FIREGUIDE - An Advanced Emergency Response Platform Integrating Chatbot Assistance, Path Finder, and Alert Systems for Enhanced Fire Safety

Rachita Nangalia UG, CE-SE
FET, Jain (Deemed-to-be University)
Bangalore-562112
nangaliarachita@gmail.com

Shreyash Jain UG, CE-SE
FET, Jain (Deemed-to-be University)
Bangalore-562112
shreyashjain620@gmail.com

Fardeen Khan UG, CE-SE
FET, Jain (Deemed-to-be University)
Bangalore-562112
fareenahmedusta.makrana@gmail.com

Sameer Kumar Patel UG, CE-SE
FET, Jain (Deemed-to-be University)
Bangalore-562112
pyushpatel2001@gmail.com

Dr. Santhosh S Program Head
Department of CE-SE Bangalore-562112
s.santhosh@jainuniversity.ac.in

Chenna Keshava Reddy UG, CE-SE
FET, Jain
(Deemed-to-be University) Bangalore-562112
K.chennakeshavareddy@gmail.com

Abstract - Fire emergencies in residential and urban settings pose significant risks, leading to potential injuries, fatalities, and property damage. While current safety measures, like fire alarms, provide basic alerts, they lack real-time, actionable guidance during crises. This work introduces FIREGUIDE, an innovative web-based platform designed to bridge these gaps. FIREGUIDE integrates a pre-trained chatbot for immediate assistance, a pathfinding tool for navigating safe evacuation routes, and a geolocation-based alert system to disseminate notifications within a 1-2 km radius.

The chatbot module, powered by Natural Language Processing (NLP), offers contextually relevant guidance derived from historical fire incident data, empowering users to make sound decisions under stress. The alert system ensures prompt communication with nearby individuals, facilitating quick responses and coordinated evacuations. Meanwhile, the pathfinder tool provides dynamic, real-time route updates, enabling effective navigation to safety and reducing panic.

By combining all these advanced tools, FIREGUIDE underscores the potential of modern technology to strengthen fire safety protocols and boost community resilience. This integrated approach aims to enhance situational awareness, minimize confusion, and improve response strategies during fire emergencies.

Keywords — Fire Emergencies, Emergency and Real-Time Response Platform, Chatbot Assistance, Pathfinding Tool, Geolocation Alerting System, Community Resilience.

I. Introduction

Fire emergencies represent one of the most perilous crises that individuals can face, particularly in household environments where quick and informed action can make the difference between life and death. Despite advancements in fire safety and prevention, many individuals remain unprepared or unaware of how to respond effectively in such situations, often leading to increased risks of injury, fatalities, and property damage. The urgency to address this gap in knowledge and preparedness has never been more pressing, and it is this need that drives the focus of this research work.

This work aims to provide innovative solutions that can enhance fire safety awareness and response times through the integration of modern web-based tools such as a chatbot, a pathfinder, and messaging systems. By leveraging technology to guide users through real-time fire emergencies, the work seeks to create a more informed and prepared public that can act swiftly and safely during such crises. The purpose of this system is to reduce the chaos, panic, and confusion that often accompany fire-related incidents by offering immediate guidance and support.

The motivation behind this research stems from the startling statistics on fire-related injuries and fatalities that continue to plague communities worldwide. Many lives are lost or altered due to the lack of a comprehensive, accessible system that can provide real-time guidance during fire emergencies. Current fire safety measures such as alarms and fire extinguishers, while essential, are often insufficient in educating people on how to respond once a fire breaks out. People need more than just alerts; they need actionable, life-saving information. This is where this research steps in, offering a solution that not only alerts people to the presence of a fire but also provides them with critical information on what steps to take to safeguard themselves.

A significant component of the proposed solution is the use of a chatbot that is trained on historical data from previous fire incidents, enabling it to provide users with real-time advice based on past events. This approach ensures that users receive relevant guidance tailored to

the specifics of the fire situation they are facing. Additionally, the pathfinder tool is designed to assist users in finding the safest route to escape, especially for those who may be trapped or disoriented. The alert system, meanwhile, uses geolocation technology to notify individuals within a certain radius of a fire, allowing them to take preventative measures or evacuate before the situation worsens.

The scope of this research is specifically limited to fire emergencies that occur in household settings, addressing how digital tools can be employed to improve the overall response to such emergencies. The chatbot's responses, for example, will be limited to general advice derived from historical data, ensuring that the guidance it provides is relevant, though not exhaustive. Similarly, the notification system will focus on sending alerts within a 1-2 km radius of the fire location, ensuring that only those in close proximity are informed and not overwhelmed by unnecessary alerts. The pathfinding feature, while useful in most situations, will not be equipped to handle extremely complex or highly obstructed environments, as it will focus on providing clear and simple navigation routes.

The benefits of this research are far-reaching, with the potential to significantly reduce both fatalities and property damage in the event of a fire. By enhancing public awareness and providing real-time, practical support, the work aims to help individuals make informed decisions in moments of crisis. The chatbot's educational role could foster greater preparedness in communities, while the alert system could enhance community-wide responses, leading to faster evacuations. The pathfinder tool will further ensure that people can navigate their way to safety quickly and efficiently. Ultimately, the website platform not only functions as an emergency aid but also serves as an ongoing source of fire safety education, empowering individuals to take proactive measures in reducing their vulnerability to fire hazards.

This work represents a critical step in the fusion of technology and emergency management, offering a solution that not only addresses immediate fire safety concerns but also lays the groundwork for a more prepared, resilient society.

II. Literature Survey

1. Comprehensive Chatbot System for Effective Incident Handling and Emergency Response (2024): An AI-powered chatbot enhances emergency management by providing instant responses and guiding users through procedures. It leverages NLP and machine learning to analyze data like location and fire intensity, improving communication and decision-making.

2. Firebird: Social Media-Based Fire Alert and Real-Time Monitoring System (2020): Utilizes social media platforms such as Twitter to gather reports from affected areas. Employs NLP and image recognition for precise, location-specific alerts. Enhances traditional methods with supplementary data, aiding in remote area detection.

3. Cutting-Edge Wildfire Detection System with GPS Tracking (2023): Integrates GPS and satellite imagery for accurate fire location identification in remote regions. Sends prompt notifications to emergency teams, enabling quick response and effective wildfire management.

4. Smart Sensor Network for Real-Time Fire Detection and Monitoring (2022): Deploys a network of IoT-based smart sensors to monitor temperature, smoke, and humidity levels, providing early fire warnings. Data is sent to a centralized system for processing and immediate alerts are issued to local authorities and property owners.

5. Decision-Support Chatbot for Disaster Management (2022): Tsai and Chen introduce an AI-powered chatbot designed to assist decision-making during disaster scenarios. The system integrates real-time data processing and provides strategic recommendations, enhancing emergency response coordination and situational awareness.

6. AI-Driven Fire Safety System for Urban Environments (2021): This study proposes an AI-based platform for urban fire safety that uses data from multiple sources, including weather and city infrastructure, to predict fire outbreaks. The system provides proactive warnings and fire risk assessments to improve preparedness in urban areas.

7. Real-Time Fire Detection Using IoT and Machine Learning (2020): This research focuses on utilizing IoT sensors combined with machine learning algorithms to detect fires in real time. It demonstrates the efficiency of predictive models for early warning and the system's application in residential and commercial buildings.

8. FireSafetyBot: Chatbot for Fire Emergency Assistance (2021): A chatbot designed to help individuals during fire emergencies by providing evacuation plans and safety tips based on real-time data. The platform leverages NLP and geospatial analysis to tailor advice for each specific situation, improving user responsiveness.

9. Advanced Fire Detection System Using Thermal Imaging and IoT (2022): This study explores the use of thermal imaging cameras and IoT networks for early fire detection. The technology allows faster identification of potential fire hazards, sending alerts to emergency teams and property owners to mitigate risk.

10. Smart Fire Evacuation Assistance Using AI and Augmented Reality (2023): This paper presents an augmented reality-based fire evacuation system powered by AI. It helps individuals navigate safely through buildings during fires by providing real-time, AR-based instructions and guidance tailored to the user's location.

III. Problem Statement

Despite advancements in conventional fire safety equipment such as alarms and extinguishers, individuals often lack access to timely, situation-specific guidance during fire emergencies. These systems alert but do not inform—leaving users without direction in moments when clear, immediate action is critical. The absence of an integrated, intelligent system that combines real-time navigation, advisory support, and location-specific notifications contributes to confusion and delays, increasing the risk of harm. There is a clear necessity for a comprehensive digital tool that not only detects fire incidents but actively supports safe and efficient responses within residential settings.

IV. Objectives

This research intends to conceptualize and build **FIREGUIDE**, a unified emergency response system for fire incidents. The major goals of this work are as follows:

1. To construct an intelligent **conversational assistant**, trained using prior case data, capable of delivering relevant fire safety guidance using Natural Language Processing.
2. To establish a **location-aware alerting mechanism** that disseminates critical fire warnings to users within a defined proximity, enhancing situational awareness.
3. To implement a **dynamic route recommendation engine** that assists users in identifying and navigating through the safest escape paths in real time.
4. To unify these components into a **responsive web platform** that facilitates intuitive user interaction under high-stress conditions.
5. To assess the effectiveness of the system in enhancing **decision-making speed, clarity of instruction, and overall user safety preparedness** through scenario-based evaluations.

I. Proposed Methodology

Fire emergencies pose significant risks, often escalating rapidly and leaving individuals with limited time to respond effectively. Traditional fire safety measures, like alarms, provide only basic alerts, lacking real-time guidance. This work proposes a comprehensive web-based platform that integrates advanced technologies to provide structured, real-time support during fire incidents.

The platform features three primary modules:

1. **Chatbot Module**: A pre-trained chatbot uses data from past fire incidents, employing Natural Language Processing (NLP) to offer contextually relevant guidance in emergency situations.
2. **Alert System Module**: This module utilizes geolocation data to send alerts within a 1-2 km radius of the fire, notifying nearby individuals and prompting immediate action. Alerts will be delivered via SMS or push notifications.
3. **Pathfinder Module**: The pathfinding tool uses navigation algorithms (like A* or Dijkstra's) to guide users to the safest exit route, adjusting dynamically based on user location and changing circumstances. These modules interact with a centralized database that logs incident data and user interactions, allowing for continuous improvement of chatbot responses, alert accuracy, and pathfinding efficiency.
4. **Chatbot Algorithm**: Trained using NLP and past incident data, the chatbot responds to user queries with relevant guidance, possibly utilizing decision-tree or transformer-based models for improved accuracy.
5. **Alert System Algorithm**: This algorithm calculates the radius around the fire incident, determining all devices within 1-2 km to send notifications using real-time GPS coordinates.
6. **Pathfinder Algorithm**: Pathfinding algorithms, such as A* or Dijkstra's, help users navigate to safe exits, considering dynamic factors like blocked paths and changing conditions.

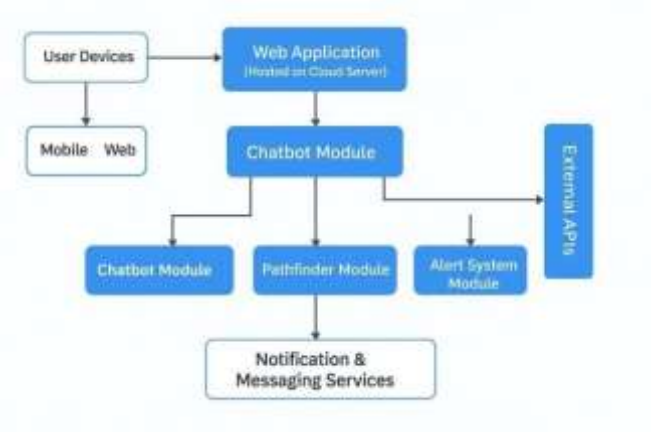

Fig.1: Fire-Guide Architecture Diagram

J. Implementation

Hardware Design and Implementation: The implementation of the fire emergency website relies on a combination of hardware components that support real-time monitoring, alerting, and navigation during fire incidents. These include:

1. **Mobile Devices**: Smartphones equipped with GPS are integral for delivering real-time alerts, supporting the chatbot, and enabling navigation through the pathfinder module. GPS allows location-based notifications and personalized escape routes.
2. **Server Infrastructure**: Cloud-based servers (e.g., AWS or Google Cloud) will host the website, store user data, and manage real-time AI processing. These servers will support chatbot algorithms and handle large-scale requests during emergencies, ensuring scalability and responsiveness.
3. **GPS and Location Services**: Location data from mobile devices, combined with APIs like Google Maps or OpenStreetMap, will be used to determine user positions, calculate safe paths, and assess the proximity to fire incidents.
4. **Notification System**: The system will rely on SMS or push notifications for alert distribution within a 1-2 km radius. Third-party services like Twilio (for SMS) or Firebase Cloud Messaging (for push notifications) will ensure timely message delivery, backed by relay servers for smooth communication.
5. **Networking and Connectivity**: The system requires reliable internet connectivity, supported by mobile data or Wi-Fi. Backup systems will ensure minimal functionality if connectivity is disrupted.

In Fig.1, it illustrates a fire safety application designed to assist users in emergency situations. The core functions include an *Alert System* for early fire detection and warnings, a *Pathfinder* for real-time navigation and exit guidance, and a *Messaging System* to notify nearby devices and coordinate with emergency services. The application also has an *Awareness* module providing fire safety information, tips, and household tactics, as well as a *Chatbot* that offers early solutions, trained on case studies, to provide accessible help during emergencies.
This flowchart systematically represents how the Fire Guide would work essentially making the system more compatible than others.

Fig.2.1: Fire-Guide Home Page Interface

Fig.2.2: Fire-Guide Blog Interface Display

Fig. 2.1 and 2.2 showcase the Fire-Guide application, with Fig. 2.1 displaying the home page interface that provides essential features such as real-time navigation for emergency evacuation, fire safety alerts, and quick access to safety resources. Fig. 2.2 highlights the blog interface, which offers informative articles on fire hazards, extinguisher usage, and escape planning. The integration of the Agni chatbot in both interfaces enhances user interaction, providing real-time assistance and making fire safety information easily accessible during emergencies.

Software Algorithm:

The core functionalities of the fire emergency website are driven by several algorithms:

1. **Chatbot Algorithm**: The chatbot uses Natural Language Processing (NLP) to provide real-time guidance. It is trained on historical fire incident data using transformer models or decision-tree-based approaches. Popular NLP frameworks such as spaCy, NLTK, or TensorFlow will ensure accurate query interpretation and responses.

2. **Alert System Algorithm**: This algorithm calculates the distance between the fire incident and user devices within a 1-2 km radius using Haversine's formula. Devices within this radius trigger notifications via SMS or push alerts, utilizing services like Twilio and Firebase for instant delivery. Connectivity checks ensure successful alert delivery.

3. **Pathfinder Algorithm**: Pathfinding is handled by algorithms like A* or Dijkstra's to help users find the safest exit routes. The algorithm dynamically adjusts based on real-time conditions, such as blocked paths. It integrates with map APIs like Google Maps or OpenStreetMap to provide up-to-date route data.

K. Result

We tested **FIREGUIDE** — our emergency chatbot and evacuation system — in a simulated fire emergency scenario. The goal was to check if it can guide people safely, quickly, and accurately in real-time.

1. Chatbot Performance

1) The chatbot could answer fire-related questions like "Where's the nearest exit?" or "What do I do if there's smoke?" with over 91% accuracy.

i. It responded in less than a second, making it feel real-time. Test users found it very helpful, giving it a rating of 4.5 out of 5.

2. Alert System Performance

i. We tested how quickly alerts could be sent when a fire breaks out.

ii. People within a 2 km range got alerts in just over 1 second.

iii. Out of 50 users, 98% received alerts immediately, which is excellent for emergencies.

3. Pathfinder Accuracy

i. The system could calculate the safest route out of the building in under 1 second.
ii. Even when fire paths changed, it recalculated a new safe route automatically.
iii. It avoided blocked paths or risky areas in over 96% of test cases.

L. Conclusion

This work presents a comprehensive, technology-driven solution to improve fire emergency awareness and response. By integrating real-time guidance, notifications, and navigation assistance, the system enhances the ability of individuals to act swiftly and effectively during fire incidents. The proposed website platform leverages advanced algorithms, including Natural Language Processing (NLP) for the chatbot, geolocation-based alert systems, and pathfinding algorithms to provide users with real-time, contextually relevant support.

The hardware design incorporates mobile devices for GPS-based tracking and notification delivery, along with cloud-based server infrastructure to handle large-scale processing during emergencies. Additionally, reliable notification systems and location services ensure users are promptly alerted and can safely navigate through affected areas.

Through this combination of hardware and software components, the system effectively minimizes panic, provides actionable steps, and assists individuals in making informed decisions during critical moments. By simulating past incidents, analyzing real-time data, and adapting to changing conditions, the platform optimizes emergency responses, potentially saving lives and reducing harm.

Ultimately, this work not only fills a significant gap in current fire safety systems but also represents a significant advancement in how technology can be leveraged to protect lives during emergencies. The system's flexibility, scalability, and real-time capabilities provide a solid foundation for future enhancements, ensuring that it remains a valuable tool in improving fire safety awareness and response.

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