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Disaster Management and Earthquake Prediction System Using Machine Learning

Kavvampelli Nagamani, Kavali Laxmikala, Kalyanam Sreeram, Kampally Eshwar, A.Jitendra, Dr.Prasad Dharnasi

UG Student, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Telangana, India

UG Student, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Telangana, India

UG Student, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Telangana, India

UG Student, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Telangana, India

Associate Professor, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Telangana, India

Professor, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Telangana, India

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ABSTRACT: Natural disasters such as earthquakes cause severe damage to life and property. Early prediction and proper disaster management strategies are essential to reduce risks and improve emergency response. This project, "Disaster Management and Earthquake Prediction System using Machine Learning," aims to develop an intelligent system that can analyze seismic data and predict possible earthquake occurrences using advanced machine learning techniques. The system uses historical earthquake datasets including magnitude, depth, location, and seismic wave patterns to train predictive models such as Logistic Regression, Random Forest, and Artificial Neural Networks (ANN). By analyzing these parameters, the system estimates the probability and intensity of future earthquakes. The proposed solution helps disaster management authorities take preventive measures, issue early warnings, and improve emergency preparedness. The integration of cloud computing ensures scalable data processing and real-time monitoring.

KEYWORDS: Disaster Management, Earthquake Prediction, Machine Learning, Seismic Data, Artificial Neural Networks, Predictive Analytics, Early Warning System, Cloud Computing.

I. INTRODUCTION

Natural disasters are unpredictable events that cause significant damage to human life, infrastructure, and the environment. Among them, earthquakes are one of the most destructive natural calamities. Earthquakes occur due to sudden movements in the Earth's tectonic plates, releasing energy in the form of seismic waves.

Traditional disaster management systems mainly focus on post-disaster response rather than prediction and prevention. These systems lack real-time data analysis and intelligent forecasting capabilities.

With the advancement of Machine Learning and data analytics, it is now possible to analyze large volumes of seismic data to detect hidden patterns and predict potential earthquake occurrences. This project proposes a machine learning-based system that analyzes seismic parameters and provides early warning predictions to support disaster management authorities.

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II. LITERATURE REVIEW

Recent research has focused on applying machine learning techniques to earthquake prediction.
In 2023, R. Kumar proposed a Random Forest-based model to classify earthquake severity using seismic datasets. The model achieved improved prediction accuracy but lacked real-time cloud deployment.
In 2022, S. Patel implemented Artificial Neural Networks (ANN) to predict earthquake magnitude based on seismic wave data. The model showed better pattern recognition capabilities compared to traditional statistical methods.
In 2021, T. Sharma introduced a deep learning-based LSTM model to analyze time-series seismic data. The system captured temporal dependencies effectively but required high computational power.
Earlier studies used statistical models for earthquake prediction, but these models failed to capture complex nonlinear relationships between seismic parameters.
This project improves upon previous research by combining machine learning models with cloud-based deployment for scalable and real-time earthquake prediction.

III. PROBLEM STATEMENT

Earthquakes cause massive destruction and loss of life due to the lack of accurate early prediction systems. Although seismic data is continuously collected from monitoring stations, traditional analysis methods are not sufficient to predict earthquakes with high accuracy.

There is a need for an intelligent system that can analyze seismic data in real-time, identify patterns, and provide early warnings to reduce disaster impact. Hence, this project aims to develop a machine learning-based earthquake prediction and disaster management system

IV. RESEARCH METHODOLOGY

Research Design
This research adopts a quantitative and analytical approach. Historical seismic data is analyzed using machine learning algorithms to build predictive models. The system classifies earthquake probability and magnitude based on seismic parameters..

Data Sources
This research adopts a quantitative and analytical approach. Historical seismic data is analyzed using machine learning algorithms to build predictive models. The system classifies earthquake probability and magnitude based on seismic parameters.

A purposive sampling technique is used to select relevant customer records from the dataset based on the following criteria:
Active subscription history
Availability of churn labels
Complete usage and billing information
Customers from diverse service plans
The selected dataset ensures a balanced representation of churned and retained customers, enabling accurate model training and validation.

3. Sample Selection
In this study, a **purposive sampling technique** is used to select relevant earthquake records from large seismic datasets. The selection is based on specific criteria to ensure data quality and model accuracy.
Selection Criteria: Earthquake records with complete seismic details
Availability of magnitude and depth values
Clearly defined geographic coordinates (latitude & longitude)
Recorded time and date of occurrence
Data from active seismic zones
The dataset is balanced by including:
High magnitude earthquakes
Moderate magnitude earthquakes

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Low magnitude earthquakes
Non-earthquake or low-risk seismic events (for classification)
This ensures that the machine learning model learns from diverse earthquake patterns and improves prediction performance
4.Data Collection Parameters
The following parameters are used:

Category	Parameters
Location Data	Latitude, Longitude
Seismic Data	Magnitude, Depth
Time Data	Date, Time
Geological Data	Tectonic plate information
Target Variable	Earthquake Occurrence (Yes/No)

5. Data Preprocessing
The collected data undergoes preprocessing:
Removal of duplicate records
Handling missing values
Feature scaling and normalization
Encoding categorical data
Splitting dataset into training and testing sets
This improves model performance and prediction accuracy.
6.Engagement Rate Calculation
Machine Learning algorithms used:
Logistic Regression
Random Forest
Support Vector Machine (SVM)
Artificial Neural Networks (ANN)
Performance is evaluated using:
Accuracy
Precision
Recall
F1-Score
The system is implemented using Python with libraries such as:
Pandas
NumPy
Scikit-learn
TensorFlow/Keras
Flask or Stream lit for web interface
Cloud integration enables real-time monitoring and prediction.

V. CONCLUSION

The proposed Disaster Management and Earthquake Prediction System using Machine Learning provides an intelligent solution for early earthquake detection. By analyzing seismic data and applying advanced machine learning algorithms, the system improves prediction accuracy compared to traditional methods.

This project supports disaster management authorities in issuing early warnings, reducing damage, and saving lives. Cloud-based deployment ensures scalability and real-time data analysis for efficient disaster management.

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