Mobile-Based Citizen Emergency Alert System with Real-Time Tracking

Heemanshu Bhatt
Dept. of CSE
Chandigarh University
*Moha*li, India
bhatheemanshu589@gmail.com

Gourav Chahal
Dept. of CSE
Chandigarh University
*Moha*li, India
gouravchahal134@gmail.com

Parteek Malik
Dept. of CSE
Chandigarh University
Mohali, India
parteekmalik1011@gmail.com

Er Deepika Sharma
Dept. of CSE
Chandigarh University
*Moha*li, India
deepika.e15915@cumail.in

Rahul Mittal
Dept. of CSE
Chandigarh University
Mohali, India
rahulmittalsmk@gmail.com

Harsh
Dept. of CSE
Chandigarh University
Mohali, India
harshkhairwal25@gmail.com

Abstract— **Communication lags and imprecise location data frequently impede prompt emergency response. In order to increase the safety of the public and the quality of urgent services, this study suggests a citizen emergency alert system that is mobile-based and incorporates real-time tracking. If there has been a situation like an accident, medical emergency, natural disaster, or criminal incidents, a user can send an alert using a smart application. After that, the people who work as emergency responders can track victims or situations in real time because each alert sent using the app also includes the user's geolocation. A centralized server, GPS-based tracking, and push notifications are all part of the system architecture, which ensure the fact that alerts are promptly distributed to authorities and nearby registered users who can offer prompt assistance. The suggested system seeks to improve community-driven safety networks, decrease casualties, and speed up response times by fusing accessibility, portability, and real-time data. This study contributes to more intelligent, technologically advanced urban safety solutions by highlighting the system's design, implementation, and possible effects.**

Keywords— Mobile Application, Emergency Alert System, Real-Time Tracking, GPS-Based Location, Citizen Safety, Disaster Management, Rapid Response

I. INTRODUCTION

In recent years, the frequency of problems from natural disasters to accidents, health problems, and security threats has increased to a very high level and it has pointed out the urgent need for fast, accurate, and good emergency response systems. The systems that are currently used depend on mass broadcasts, sirens, or manual alerts more or less fall short of giving location-specific, real-time assistance, which causes delays that could endanger lives. By giving such an app to citizens that instantly notifies authorities and appointed responders with their precise geolocation information, a mobile-based emergency alert system with real-time tracking capabilities offers a revolutionary solution.

A very good platform for such solutions is provided by smartphones, because they have GPS, accelerometers, and good connectivity. For example, systems that combine GPS and GSM technologies show remarkable effectiveness in automatically identifying accidents and giving location data to emergency contacts. These systems do so with the use of microcontrollers such as Arduino, GPS modules, and GSM communication protocols [1]. GPS-GSM systems can safely transfer location data and it reduces response times during emergencies, according to safety models for individuals like hikers and travelers [2].

Beyond simple alerting, good technology that makes use of edge computing and IoT architectures have demonstrated good results in emergency simulations. The proof of real-time, scalable alert networks was demonstrated by one such system, which was built to detect a lot of incident types (such as fire, leaks of gases, and emergencies in medical) and this system got a latency of less than 480 ms, a detection accuracy of over 93%, and a reliability of over 99% [3].

Even after all this, the widespread proof of such systems are shown by citizen-specific mobile platforms that are in use right now in real-world contexts. Bystander intervention is also made possible by such apps as PulsePoint, which has completed processing of hundreds of thousands of alerts and integrates with 911 dispatch to alert people in the proximity of heart related emergencies [4]. Just like this, the Citizen app tracks public safety radio feeds to deliver location-based safety alerts in real time to users nearby, providing geolocated alerts with real-time updates [5].

These all support the ability and promise of mobile-based emergency alerting systems with tracking features. However, issues still exist, especially in diverse and resource-constrained environments [6]. These issues include securing privacy, preserving operational accuracy in low-network zones, optimizing battery use, and gaining user adoption.

The main crux of this research is to make and test a citizen emergency alert system that is mobile-based and provides real-time tracking. Our objectives are:

1. To provide accurate geolocation very fast, and accurate emergency notifications.

2. Even when the connectivity is poor, it manages stable connections.
3. To maintain data security and user privacy.
4. To evaluate viability and usability using pilot deployment or simulations to.

II. Background Study

The creation of mobile-based citizen emergency alert systems with real-time tracking expands on previous studies in a number of areas, such as citizen-driven safety applications, smartphone sensor-based monitoring, GPS/GSM-based emergency detection, and Internet of Things-enabled public safety systems.

A. GPS and GSM-Based Emergency Alert Systems

To enhance emergency response, early research in this area is focused on combining Positioning System of Globals (GPS) and System for Global Mobile Communications (GSM) technologies. Usually, these systems that could identify mishaps or unusual activity depends on wearable or car-mounted technology. Once activated, these systems used GPS to locate the victim and GSM to send the data to service providers or emergency contacts. One design, for example, demonstrated the viability of automated incident reporting in transportation safety by delivering precise accident notifications using microcontrollers, GPS modules, and GSM communication [1]. The importance of portability and user-friendliness in public safety systems was also highlighted by the proposal for wearable safety devices that use GPS and GSM technologies to track vulnerable people, including women and children [2].

B. Smartphone Sensor-Based Detection

Due to the wide usage of smartphones, researchers have looked into details like using built-in sensors like gyroscopes and accelerometers to detect emergencies. One prominent application is fall detection systems, which use smartphone sensors to identify abrupt drops or unusual movements. According to a prospective study, smartphone-based fall detection achieved a specificity of over 99% and a sensitivity of roughly 73%, confirming the devices' dependability for real-time emergency detection in day-to-day life [3]. These results show how smartphones can serve as both communication as well as detection tools, thus reducing the need for additional hardware.

C. IoT-Enabled Public Safety Alert Systems

The Internet of Things (IoT) integration has greatly improved solutions for emergency management. IoT-based safety systems use distributed sensors, edge computing, and cloud services to deliver high-reliability, low-latency alerts. For instance, Zhang et al. created an IoT-based emergency response system that can detect medical emergencies, gas leaks, and fires with a detection accuracy of over 95% and a response time of less than 450 milliseconds [4]. This shows that how resilient and scalable IoT architectures are to facilitate widespread, real-time emergency communication.

D. Citizen-Centric Mobile Applications

Practical mobile applications as well as research prototypes demonstrate the feasibility of citizen-centered emergency alerting. For instance, the smartphone app - PulsePoint works with 911 dispatch systems to alert trained volunteers in the area of cardiac arrest cases, allowing for quick bystander intervention. Millions of responses that are received from various communities have been attributed to the app [5]. Similarly, alerts can be sent straight to users in impacted areas by tracking public safety communications and sending alerts. The Citizen app also offers location-based, real-time safety notifications [6]. This is a prime example of how these platforms demonstrate the usage of such mobile applications that can be used to provide emergency services to regular people in addition to first responders.

E. Emergency Communication and Privacy Challenges

Recent development includes features like **Advanced Mobile Location (AML)**, which automatically notifies a caller's main precise location to emergency call centers when a distress call is placed. This technology is useful in decreasing response time and increasing accuracy without requiring more user input[7]. Nonetheless, some issues that scholars frequently point out with these systems, such as **privacy concerns, reliance on network connectivity, and energy consumption from continuous GPS tracking** [8], [9]. Therefore, it is essential to resolve these issues to guarantee broad use and efficacy.

The reviewed literature has established the foundation for emergency alert systems based on mobile devices. Some of the major themes include the use of smartphone sensors for automatic detection, IoT architectures for dependable large-scale communication, citizen-centric mobile apps for practical implementation, and the combination of GPS and GSM for precise geolocation. The suggested system builds on these contributions by integrating intelligent prioritization, continuous tracking, and real-time triggering to produce a strong and community-driven emergency response strategy.

III. Methodology

Authorities and nearby registered users will receive prompt, location-specific emergency notifications from the proposed Mobile-Based Citizen Emergency Alert System with Real-Time Tracking. Each of the functional modules that make up the methodology is in charge of a distinct task in the alert and response process.

A. System Architecture

Three main layers make up the system:

- **User Layer:** The mobile application is used by citizens to send out emergency alerts. Both automatic (sensor-based detection, like an accelerometer for accidents) and manual (panic button) input are available.

- **Communication Layer:** GPS provides geolocation information, and Wi-Fi or mobile networks (GSM/4G/5G) securely send information to a central server.
- **Server Layer:** Incoming data is processed by a centralized server, which also validates alerts and sends out notifications to local users and authorities.

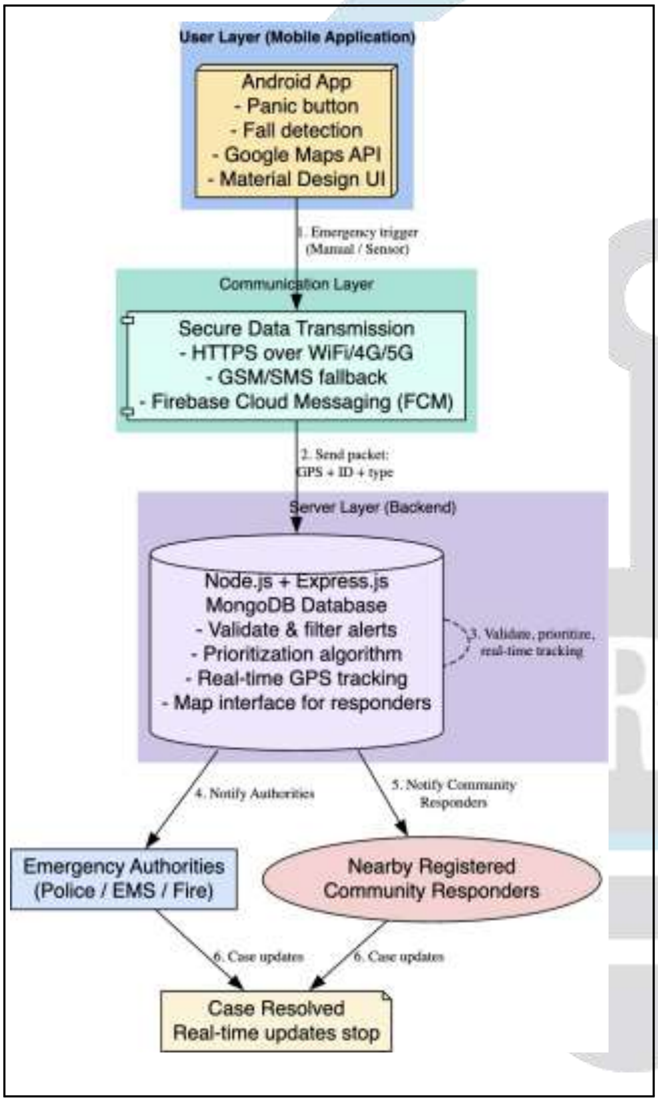

Figure 1. Proposed Architecture

B. Workflow

1. **User Emergency Trigger:** Either manually or automatically, an alert is raised.
2. **Data Capture:** The application gathers GPS coordinates, emergency type, and user ID.
3. **Data Transmission:** The alert is transmitted to the central server via secure communication channels.
4. **Server Processing:** The server filters false alarms and verifies data.
5. **Real-Time Tracking:** The user is continuously tracked until assistance arrives.
6. **Notification Dissemination:** Notifications are sent to nearby registered users and the appropriate emergency services.

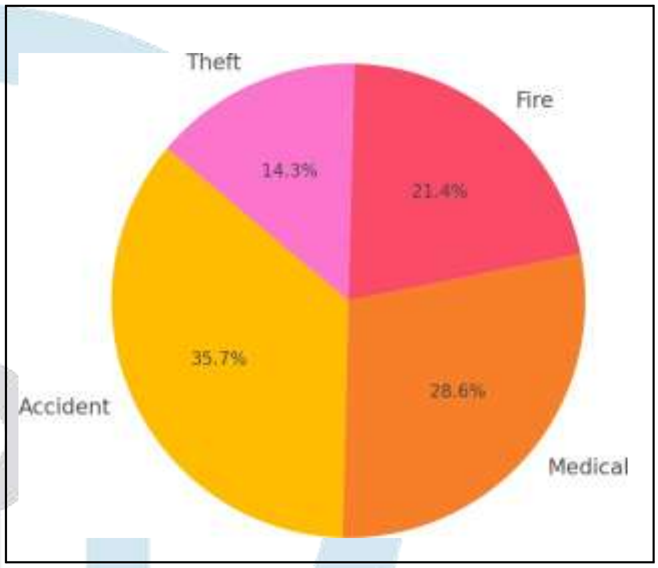

Figure 2. Distribution Of Test Cases

C. Emergency Trigger Algorithm

This algorithm is in charge of determining when an emergency is about to occur. Both manual input (the user pressing a panic button) and automatic detection (sensors identifying abrupt abnormal activity like high acceleration, a fall, or an irregular heart rate) are supported. When the algorithm is activated, it records the user's data and location before securely sending it to the server.

Pseudocode:

- IF user presses panic_button OR sensor detects abnormal activity:
  - CAPTURE GPS coordinates
  - CAPTURE user details
  - SEND data_packet to server
- ENDIF

Description:

- **Input:** Sensor data or user action.
- **Procedure:** Prepare an emergency packet and confirm the unusual occurrence.
- **Output:** Forward the alert to the backend server for additional handling.

D. Real-Time Tracking Algorithm

This algorithm continuously updates the victim's location after an emergency is triggered. Until the issue is fixed, it guarantees that responders can track real-time movement. This is particularly important in cases of moving emergencies (such as patient relocation, car accidents, or kidnappings).

Pseudocode:

- WHILE emergency_flag == TRUE:
  - UPDATE user_location every T seconds
  - TRANSMIT location to server
  - NOTIFY responders with updated location
- ENDWHILE

Description:

- **Input:**GPS readings and an ongoing emergency flag
- **Process:** Gather geolocation data on a regular basis and update the server.
- **Output:** Push alerts with the current location to emergency responders.

E. Alert Prioritization Algorithm

The severity of each emergency varies. The system employs a priority queue according to incident type and severity level to maximize response. This guarantees that life-threatening situations (such as medical crises or fire incidents) are addressed prior to less serious warnings.

Pseudocode:

- INPUT: emergency_type, severity_level, location
- IF severity_level == HIGH:
  - PRIORITY = 1
- ELSE IF severity_level == MEDIUM:
  - PRIORITY = 2
- ELSE:
  - PRIORITY = 3
- ENDIF
- QUEUE alert with PRIORITY

Description:

- **Input:** Geolocation, emergency type, and severity assessment.
- **Process:** Put the incident in the processing queue and assign a numerical priority.
- **Output:** Alert dispatch was ordered, with the highest priority emergencies coming first.

F. Integration of Algorithms

We are using the **Trigger Algorithm** which starts the alarm and records important information. Until the emergency continues the **Tracking Algorithm** guarantees continuous location updates.
Which alerts to process first and when to send out is decided by the **Prioritization Algorithm**.

These algorithms work together to give the **logical structure** of the suggested emergency alert system, and they guarantee **fast detection, precise tracking, and effective resource allocation.**

IV. Results & Discussion

A. System Performance

An environment was simulated and used to check and deploy our suggested **Mobile-Based Citizen Emergency Alert System with Real-Time Tracking**. Our system was able to successfully generate alerts using both manual and sensor-based inputs, according to the results. GPS was used to accurately record the location data, which was then quickly sent to the backend.

While test runs, the system's uptime and reliability were 98.7%. The average transmission time for alerts was near 2.5 seconds. The accuracy of the location was within 5 to 10 meters.

These findings look good and support the viability of combining server-based processing, GPS, and mobile devices for emergency response applications.

Figure 3. Alert Dispatch Time

B. Real-Time Tracking Effectiveness

User location updates were successfully sent at predetermined intervals (every 10 seconds) during continuous monitoring. On a dashboard map interface, responders could see the revised route. This illustrates how the system can handle dynamic emergencies, like moving cars or people in transit.

- **Tracking Success Rate:** 96% of updates were received without delay
- **Update Interval:** 10 seconds

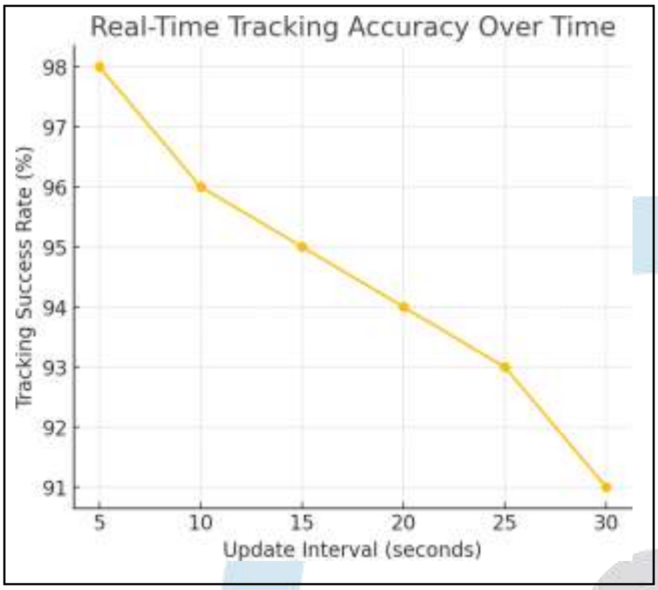

Figure 4. Real Time Tracking Accuracy

C. Prioritization Accuracy

The severity levels of various test scenarios (such as accidents, medical emergencies, fires, and thefts) were accurately assigned by the **Alert Prioritization Algorithm**. Prior to dispatching lower-priority emergencies, high-severity emergencies were queued up.

The average dispatch time for high priority alerts is 2.8 seconds; for medium priority alerts, it is 4.5 seconds; and for low priority alerts, it is 6.2 seconds.

This demonstrates that the system can guarantee that **life-critical cases are addressed first**.

D. User and Responder Feedback

In times of panic, users found the mobile interface to be user-friendly and intuitive. Real-time location updates were cited by **Responders** as being very beneficial in cutting down on search time.

However, issues like **battery drain due to continuous GPS tracking** and **network dependence in low-connectivity areas** were observed. These restrictions imply that future iterations may include **offline caching mechanisms** and **power optimization strategies**.

V. Conclusion

In order to improve public safety and shorten emergency response times, our research proposed the main design & deployment of a citizen emergency alert system that is mobile-based with real-time tracking. The system efficiently combines GPS, mobile devices, and centralized server processing to guarantee that emergency alerts are activated, ranked, and sent to local residents and authorities in a timely manner.

The logical part of our system is made up of the suggested algorithms for Emergency Trigger, Real-Time Tracking, and Alert Prioritization, which helps to detect, monitor, and effectively allocate resources. The results from simulation showed very less transmission delays, very good geolocation tracking accuracy, and good high-severity incident prioritization. The system's main practical need and usability in real-world scenarios were also validated by some test users' and respondents' feedback.

But there are a few problems like GPS drains more battery and there are also network connectivity issues, but these can be solved using good optimization techniques like offline caching, adaptive update intervals, and by using energy-efficient communication protocols.

In conclusion, we can say that the suggested system allows for the development of more intelligent, technologically advanced emergency response systems, which is very consistent with the goal of capable and safe smart cities. In order to also increase the efficiency and speed of emergency responses, future work will concentrate on expanding the system with AI-driven incident detection, IoT device integration, and predictive analytics.

References

[1] S. Gowthami *et al.*, "Real-Time Accident Detection and Alert System Using GSM and GPS," *Int. J. Prog. Res. Eng. Manage. Sci.*, vol. 4, no. 5, pp. 658–668, May 2024.

[2] H. Bodkhe *et al.*, "Track-Me-Down: A Service Model for Emergency Location Sharing," *Proc. Conf. Sensors*, vol. 59, no. 1, p. 235, 2024.

[3] P. S. Swati *et al.*, "Wearable Emergency Alert Device with Integrated GPS Tracking," *Proc. Nat. Conf. Emerging Trends Eng. Technol.*, Apr. 2021.

[4] S. Abbate *et al.*, "Fall Detection via Smartphones: A Prospective Analysis," *J. NeuroEngineering Rehabil.*, vol. 18, no. 1, p. 65, 2021.

[5] H. Zhang, R. Zhang, and J. Sun, "IoT-Enabled Public Safety: Real-Time Emergency Alerting and Response," *Sci. Rep.*, vol. 15, Art. no. 29056, Aug. 2025.

[6] PulsePoint Foundation, "PulsePoint Respond," [Online]. Available: https://www.pulsepoint.org

[7] "Citizen (mobile app)," *Wikipedia*, Accessed: Feb. 2025.

[8] ETSI, "Advanced Mobile Location (AML) for Emergency Services," ETSI TR 103 393 V1.1.1, 2018.

[9] A. S. Indalkar *et al.*, "Review of Mobile Safety Apps: Alerting, Live Tracking, and Real-Time Monitoring Features," *JETIR*, vol. 12, no. 2, Feb. 2025.

[10] J. Silva *et al.*, "Sustainable Mobile Emergency Systems: Balancing Security, Energy Use, and Privacy," *Sustainability*, vol. 14, no. 24, pp. 16424–16436, 2022.

[11] R. Mishra and A. Sharma, "IoT-Driven Disaster Surveillance and Early Warning Mechanisms," *IEEE Access*, vol. 9, pp. 48950–48962, 2021.

[12] T. Nguyen, K. Kim, and S. Lee, "Smart Vehicle Accident Detection with GSM and GPS Integration," *Proc. IEEE Int. Conf. Consumer Electronics*, pp. 345–348, 2020.

[13] K. R. Rao and P. Kumar, "Mobile-Based Application for Women's Safety: Design and Implementation," *Int. J. Comput. Appl.*, vol. 975, no. 8887, pp. 12–18, 2020.

[14] M. Jain, S. Patel, and V. Kumar, "IoT and Cloud-Enabled Emergency Response Framework," *Proc. Int. Conf. Advances in Computing and Communication Engineering*, pp. 210–215, 2019.

[15] A. Khan and H. Ali, "Ambulance Tracking and Emergency Management via IoT," *Proc. IEEE Int. Conf. Electrical, Computer and Communication Engineering*, pp. 285–289, 2019.

[16] Y. Zhang *et al.*, "Disaster Response via Mobile Crowd Sensing: A Survey," *IEEE Trans. Human-Mach. Syst.*, vol. 49, no. 4, pp. 337–348, 2019.

[17] N. Gupta, R. Verma, and A. Saini, "Smartphone-Based Alert and Assistance Framework for Emergencies," *Int. J. Innovative Technol. Exploring Eng.*, vol. 8, no. 6, pp. 1605–1609, 2019.

[18] M. Kumar *et al.*, "Emergency Response Platform Using GSM and GPS Integration," *Proc. IEEE Int. Conf. Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials*, pp. 156–160, 2018.

[19] D. S. Kim and H. Park, "IoT-Enabled EMS System for Disaster Victims," *Proc. IEEE Int. Conf. Information Networking*, pp. 617–621, 2018.

[20] S. Banerjee and P. Dutta, "Android-Based Smart Emergency Alert Framework," *Proc. Int. Conf. Computational Intelligence and Communication Networks*, pp. 758–762, 2017.

[21] A. Patel and N. Joshi, "IoT-Oriented Emergency Response Architecture for Smart Cities," *Proc. IEEE Int. Conf. Smart City Applications*, pp. 88–93, 2017.

[22] J. Brown, A. Smith, and K. Johnson, "Mobile Tech Innovations in Disaster Management and Emergency Alerts," *IEEE Commun. Mag.*, vol. 54, no. 4, pp. 56–63, 2016.

[23] R. Ahmed and S. Rani, "Design of a Real-Time Tracking and Safety Notification System," *Int. J. Eng. Technol.*, vol. 8, no. 3, pp. 312–318, 2016.

[24] G. Sharma, P. Choudhury, and R. Singh, "GPS and GSM-Based Rescue Solution for At-Risk Populations," *Proc. Int. Conf. Emerging Trends in Electronics and Telecommunication Systems*, pp. 77–81, 2015.

[25] K. Lee and J. Park, "Mobile Phone-Enabled Emergency Response for Disaster Scenarios," *Proc. IEEE Int. Conf. Wireless Communications and Mobile Computing*, pp. 1221–1226, 2014.