Android Based Disaster Management Application Using Machine Learning

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Abstract

A good saying" Precaution is better than cure" for emergency situations. Natural disasters in India, many of them related to the climate of India, cause massive losses of Indian life and property. Droughts, flash floods, cyclones, avalanches, landslides brought on by torrential rains and snowstorms pose the greatest threats. Landslides are common in the Lower Himalayas. Parts of the Western Ghats also suffer from low-intensity landslides. Floods are the most common natural disaster in India. Therefore, developing a system which can monitor as well as providing instructions on basis of current disaster using Supervised learning, reducing time for quick actions, Google map API for locating nearby locations, Disaster prediction using data analytics. The mobile application will have four tabs: Alert buzzer, weather forecast, the menu tab and the communication forum. Furthermore, the system notifies the users through SMS and even through the forum whenever there is the alert notification posted on the application Using system can help a great deal in the planning and implementation of disaster mitigation schemes.

Keywords: ML-Machine Learning, SVM-Support Vector Machine, NDRF-National Disaster Response Force, SDRF-State Disaster Response Force

I. Introduction

Disaster management is the act through which communities are connected and encouraged to overcome adversity towards hazards and to contend with disasters. Disaster management is not about addressing or directing threats; instead, it accentuates creating plans to lessen the outcomes of natural or man-made disasters. Disasters have two types, natural and man-made disasters. The disasters took away the lives of many people. And Government of India is constantly trying to help out with disaster situations to decrease the unfavorable effect of disasters

Machine learning is a sub-domain of computer science which evolved from the study of pattern recognition in data, and also from the computational learning theory in artificial intelligence. It is the first-class ticket to most interesting careers in data analytics today. As data sources proliferate along with the computing power to process them, going straight to the data is one of the most straightforward ways to quickly gain insights and make predictions

As the output of our model is in the format of positive and negative, binary classification is more suitable. There are three types of binary classifiers which we can apply into our model, they are namely,

- Support Vector Machine (SVM).
- K Nearest Neighbour (KNN) Classifier.
- Naive Bayes Classifier.

No personal Alerts and notifications are provided by the government to people who come under the disaster zone. The existing system consists of either pre-disaster or post-disaster. We are proposing a system which can predict the early alert as well as the situation-based alert.

Quick actions will increase the disaster recovery rate and decrease the time required for performing post disasters conditions, also the periodical material provided will spread the disaster awareness among the common citizens and the communication will be prompt and effective.

Key points

There are a few essential elements and factors to take into account while developing a machine learning-based disaster management application for Android. The following are some crucial aspects to remember:

1.Data Collection:

Compile pertinent catastrophe-related data, including historical disaster records, meteorological trends, seismic activity, and geographic data.

To update and improve your dataset, think about leveraging crowdsourcing data, APIs, or sensors.

2.Machine Learning Models:

To anticipate and identify disasters, apply machine learning models. Natural Language Processing (NLP) for text analysis in social media for early warning indicators is one example of a common algorithm. Computer vision for examining pictures or satellite imagery to find visual indicators of calamities. time series forecasting to anticipate seismic activity or weather trends. Make sure the datasets used to train your models are representative and varied.

3.User Interface (UI):

Create an intuitive UI for your Android application. Provide a map view that shows user locations and current disaster information.

Provide tools for reporting crises or catastrophes.

4.Real-time Data Integration:

Incorporate up-to-date data streams from pertinent sources, including government organizations, seismic sensors, and meteorological APIs. Use push notifications to inform consumers of impending emergencies.

5.Geographical Information System (GIS):

Map safe zones, evacuation routes, and disaster-prone locations using GIS. When developing an app for location-based services, incorporate GIS data.

6.Early Warning System:

Implement an early warning system that can notify users when a potential disaster is imminent in their area.

Use machine learning models to analyze historical data and predict future events.

Challenges

1. Data Quality and Availability:

Ensuring It might be difficult to guarantee that people have access to current, high-quality data, such as real-time meteorological, geological, and disaster-related information. Accurate machine learning model training might be challenging in some areas due to scarce or faulty data.

2. Model Accuracy:

To be useful, machine learning models for catastrophe detection and prediction need to be extremely precise. Because of the complexity of natural catastrophes and the requirement for huge and diverse information, achieving this accuracy can be difficult.

3. Resource Intensiveness:

Machine learning models have the potential to be computationally demanding, which can rapidly deplete a mobile device's battery life. It's important to optimize the app's performance.

4. Data Privacy and Security:

To safeguard user information, handling sensitive disaster-related data, user location data, and other personal details calls for strong security and privacy measures.

5. User Engagement:

It's critical to make sure users actively interact with and have faith in the app. It can be difficult to persuade consumers to continuously utilize the app, particularly in areas with minimal catastrophe risk.

6. Network Connectivity:

The app's capacity to deliver real-time information may be hampered in crisis scenarios by a disruption in network connectivity. It's critical to include offline functionality.

7. False Positives and Negatives:

It's crucial to balance the catastrophe prediction models' accuracy. It can be difficult to reduce false positives, or wrong catastrophe predictions, and false negatives, or failure to forecast disasters.

8. Scalability:

Scaling the infrastructure to support a big number of users and real-time data can be a significant difficulty as the app's user base expands and it becomes extensively used.

Purpose

The motive of the project is to connect trained volunteers with higher authority during disasters.

•To reduce, or avoid, the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery.

•To spread the awareness of the disaster management.

•The most essential but difficult part of disaster management is how to motivate people to understand the disaster risk and to take actions appropriately against such risk with their own will.

•In order to motivate individuals for disaster management, it would be therefore effective to make them understand their own risk, which differs from person to person, through interaction among the stakeholders, and to decrease the cost of the risk.

II. LITERATURE SURVEY

IoT has emerged as a game-changer in disaster management, revolutionizing how we prepare for and respond to natural and man-made disasters. Numerous studies have explored its multifaceted applications across various disaster phases. In "Internet of Things for Disaster Management: State-of-the-Art and Prospects," Alsaqer et al. (2017) highlight how IoT enables real-time monitoring and data collection, enhancing disaster response by providing critical information to authorities. This real-time data empowers decision-makers with insights into evolving situations, such as flood levels, air quality, or seismic activity, enabling more effective resource allocation and evacuation planning. Moreover, IoT extends its impact beyond response to the entire disaster management lifecycle. The paper "A Survey on Internet of Things for Disaster Management" by Khan et al. (2017) discusses how IoT contributes to preparedness and mitigation by offering predictive capabilities through sensor networks. These networks continuously gather environmental data, facilitating early warning systems for tsunamis, hurricanes, or wildfires. Additionally, IoT's role in recovery cannot be overlooked, as it supports damage assessment and infrastructure restoration efforts. Overall, the literature underscores IoT's potential to reshape disaster management strategies, making them more proactive, data-driven, and responsive to the needs of affected communities

Furthermore, the incorporation of cooperative D2D communication in disaster-recovery scenarios has gained significant attention. D2D communication allows devices to communicate directly with each other without relying solely on infrastructure, which can be critical in disaster-stricken areas with damaged or congested networks. Research in this area focuses on how cooperative D2D communication can enhance network resilience and improve information dissemination during emergencies. By combining Stackelberg game theory with cooperative D2D communication, researchers aim to develop novel strategies that address the unique challenges of disaster recovery, such as limited resources, dynamic network conditions, and the need for rapid response and adaptive communication protocols. Overall, the literature highlights the potential of this approach to enhance disaster-recovery communications and contribute to more efficient and reliable post-disaster communication networks.

Disaster communication systems play a pivotal role in ensuring connectivity during emergencies. In recent years, Device-to-Device (D2D) multi-hop relaying services have emerged as a promising solution to enhance the reliability and reach of such systems. A literature survey reveals that researchers have been actively exploring D2D multi-hop relaying in disaster scenarios. They have investigated various aspects, including routing protocols, energy efficiency, and network resilience. Some studies have proposed dynamic routing algorithms that adapt to changing disaster conditions, while others have focused on optimizing the use of energy-constrained D2D devices. Additionally, research has delved into ensuring network robustness by considering factors such as node mobility and interference mitigation. These efforts collectively contribute to the development of more effective and resilient disaster communication systems.

III. System Design:

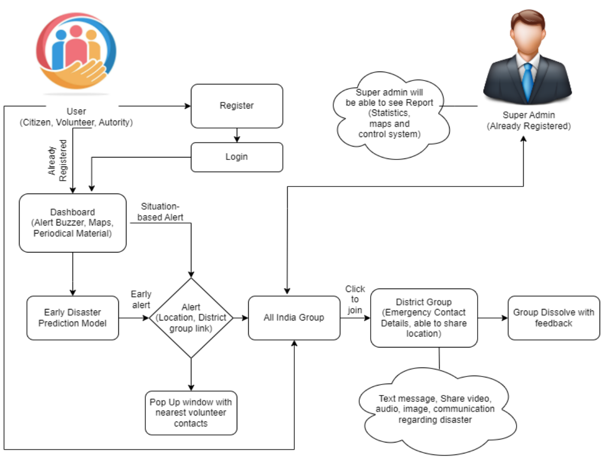

Fig. 1 System Architecture

The system architecture is elaborated into two modules:
i. Situation based alert. ii. Prediction based

- Situation based Alert:

In this module the alert will be pressed by the volunteer/citizen whoever is present at the disaster location [6]. The alert will be notified to the nearest volunteers or citizens, consecutively the district wise disaster group will be created where the further discussion of the disaster prevention strategies will be discussed among the disaster prevention authorities and the common citizen, volunteers, etc.

- Prediction based Alert:

In this module we are giving an early alert which will help the disaster authorities to connect with the nearby people more easily and take necessary actions accordingly.

IV H/W and S/W Requirement:

A. H/W Requirement:

1.CPU Speed-2.5GHz- Provides the instructions and processing power the computer needs for android development.

2.RAM-4GB- The faster the RAM, the faster the processing speed

B. S/W Requirement:

Platform:

1.Operating System: Windows 10 or later (64-bit), x86-64 based.

2.IDE: Microsoft Visual Studio 2019 or Android Studio 10.

3.Programming Language: DART (Flutter development) Python (API development).

V Proposed Work:

The development of an Android-based machine learning disaster management application can greatly improve emergency response activities' efficacy and efficiency. An example overview for such an application is provided below:

1. Design of the User Interface (UI): User Registration/Login: Permit users to safely log in or establish accounts. Dashboard: Show catastrophe notifications in real time. Give emergency contacts' details. Display a map showing the locations of disasters.

2. Disaster Alert System: Using External APIs Integration: To receive updates in real time, integrate with weather APIs. Make use of flood or seismic monitoring systems. Push Notifications: Notify users instantly based on where they are. Permit consumers to alter their choices for notifications.

3. Mdels for Machine Learning:

Catastrophe forecast: Use achine learning models to forecast disasters by analyzing past data. Think about employing models for forecasting floods, earthquakes, etc.

4. Integration of Emergency Services:

Location-Based Services: Let consumers tell emergency services where they are in real time. Provide a map of the impacted locations to emergency services. Allocating Resources: During catastrophes, using machine learning to forecast the need for resources in particular areas.

5. User-Generated Reports Using Crowdsourced Data: Permit users to submit reports in real-time that include text, images, and videos. Use sentiment analysis to rank the most important reports. Social Media Integration: Keep an eye out for posts about disasters on social media and add pertinent information to the system.

6. Communication Channels:

Two-Way Communication: Create a channel for users and emergency services to communicate back and forth.

7. Offline Features:

Data Caching: Provide consumers with offline access to vital information. Use local storage for important files and maps.

8. Community Building:

Community Forums: Establish forums where users may assist, advise, and exchange experiences. Promote participation in disaster preparedness within the community.

9. Instruction and Learning Resources: Manuals and Guides Provide lessons about being prepared for emergencies. Provide interactive instructions on what to do in case of

particular disaster scenarios.

10. Accessibility:

Multilingual Support: Make sure that users who speak various languages may utilize the program. Offer voice-activated functionalities to those with impairments.

11. Feedback Mechanism for Continuous Improvement: Set up a feedback system where users may report problems or make suggestions for changes. Update the program often in response to user input and new technological developments.

12. Data transfer security: Use encryption to protect sensitive information. Ascertain that user data is safely maintained and complies with data protection laws.

13. Scalability: Cloud Integration: For scalability and dependability, leverage cloud services. Make sure the program can manage higher user loads during emergencies.

14. Evaluation: Emulation Evaluation: To evaluate the responsiveness and efficacy of the application, simulate catastrophe scenarios. Test and update often to make sure.

VI. Other Specification

A. Advantages

• The model is essential to maintaining community safety.

• It entails organizing the tools required to avoid, prepare for, respond to, and recover from calamities. These tools include pamphlets, emergency contacts, and news relevant to disasters.

• The volunteers' positions in disaster-prone areas are visible; their personal information, including their contact number, is available.

• Encouraging bidirectional communication

B. Limitations

• Since everyone can hear the alarm buzzer, there's a possibility that someone will press a fake one.

• Network connectivity as a result of offline maps not being available.

• No MMS is accessible.

• Since predictions aren't always accurate, they have a higher chance of failing.

C. Applications

The government-based disaster management agency can utilize it, and private volunteer organizations with a focus on disaster relief can use it to reach out to the general public.

environments.

VII. Conclusion and Future Work:

Conclusion:

The prediction field is revolutionized by machine learning, which is why the success percentage of the system was significantly increased in these suggested models. Using the given dataset, machine learning (supervised learning) successfully makes catastrophic predictions. As a result, people will receive early warning of impending disasters, which will lower economic losses and, most importantly, human life. Disasters can, as we have seen in modern times, result in fatalities as well as affect basic necessities. In the event that the algorithm is unable to forecast, we may also manually send the alarm in this instance, which is why we referred to it as the "Manual way" in the report above. Because of this, all residents may now communicate directly with higher disaster management authorities. Citizens are now able to submit requests to authorities with just one click, saving time and effort.

Additionally, the program is accessible to a broad audience due to the Android platform's user-friendly design, enabling both individuals and authorities to take preventive actions in the face of adversity. We may anticipate a future in which disaster management becomes more effective, accurate, and responsive thanks to continued developments in machine learning and the continual improvement of this application, eventually strengthening our resilience in the face of natural or man-made disasters. This application's strength lies in its adaptability to different geographies, types of disasters, and changing threats. With the ongoing development and enhancement of this technology, we are heading towards a future in which disaster management will no longer be limited to reactive measures but will instead be a proactive force that reduces risks and protects our communities. This disaster management software for Android, which uses machine learning to plan for and respond to calamities, is proof of the revolutionary ways that technology may change our way of life.

Future Work:

1. Advanced ML Models: Explore deeper ML models for improved disaster prediction.

2. Emerging Tech Integration: Integrate edge computing and federated learning for efficiency.

3. Enhanced GIS Features: Implement 3D mapping and real-time updates.

4. IoT Device Integration: Utilize IoT devices for better data collection and monitoring.

5. Predictive Analytics: Develop analytics for estimating disaster impact.

6. Human Behavior Analysis: Analyze human behavior during disasters for insights.

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