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IoT and GPS Enabled Road Crash Detection with Automated Ambulance Alert and Web-Based Monitoring

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ABSTRACT

The rapid increase in road accidents has created a strong need for intelligent safety systems that can detect accidents immediately and provide emergency assistance without delay. Traditional accident reporting methods depend mainly on nearby people, manual phone calls, or delayed police and ambulance communication, which often results in late medical response and increased risk to human life. To overcome these limitations, the proposed Accident Detector with Automatic Emergency Messaging to Nearby Ambulance with Web Dashboard using IoT and GPS introduces a hardware-based smart emergency response system capable of detecting vehicle accidents in real time and automatically sending alert messages to nearby ambulance services and emergency contacts. The system uses sensors such as accelerometer, gyroscope, vibration sensor, and GPS module to identify abnormal vehicle movement, sudden impact, collision, or rollover conditions. Once an accident is detected, the microcontroller processes the sensor data and obtains the exact location of the vehicle using GPS. The location and accident alert message are then sent through GSM or IoT communication modules to nearby ambulance services, family members, and the web dashboard. The web dashboard displays real-time accident location, alert status, ambulance response details, and emergency history for monitoring and management. By integrating IoT, GPS, embedded hardware, and web-based monitoring, the proposed system reduces emergency response time, improves accident reporting accuracy, and helps save lives through faster medical assistance. The system is highly suitable for smart vehicles, public transportation, highway safety systems, emergency medical services, and smart city traffic management applications.

Keywords: Accident Detection, Emergency Messaging, IoT, GPS, GSM Module, Web Dashboard, Ambulance Alert System, Smart Vehicle Safety, Road Accident Monitoring, Microcontroller, Sensor-Based Detection, Real-Time Tracking, Embedded System, Smart Transportation, Emergency Response System.

I. INTRODUCTION

Road accidents continue to be a major public safety concern, particularly when emergency assistance does not reach the accident location within the critical period following a collision. In many cases, the severity of an accident is increased not only by the impact itself but also by delays in reporting the incident, identifying the exact location, and arranging medical support. Conventional accident reporting largely depends on victims, witnesses, or nearby individuals making a phone call. Such a process may become ineffective when an accident occurs in an isolated area or when the occupants of the vehicle are unable to communicate. To reduce this dependency, connected sensing and automated emergency communication have emerged as practical solutions for modern transportation systems [1], [2].

The Internet of Things (IoT) enables vehicles to operate as connected units capable of sensing abnormal events and sharing information through communication networks. Sensors installed in a vehicle can observe sudden impact, unusual vibration, rapid changes in orientation, and other physical conditions associated with a crash. When these observations cross predefined safety limits, the embedded unit can recognize a

possible accident and initiate an emergency response without waiting for manual input. Earlier IoT-based systems have demonstrated the usefulness of automatic accident identification and immediate reporting for improving post-accident assistance [3]–[5].

Accurate location information is another essential part of an emergency response system. Global Positioning System (GPS) technology can provide the geographical coordinates of the affected vehicle immediately after an accident is detected. These coordinates can be transmitted along with the alert message, allowing emergency personnel to locate the accident scene with less dependence on verbal directions. The integration of IoT communication and location services therefore creates a connected environment in which accident information can move rapidly from the vehicle to emergency response units. Secure vehicular communication and reliable information exchange are also important for maintaining the dependability of such connected transportation applications [6].

Recent research has explored different techniques for improving accident recognition. Automotive monitoring units and smart black-box systems collect vehicle-related data that can support faster identification of dangerous incidents [7]. Vision-based action recognition has also gained attention in intelligent transportation environments, particularly for detecting road events from visual information [8]. In addition, vehicular fog computing can process emergency data closer to its source, reducing communication delays and supporting quicker decisions [9]. These developments indicate that effective accident management requires more than a single sensor; it benefits from coordinated sensing, communication, processing, and location tracking.

Compared with traditional reporting approaches, automated IoT-based systems can reduce human involvement during the first stage of emergency communication. Continuous monitoring allows the system to detect an abnormal event, determine the vehicle location, and transmit relevant information in a short period [10]. Accident detection and rescue frameworks further demonstrate the value of linking vehicle-side hardware with remote emergency services [11]. Broader smart emergency response systems have also shown how IoT infrastructure can combine monitoring, communication, and remote supervision within a common platform [12].

Recent studies have increasingly focused on real-time accident recognition and faster road safety responses. Rapid detection methods can support earlier intervention by minimizing the time between a collision and the delivery of emergency information [13]. Reviews of IoT-based accident detection systems also identify automatic notification, accurate location sharing, reliable communication, and timely medical assistance as important requirements for future intelligent road safety solutions [14]. Real-time collision detection and emergency response research further highlights the need for systems that can immediately transfer meaningful crash information to responsible services [15].

Motivated by these requirements, the proposed work develops an IoT and GPS Enabled Road Crash Detection with Automated Ambulance Alert and Web-Based Monitoring system. The hardware unit continuously observes vehicle conditions through connected sensors. When a crash-like event is identified, the system acquires the current GPS position and sends an automatic emergency notification containing the accident details and location. The alert is intended to support communication with a nearby ambulance or emergency service, while a web-based dashboard provides centralized monitoring of accident events and location information. By combining embedded hardware, IoT connectivity, GPS tracking, automated emergency messaging, and web monitoring, the proposed system aims to shorten the accident reporting process and support a faster, more coordinated emergency response.

II. LITERATURE SURVEY

S. U. Rehman, S. A. Khan, A. Arif, and U. S. Khan (2021) The authors developed an IoT-oriented accident detection and emergency alert mechanism mainly intended for motorbikes. Their work uses connected sensing components to recognize accident-related conditions and initiate an emergency message. The study showed that automated communication can reduce the dependence on victims or nearby people for

reporting an accident. However, the work offers limited support for centralized web monitoring and direct coordination with nearby ambulance services.

K. S. Kulkarni, S. S. Kumbhar, A. V. Jadhav, and S. B. Patil (2021) The researchers proposed a vehicle accident detection, life-saving, and smart reporting framework. The system focuses on recognizing a collision and forwarding accident information to responsible contacts or emergency authorities. Their approach demonstrates the importance of immediate accident reporting for improving rescue operations. A major limitation is the lack of an integrated web dashboard for continuously observing accident locations and emergency response status.

P. Sasipriya (2021) The author presented an accident alert and ambulance tracking system designed to improve communication after road incidents. The proposed method combines accident notification with ambulance location tracking to assist emergency operations. The work highlights the usefulness of location-aware services for reducing delays in medical assistance. Nevertheless, further integration of real-time sensor data, nearest-ambulance identification, and centralized web supervision could improve the overall system.

T. P. Chikaka and A. K. B. M. Muzahid (2021) The authors introduced an automatic vehicle accident detection and rescue system for reducing delays in post-accident assistance. The proposed model detects accident situations and communicates emergency information without requiring complete human involvement. The research confirms that automated rescue communication can be valuable when victims are unable to report the event. The system can be extended through live GPS visualization and web-based management of emergency incidents.

A. Oguntimilehin, O. O. Obe, and O. A. Olatunji (2022) The researchers designed an IoT-enabled automobile accident detection and reporting system. Connected sensors and communication technologies were employed to identify possible accidents and transmit relevant information. The study demonstrates how IoT can link vehicle hardware with remote emergency services. Although the reporting process is automated, a more complete solution could include intelligent ambulance selection and a dashboard for tracking the entire emergency response process.

H. A. El Zouka and M. M. Hosni (2022) The authors investigated efficient and secure vehicular networking through the integration of IoT and visible light communication. Their research emphasizes reliable information exchange between connected vehicles and surrounding infrastructure. Although the study is not limited to accident detection, its communication framework is relevant to emergency systems that require dependable transmission of vehicle and location information. The work also indicates the need for secure communication in connected transportation environments.

P. Josephinshermila, K. Malarvizhi, S. G. Pran, and B. Veerasamy (2023) The authors proposed an automotive smart black-box monitoring system for accident detection. The system records and analyzes vehicle-related conditions to identify unusual events associated with collisions. This approach improves the availability of accident information and supports post-event analysis. However, the framework can be enhanced by connecting the detection unit directly to GPS services, nearby ambulances, and a real-time web dashboard.

III. EXISTING SYSTEM

In the existing accident reporting system, emergency communication is mostly dependent on manual reporting by nearby people, victims, traffic police, or vehicle owners. When an accident occurs, someone must notice the accident, identify the location, and contact ambulance services manually. This process is slow and unreliable, especially when accidents occur in isolated areas, highways, rural roads, or during night time.

Existing vehicle safety systems mainly focus on airbags, seat belts, braking systems, and vehicle alarms. Although these systems protect passengers during accidents, they do not automatically inform ambulance services or provide real-time accident location details. Some

vehicles may have basic GPS tracking, but they may not include automatic accident detection and emergency alert features.

Many current accident detection systems lack proper web dashboard integration, nearby ambulance identification, real-time alert monitoring, and emergency history management. Some systems send alert messages only to predefined contacts and do not support centralized monitoring by hospitals or emergency service providers. Due to these limitations, emergency response may be delayed, and accident victims may not receive timely medical assistance.

The existing systems also face problems such as inaccurate accident detection, false alerts, limited communication range, dependency on manual response, and lack of real-time monitoring. Therefore, an automated IoT and GPS-based accident detection system with emergency messaging and web dashboard support is required to improve road safety and ambulance response efficiency.

IV. PROPOSED SYSTEM

The proposed system is a hardware-based accident detection and emergency messaging solution designed using IoT, GPS, GSM, sensors, and a web dashboard. The system continuously monitors vehicle movement and detects accidents using sensors such as accelerometer, gyroscope, vibration sensor, and optional flame or heartbeat sensor. These sensors are connected to a microcontroller such as Arduino, NodeMCU, or ESP8266, which processes real-time sensor values and identifies accident conditions.

When the vehicle experiences sudden impact, abnormal vibration, high tilt angle, or unexpected movement beyond the threshold value, the microcontroller confirms the accident condition. Immediately, the GPS module collects the exact latitude and longitude of the accident location. The GSM module sends emergency alert messages containing location details to nearby ambulance services, emergency contacts, and vehicle owner contacts.

The IoT module uploads accident data to the cloud server and updates the web dashboard in real time. The web dashboard displays accident location on a map, alert time, vehicle details, sensor status, ambulance response status, and emergency history. Ambulance operators can view new accident alerts, track the location, and respond quickly using navigation support.

The proposed system reduces emergency response time and improves communication between accident victims, ambulance services, and monitoring authorities. It is suitable for cars, bikes, buses, trucks, public transport vehicles, school vehicles, and smart city traffic safety systems. By integrating IoT and GPS with embedded hardware, the proposed system provides a reliable and automatic emergency response solution for road accident management.

V. Block Diagram

The system architecture of the proposed Accident Detector with Automatic Emergency Messaging system consists of hardware sensor modules, microcontroller unit, GPS tracking unit, GSM communication module, IoT cloud server, web dashboard, and ambulance response interface. The sensor module continuously collects vehicle movement data using accelerometer, gyroscope, vibration sensor, and other safety sensors. These sensors detect sudden impact, vehicle rollover, abnormal tilt, and crash-like conditions.

The microcontroller acts as the main processing unit of the system. It receives sensor values, compares them with predefined threshold values, and determines whether an accident has occurred. If the sensor values exceed the safety limit, the controller activates the emergency alert process. The GPS module then identifies the exact accident location using latitude and longitude coordinates.

The GSM module sends an emergency SMS alert to nearby ambulance services and emergency contacts. The IoT communication module transfers accident details to the cloud server through internet connectivity. The cloud server stores accident information and updates the web dashboard in real time.

The web dashboard displays accident location, vehicle information, emergency alert status, ambulance availability, and response progress.

Ambulance service providers can open the map location, navigate to the accident spot, and update the response status. The entire architecture is designed to provide automatic accident detection, fast emergency communication, accurate GPS tracking, and real-time monitoring for smart transportation and emergency healthcare systems.

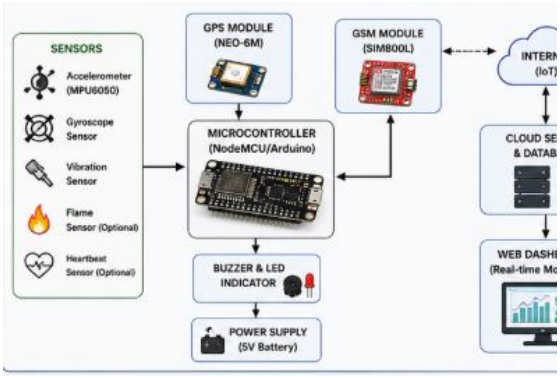

Fig 5.1: Accident Detection and Emergency Messaging System Architecture

VI. IMPLEMENTATION

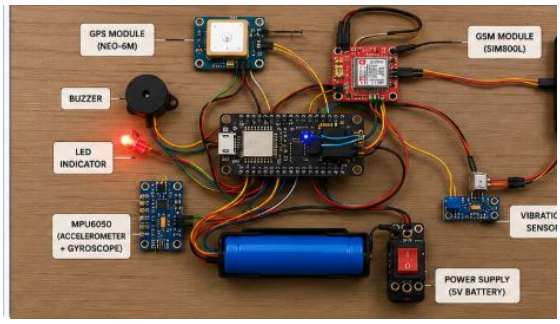

Fig 6.1: Hardware Sensor and Microcontroller Setup

Fig 6.2: GPS and GSM Emergency Alert

Integration

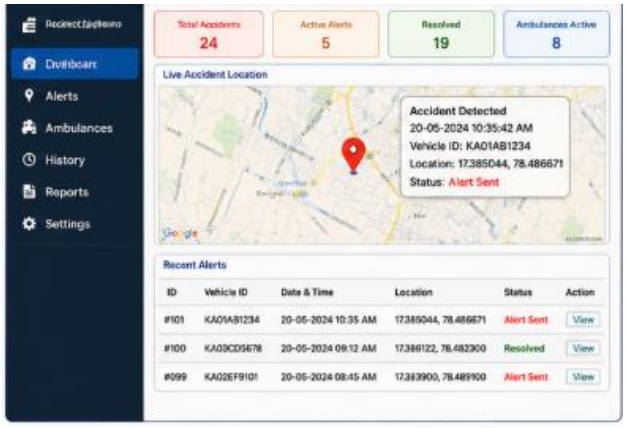

Fig 6.3: IoT Cloud and Web Dashboard Monitoring

Fig 6.4: Ambulance Response and Live Location Tracking

This implementation image represents ambulance response management after receiving an accident alert. The nearby ambulance receives the accident location, navigates to the spot using GPS, and updates response status through the web dashboard. This improves emergency service coordination and reduces rescue time.

VII. CONCLUSION

The proposed Accident Detector with Automatic Emergency Messaging to Nearby Ambulance with Web Dashboard using IoT and GPS provides an efficient and reliable solution for automatic accident detection and emergency response. By using sensors, microcontroller, GPS, GSM, IoT cloud, and dashboard monitoring, the system detects vehicle accidents in real time and sends

emergency alerts without depending on manual reporting.

The system reduces ambulance response time, improves accident location accuracy, and helps save lives by providing faster medical assistance. The web dashboard enables real-time monitoring of accident alerts, ambulance status, and emergency history, making the system suitable for smart transportation and emergency healthcare management.

The proposed system improves road safety, supports intelligent vehicle monitoring, and provides a scalable solution for smart cities, public transport, highway safety, and emergency medical services. Thus, it serves as a practical and effective hardware-based IoT solution for modern accident detection and emergency communication.

VIII. FUTURE SCOPE

The proposed system has significant scope for future improvement by integrating advanced technologies such as Artificial Intelligence, Machine Learning, and smart vehicle communication systems. AI algorithms can be used to reduce false accident alerts by analyzing sensor patterns, vehicle speed, road conditions, and impact intensity more accurately.

In the future, the system can be integrated with hospital management systems, ambulance dispatch centers, traffic police departments, and smart city control rooms. This will improve coordination between emergency services and reduce rescue delays. Mobile application support can also be added for drivers, family members, ambulance drivers, and emergency operators.

Advanced features such as live video streaming, automatic voice calling, vehicle health monitoring, cloud-based analytics, and accident severity prediction can be included. The system can also be connected with 4G/5G networks for faster data transmission and real-time vehicle tracking.

Future versions may include integration with vehicle airbags, engine control units, and onboard diagnostics systems to improve accident detection accuracy. Overall, the proposed system can be enhanced into a complete intelligent road safety and emergency response platform for future smart transportation systems.

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