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IOT Based Vehicle Accident Detection and Emergency Alert System

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Abstract

1. **Overview:**
   - Develop an IoT solution to detect vehicle accidents in real time.
   - Integration of key sensors and communication modules.
   - Aim to reduce response time and minimize fatalities.
2. **Key Elements:**
   - Collision detection via MPU6050 sensor.
   - GPS for precise location tracking.
   - GSM for SMS-based emergency alerting.
   - Optional “No Casualty” button for false alert cancellation.

Objectives

1. **Primary Objective:**
   - Automate accident detection to ensure timely emergency alerts.

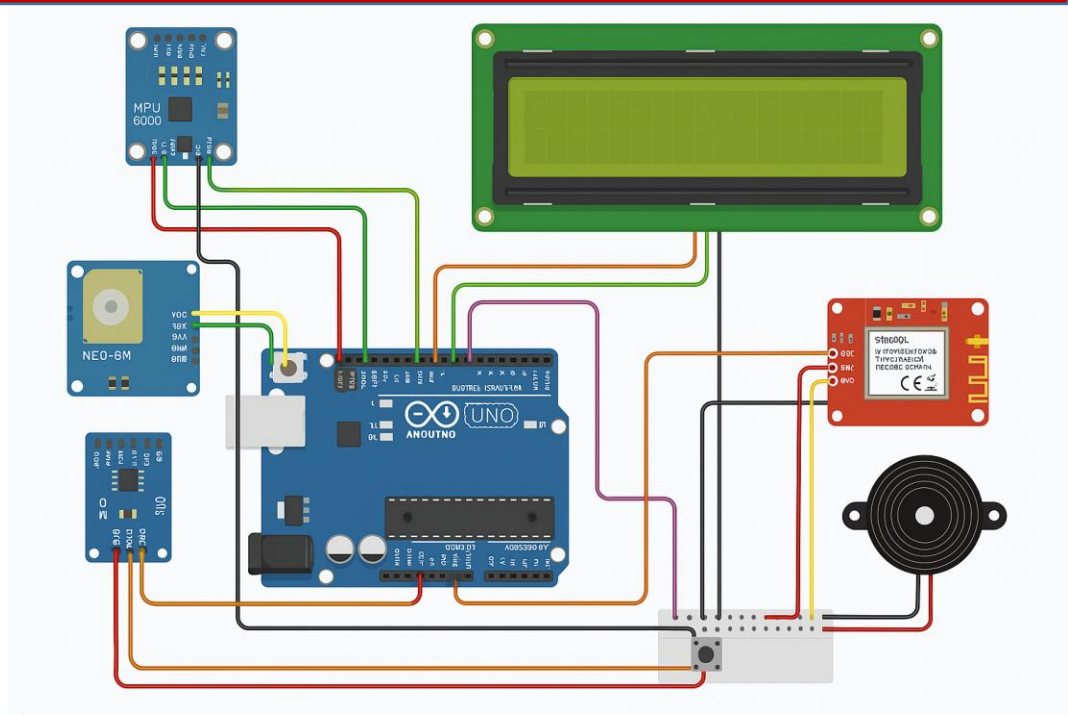
2. **Secondary Goals:**
   - Enhance road safety by reducing response delay.
   - Provide accurate location data with the GPS module.
   - Enable user input to cancel false alerts (via the ‘No Casualty’ button).
   - Lay the foundation for future enhancements, including integration with cloud-based monitoring and AI analytics.

Literature Review

1. **Past Studies Show:**
   - Manual accident reporting often leads to delays.
   - Early sensor-based systems (using the MPU6050) faced challenges with false alerts.
   - Hybrid systems incorporating GPS-GSM have been successful but still require improvements.
2. **Key References:**
   - Singh et al. (2018) – Emphasized delays in emergency response.
   - Gupta and Rao (2021) – Explored GPS-GSM integration.
   - Mukherjee and Verma (2023) – Introduced AI for improved accuracy.
3. **Our Contribution:**
   - A robust integration of sensors with a user confirmation mechanism to reduce false positives.

Methodology/ Proposed System

1. **Central Controller:** Arduino Uno
2. **Sensors & Modules:**
   - MPU6050 (Accelerometer & Gyroscope)
   - NEO-6M GPS Module
   - SIM800L GSM Module
   - 16×2 LCD Display, Buzzer, LED indicators
   - “No Casualty” Button for user confirmation
3. **Operation Flow:**
   - Initialize and continuously monitor sensor data.
   - Detect collision through acceleration threshold.
   - Alert: Activate buzzer and display alert message.
   - Wait for manual override via “No Casualty” button.
   - If no override, fetch GPS coordinates and send emergency SMS.
   - Reset and resume monitoring.



Dataset

1. **Note:**
   - While our project does not rely on a pre-existing dataset, it gathers live sensor data from:
     a. The MPU6050 for acceleration and tilt.
     b. GPS readings for location coordinates.

2. **Data Characteristics:**
   - Real-time dynamic sensor data.
   - Minimal data storage locally, with potential cloud integration in future iterations.

Algorithms

1. **Accident Detection Algorithm:**
   - Continuously read acceleration values from the MPU6050.
   - Compute the magnitude of acceleration.
   - Compare with a pre-set threshold to determine abnormal impacts.
2. **User Confirmation Logic:**
   - Start a timer upon detecting a potential accident.
   - Monitor the “No Casualty” button for cancellation input.
3. **Alert Transmission Algorithm:**
   - Fetch GPS coordinates if no cancellation is received.
   - Format and send SMS notifications via the GSM module.
4. **Reset Mechanism:**
   - After executing alerts, system resets for continuous monitoring.

Results and Discussion

1. Key Findings:

- The sensor fusion approach reliably detects collisions in a controlled setup.
- The manual override button effectively reduces false alerts.
- GPS and GSM modules perform adequately, though network and signal conditions can affect performance.

2. Discussion:

- The system is robust in controlled environments.
- Challenges remain regarding sensor calibration and external factors (e.g., poor GPS reception, GSM network dependency).
- The potential for AI integration and cloud connectivity can further enhance system performance.

Conclusion

1. Summary:

1. The proposed IoT-based accident detection and alert system enhances road safety by reducing emergency response times.
2. It integrates multiple sensors and communication modules using a modular design.
3. The system is both scalable and cost-effective, with significant potential for future upgrades.

2. Future Directions:

1. Incorporation of AI for improved detection accuracy.
2. Cloud-based data logging and remote monitoring.
3. Exploration of advanced communication protocols (5G, NB-IoT) and integration with V2X networks.

References

Citations:

a. Singh et al. (2018): Study on delays in emergency response.
b. Gupta and Rao (2021): GPS-GSM based alert system analysis.
c. Mukherjee and Verma (2023): AI integration for accident detection.
d. Additional references from our literature review and technical datasheets (e.g., MPU6050, SIM800L, NEO-6M).