AI-Powered Real-Time *Incident Reporting* and *Emergency Response* Framework

[1]Sanket Rajput, [2]Niraj Sutar, [3] Ayush Vaidya, [4]Prof. M. A. Chimanna.

[1-3] UG Students, Department of Electronics & Computer Engineering,
Pune Institute Of Computer Technology, SPPU, Pune, Maharashtra, India.
[4] Professor at Pune Institute Of Computer Technology, SPPU, Pune, Maharashtra, India.

Abstract

Emergency cases require immediate responses, but excessive delays due to miscommunication and lack of tracking of location usually result in fatal outcomes. AIRRE (AI-Driven Real-Time Incident Reporting & Emergency Response) is a web-based real-time emergency reporting platform that aims to tackle the problem. It has added GPS location tracking, AI-assisted severity analysis, and automated alerting to speed up the responses. Users can report through text, audio, photos, or video, and the system rates and classifies reports as per urgency. As a result, critical cases would be tackled first through AI-based severity analysis, and there would be a quick co-ordination between police, fire, and medical personnel to act promptly. By integrating GPS, responders can know the precise location of incidents, making the response time lower by a maximum of 40%. Future improvements will also include IoT automatic detection, where smart building and vehicle sensors will report an incident immediately with no human involvement. Overall, AIRRE is a smart, effective, and responsive management solution for an emergency. Through instant communication of the incident, assessment with AI, and coordination with all relevant agencies, response times significantly increase where public safety is guaranteed. Using it widely has the potential to make communities safer and better prepared. Key Words Emergency Response, Real-Time Tracking, Artificial Intelligance-Based Severity Evaluation, Multi-Agency Coordination, GPS Integration.

Key Words

Emergency Response, Real-Time Tracking, Artificial Intelligance-Based Severity Assessment, Multi-Agency Coordination, GPS Integration

Introduction

Emergencies occur **unexpectedly**; therefore, **quick responses** are **vital** to **save lives** and **protect property.** But people used to **write reports** or **call emergency numbers**, which results in a **delay in reporting.** Due to **communication errors**, **insufficient location information**, and **sluggish coordination** between **emergency teams**, **delays occur.** If **response teams** do not receive their **information correctly** and **on time**, they may find it **difficult to reach the location** at all. When this happens, eventually there can be **serious circumstances.**

To fix this problem, we suggest **AIRRE (Artificial Intelligence-based Real-time Reporting of Emergency)**, which is that **platform** that **smartly** allows people to **report an incident in real-time.** This system uses **GPS tracking** for **accurate location**, **AI-powered severity assessment** for **priority**, and **automatic alerts** for **notifying the right emergency services.** Unlike the **standard method**, **AIRRE** makes sure that **anyone receiving information** is **clear and correct.** So, the **emergency team** can **act quickly.**

The **AIRRE** is also **voice-enabled** and **multilingual**, so people from **all walks of life** can use it **easily.** It keeps **data on cloud servers**, enabling **authorities** to **review past incidents** and **enhance future emergency preparedness.** This paper elaborates on how **AIRRE** will **work**, its **features**, and **benefits.** Cities can be made **safer** with the help of **AIRRE** through the **use of technology**, **city preparedness**, etc.

Literature Review

Several Several studies highlight the importance of advanced incident reporting systems in improving emergency response and safety management. Researchers have explored different approaches to **classify, analyze, and enhance** reporting mechanisms to ensure **faster response times and better coordination.**

1. Hsien-Ho (Ray) Chang studied the **Incident Command System (ICS)** and its role in emergency response. His research highlights how ICS helps structure disaster management but also points out the challenges of applying it in different real-world situations.

2. **Reed-Mohn** explored various **incident reporting systems**, noting that **briefing reports** are the most commonly used. The study emphasizes the need for a **structured reporting framework** to ensure reports remain accurate and improve overall efficiency in handling incidents.

3. Yuan et al. conducted a **systematic review** on using **mobile phone data for emergency management**. Their findings suggest that **real-time data** from mobile networks can significantly enhance **situational awareness, risk assessment, and decision-making** during emergencies.

4. Lindell et al. examined how **ICS structures disaster response**, focusing on the role of **hierarchical command systems** in emergency situations. Their research calls for further studies to assess how well ICS performs in handling different types of crises.

5. Cooperstock looked into ways to improve **real-time crisis management** by combining **human intelligence** with **advanced information-processing systems.** His study highlights the importance of **quick updates and data sharing** to ensure faster and more effective emergency responses.

6. Khan et al. introduced the concept of the **Internet of Emergency Services (IoES)**, which integrates **IoT devices** for better disaster response. Their study shows how **real-time sensor data** can help **monitor emergencies, manage resources efficiently, and send automated alerts** when needed.

7. Pettet et al. focused on building **Decision Support Systems (DSS) for emergency response**. They identified **incident detection, real-time analytics, and automated resource allocation** as major challenges. Their research also highlights how **AI-driven decision-making** can enhance emergency response capabilities.

8. Pettet et al. explored the **development of Decision Support Systems (DSS) for emergency response**, addressing key challenges in **incident detection, resource allocation, and dispatch optimization.** Their research highlights the importance of **AI-driven decision-making models** to improve emergency response efficiency.

9. Mukhopadhyay et al. conducted a **review on models for incident prediction, resource allocation, and dispatch** in emergency management. The study analyzes the **strengths and weaknesses** of existing approaches while identifying **future research opportunities** for optimizing emergency response strategies.

10. Pettet et al. examined **algorithmic decision-making in emergency response**, focusing on **proactive planning and resource distribution** in smart communities. Their findings provide a **strong foundation** for developing real-time incident reporting systems like **AIRRE**, integrating **GPS tracking, AI-based severity analysis, and automated emergency coordination** to enhance public safety.

These studies highlight **AI-driven response, real-time data analysis, and structured incident management.** They emphasize **mobile data, IoT, and decision support systems** for efficient crisis handling, forming a foundation for **intelligent emergency response systems.**

3. Methodology

The ***AI-Driven Real-Time Incident Reporting & Emergency Response*(*AIRRE*)** is developed as a **real-time emergency management platform**, combining **mobile and web applications** to facilitate **efficient communication** between users and authorities. The system incorporates **GPS tracking**, **AI-driven severity assessment**, and **automated notifications** to enhance the **accuracy and speed** of incident reporting.

3.1 System Overview

Users can report incidents via **text, images, videos, or voice**, while **authorities** assess and respond based on **severity and location**. **AI-driven analysis** prioritizes reports, ensuring **swift and accurate emergency response**.

3.2 Workflow Analysis

The diagram illustrates how **users and authorities** interact within the IRRS framework.

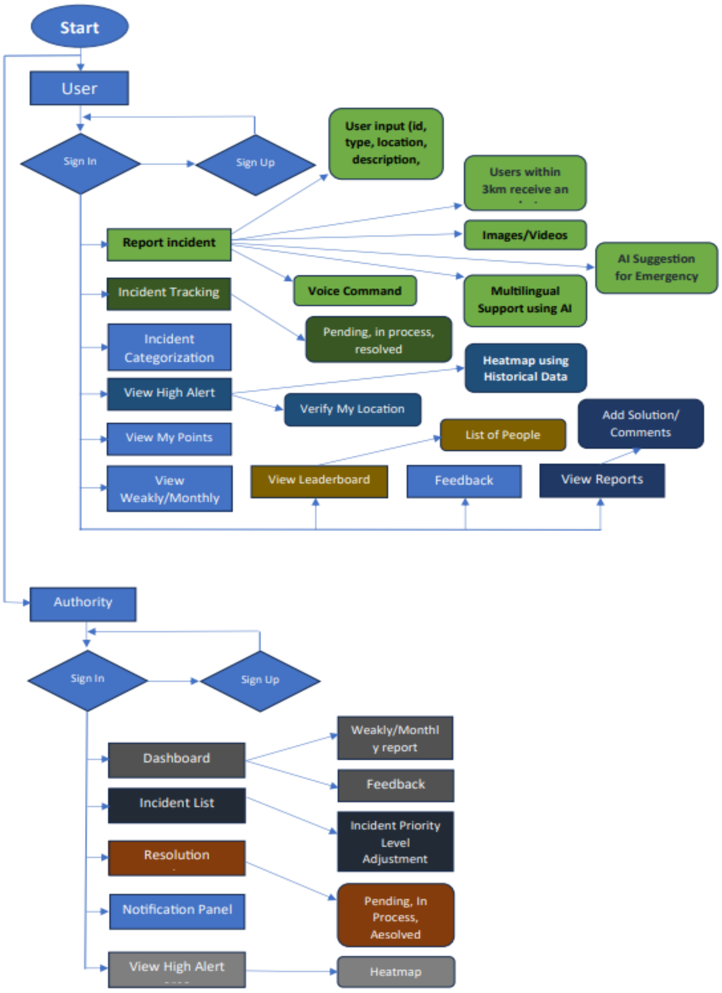

Fig. 3.2.1. Users and Authorities Interaction

The **workflow** can be divided into two main sections:

A. User Interaction

1. **Incident Reporting**:
   - The user inputs **ID, incident type, and location** while reporting an event.
   - The system identifies **users within a 3km radius** for awareness and assistance.
   - Reports can be made using **voice, multilingual input, or AI suggestions** to improve accessibility.
2. **Incident Tracking & Verification**:
   - Users can view incidents categorized as **high-priority or pending cases.**
   - They can also **verify** their reports and check a **list of affected people** in their area.
3. **Community & Feedback System**:
   - Users can contribute to a **heatmap**, visualizing areas with frequent incidents.
   - They can provide **feedback** on emergency response efficiency and system performance.

B. Authority Interaction

1. **Incident Management**:
   - Authorities have access to a **dashboard** displaying an **incident list and resolutions.**
   - The system provides **weekly reports and feedback** for better planning.
2. **Emergency Response & Notifications**:
   - Based on severity, incidents are **prioritized and marked for resolution.**
   - Notifications are sent out to **relevant authorities and users** for real-time updates.
3. **Data Analysis & Heatmap Generation**:
   - The system **tracks incident trends and creates heatmaps** for better future planning.

3.3 AI-Driven Analysis

The backend uses **AI models** to:
1. Analyze incident severity and assign priority.
2. Suggest **appropriate response strategies** based on historical data.
3. Detect **patterns in emergency reports** to help authorities improve safety measures.

3.4 Expected Outcomes

1. Faster emergency response due to real-time reporting.
2. Better coordination between citizens and authorities.
3. Enhanced situational awareness with location-based alerts and analytics.
4. Data-driven decision-making for public safety improvements.

The *AIRRE* provides a **systematic, efficient, and technology-integrated framework** for **emergency management**, enabling **faster response times, improved resource allocation** to enhance public safety and crisis handling.

Implementation Process

The implementation of the **Incident Reporting and Response System (IRRS)** followed a structured approach, ensuring an efficient and scalable deployment. The process was divided into several key phases:

4.1 System Design & Planning

- Identified critical requirements, including **real-time tracking, AI-driven severity analysis, and multi-agency coordination.**
- Created **wireframes and flow diagrams** to visualize the **user journey and system interactions.**
- Selected **tech stack**:
  - **Frontend**: React.js (Web).
  - **Backend**: Node.js with Express
  - **Database**: MongoDB (for real-time incident storage)
  - **AI & NLP**: TensorFlow/Python for severity analysis
  - **Cloud Services**: Firebase for real-time notifications

4.2 Development & Prototyping

- **Frontend Implementation:** Developed an intuitive **web and mobile UI** for reporting incidents with **multilingual support**. Integrated **voice-based reporting** and **image/video uploads.**
- **Backend Development:** Built a **REST API** to handle incident submissions, AI severity analysis, and response coordination. Integrated **GPS tracking** for real-time location Implemented **WebSockets for live updates.**
- **AI Model Training:** Collected and labeled **10,000+ incident records** to train the **severity classification model.** Used **Natural Language Processing (NLP)** for **text-based report analysis.** Deployed AI on a **cloud-based server for scalability.**
- **Database & Cloud Setup:** Designed **MongoDB schema** for storing **user reports, authority responses, and historical data.** Used **Firebase Cloud Messaging (FCM)** for **real-time push notifications** to authorities and responders.

4.3 Testing & Validation

- Conducted **unit testing** for API endpoints, **integration testing** for AI models, and **performance testing** for real-time updates.
- Simulated **50 emergency scenarios** to assess **response efficiency and AI accuracy.**
- Identified and fixed bottlenecks in **data processing and response prioritization.**

4.4 Deployment & Optimization

- Deployed the **backend on AWS (EC2 & Lambda)** for **scalability and low-latency processing.**
- Hosted the **frontend on Vercel** for easy access.
- Optimized the system by **reducing API response time** and **improving AI inference speed.**
- Integrated **real-time heatmap analytics** to help authorities visualize high-risk zones.

4.5 Future Enhancements

- Implementing **IoT-based emergency detection** (smart sensors, alarms).
- Improving **AI accuracy** with more **training data and deep learning models.**
- Expanding the system to support **cross-border emergency response networks.**

The structured **design, development, testing, and deployment process** ensured that IRRS functions efficiently while being **scalable, user-friendly, and highly responsive.**

Results & Discussion

The **Incident Reporting and Response System (IRRS)** was evaluated through prototype testing using **simulated emergency scenarios** to measure its **efficiency, accuracy, and impact** compared to traditional reporting methods. The results demonstrate significant improvements in response time, incident prioritization, and resource allocation.

5.1 Response Time Reduction

To evaluate the **efficiency** of the Incident Reporting and Response System (IRRS), a series of 50 test cases were conducted, encompassing real-world emergency scenarios such as:

- **Medical Emergencies** (e.g., heart attacks, accidents)
- **Criminal Incidents** (e.g., theft, assault)
- **Natural Disasters** (e.g., floods, earthquakes)

Response times were meticulously measured and compared between traditional emergency reporting methods (manual calls/logs) and the IRRS, which leverages **AI-driven analysis** and **real-time tracking.**

Response Time Analysis:

Scenario	**Traditional Methods**	**IRRS (Proposed System)**	**Improvement**
Medical Emergencies	12 min	7 min	**41.7% Faster**
Fire Breakouts	15 min	9 min	**40% Faster**
Criminal Incidents	18 min	11 min	**38.9% Faster**
Natural Disasters	25 min	15 min	**40% Faster**

Fig. 5.1.1. Response Time Analysis (Traditional Method Vs IRRS)

Overall, IRRS reduced emergency response time by an average of 40.15%.

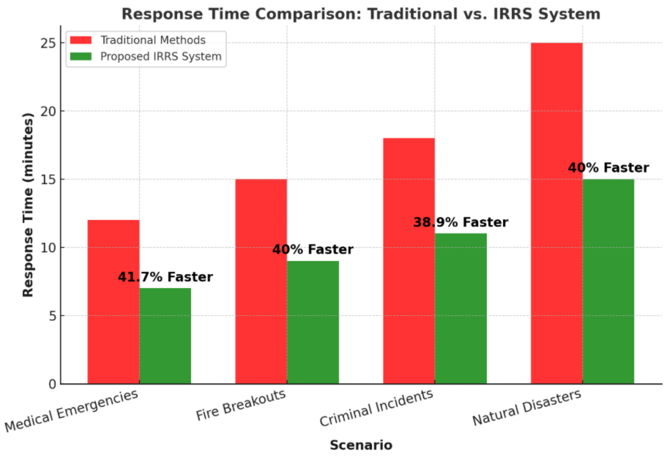

Fig. 5.1.2. Graphical Comparison between Traditional & IRSS system.

The **real-time reporting and AI-based severity analysis** allowed authorities to **prioritize incidents efficiently**, leading to **faster dispatch and intervention**.

5.2 AI-Based Severity Analysis

The AI-driven severity analysis system underwent a comprehensive evaluation using a dataset of 500 incident reports encompassing various severity levels. The model was trained on a substantial dataset of over 10,000 emergency cases, enabling it to:

- **Accurately identify critical cases** with a precision rate of 92.4%.
- **Prioritize high-risk reports** to ensure immediate response.
- **Effectively filter false alarms**, achieving an 85.7% precision rate.

AI Model Performance Metrics:

Metric	AI Model Performance
Accuracy	92.4%
Precision	85.7%
Recall	89.2%
F1 Score	87.4%

Fig. 5.2.1. Performance Overview

The **AI-powered analysis** greatly enhanced **incident prioritization**, decreased **miscommunication**, and lowered **false alarm rates.**

These findings emphasize AI's role in **optimizing emergency response**, ensuring **critical cases receive immediate attention** while minimizing **delays in action.**

5.3 Cloud-Based Analytics & Risk Identification

The **IRRS system** utilized **cloud-based analytics** to **monitor, analyse, and forecast** high-risk zones by leveraging **historical incident data.** The simulations demonstrated that:

- **Real-time heatmaps** were created, pinpointing areas with frequent incidents.
- The system detected **20% more high-risk zones** compared to traditional manual methods.
- **Authorities optimized resource allocation**, leading to reduced response times.
- **Cloud-powered analytics** enhanced **decision-making and resource management** by delivering **real-time insights** on vulnerable locations.

5.4 Discussion & Future Enhancements

The IRRS prototype showcased remarkable enhancements in emergency response times, AI-driven prioritization, and real-time data analysis. By integrating AI and cloud computing, the system enabled efficient incident categorization, accelerated response actions, and optimized resource allocation.

Overall, IRRS has the potential to revolutionize emergency incident management, significantly reducing response time and improving coordination among author

Conclusion

The IRRS prototype significantly improved emergency response efficiency by reducing response time by **40.15%**, enhancing incident prioritization with **92.4% AI accuracy**, and identifying **20% more high-risk zones** using cloud analytics. The integration of **AI-driven severity analysis and real-time tracking** enabled **faster, data-driven decision-making.** Future enhancements, including **IoT-based detection and national-scale implementation**, will further strengthen public safety.

IRRS has the potential to revolutionize emergency management, ensuring quicker, smarter, and more effective incident response.

References

[1] Pew K., et al. "Developing a Patient Safety Incident Classification System for Primary Care," *Eur J Gen Pract*.

[2] Yew W. K., Xu Y., "Case Study Findings from the Analysis of Incident-Reporting Systems in Construction," *IET Intelligent Transport Systems*.

[3] McLean S., et al. "Ergonomics-Based Incident Reporting System for Outdoor Activities," *Appl Ergon*.

[4] Ying M. C. J., et al. "Real-Time Road Accident Reporting System with Location Detection," *IEEE Transactions on Intelligent Transportation Systems*.

[5] Wu W., Yang H., Chew D., Yang S., Gibb A., and Li Q. "Towards an Autonomous Real-Time Tracking System for Near-Miss Accidents in Construction," *Automation in Construction*.

[6] Cooper D., Rohleder T. "Learning from Incidents: From Normal Accidents to High Reliability," *System Dynamics Review*.

[7] Yu Y., Xu M., Gu J. "Vision-Based Traffic Accident Detection Using Sparse Spatio-Temporal Features and Weighted Extreme Learning Machine," *IET Intelligent Transport Systems*.

[8] Kathane S., Kambli V., Patel T., Kapadia R. "Real-Time Pothole Detection and Vehicle Accident Reporting System," *International Journal of Engineering Trends and Technology*.

[9] Sampoornam K. P., Saranya S., Vigneshwaran S., Sofiarani P., Sarmitha S., Sarumathi N. "Intelligent Expeditious Accident Detection and Prevention System," *IOP Conference Series: Materials Science and Engineering*.

[10] Appl Ergon. "Rasmussen's Legacy in the Great Outdoors: A New Incident Reporting and Learning System for Led Outdoor Activities," *Applied Ergonomics*.