iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: II Month of publication: February 2025

DOI: https://doi.org/10.22214/ijraset.2025.67069

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue II Feb 2025- Available at www.ijraset.com

Crisis Connect: Real-time Emergency Response System using Machine Learning

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Abstract: The "Crisis-Connect" project addresses the urgent need for effective disaster management solutions in the face of increasing natural and man-made disasters. By leveraging an extensive sensor network, the project collects real-time data on environmental parameters such as humidity, temperature, and ground movement. This data is analyzed using advanced machine learning models, including Random Forest and Support Vector Machines (SVMs), to accurately predict the likelihood of disasters like floods, forest fires, and earthquakes. The early detection and prediction capabilities of "Crisis-Connect" enable proactive emergency responses, facilitating timely evacuations and resource deployment to high-risk areas. In addition to predictive analytics, "Crisis-Connect" enhances coordination and information sharing during rescue operations, a critical need in the chaotic aftermath of disasters. Sensor data and victim locations are securely stored on cloud-based platforms, making them readily accessible to emergency teams. This system allows for informed decision-making and efficient management of rescue efforts.

The project's user-friendly interfaces cater to both general users and emergency departments, providing incident information, initiating alerts, and coordinating response strategies. This integrated approach ensures swift and effective action from all stakeholders involved in crisis management. By combining geospatial technology, intelligent automation, and real-time detection algorithms, "Crisis-Connect" revolutionizes emergency response systems. Advanced mapping capabilities offer precise visualization of affected areas, aiding in the strategic allocation of resources and personnel. The seamless integration with service providers enhances the coordination and effectiveness of emergency response efforts. Overall, "Crisis-Connect" represents a comprehensive approach to disaster management, significantly improving crisis preparedness and response through technological innovation.

As disasters become more frequent and severe, "Crisis-Connect" will be instrumental in mitigating their impact and ensuring community resilience.

Keywords: Disaster Management, IoT, Machine Learning, Support Vector Machines, Random Forest, Geospatial Technology, Real-time Detection Algorithms.

I. INTRODUCTION

The “Crisis-Connect” project emerges as a vital response to the escalating frequency and devastating impact of natural and man-made disasters globally. Driven by the imperative to save lives and protect communities, the project tackles two primary challenges in disaster management.

The first challenge lies in the timely detection and prediction of impending disasters. To address this, the project leverages an extensive sensor network to gather real-time data on critical environmental parameters, such as atmospheric humidity, temperature, and ground movement. By employing advanced machine learning models, including Random Forest and Support Vector Machines (SVMs), “Crisis-Connect” is able to analyze this data and accurately predict the likelihood of disasters, such as floods, forest fires, and earthquakes. This predictive capability enables early warning systems and allows for proactive emergency response, positioning the project as a crucial tool in mitigating the devastating effects of these calamities. The second challenge the project addresses is the efficient coordination and information sharing during rescue operations. In the aftermath of a disaster, the timely collection and dissemination of critical information are crucial for effective rescue and relief efforts. “Crisis-Connect” addresses this challenge by securely storing sensor data and victim locations in cloud-based platforms, making it readily accessible to designated emergency teams. The project’s user-friendly interfaces empower both general users and emergency departments, allowing the former to access incident information and the latter to initiate alerts and coordinate response strategies. This seamless integration of technology and emergency services enhances crisis management capabilities, ultimately contributing to a future where technology safeguards lives and fosters resilient communities.

II. PROBLEM STATEMENT

A. Literature Survey

In the current landscape of emergency response systems, traditional methodologies are predominantly characterized by manual processes and limited technological integration. These systems are inadequate for efficiently handling the increasing frequency and complexity of natural and man-made disasters. The reliance on historical data and conventional methods often leads to delayed reactions and imprecise identification of high-risk regions. This inadequacy in timely detection and prediction, coupled with inefficient coordination and information sharing during rescue operations, significantly hampers the effectiveness of disaster management efforts. There is an urgent need for a robust, technologically advanced system that can provide accurate, real-time data and enable proactive, well-coordinated emergency responses to mitigate the devastating impacts of disasters on communities.

1) Urban Flooding in Mega Cities of India: Trends, Challenges, and Mitigation Strategies. Authors: U.S. De, G. P. Singh, D. M. Rase. The document, dated April 2013, delves into the escalating issue of urban flooding in four major cities of India—Kolkata, Mumbai and Delhi. It highlights the increasing frequency and intensity of urban flooding events, primarily during the Southwest Monsoon season. Kolkata, with its dense population and aging infrastructure, faces severe challenges as its drainage systems are often overwhelmed by heavy rainfall, leading to widespread waterlogging that disrupts daily life, hampers transportation, and poses significant health risks. Mumbai experiences similar issues, where the combination of heavy monsoon rains and high tides frequently results in severe flooding, impacting the city's transportation network and causing substantial economic losses. Delhi's rapid urbanization and inadequate drainage infrastructure exacerbate the flooding problem, with significant areas of the city experiencing waterlogging after intense rainfall, disrupting public services and daily activities
2) IoT-Based Disaster Management System: A Prototype for Sensing and Mitigating Atmospheric Hazards. Authors: Dr. C. Aarthi, S.A. Manish, S. Nadarajan, K. Akash path This paper, dated April 2021, introduces a prototype for a disaster management system that leverages the Internet of Things (IoT) to detect atmospheric changes and transmit data to a cloud server. The system is designed to monitor environmental parameters in real-time, utilizing IoT sensors to gather data on temperature, humidity, pressure, and other relevant atmospheric conditions. This data is then transmitted to a cloud server, where it can be analyzed to predict and manage potential disasters. The prototype aims to enhance disaster preparedness and response by providing timely and accurate information to relevant authorities and stakeholders, enabling them to take proactive measures to mitigate the impact of natural disasters.
3) IoT-Enabled Disaster Management: Integrating WSN for Centralized Control and Early Warning. Authors: Triveni Dhamale, Saurabh Sawant, Aman Soitkar, Prajwal Borse Published in May 2022 in The International Journal of Advanced Research in Science, Communication, and Technology (IJARSCT), this paper underscores the significance of an Internet of Things (IoT)-based disaster management system. The study presents a prototype designed to detect atmospheric changes and transmit data to a cloud server. By leveraging IoT technology, the system aims to monitor environmental parameters in real-time, providing critical data on temperature, humidity, pressure, and other relevant conditions. This information is then analyzed in the cloud to predict and manage potential disasters, thereby enhancing disaster preparedness and response. The paper highlights the potential of IoT to improve the accuracy and timeliness of disaster management efforts, enabling authorities and stakeholders to take proactive measures to mitigate the impact of natural disasters.
4) Harnessing the Power of IoT for Enhanced Disaster Management: A Smart Network Approach. Authors: John Wellington J (M.Tech Scholar), Ramesh P (Associate Professor) Dated May 2017, this paper explores the critical role of the Internet of Things (IoT) in disaster management, aiming to minimize the impact of natural or man-made disasters on life, property, and the environment. It presents a detailed analysis of an IoT-based system designed to detect atmospheric changes and transmit data to a cloud server. By monitoring real-time environmental parameters such as temperature, humidity, and pressure, the system enables the prediction and management of potential disasters. The study highlights how IoT technology can significantly enhance disaster preparedness and response efforts, providing timely and accurate information to relevant authorities and stakeholders. This proactive approach facilitates more effective mitigation strategies, ultimately reducing the adverse effects of disasters.
5) IoT-Based Flood Detection and Water Monitoring System for Effective Disaster Management. Authors: Mr. Bhushan M. Borhade, Miss. Kajal G. Date, Miss. Pooja U. Kahane, Miss. Rutuja B. Rasal, Miss. Komal S. Aher Dated November 2021, this document outlines the implementation of an Internet of Things (IoT)-based flood detection and water monitoring system designed for effective disaster management. The system leverages IoT technology to monitor real-time environmental parameters, such as water levels, rainfall, and flow rates, transmitting this data to a cloud server for analysis. By providing accurate and timely information, the system aims to predict and manage flood events more effectively, enhancing disaster

preparedness and response. This innovative approach seeks to minimize the impact of floods on life, property, and the environment by enabling relevant authorities and stakeholders to take proactive and informed measures.

6) Smart Fire Security System: Arduino UNO and GSM Integration. Authors: Bangar Gauri Narayan, Kamble Gaurav Mohan, Lad Varun Hemant, Shirsath Dated April 2021, this project focuses on the implementation of a Smart Fire Security System utilizing Arduino UNO and GSM technology. The system is designed to enhance fire detection and response by integrating various sensors to monitor environmental parameters such as temperature, smoke, and gas levels. Upon detecting potential fire hazards, the Arduino UNO processes the sensor data and uses GSM technology to send real-time alerts to designated authorities and stakeholders. This smart system aims to provide a rapid and reliable means of fire detection, thereby minimizing the risk of fire-related damage to life and property. The project underscores the potential of combining Arduino and GSM technologies to develop efficient and effective fire security solutions.
7) A Location-Aided Flooding Mechanism for Efficient Data Dissemination in Community-based IoT Networks. Authors: Wei Liu, Kiyohide Nakauchi, Yozo Shoji Dated July 2017, this paper introduces an effective flooding mechanism designed for the dissemination of local sensing data within community-based Internet of Things (IoT) networks. The proposed mechanism facilitates the efficient sharing and distribution of real-time environmental data collected by IoT sensors, focusing on parameters such as water levels, rainfall, and soil moisture. By leveraging a community-based network, the system enhances the rapid and widespread dissemination of critical information, which is crucial for effective disaster management and response. This approach aims to improve the accuracy and timeliness of flood detection and mitigation efforts, thereby reducing the adverse impacts of flooding on communities.

B. Objectives

The objective of "Crisis-Connect" is to enhance disaster management through real-time data collection, predictive analytics, and intelligent automation. By leveraging sensor networks and machine learning, it enables early disaster detection, efficient emergency response, and resource allocation. The system improves coordination among stakeholders, ensuring swift action and community resilience against crises.

C. Existing System

Traditional Methodologies in Emergency Response In the current landscape of emergency response systems, traditional methodologies prevail, largely relying on manual processes and limited technological integration. These systems often depend on historical data and conventional methods, which can lead to delayed reactions and less precise identification of high-risk regions.

D. Proposed System

The "Crisis-Connect" project proposes a groundbreaking initiative to revolutionize disaster management by integrating cutting-edge geospatial technology, intelligent automation, ML models, and IoT devices. This innovative approach aims to bridge the crucial gap between disaster occurrence and the initiation of targeted assistance.

III. METHODOLOGY

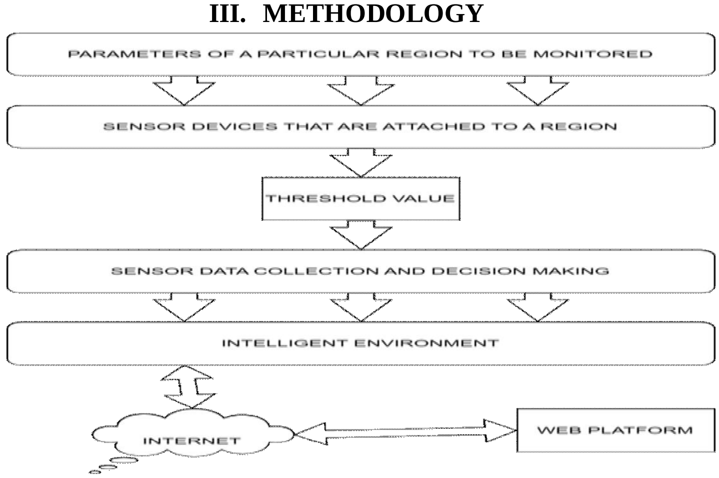

Fig 3.1

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The methodology is as shown in Fig 3.1

Project Involves the IoT device, Cloud platform, and ML model.

The IoT device integrates various hardware components and communication protocols for seamless interaction with the Cloud platform. Key components utilized in this system include:

Sensors: Capable of measuring both moisture and air temperature, providing essential data for assessing environmental conditions during disaster events.

ESP8266 Module: An UART-WiFi transparent transmission module offering low power consumption and self-contained Wi-Fi networking capabilities, enabling wireless communication with the Cloud platform.

GPS Module NEO06MV2: A stand-alone GPS receiver featuring the u-blox 6 positioning engine, providing accurate location data crucial for disaster monitoring and response.

The IoT device interfaces with these components via connections to the DHT11 sensor, ESP8266 module, and GPS module, as depicted in Figure 5(a). Data collected from these sensors is uploaded to the Cloud platform, with platforms like 'Thing speak' commonly employed.

The ML model plays a vital role in predicting the 'Risk Factor,' leveraging unsupervised learning techniques due to the absence of labeled data. Python, with libraries like 'sklearn,' facilitates data preprocessing tasks, including normalization and dimensionality reduction. The ML model utilizes input from the IoT device, supplemented by additional location data, to create a comprehensive dataset. After performing necessary preprocessing steps, the dataset is used to train the ML model, enabling accurate prediction of the 'Risk Factor.

IV. RESULTS AND DISCUSSION

Support Vector Machine (SVM) serves as a pivotal component in our machine learning model designed for earthquake prediction, complementing existing disaster management techniques. Initially, we import a dataset containing crucial earthquake features from a CSV file, including axis x, axis y, and axis z, alongside their corresponding output labels. These features provide vital insights into seismic activity recorded by sensors, enhancing our understanding of earthquake patterns. Following data extraction, we isolate the features to serve as input (X) for the SVM model, while the output labels (output) act as the target variable (y) during training. The SVM model is instantiated with a linear kernel using the SVC(kernel='linear') function, fitting well with the linearly separable nature of earthquake prediction data. We then train the SVM model using theinput features (X) and output labels (y) through the svm_model.fit(X, y) method, allowing it to learn underlying patterns and relationships. Once trained, the SVM model makes predictions on the dataset to evaluate its performance, using svm_model.predict(X) to generate predictions. Additionally, we introduce new data points for real-time prediction, forecasting their output labels (new_prediction) using the trained SVM model. To assess the SVM model's efficacy, we compute key metrics such as accuracy and F1 score using functions like accuracy score and f1_score from the scikit-learn library. Furthermore, we calculate the confusion matrix using confusion_matrix to provide a detailed breakdown of the model's performance, including true positives, true negatives, false positives, and false negatives. These metrics offer valuable insights into the SVM model's ability to accurately classify seismic events based on input features, demonstrating its superiority over previously invented disaster management techniques.

Fig 4.1

Fig 4.2

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Fig 4.3

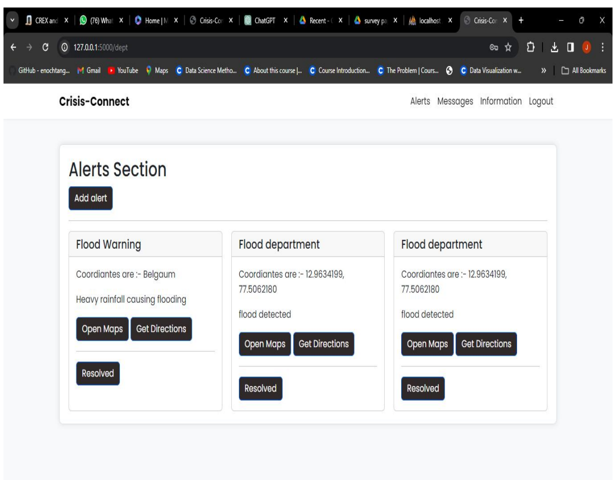

Fig 4.4

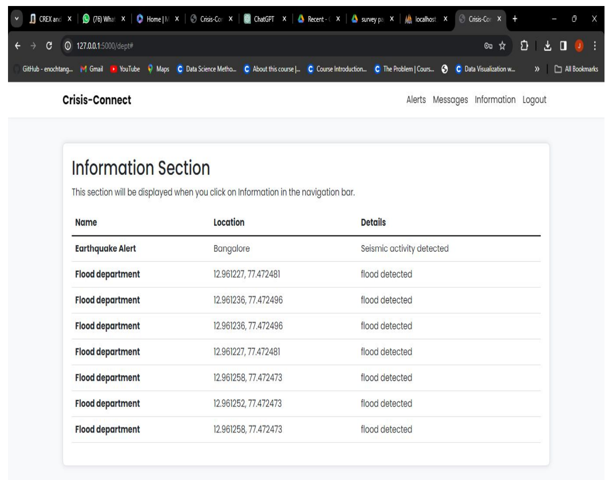

Fig 4.5

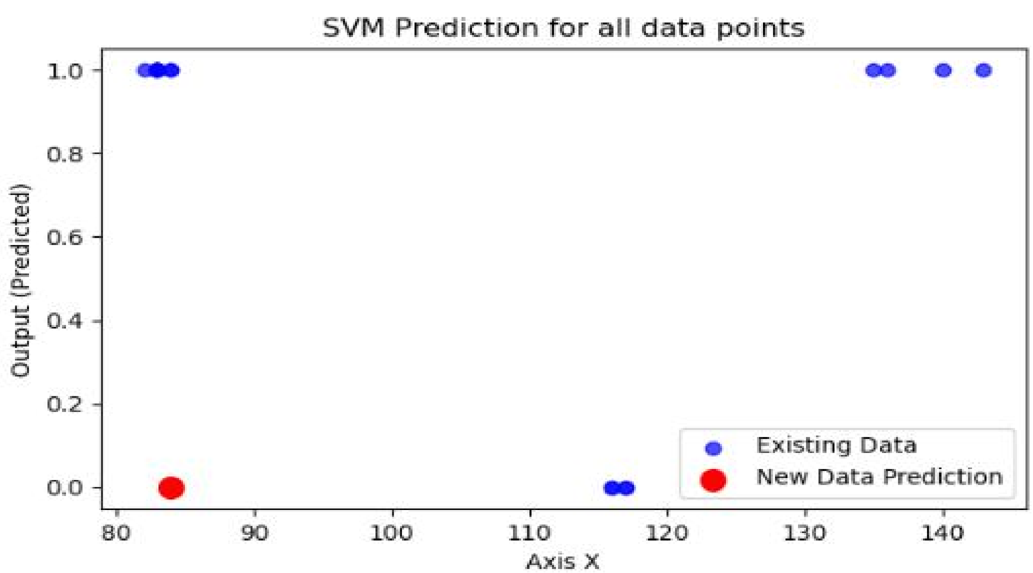

Fig 4.6

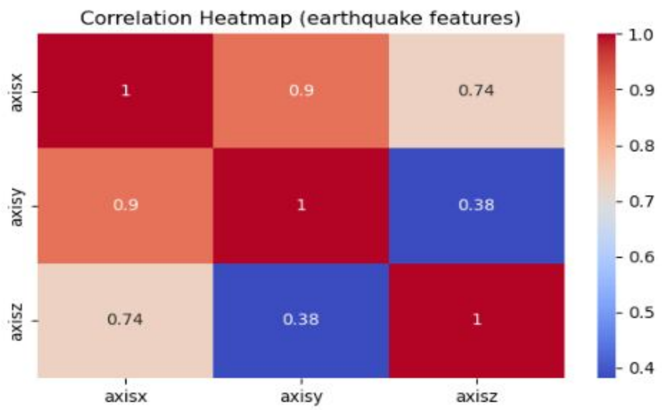

Fig 4.7

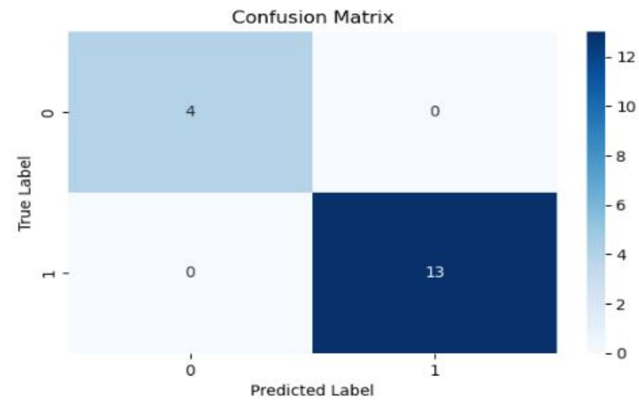

Fig 4.8

V. CONCLUSIONS

Disasters, whether natural or man-made, inflict significant damage to property and result in the loss of lives. Effective disaster management is essential in mitigating these impacts and ensuring the safety and resilience of communities. Disaster management encompasses proactive planning to identify potential hazards, implementing measures to prevent or minimize their effects, and developing strategies for rapid response and recovery. This comprehensive approach is encapsulated in a disaster management plan, which outlines the risks faced by a business, preventive measures, and protocols for response and recovery. In conclusion, a well-structured disaster management plan serves as a crucial tool for businesses and communities, providing a framework for preparedness, response, and continuity in the face of adversity. It emphasizes the importance of proactive measures, clear communication, and collaborative efforts in safeguarding lives and livelihoods during times of crisis.

VI. ACKNOWLEDGMENT

The authors express their sincere gratitude to Prof. Dr. Siddaraju, Head of the Computer Science and Engineering Department, and Vice Principal of Dr. Ambedkar Institute of Technology, for his invaluable guidance and support throughout the course of this work. Special thanks are also extended to Dr. Smitha Shekar B, Assistant Professor at Dr. Ambedkar Institute of Technology, for her insightful comments and contributions. Their expertise and encouragement have been instrumental in shaping this research endeavor.

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