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Smart Crash Alert System

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Abstract-*Road accidents are a major cause of injuries and fatalities worldwide, often exacerbated by delays in emergency response. This paper presents a Smart Crash Alert System that automatically detects accidents and notifies emergency contacts in real time. The system uses an accelerometer (MPU6050) and a vibration sensor (SW-420) to detect sudden impacts and abnormal vehicle movements. Upon detection, the system determines the vehicle's location using a GPS module and transmits an alert via a GSM module. A buzzer and LCD display provide immediate feedback, while a manual override option helps reduce false alerts. Experimental results show reliable detection with alert transmission within 20–25 seconds. The proposed system is a cost-effective solution for improving road safety and reducing response time.*

Index Terms-Accident Detection, GPS, GSM, Embedded System, Road Safety, Real-Time Monitoring

I. INTRODUCTION

Road accidents are a significant cause of injuries and fatalities worldwide, and delays in emergency response often increase the severity of outcomes. In many situations, victims are unable to communicate their condition or location, particularly in remote areas or when they are unconscious. This highlights the need for an automated system that can detect accidents and immediately notify emergency contacts.

Recent advancements in embedded systems and wireless communication technologies have enabled the development of intelligent safety solutions. Sensors such as accelerometers and vibration sensors can be used to detect sudden impacts or abnormal movements, while GPS and GSM modules allow real-time location tracking and communication. In this context, this paper presents a Smart Crash Alert System that automatically detects accidents and sends alert messages with location details to predefined contacts. The system integrates an accelerometer (MPU6050) and a vibration sensor (SW-420) for accident detection, along with a GPS module for location tracking and a GSM module for communication. Additional features such as a buzzer, LCD display and manual override mechanism enhance usability and reliability.

The proposed system aims to reduce emergency response time, improve road safety and provide a cost-effective solution suitable for real-world applications.

II. LITERATURE REVIEW

[1] P. Yellamma, V. S. Kumar and K. R. Reddy, "Arduino Based Vehicle Accident Alert System Using GPS and GSM," 2021. This paper presents an automated system for detecting vehicle accidents using MEMS accelerometer sensors. The system uses GPS to track the location of the vehicle and GSM to send alert messages to predefined contacts. The proposed method ensures quick response and reduces delay in emergency assistance.

[2] A. Chaudhari, R. Patil and S. Patil, "Smart Accident Detection and Alert System," 2021. This work discusses the use of vibration and ultrasonic sensors along with GPS and GSM modules for accident detection. The system improves accuracy by combining multiple sensors and provides realtime alert notifications to emergency contacts.

[3] S. Chitransh, R. Singh and P. Sharma, "Accident Alert System Using GSM," 2024. This paper introduces a system that integrates accident detection with vehicle tracking using GSM communication. The system enhances safety by providing real-time alerts and accurate location information during emergencies.

[4] M. Vijayakumar, R. Venkatesh and S. Kumar, "Vehicle Accident Detection Using GPS and GSM," 2024. This study focuses on detecting accidents and transmitting location details using GPS and GSM modules. The system emphasizes reliable communication and accurate location tracking for emergency response.

[5] P. S. Priyadharshini, A. L. H. B., A. S. and A. S., "Automated Vehicle Accident Alert System using IoT," 2023 7th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Kirtipur, Nepal, 2023, pp. 1040-1046. This paper presents an IoT-based accident alert system that detects accidents using sensors and sends alerts through communication modules. The system improves response time by integrating IoT technology but increases system complexity.

[6] P. P. Babu, M. Sanjana, M. H. Vasantha and Y. B. Nithin Kumar, "Crash Alert System: Automated Accident Detection and Prevention system," 2024 IEEE India Geoscience and Remote Sensing Symposium (InGARSS), Goa, India, 2024, pp. 1-4. This study focuses on detecting accidents using sensor-based monitoring and provides alert mechanisms for emergency response. The system emphasizes reliability and real-time communication.

[7] Y. Ugale, V. Vangala, G. Tajne and D. Karia, "Smart Ignition Control and Accident Alert in Two-Wheelers," 2024 IEEE International Conference on Intelligent Systems, Smart and Green Technologies (ICISSGT), Visakhapatnam, India, 2024, pp. 153-158. This work proposes an integrated system combining ignition control and accident detection, enhancing safety in two-wheelers through real-time monitoring and alert generation.

[8] S. R., T. V. M. E., M. J. and D. K., "Automatic Accident Detection System," 2023 Intelligent Computing and Control for Engineering and Business Systems (ICCEBS), Chennai, India, 2023, pp. 1-5. This paper presents an accident detection system using embedded technologies and communication modules, focusing on efficient detection and alert transmission.

III. MOTIVATION

Road accidents continue to be a major public safety concern, with many fatalities occurring due to delays in emergency response. In several cases, victims are unable to communicate their condition or location immediately after an accident, especially in remote areas or when unconscious. This delay significantly reduces the chances of timely medical assistance. Existing safety mechanisms often rely on manual reporting or are limited by high cost, complexity or lack of real-time response. There is a clear need for a simple, reliable and cost-effective system that can automatically detect accidents and notify emergency contacts without human intervention. The motivation behind this work is to develop a Smart Crash Alert System that ensures rapid accident detection and immediate communication of location information. By integrating sensor based detection with GPS and GSM technologies, the proposed system aims to reduce response time, improve survival rates and enhance overall road safety.

IV. REQUIREMENT ANALYSIS

A. Target Users

The proposed Smart Crash Alert System is intended for:

- Vehicle owners (cars and two-wheelers)
- Daily commuters and long-distance travelers
- Fleet management services
- Emergency response agencies

B. Customer Requirements

The system should meet the following user expectations:

- Accurate and reliable accident detection
- Quick notification to emergency contacts
- Real-time location tracking
- Easy installation and user-friendly operation
- Low cost and minimal maintenance
- Reduced false alerts

V. DESIGN

A. Sequence Diagram

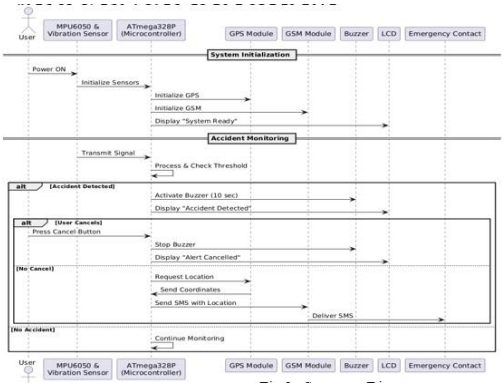

Fig. 1. Sequence Diagram

B. Use Case Diagram

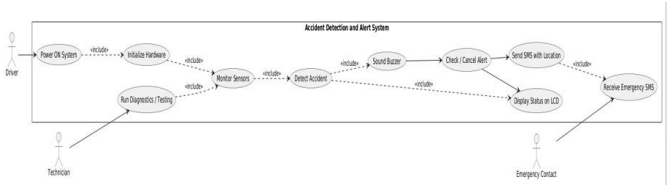

Fig. 2. Use Case Diagram

VI. BLOCK DIAGRAM

The block diagram of the Smart Crash Alert System illustrates the integration of sensing, processing, communication, and power management units. The system is powered by a 230V AC supply, which is stepped down to 12V using a step-down transformer. The AC signal is then converted to DC using a bridge rectifier and regulated using an LM2596 buck converter

to provide stable voltage levels required for the components. A fuse is included for protection against overcurrent conditions. The core of the system is the ATmega328P microcontroller, which processes inputs from various sensors and controls the overall operation. An accelerometer (MPU6050), vibration sensor (SW-420) and gyroscope are used to detect sudden impacts and abnormal vehicle movements. These sensors continuously monitor the vehicle condition and send signals to the microcontroller. The GPS module (NEO-6M) is used to obtain the real-time location of the vehicle when an accident is detected. The GSM module (SIM800L) is interfaced with the microcontroller to transmit alert messages containing location information to predefined emergency contacts. For user interaction, a 16×2 LCD display is used to show system status, while a buzzer provides immediate audio alerts. A push button is included to allow manual override, helping to cancel false alarms when necessary. Additionally, an SD card module is used for data logging purposes. The system operates by continuously monitoring sensor data. When an abnormal condition is detected, the microcontroller triggers the alert mechanism, retrieves the location via GPS and sends an emergency message through the GSM module. Thus, the system ensures quick response and enhances road safety.

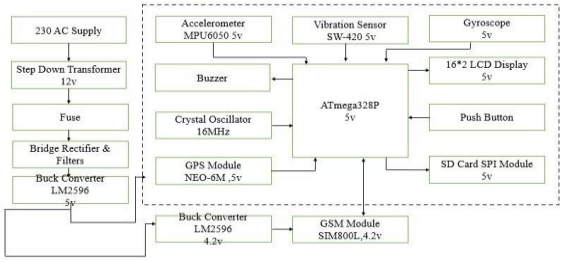

Fig. 3. Block Diagram

VI. CIRCUIT DIAGRAM

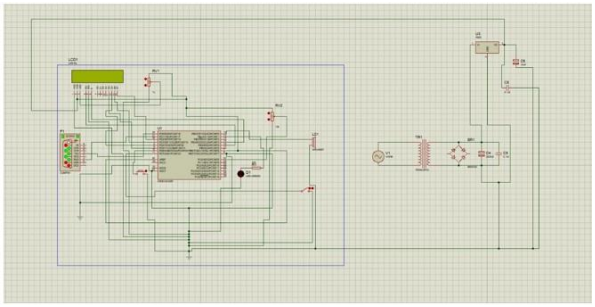

Fig. 4. Circuit Diagram

VIII. RESULT AND DISCUSSIONS

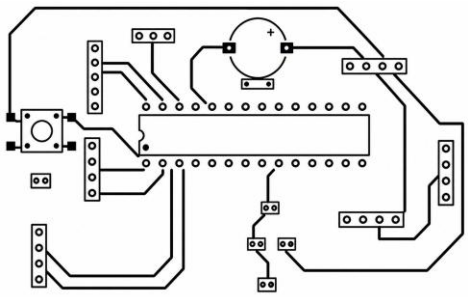

Fig. 5. PCB Layout

IX. CONCLUSION

This paper presented a Smart Crash Alert System for automatic accident detection and real-time emergency notification. The system integrates sensors such as an accelerometer (MPU6050) and a vibration sensor (SW-420) with GPS and GSM modules to detect accidents, determine location and transmit alerts to predefined contacts.

Experimental results demonstrate that the system can reliably detect accidents and send alerts within 20–25 seconds. The inclusion of a buzzer, LCD display and manual override mechanism improves usability and helps reduce false alerts. The overall design is simple, cost-effective and suitable for practical deployment.

The proposed system contributes to improved road safety by minimizing delays in emergency response. Future enhancements may include integrating IoT connectivity, mobile application support and advanced algorithms to further improve accuracy and system performance.

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