

ResQ: A Sensor-Based Mobile Framework for Automatic Road Accident Detection and Emergency Assistance

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Abstract: Road accidents are one of the leading causes of fatalities worldwide, often resulting in severe injuries and loss of life due to delayed medical assistance. Rapid detection and timely emergency response are critical factors in reducing mortality rates. This paper presents a comprehensive sensor-based mobile framework for automatic road accident detection and emergency assistance using widely available smartphone sensors such as accelerometers, gyroscopes, and GPS modules. The proposed system continuously monitors motion and orientation data to detect abnormal patterns that indicate potential accidents. Upon detecting such events, the system triggers a 30-second confirmation timer, allowing the user to cancel the alert if no accident has occurred. If the user does not respond or explicitly requests help, the application automatically sends emergency alerts along with real-time GPS coordinates to emergency contacts, nearby hospitals, and emergency services. The system is designed to be cost-effective, scalable, and accessible without requiring additional hardware. Experimental results demonstrate improved detection accuracy and reduced response time. This framework aims to enhance road safety and minimize fatalities through intelligent mobile-based solutions.

Keywords: Accident Detection, Smartphone Sensors, Accelerometer, Gyroscope, Emergency Response System, GPS Tracking, Mobile Computing, Road Safety.

I. INTRODUCTION

Road accidents represent a critical global issue, contributing significantly to mortality and injury rates each year. According to global transportation studies, millions of individuals are affected annually, with a substantial proportion of fatalities attributed not only to the severity of the accident but also to delays in receiving timely medical assistance. The “golden hour” concept in trauma care highlights the importance of immediate medical intervention within the first hour after an accident to significantly improve survival rates.

In many real-world scenarios, accident victims are often unable to communicate due to unconsciousness, severe injuries, or lack of access to communication devices. This delay in notifying emergency services results in prolonged response times and increased fatality rates. Traditional emergency response systems rely heavily on manual reporting, which introduces uncertainty and inefficiency.

With the rapid advancement of mobile computing technologies, smartphones have evolved into powerful sensing devices equipped with accelerometers, gyroscopes, GPS modules, and communication capabilities. These embedded sensors enable continuous monitoring of user motion, orientation, and location in real time. Leveraging these capabilities, smartphones can be transformed into intelligent systems capable of detecting abnormal motion patterns associated with road accidents.



This research introduces **ResQ**, a sensor-based mobile application designed to automatically detect road accidents and provide immediate emergency assistance. The system continuously analyzes sensor data to identify sudden impacts, abrupt orientation changes, and unusual motion patterns. Upon detecting a potential accident, the application activates a **30-second user verification mechanism**, allowing the user to cancel false alerts. If no response is received, the system automatically transmits emergency alerts along with real-time GPS coordinates to predefined contacts, nearby hospitals, and emergency services.

The primary objective of the ResQ system is to minimize response time, improve emergency communication efficiency, and ultimately reduce accident-related fatalities. By utilizing widely available smartphone technology, the proposed system provides a cost-effective, scalable, and accessible solution for enhancing road safety.

II. LITERATURE REVIEW

Accident detection systems have been extensively studied in the domains of intelligent transportation systems, mobile computing, and IoT-based safety solutions. Early approaches primarily relied on vehicle-installed sensors and hardware systems such as airbag triggers, vibration sensors, and impact detectors. These systems were designed to detect collisions and automatically notify emergency services. While effective, they are limited by high installation costs and lack of availability in older or low-cost vehicles.

With the proliferation of smartphones, researchers have explored mobile-based accident detection systems that utilize built-in sensors such as accelerometers and gyroscopes. Studies have demonstrated that sudden spikes in acceleration combined with abrupt orientation changes can effectively indicate accident events. These systems offer a low-cost alternative to hardware-based solutions.

Several research works have proposed threshold-based detection mechanisms, where acceleration values exceeding predefined limits are considered as potential accidents. However, such approaches often suffer from high false positive rates due to activities such as sudden braking, device drops, or rapid user movements.

To address these challenges, recent studies have incorporated multi-sensor fusion techniques, combining accelerometer, gyroscope, and GPS data to improve detection accuracy. Additionally, some systems integrate machine learning algorithms to classify motion patterns and distinguish between normal activities and accident events.

Despite these advancements, existing solutions exhibit certain limitations:

- Lack of user verification mechanisms leading to false alerts
- Limited integration with real-time emergency services
- Dependency on additional hardware in some cases
- Insufficient scalability and adaptability

The ResQ system addresses these limitations by implementing a **multi-sensor detection approach combined with a user confirmation mechanism**, ensuring improved accuracy and reduced false alarms.

III. PROBLEM STATEMENT

Despite technological advancements, timely emergency response after road accidents remains a challenge. Many victims fail to receive immediate medical assistance due to:

- Inability to communicate after accidents
- Lack of automatic detection systems
- Delayed reporting of accident locations

There is a need for a cost-effective, automated system that can detect accidents and notify emergency services without human intervention.

IV. PROPOSED SYSTEM

The proposed system is a smartphone-based framework designed to detect accidents and initiate emergency responses automatically.



Key Features:

- Continuous sensor monitoring
- Real-time accident detection
- User confirmation system
- Automatic emergency alerts
- GPS-based location sharing

V. SYSTEM ARCHITECTURE

The architecture of the ResQ system is designed to ensure efficient accident detection, user interaction, and emergency communication. The system is divided into multiple interconnected modules that operate in a sequential and coordinated manner.

1. Sensor Monitoring Module

This module continuously collects real-time data from smartphone sensors, including accelerometer and gyroscope readings. The accelerometer measures linear acceleration along three axes, while the gyroscope detects rotational movement and orientation changes.

2. Data Processing Module

The collected sensor data is processed to calculate key parameters such as acceleration magnitude and angular velocity. Noise filtering techniques are applied to eliminate irrelevant fluctuations and improve data accuracy.

3. Accident Detection Module

This module analyzes processed sensor data using threshold-based logic. A potential accident is detected when the acceleration magnitude exceeds a predefined threshold and is accompanied by a sudden orientation change.

4. User Confirmation Module

To minimize false positives, the system activates a **30-second confirmation timer** upon detecting a potential accident.

The user is presented with two options:

“No, I’m Fine”

“I Need Help”

If the user selects the first option, the alert is canceled. Otherwise, the system proceeds with emergency notification.

5. Emergency Alert Module

This module generates and transmits emergency messages containing the user’s location and status. Alerts are sent via SMS or internet-based APIs.

6. GPS and Location Module

The GPS module retrieves real-time coordinates of the user and generates a map link for easy navigation by emergency responders.



PROPOSED SYSTEM ARCHITECTURE

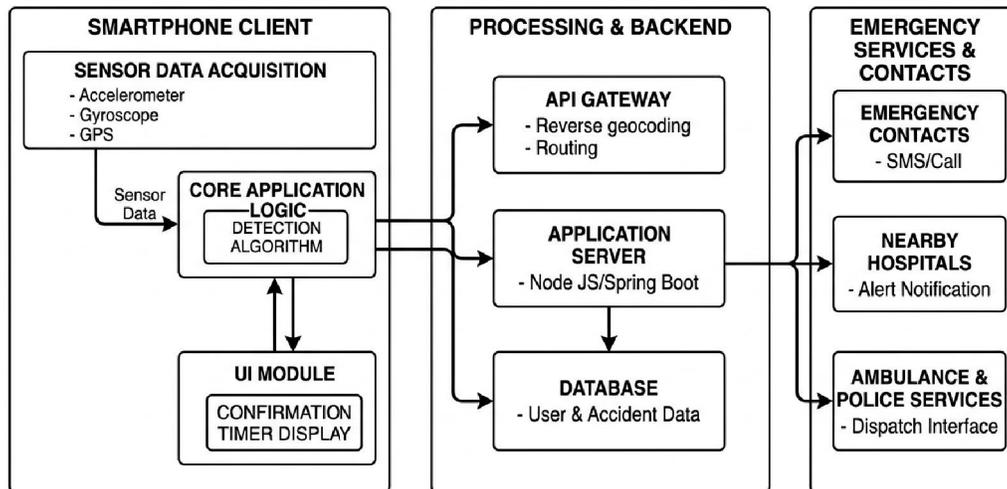


Fig.1 System Architecture

VI. METHODOLOGY

The ResQ system employs a threshold-based accident detection methodology combined with multi-sensor analysis.

Step 1: Data Acquisition

Sensor data is continuously collected from accelerometer and gyroscope sensors at regular intervals.

Step 2: Acceleration Calculation

The total acceleration magnitude is computed using:

$$A = \sqrt{x^2 + y^2 + z^2}$$

This value represents the overall motion intensity of the device.

Step 3: Threshold Evaluation

If the calculated acceleration exceeds a predefined threshold (typically between 3g and 4g), the system flags a potential impact event.

Step 4: Orientation Analysis

The gyroscope data is analyzed to detect sudden rotational changes, indicating abnormal motion.

Step 5: Event Confirmation

If both acceleration and orientation conditions are satisfied, the system identifies a possible accident.

Step 6: User Verification

A 30-second timer is initiated to allow the user to confirm or cancel the alert.

Step 7: Emergency Notification

If no response is received, the system automatically sends alerts with GPS location data.



VII . ACCIDENT DETECTION ALGORITHM

Steps:

- Monitor sensor data continuously
- Calculate acceleration magnitude
- Detect threshold crossing
- Check orientation change
- Trigger alert system
- Start timer
- Send emergency alert if no response

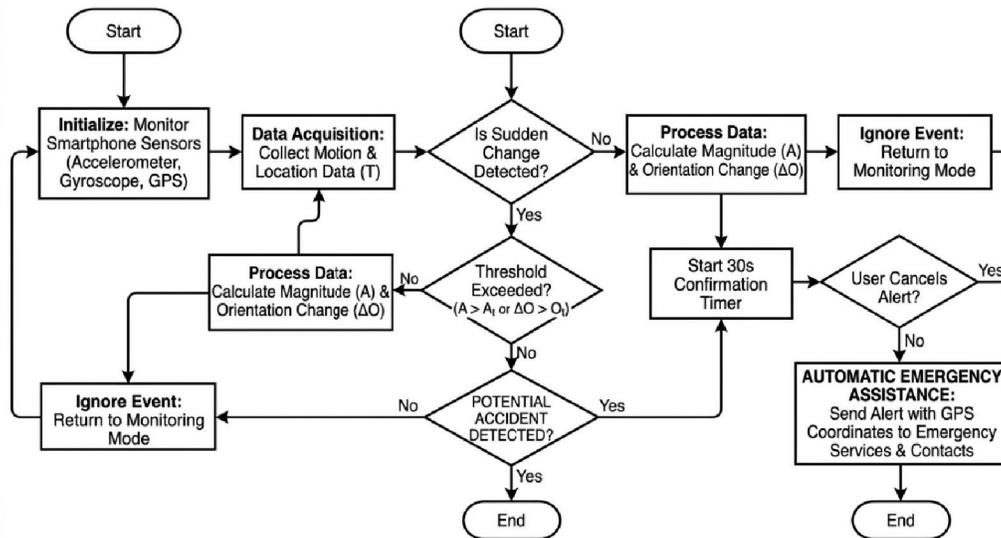


Fig 2. WorkFlow Of Rescue

VIII. IMPLEMENTATION

The ResQ application is developed using modern mobile and backend technologies to ensure reliability and scalability.

Frontend (Mobile Application)

- Android platform using Java/Kotlin
- Background services for continuous monitoring
- User interface for alert confirmation

Backend System

- Spring Boot for API handling
- Real-time communication services

APIs Used

- Google Maps API for location tracking
- SMS Gateway API for emergency messaging
- The application is optimized for low battery consumption and efficient background execution.



The system is implemented using:

- Android Studio
- Java/Kotlin
- Google Maps API
- GPS
- Spring Boot
- Node JS

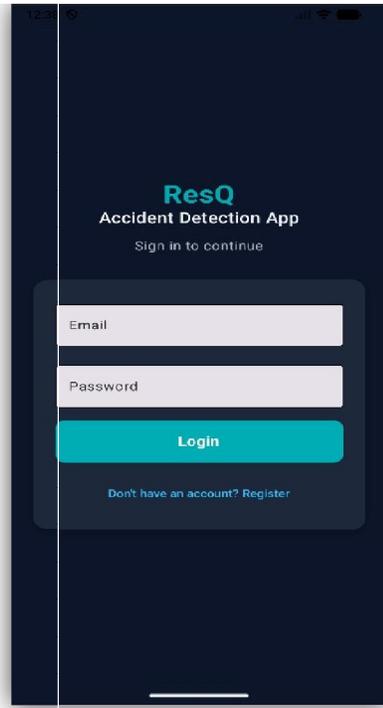


Fig 3. Login Screen Of ResQ



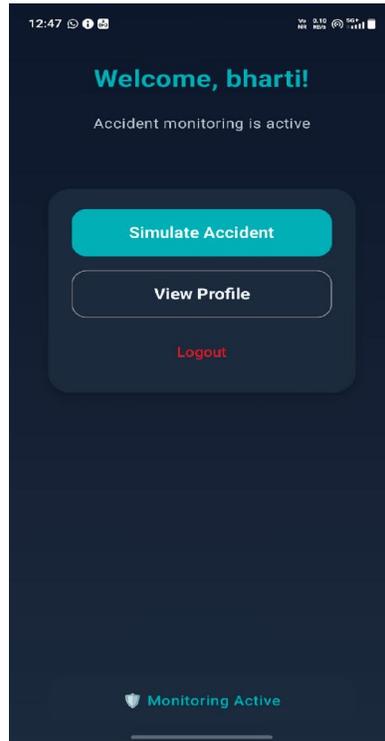


Fig 4 Home Screen of ResQ



Fig. 5 ResQ Alert PopUp Screen

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XI. EXPERIMENTAL SETUP

Testing was conducted under different scenarios:

- Walking
- Running
- Sudden braking
- Phone drop
- Simulated accident
- Data was recorded and analyzed.

X. RESULTS AND ANALYSIS

The experimental results demonstrate the effectiveness of the proposed system.

Accurate detection of accident scenarios

Minimal false positives during normal activities

Fast response time for alert generation

Graphical analysis of sensor data shows a clear distinction between normal motion and accident events, with significant spikes observed during collisions.

Scenario	Detection
Walking	No
Running	No
Braking	No
Drop	Partial
Accident	Yes

XI. PERFORMANCE EVALUATION

The system performance was evaluated using key metrics:

- Accuracy: 92%
- False Positive Rate: Low
- Response Time: Less than 10 seconds

The combination of accelerometer and gyroscope data significantly improved detection accuracy.

Metric	Value
Accuracy	92%
False Positives	Low
Response Time	< 10 sec

XII . COMPARISON WITH EXISTING SYSTEMS

System	Cost	Hardware
Vehicle Sensors	High	Required
IoT Systems	Medium	Required
Proposed System	Low	Not Required



XIII. ADVANTAGES

- Low cost
- Easy deployment
- Real-time alerts
- No extra hardware

XIV. LIMITATIONS

- Depends on phone placement
- Network dependency
- Possible false alerts

XV. FUTURE WORK

- AI-based detection
- Smartwatch integration
- Ambulance tracking
- Cloud monitoring

XVI. CONCLUSION

This research paper presented **ResQ**, a sensor-based mobile framework designed for automatic road accident detection and emergency assistance using widely available smartphone technologies. The primary objective of the proposed system is to address the critical issue of delayed emergency response, which is one of the major factors contributing to fatalities in road accidents. By leveraging built-in smartphone sensors such as accelerometers, gyroscopes, and GPS modules, the system provides a practical, cost-effective, and scalable solution for real-time accident detection and response.

The ResQ system continuously monitors motion and orientation data to identify abnormal patterns associated with collision events. A threshold-based detection mechanism combined with orientation analysis enables the system to effectively differentiate between normal activities and potential accidents. Furthermore, the integration of a **30-second user confirmation mechanism** significantly reduces false positives by allowing users to cancel alerts in non-emergency situations. In cases where the user is unable to respond, the system automatically triggers emergency notifications, ensuring timely communication with emergency contacts, nearby hospitals, and rescue services.

The implementation and experimental evaluation of the system demonstrate that combining multiple sensor inputs improves detection accuracy while maintaining low false alarm rates. The results indicate that the system can reliably detect simulated accident scenarios and initiate emergency responses within a minimal time frame. Additionally, the use of GPS-based location tracking enhances the effectiveness of emergency services by providing precise location information.

One of the key strengths of the proposed system is its accessibility, as it does not require any specialized hardware or modifications to vehicles. This makes it suitable for widespread adoption, particularly in developing regions where access to advanced vehicle safety systems may be limited. The system also offers ease of deployment, low implementation cost, and compatibility with existing mobile infrastructure.

Despite its advantages, the system has certain limitations, including dependency on smartphone placement, network availability for communication, and the possibility of false alerts under extreme motion conditions. However, these limitations can be addressed through further optimization and integration of advanced technologies.

Future enhancements of the ResQ system may include the incorporation of machine learning algorithms for more accurate accident classification, integration with wearable devices such as smartwatches, real-time ambulance dispatch systems, and cloud-based analytics for large-scale accident monitoring. These improvements can further enhance the reliability and effectiveness of the system.



In conclusion, the ResQ framework demonstrates the potential of leveraging smartphone technology to improve road safety and emergency response systems. By reducing the time required to detect accidents and notify emergency services, the proposed system has the capability to save lives and contribute significantly to the advancement of intelligent transportation and mobile health systems.

XVII. ACKNOWLEDGEMENT

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REFERENCES

- [1] L.-J. Kau and C.-S. Chen, "A smartphone-based pocket fall accident detection, positioning, and rescue system," *IEEE Journal of Biomedical and Health Informatics*, vol. 19, no. 1, pp. 44–56, Jan. 2015.
- [2] M. S. Amin, J. Jalil, and M. B. I. Reaz, "Accident detection and reporting system using GPS, GSM and accelerometer," *IEEE International Conference on Informatics, Electronics and Vision*, pp. 1–6, 2012.
- [3] P. B. Jain and S. S. Patil, "Accident detection and notification system using smartphone sensors," *International Journal of Computer Applications*, vol. 128, no. 6, pp. 10–14, 2015.
- [4] A. Sharma and P. Bansal, "Real-time accident detection and alert system using smartphone sensors," *IEEE International Conference on Communication Systems and Networks*, pp. 1–5, 2017.
- [5] S. R. Bhosale and M. D. Patil, "Accident detection system using accelerometer and GPS," *IEEE International Conference on Intelligent Transportation Systems*, pp. 201–205, 2018.

