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SMART ROAD ACCIDENT DETECTION AND RESCUE SYSTEM

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Abstract: Road accidents are a major global issue, leading to significant loss of life due to delayed emergency response. This paper proposes a Smart Accident Detection and Rescue System that uses IoT sensors, GPS, and communication technologies to automatically detect accidents and alert emergency services. The system integrates accelerometers, gyroscopes, GPS modules, and GSM communication to identify collisions and transmit real-time location data. Advanced approaches using machine learning further improve detection accuracy and reduce false alarms. The proposed system ensures faster rescue operations, minimizes response time, and enhances road safety.

I. INTRODUCTION

In today's world road accidents are a major global concern, causing significant loss of life, injuries, and physical damage every year. According to various reports, thousands of accidents occur daily ;especially in developing countries, due to factors such as over-speeding, distracted driving, poor road conditions, and lack of immediate medical assistance.

A major challenge in accident management is the delay in detecting incidents and informing emergency services, which often leads to increased fatalities.

With the advancement of technology, automated systems using IoT, sensors and GPS, can help in quick accident detection and response. This paper proposes a Smart Accident Detection and Rescue System that detects accidents in real time and sends alerts with location details to emergency services, thereby reducing response time and improving road safety.

II.THEORETICAL BACKGROUND

Smart accident detection and rescue system uses sensors like accelerometers and gyroscopes to pick up on sudden shifts in speed or how the vehicle tilts. Those changes can signal a crash pretty quickly. When the readings go over certain limits, it basically flags it as an accident happening.

GPS comes in to figure out where exactly the car is, giving out latitude and longitude numbers that help direct help right to the spot. Without that, emergency people might waste time searching around.

Then there's the GSM part or whatever wireless setup sends out the message with all the details, like what happened and the location, straight to contacts or rescue teams. It feels like that step makes everything faster.

In some setups they add machine learning to look over the sensor info more carefully, trying to tell apart regular driving from a real wreck so there aren't as many wrong alerts. I think that helps cut down on unnecessary calls.

All these pieces working together means the detection happens on its own and responses come quicker, which probably saves lives on the road, though not totally sure how often it gets used in real life. The safety part stands out, but integrating it all might be tricky sometimes.

III.FOUR-TIER TAXONOMY

The proposed Smart Accident Detection and Rescue System can be structured into a four-tier architecture to ensure efficient data collection, processing, communication, and response. The clear division in layer helps in achieving better efficiency. The four tier taxonomy is smart accident detection and rescue system are namely-sensing layer ,communication layer ,processing layer and application layer.

A. Sensing Layer

This layer consists of sensors such as accelerometers, gyroscopes, and other detection modules installed in the vehicle. These sensors continuously monitor parameters like speed, vibration, and orientation to identify abnormal conditions that may indicate an accident.

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B. Processing Layer

The processing layer includes a microcontroller (such as Arduino) that analyzes sensor data in real time. It applies predefined thresholds or algorithms to determine whether an accident has occurred and initiates further actions.

C. Communication Layer

This layer is responsible for transmitting information. It uses modules like GSM or IoT-based communication systems to send alerts along with GPS location data to emergency services, hospitals, and registered contacts.

D. Application Layer

The application layer represents the end-user interface where the received information is utilized. Emergency responders, hospitals, and users can access accident details, location, and severity, enabling quick decision-making and rescue operations.

IV.LITERATURE REVIEW

The studies reviewed here are from the recent research papers on accident detection and machine learning techniques for rescue. Recent studies have focused on improving detection reliability by integrating multiple sensors and communication technologies.

SL NO	Author(s)	Year	Title	Method/Technique	Key findings	Limitations
01	Chen et al.	2020	Accident Detection Using CNN	Deep Learning (CNN)	Detects accidents via cameras	High computation cost
02	Kumar et al.	2021	IoT-Based Accident Monitoring System	IoT + Cloud computing	Real-time processing and alerts	Requires strong network connection.
03	Zhang et al	2022	5G-Based Accident Detection Using V2X	5G + V2X	Fast real-time communication	Expensive infrastructure
04	Pathik et al.	2022	AI Enabled Accident Detection Using IoT & Deep Learning	IoT + Deep Learning	High accuracy accident detection using AI	High computational cost
05	Alkhaiwani et al.	2023	Secure IoT-Based Accident Detection Framework	IoT + Security Framework	Ensures data privacy and secure reporting	Complex implementation
06	Kumar et al.	2023	IoT-Based Vehicle Accident Detection & Rescue System	IoT + Sensors	Automatic alert with location	Network dependency
07	Barkade et al.	2024	Smart Sensors Based Accident Detection System	Piezo + Flame Sensors	Detects collision and fire hazards	Sensor dependency
08	Chatterjee et al.	2025	Smart Accident Detection System Using IoT	Arduino + GPS + GSM	Detects accidents and sends location alerts	Prone to false alarms

TABLE i. LITERATURE REVIEW SUMMARY

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V. Workflow of Smart Accident Detection and Rescue System

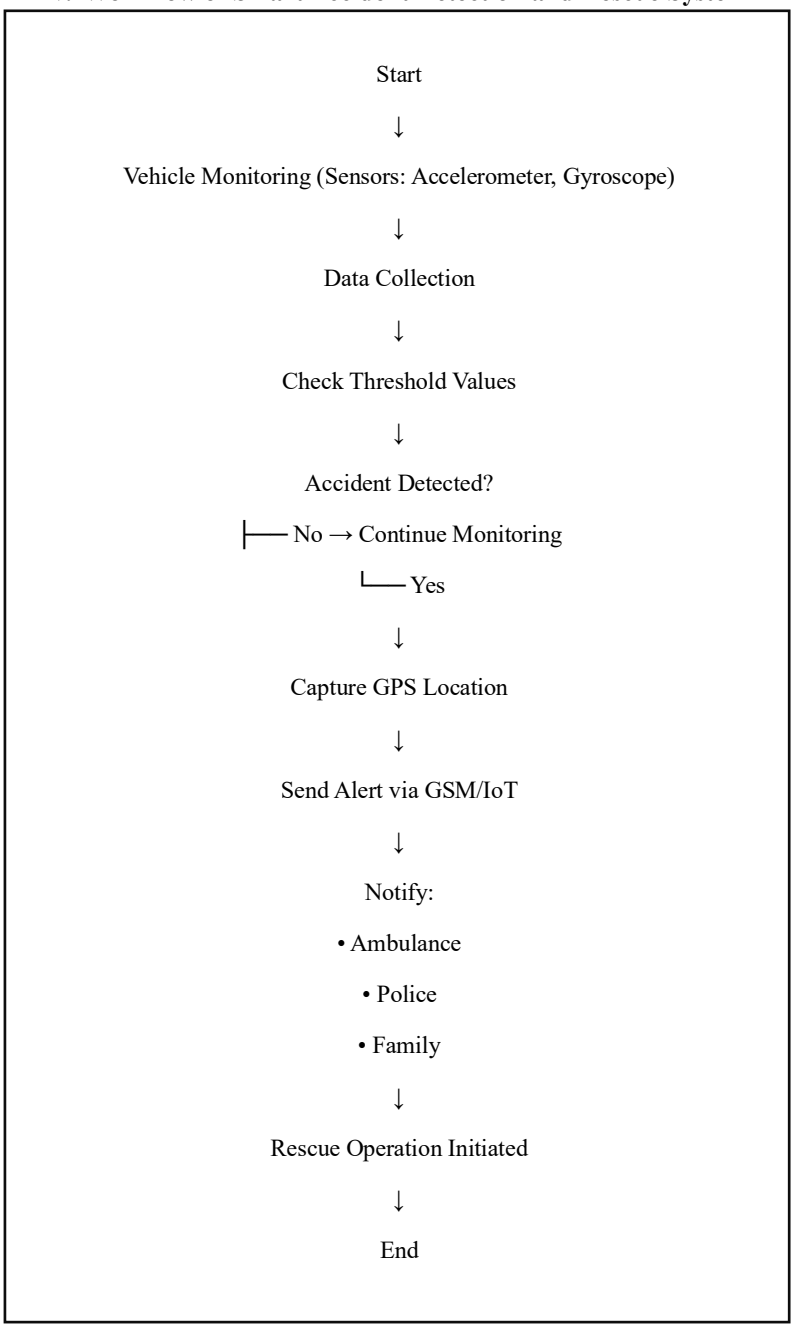

Fig i. WORKFLOW DIAGRAM

The system keeps an eye on how the vehicle moves all the time, using things like accelerometers and gyroscopes for that. It picks up on weird readings from those sensors. When the values go over some set limit, that is when it figures out there has been an accident. I think it also grabs the GPS spot right then.

Sending out the alert comes next, through GSM or IoT stuff. That message goes to emergency people and maybe some contacts too. The whole point is to get rescue going fast, you know. It seems straightforward, but the details on thresholds might vary a bit. Anyway, that covers the basic flow.

V1.PROPOSED METHODLOGY

Step 1: Initialize system components (Sensors, GPS, GSM module)
Step 2: Continuously monitor vehicle parameters using accelerometer and gyroscope

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Step 3: Read sensor data (acceleration, vibration, tilt)
Step 4: Compare sensor values with predefined threshold limits
Step 5: If values are within limit → Continue monitoring
Step 6: If values exceed threshold → Accident detected
Step 7: Activate GPS module to fetch location coordinates
Step 8: Prepare alert message with location details
Step 9: Send alert via GSM/IoT to emergency services and contacts
Step 10: End process / Continue monitoring

VII.FUTURE SCOPE

The Smart Accident Detection and Rescue System can be further enhanced by integrating advanced technologies to improve accuracy and efficiency. Future work may include the use of artificial intelligence and machine learning algorithms to better analyze sensor data and reduce false alarms. Integration with smart city infrastructure and traffic management systems can enable faster emergency response and optimized routing for ambulances.

Additionally, the system can be connected with cloud platforms to store and analyze large-scale accident data for predictive analysis and safety improvements. The use of advanced communication technologies such as 5G and Vehicle-to-Everything (V2X) can provide real-time data exchange between vehicles and infrastructure. Furthermore, integration with autonomous vehicles and wearable health monitoring devices can enhance driver safety and provide immediate medical assistance during accidents.

VIII.CONCLUSION

The Smart Accident Detection and Rescue System provides an effective solution to reduce fatalities caused by road accidents by enabling automatic detection and rapid emergency response. By integrating sensors, GPS, and communication technologies, the system ensures real-time monitoring and immediate alert generation without human intervention. This significantly reduces the delay in rescue operations and improves the chances of survival.

Overall, the proposed system enhances road safety, minimizes response time, and demonstrates the potential of IoT-based solutions in modern transportation systems.

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