (m/s²)	Alert Triggered	Buzzer Status	IFTTT Request Sent
0	Connecting...	-	-	No	Off	No
5	Connected, IP: 192.x.x.x	-	-	No	Off	No
10	-	Lat: 23.716047, Lon: 86.950086	X: 1.50, Y: 0.90, Z: 9.81	No	Off	No
20	-	Lat: 23.716047, Lon: 86.950086	X: 9.50, Y: 7.00, Z: 9.81	**Yes**	**On**	**Yes** (location data sent to IFTTT)
21	-	Lat: 23.716047, Lon: 86.950086	X: 9.50, Y: 7.00, Z: 9.81	Yes (already sent)	On (for 100 ms)	No (already sent)
30	-	Lat: 23.716047, Lon: 86.950086	X: 0.50, Y: 0.30, Z: 9.81	No	Off	No
40	-	Lat: 23.716049, Lon: 86.950089	X: -8.50, Y: -6.50, Z: 9.81	**Yes**	**On**	**Yes** (location data sent to IFTTT)

CONCLUSION

The Automatic Vehicle Accident Detection and Alert System presented in this research effectively enhances road safety by ensuring real-time accident detection and rapid emergency response[2]. By integrating IoT components, including the MPU-6050 accelerometer, NEO-6M GPS module, NodeMCU ESP8266 microcontroller, and IFTTT server, the system autonomously identifies accidents and immediately alerts emergency responders. The MPU-6050 sensor continuously monitors vehicle motion, and when a predefined threshold is exceeded, the ESP8266 microcontroller processes the data and transmits an alert. The NEO-6M GPS module provides accurate location details, which are sent via Wi-Fi to the IFTTT server, triggering automated SMS alerts and emergency calls to nearby hospitals and pre-configured contacts.

This IoT-based system overcomes the limitations of GSM-based solutions, such as network dependency, high costs, and communication delays. Its real-time response, automation, and cost-effectiveness make it a reliable alternative for accident detection. By reducing emergency response times, this system has the potential to save lives and improve road safety. Future enhancements could include machine learning algorithmsfor more accurate accident prediction and classification, further increasing system efficiency [20]. Model prototype has shown in Fig 4. & Fig 5.

Fig.4

Fig.5

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