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Class : D6

IoT based landslide prediction and prevention

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Understanding the problem statement :

A landslide is the movement of rock, earth, or debris down a sloped section of land. Landslides are caused by rain, earthquakes, volcanoes, or other factors that make the slope unstable. Geologists, scientists who study the physical formations of the Earth, sometimes describe landslides as one type of mass wasting. A mass wasting is any downward movement in which the Earth's surface is worn away. Near populated areas, landslides present major hazards to people and property. Landslides cause an estimated 25 to 50 deaths and $3.5 billion in damage each year in the United States.

Causes : Landslides have three major causes: geology, morphology, and human activity.

Geology refers to characteristics of the material itself. The earth or rock might be weak or fractured, or different layers may have different strengths and stiffness.

Morphology refers to the structure of the land. For example, slopes that lose their vegetation to fire or drought are more vulnerable to landslides. Vegetation holds soil in place, and without the root systems of trees, bushes, and other plants, the land is more likely to slide away.

Human activity, such as agriculture and construction, can increase the risk of a landslide. Irrigation, deforestation, excavation, and water leakage are some of the common activities that can help destabilize, or weaken, a slope.

Effects : The impact of a landslide can be extensive, including loss of life, destruction of infrastructure, damage to land and loss of natural resources. Landslide material can also block rivers and increase the risk of floods. Deep landslides, triggered by major earthquakes or volcanic activity can destroy thousands of square kilometres of land and kill thousands of people. Landslides have a devastating effect on farmers' livelihoods as they can prevent access to land for years, destroy seed and food stocks and will commonly result in the loss of livestock and standing crops.

Review of Literature :

As stated by J. K. Eknath, N. A. Dashrath, S. V. Pandurang, and R. S. Dinkar in IOT based Landslide Detection & Prevention System: Semantic Scholar published on 01-Jan-1970 [1], a Landslide , also known as a landslip , is a geological phenomenon that includes a wide range of ground movements. Monitoring is essential to predicting the behaviour of landslides and forecasting which storms can trigger large numbers of landslides. This can help save a number of lives and prevent loss of life and property as people will be aware of the upcoming danger and can take necessary steps for safety. Network of IoT is used in the project that helps updating the information about landslides on the internet. A Moisture sensor and Vibration Sensor are employed that detects landslides as some critical value will be set for these sensors, if value exceeds these critical values the people will be notified about the forthcoming landslide and huge loss can be prevented.

As briefly explained by Pawar, Pitambar & Patil, Akshay & Rathod, Hardik & Hadale, Ravi & Kharche, Shubhangi in IoT Based Landslide Detection and Monitoring [2], the system consists of sensor nodes, controller at the landslide site and raspberry pi at the monitoring station. Usually several sensor nodes are needed to cover a certain area. All these sensors collect the landslide monitoring parameters such as landslide displacement, soil moisture, and tilt angle. The proposed system uses soil moisture sensors operating on 3.3V to 5V. The accelerometer used for vibration sensing (slope displacement measurement) is ADXL335 which contains a polysilicon surface-micro machined sensor and signal conditioning circuitry.The collected data from the sensors is given to the controller through multiplexer CD4051B. This is done because the controller used here is NodeMCU which has only one analog input pin and in-build Wi- Fi module which is required for transmission of data towards the monitoring station. The entire data range is divided in three classes; SAFE zone, MIDDLE zone and DANGER zone. Alert is given for the MIDDLE and DANGER zone.

Componentes Used :

Hardware :

1. Moisture Sensor : (Input Range : 3.3V to 5V ; Output Range : 0V to 5V)
   A small charge is placed on the electrodes and electrical resistance through the sensor is measured. During heavy rainfall the soil moisture increases, more water is supplied to the sensor and resistance decreases. Conversely, as soil moisture decreases, resistance increases.
2. Vibration Sensor(SW-420) : (Detection distance 760 nm – 1100 nm)
   A vibration sensor is a device that measures the amount and frequency of vibration in a given system, machine, or piece of equipment. During no vibration, the sensor provides Logic Low and when the vibration is detected, the sensor provides Logic High.
3. Accelerometer (ADXL335) : (±3 g measurement range)
   An accelerometer is a sensor that measures the dynamic acceleration of a physical device as a voltage.
4. NodeMCU Microconroller
5. Arduino Uno
6. Buzzers, LEDs for output detection

Software :

1. Proteus Design Suit
2. Arduino IDE
3. Python

Additions & Updates : The proposed system uses an 8-bit multiplexer, considering this, approximately 188 multiplexers and NodeMCU's are required to cover the 1000 sq.ft. If the system uses a 16-bit multiplexer, then approximately 94 multiplexers and NodeMCU would be required. As the system uses raspberry pi at the monitoring center, machine learning can be implemented in the system through python programming in future work.

Applications, Advantages & Challenges :

Applications : Used in areas where landslides occur frequently like in hilly or mountainous landscapes, along coastlines and river valleys.

Advantages : The early warning system uses thresholds for soil moisture and water supply from rain and snowmelt to issue warnings to the public and relevant authorities when the risk for landslide hazard is present. IOT based networks detect the slightest movements of ground or slope instability due to the several reasons such as dielectric moisture, pore pressure and so on that may occur during a landslide.

Conclusion : The sensors effectively sense the surrounding conditions and give the readings. Based on readings, the prediction of landslide is achieved successfully. The system senses data and transmits it continuously. When NodeMCU tries to connect with Wi-F it consumes 1.6 Watt (i.e. 320mA current is drawn with 5V supply voltage) and when NodeMCU gets connected to Wi-fi and sends data it consumes 0.49 Watt (i.e. 98mA current at 5V supply voltage). To minimize power consumption and increase the battery backup, the NodeMCU can be operated in duty-cycled mode.In order to cover a large area, say 1000 sq. ft. , approximately 375 nodes are required where one node consists of one soil moisture and one accelerometer.

References :

[1] J. K. Eknath, N. A. Dashrath, S. V. Pandurang, and R. S. Dinkar, "IOT based Landslide Detection & Prevention System: Semantic Scholar," *undefined*, 01-Jan-1970. [Online]. Available: <https://www.semanticscholar.org/paper/IOT-based-Landslide-Detection-%26-Prevention-System-Eknath-Dashrath/22a8c36fa76f2094edb0960594a0837355b956b5#citing-papers>.

[2] Pawar, Pitambar & Patil, Akshay & Rathod, Hardik & Hadale, Ravi & Kharche, Shubhangi. (2019). IoT Based Landslide Detection and Monitoring.