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Earthquake Prediction Using AIML and Landslide Detection Using IoT

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Abstract : Landslides and earthquakes are the most dangerous natural hazards that cause damage to people's lives and their belongings and one of the primary causes of landslides seems to be heavy rainfall and earthquakes. This project aims to develop a system that helps identify the earthquake-prone areas using the K-Means machine learning algorithm and then place an IoT system used to detect landslides. The IoT system consists of a soil moisture sensor and accelerometer, we use a data set provided by the Kaggle website to identify the earthquake-prone areas and implement the IoT system to monitor the landslide activities and we use the data generated by the sensor to warn the people in the locality whenever there is a chance of landslide occurrence, as a result, this project is helpful to save people's lives and properties.

Keywords - Earthquake, IoT, landslide, sensor.

I. Introduction

Landslides are caused by the movement of huge masses of rocks and other soil materials down the slope due to heavy rainfall, earthquake, volcanic activity, or disturbance caused by human activities. Earthquakes are caused when tectonic plates hit or slide past one another, the surface where the plate slip is called the fault and the place where the earth originate is called the hypocenter. This project is mainly focused on the Indian region where these natural hazards occur. The Strongest earthquake that happened in India was on 08/15/1950 nearly 1530 people died and about 58% of land in India is prone to earthquakes of moderate to very high intensity. Nearly 12% of land in India is prone to landslides and according to a study conducted by National Crime Records Bureau in 2019, 264 Indians died in landslides and over 65% of death happened in Western Ghats and Himalayas. The approach of this project is to identify the areas where this natural hazard occurs and implement a warning system. With the help of this system, many lives and properties can be saved.

Since earthquakes and landslides have a massive impact on the social and economic state of the country many studies have been conducted to predict and detect the natural hazards. Many studies have been conducted to detect landslides using IoT technologies using various sensors like optical sensors which are used to multiplex various sensors through the same fiber to detect earthquakes, landslides, and floods, and have used artificial intelligence along with the IoT sensors and used the cloud to store the data generated by the sensors, And studies have been done to predict earthquake by applying radial base functions and artificial intelligence and machine learning algorithms on real-time data and data generated by laboratory experiments to alert the population and disaster management authorities.

II. Methodology

2.1. ML prediction for earthquake-prone areas

The dataset consists of earthquakes in India taken from Kaggle.com and loaded into a pandas data frame object. Then the Origin time is refactored to pandas Date Time object and the place of occurrence is extracted from within the dataset. Then the data is visualized using the KeplerGl module. The data frame is later preprocessed to avoid inconsistencies like whitespaces, punctuations, and aliases, and a unique array of all the states is generated. A graph of states vs. several occurrences is plotted. To apply the K-Means algorithm the 3 features considered are namely longitude, latitude, and magnitude of earthquake occurrences. A graph is plotted based on the clustered output from the Kmeans algorithm along with Voronoi diagrams. Another graph consisting of cluster values plotted against occurrences is plotted. Now, focusing on individual clusters 3 different graphs are plotted for each year namely 2019,2020, and 2021. Each graph consists of magnitude plotted against the occurrence.

2.2. IoT LANDSLIDE DETECTION SETUP

2.2.1. COMPONENTS REQUIRED

1. Arduino Board
2. Soil moisture sensor
3. ADXL345 Accelerometer
4. ESP8266 Wi-Fi module

2.2.2. ARDUINO BOARD

Arduino Board shown in **fig1** contains an Atmel Atmega328P microcontroller with 1KB of EEPROM, 32KB of flash memory, and 2KB of SRAM for data. The power to Arduino Board is supplied through a USB connector 5V, DC power jack 7-12V, or 9V battery. The Board supplies 3.3V and 5V for powering external components. Arduino IDE is the software used for writing the code and uploading the code to the Arduino Board.

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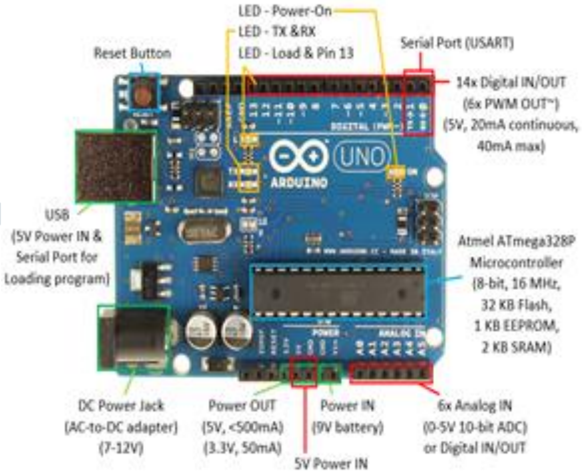

Figure 1: Arduino Board

2.2.3. SOIL MOISTURE SENSOR

The soil moisture sensor in **fig2** operates under 3.3V to 5V and provides Analog as well as digital outputs. Soil moisture sensors are used to detect moisture content in the water. Many soil moisture sensors have variable resistor which is used to detect the moisture content in the soil. Variable resistors are those whose resistance values keep on varying and depend upon environmental factors. As the water content increase in soil and since water is a very good conductor of electricity the resistance value decreases and thereby indicating the moisture content of the soil.

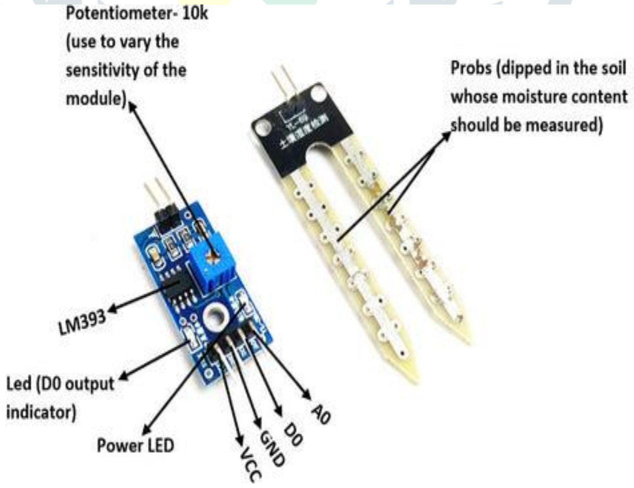

Figure 2: Soil Moisture Sensor

2.2.4. ADXL345 ACCELEROMETER

ADXL345 Accelerometer shown in figure 3 is used to measure acceleration on 3 axes, it operates under 3.3V to 5V and while the sensor is in the stable position it will only measure the standard acceleration i.e. acceleration due to gravity. The accelerometer consists of moving and fixed plates. When the force is applied to the sensor the capacitance between the fixed and moving plates changes which results in sensor output voltage which is proportional to the acceleration on three different axes.

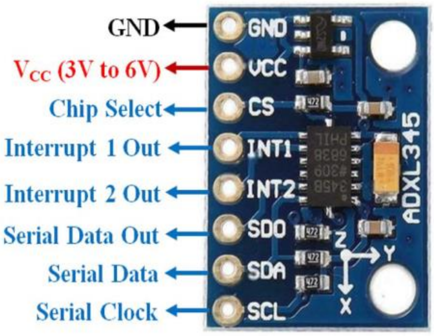

Figure 3: Accelerometer

2.2.5. ESP8266 Wi-Fi Module

The ESP8266 Wi-Fi module **fig4** is integrated with TCP/IP protocol which gives the microcontroller to access the Wi-Fi network. This module allows us to integrate with other sensors through GPIO pins. It also supports Bluetooth co-existence interface and APSD for VoIP.

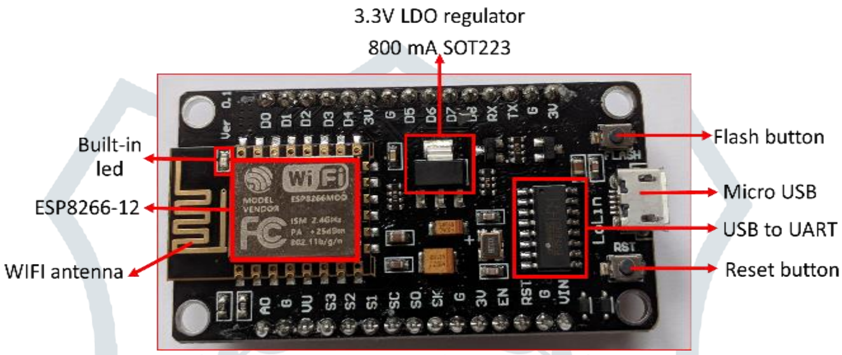

Figure 4: Wi-Fi Module

III. Implementation

K-means clustering is a method of vector quantization, originally from signal processing that aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean (cluster centers or cluster centroid), serving as a prototype of the cluster. This results in a partitioning of the data space into Voronoi cells. K-means clustering minimizes within-cluster variances (squared Euclidean distances), but not regular Euclidean distances, which would be the more difficult Weber problem: the mean optimizes squared errors, whereas only the geometric median minimizes Euclidean distances. For instance, better Euclidean solutions can be found using k-medians and k-medoids. In this work, K-Means is used to cluster earthquake-prone areas into sectors and give a result of the number of earthquake occurrences in a particular sector as shown in Fig. 5 and Fig. 6. The parameters/ features used for K-Means clustering are longitude, latitude, and Magnitude and show the occurrences of the earth in a particular region of the country, and the above parameters are used to determine the result.

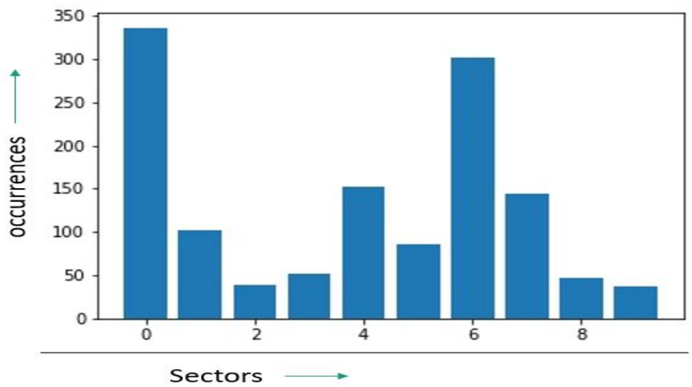

Figure 5: Analysis of earthquake (sector-wise)

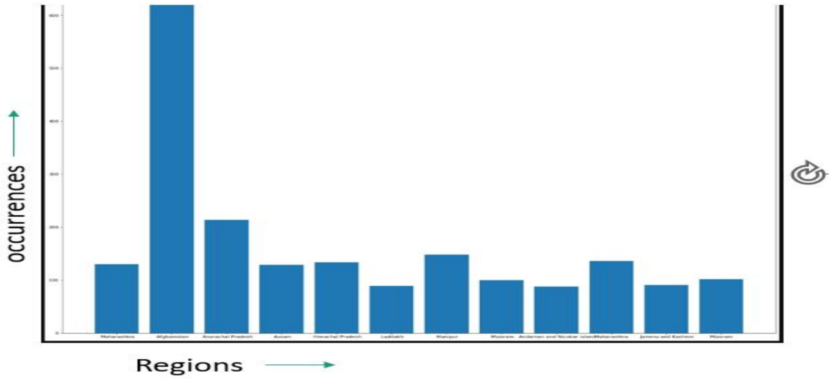

Figure 6: Analysis of earthquake (region-wise)

The landslide detection model shown in Fig. 7 mainly involves two sensors i.e. soil moisture sensor Fig. 8 and the ADXL345 accelerometer sensor (Fig. 9). The soil moisture sensor is to check the moisture content of the soil and the accelerometer is used to detect any movement in the soil. The data that is collected by the sensor is uploaded into the Thing Speak IoT platform where the data are analyzed and using the Thing Speak react app we can trigger a warning message when certain threshold values cross, by using this approach we can warn the people of the locality where this system is implemented during this natural hazard. Fig 8 shows the drop when the moisture content increase in the soil and Fig 9 varies when there is a movement in the soil.

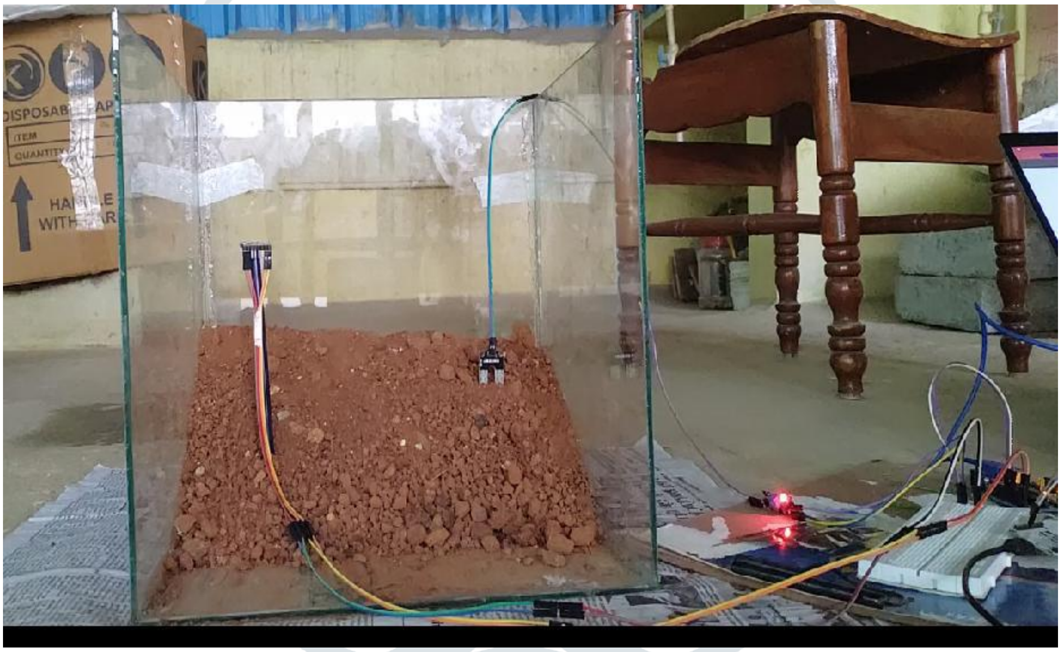

Figure 7: Landslide detection model

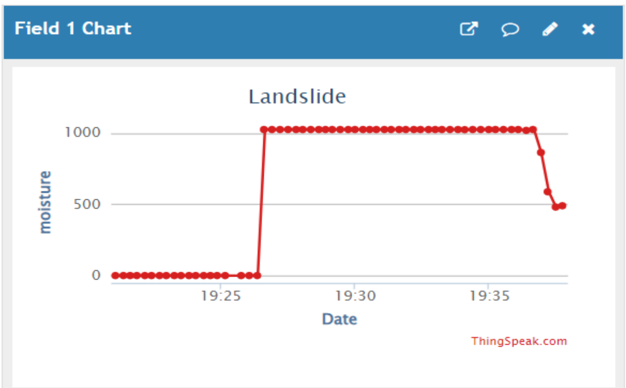

Figure 8: Soil moisture data

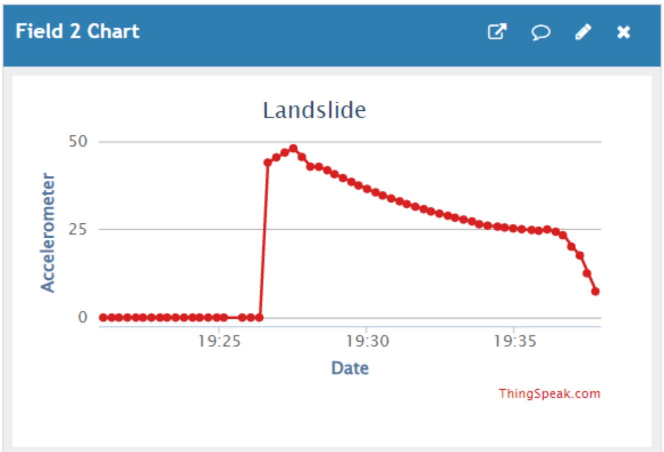

Figure 9: Accelerometer data

IV. CONCLUSION

With this implementation, we can cluster high-density Earthquake-prone areas and analyze their consistent occurrences where the IoT components can be installed. and with the help of the Thing Speak IoT analytics platform, we can analyze the data generated by the sensors, and once it crosses the threshold value i.e. when moisture content rises about 70% and movement greater than 5 degrees in the accelerometer a warning message is generated using Thing Speak react which works with ThingHTTP to trigger a message.

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