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LandSliDer - An Early Warning System for Landslides

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Abstract : A framework to an early warning to the occurrence of landslides is proposed in our project. The framework, in turn, helps to reduce the death toll and loss of other resources. The venture is proposed to recognize the volume of water content in soil, vibrations and developments in soil and subsequently precisely foresee the chance of a landslide event. Sensors are used to distinguish the water content, vibrations and ensuing developments of the soil. The framework comprises three layers: Sensor layer, Edge layer and Cloud layer. The sensor layer collects sensitive data using sensors and sends it to the edge layer. Our system makes use of a machine learning model to improve reliability of predictions. The Edge layer receives the data and makes predictions using an ML model. The cloud layer sends the sensor data along with predictions to the user interface. Based on ML predictions it is possible to alert the people living in landslide prone areas to move to safer zones. We mainly use a buzzer to alert people. It is also possible to make pre monsoon alerts. So it provides a sufficient time gap for evacuation of people in that area.

IndexTerms **- Raspberry PI, Machine Learning, Sensors.**

I. INTRODUCTION

High scopes of Kerala have been an exceptionally alluring objective for farmers because of the profoundly fruitful soil. Farmers fought with the dirt and climate to change over the slopes into high yielding farms. Elastic, Pepper, Cardamom, Cloves, Coco and numerous different items made the existence of the ranchers protected and stable. However, these days during the storm season we see various instances of landslides causing weighty harm to life, resources and climate. The weighty losses occurred because of inaccessibility of opportune cautions.

An early admonition framework for landslide event targets recognizes the purposes behind the event of the avalanches and subsequently to lessen the damage to individuals. Because of focused energy, vibrations break creep into the dirt and rocks hide the dirt. During the blustery season the strain made by the huge volume of water due weighty downpours on these breaks lead to high volume soil and water development downstream making weighty harm to life and resources. Our proposed model identifies the water content, vibrations and development of soil utilising sensors and gives an opportune caution to individuals.

To empower precise forecasts we utilise an ML model which can gather the information gathered by the sensor progressively and make expectations which are exact. Likewise, we plan edge figuring to empower quicker assortment, handling and stockpiling of the constant information expected to refresh the ML model. Raspberry-pi loads are utilised for the on-the-site assortment, handling and expectation of the continuous information. Raspberry-pi along with edge processing innovation can empower the age of profoundly exact landslide information, which can assist with bettering expectations of landslides in future.

II. LITERATURE SURVEY

For the literature survey we have taken 13 papers .The first paper was an Edge assisted Reliable Landslide Early Warning System [1]. This research work presents methods to monitor landslide occurrence in south-east Asian regions.This paper tells the best way to execute solid information handling so that regardless of whether the association between the source/facilitator hub and the cloud server is lost, the information can in any case be handled and input received. The methods used in this paper are IoT Machine Learning.The next paper was a Design of Landslide Early Warning System Using Fuzzy Method Based on Android [2].This research work presents methods to monitor landslide occurrence in Indonesia. The methods used in this paper are fuzzy logic.The next paper was a Mobile App-Based Early Warning System for Landslides Using Land Monitoring Through GSM [3].The methods used in this paper is IoT.The next paper is IoT Based Landslide Detection and Monitoring [4].In the proposed framework, the principal objective is to identify specific circumstances that could prompt the event of avalanches and to inform them a long time before time to restrict, and conceivably save, human misfortunes. An accelerometer and soil dampness sensor are utilized in the framework. The methods used in this paper are IoT.

The next paper is Integrated Earthquake and Landslide Monitoring Over Wireless Sensor Network [5].The methods used in this paper are IoT.The proposed framework is being tried in Imphal,Manipur, India. Another paper is IOT Based Landslide Detection Prevention System [6]. This project illuminates the inhabitants about the forthcoming calamity and works with a more compelling reaction.The next paper is Smart Autonomous Self Powered Wireless Sensor Networks based Low-cost Landslide Detection System [7].In this paper, a minimal expense independent remote sensor network is utilised in the turn of events and execution of a landslide

recognition framework that is coordinated with a self-energy collecting framework (WSN-SEH). The methods used in this paper are the XBee module(IoT).The next paper is Intelligent Early-warning System for Landslides Based on the ZigBee Network [8].A framework for landslides advance notice is proposed in this paper in light of the ZigBee organisation. Cortex-M3 engineering of the chip is used as the installed centre control processor to further develop framework coordination and information handling administrations.The next paper is Research on Application of Temporal GIS Technology in Monitoring Landslide Hazard [9]. This method is used to monitor landslide occurrence in hilly regions.This method uses temporal GIS Technology.Next paper is Landslide-Hazard Mapping Using an Expert System and a GIS [10].In this paper, we depict how to make landslide advance notice and ready guides utilising a standard-based master framework that utilises Earth perception information as well as geographical, precipitation, and quake information to make maps.This paper uses Expert System and a GIS.

Another paper we have taken is Landslide identification using machine learning [11].This paper have has presented machine learning and deep-learning methods to identify landslides.By utilising ML and profound learning procedures, the proposed landslide ID strategy shows extraordinary heartiness and incredible potential in handling the landslide's recognizable proof issue.The next paper is Multi-Regional landslide detection using combined unsupervised and supervised machine learning [12].Presently,there are numerous innovations created for the identification of landslides; however, this has poor geological degrees. So they are wasteful when applied to various geological locales. Final paper we have taken is Landslide detection in the Himalayas using machine Learning algorithms and U-Net [13].Landslide inventories are made in light of manual translation, and there can be massive contrasts in the planning inclinations among mediators. To resolve this issue, we utilised two different datasets to investigate the capability of U-Net and ML approaches for mechanised avalanche location in the Himalayas.

III. PROPOSED SYSTEM

A. System Architecture

LandSliDer is an IoT based landslide monitoring system which consists of data acquisition and analysis unit to predict the occurrence of landslides with various warning levels in near real-time. The proposed Reliable LEWS or LandSliDer enrols edge computing paradigm in its architecture. The sensors' data is transmitted to a edge server. The entire architecture is divided into four layers namely Sensors Layer, Edge Layer, Cloud Layer and User Interface. Sensors Layer is implemented using NodeMCU that collects data from the sensor nodes. The sensor data is sent to the raspberry pi for the processing of the data.The edge layer contains a raspberry pi that receives the sensor data and processes the data with a model file. In this layer, predictions are made based on the sensor data and will activate the local actuator to alert the people.

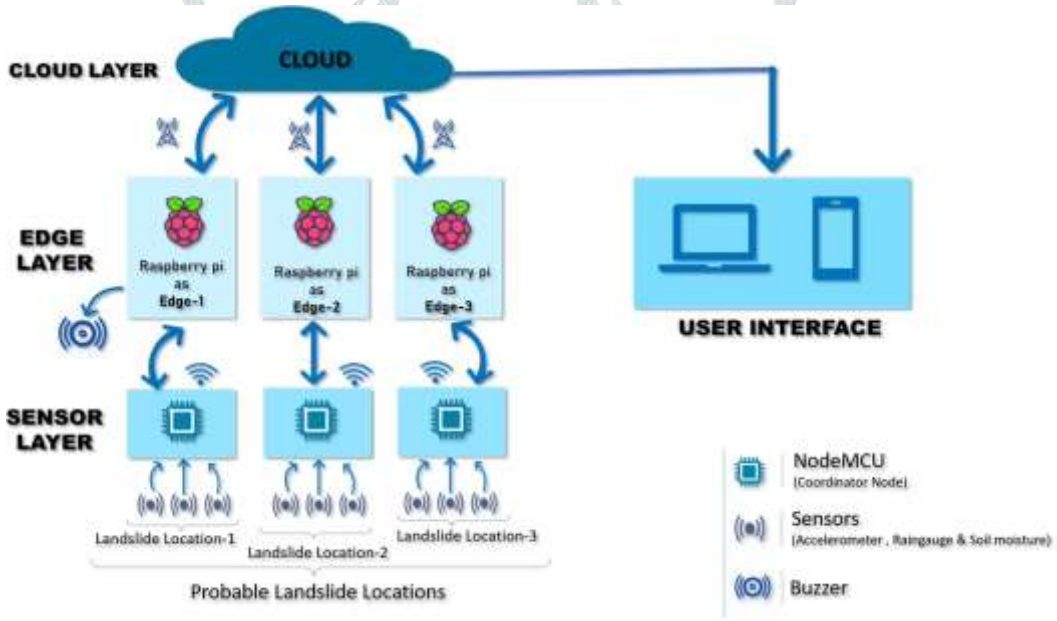

Fig. III.1. *System Architecture*

Now, for delivering warnings to disaster management teams and users.The cloud Layer contains a Firebase that stores the data including the sensor data and prediction results. User Interface, displays the data in the form of a dashboard. It is used for warning people in case of a landslide.

B. Methods and algorithms involved

Artificial intelligence plays a major role in the modern era.Machine Learning is a type of artificial intelligence in which the Landslide Early Warning System mainly works. Machine Learning allows the system application to accurately predict the outcome without directly programming it.

ML predicts or classifies the provided data set. In the Landslide Early Warning System we want to classify the given data set into two classes such as "SAFE" or "DANGER". Cost effectiveness distinguishes this project from others.The data received from a number of sensors are gathered to be processed in raspberry Pi. In a solid case, the real time datas collected from the sensors are divided into training set and test set then it is furnished to classification model thereby to check the accuracy. Moreover, in the Raspberry Pi 3 B+ model, real time processing is not possible. So with the help of a synthetic data set we design a training set. With the support of the training set we define using two algorithms such as SVM (Super Vector Machine) and Naive Bayes for checking the accuracy of both.

SVM is categorized in supervised learning which is primar- ily used for classification problems and produces a decision line called hyperplane which separates the data into classes. Naive Bayes works on bayes' theorem which describes inde- pendence is between predictors. By examining the accuracy, SVM (89 percent) receives the peak value compared to Naive Bayes (80 percent).

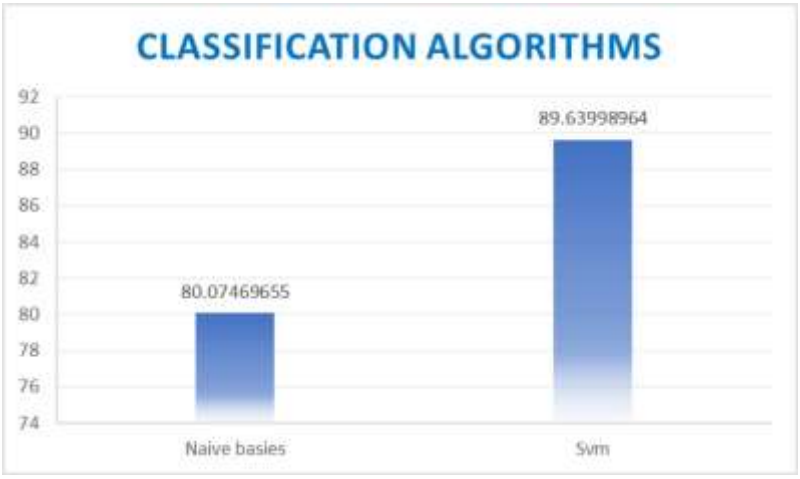

Fig. III.2. Accuracy of Naive Baise and SVM

We proceed with the SVM algorithm for model designing. This model is used to evaluate the test data and classify the given data values into respective classes. This processed data is transferred to a firewall which acts as a database to store huge datasets. This data is retrieved to the dashboard for reference of local authorities,users etc

C. Technologies involved

1. *Machine Learning :* Presently, most of the real time applications are based on ML predictions and classifications. Digital payment, fraud detection, and face identification are some of the applications of Machine Learning. ML is classified into 3 groups
   - Supervised learning
   - Unsupervised learning
   - Reinforcement learning

   Machine learning algorithms are the key aspects of ML. KNN, decision tree, SVM, Linear Regression, Naive Bayes, Logistic Regression etc are some of the algorithms.
2. *Internet of Things (IoT) :* The Internet of Things (IoT) portrays the organization of actual items that are inserted with sensors, programming, and different advancements to interface and trading information with different gadgets and frameworks over the web.

IV. EXPERIMENTAL SETUP AND RESULTS

A. Experimental setup

LandSliDer - An Early Warning System for Landslides uses machine learning. Machine Learning allows the system application to accurately predict the outcome without directly programming it. The ML model in LandSliDer receives the live input from the sensors, classifying them as susceptible for landslide or not. The LandSliDer system classification falls into either of the two classes "SAFE" or "DANGER" representing no landslide condition and landslide condition respectively.

The data received from a number of sensors are gathered to be processed in raspberry Pi. The real time datas collected from the sensors are divided into training set and test set then it is furnished to classification model thereby to check the accuracy. The ML model for LandSliDer was trained using synthetic data. To choose the training algorithm for the model, two classification algorithms namely SVM (Support Vector Machine) and Naive Bayes classifier were chosen. SVM gave a better accuracy compared to Naive Bayes classifier, hence SVM was selected for building the LandSliDer model.

We proceed with the SVM algorithm for model design- ing. This model is used to evaluate the test data and classify the given data values into respective classes. This processed data is transferred to firebase which acts as a database to store huge datas. This data is retrieved to the dashboard for reference of local authorities,users etc.

We have used a synthetic dataset as the real dataset for landslide could not be identified. Our synthetic dataset makes use of slope, moisture content and vibration as the features. The dataset was generated based on our literature survey. The dataset has been generated to incorporate all possible ranges of slope, moisture , vibrations which in turn result in different landslide situations.

rainfall	vibration	moisture	status
37	0.0001	70	0
37	0.0001	75	0
37	0.0001	80	0
37	0.0001	85	0
37	0.0001	90	0
37	0.0001	95	0
37	0.0001	100	0
37	0.0009	0	1
37	0.0009	10	1
37	0.0009	15	1
37	0.0009	16	1
37	0.0009	17	1
37	0.0009	20	1
37	0.0009	23	1
37	0.0009	25	0
37	0.0009	30	0
37	0.0009	32	0

Fig. IV.1. *Dataset*

B. Results

Based on the synthetic dataset we trained the algorithm to generate a model file. The model file makes predictions based on the input sensor readings. The predictions help to alert people in that locality. The classification of input data into two classes, Safe and Danger. Here ’1’ stands for Safe and ’0’ stands for Danger in the above predictions results. The results are displayed on the dashboard on a real-time basis. It includes sensor data as well as the prediction results are displayed. Through a GSM module, we can also alert the local authorities as well as the disaster management teams through SMS about the landslide information. It will help in quick evacuation of people from that landslide prone areas

Fig. IV.2. *ML Predictions*

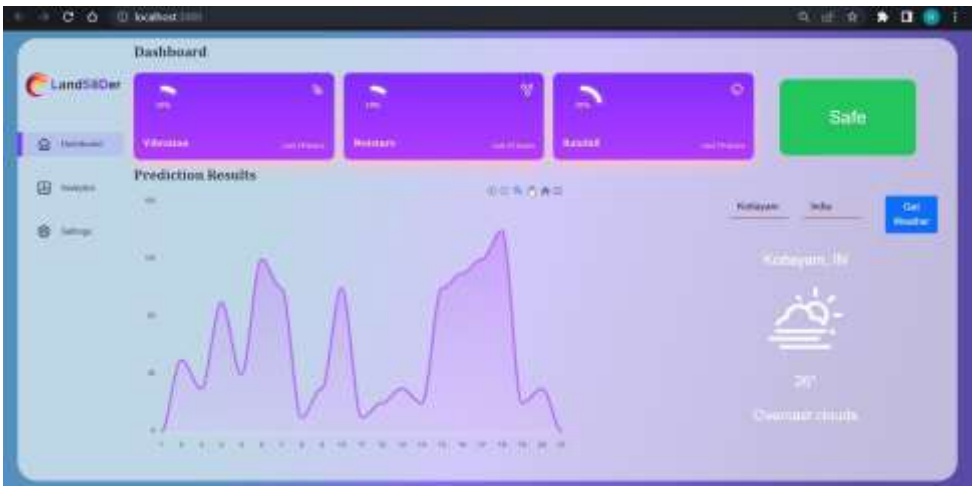

Fig. IV.3. *Safe Prediction*

The implementation setup for our project contains hard- wares including accelerometer, Rain sensor, Soil moisture Sensor, mcp3008(ADC), Raspberry PI 3B+ etc. The raspberry pi act as an edge server in collecting of input data and makes predictions with an ML model. Sufficent power is provided for the raspberry pi and sensors.

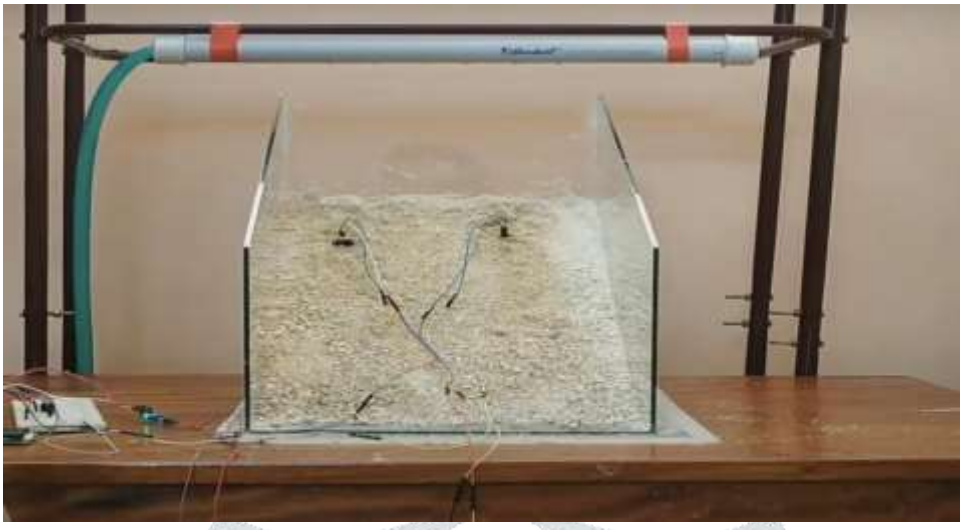

Fig. IV.4. *Implementation Setup*

V. CONCLUSION

Landslides make significant harm to environment and hu- man life.A landslide recognition framework is proposed in this undertaking that makes individuals aware of move to more secure zones.The sensors actually sense the encompassing cir- cumstances and gives continuous values.Based on this values alert is given.The framework works in three significant layers Sensor Layer,Edge layer and Cloud layer.The checking of the framework is empowered through a dashboard.The system is supposed to give a practical and productive component to caution event of landslides.

In spite of the fact that we accomplished promising outcomes in this review, more landslide and non-landslide sec- tions are required to increase the reliability and performance of the system. This can be viewed as the significant limitation of our review, which can be eased in future by adding more information to the landslide dataset that we made. The restrictions and arrangements examined above are subject of our future investigations.

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