APPLICATION OF ARDUINO SENSORS FOR MOISTURE DETECTION AS AN EARLY WARNING SYSTEM FOR RAINFALL-INDUCED LANDSLIDE

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Introduction:

Landslides are the flow of soil mass down a slope, which may lead to serious death and property loss. Most steep terrains are becoming urbanized as a result of population growth, because in similar conditions, the risk of landslides is rising globally, prompting researchers to investigate the causes and mitigation of landslides.

A warning system that includes sensors, event detection, and decision subsystems for early hazard identification is known as an early warning system. It can be implemented as a network of information communication systems. In order to foresee and alert disturbances that have a negative influence on the stability of the physical world, researchers collaborate. This gives the response system time to get ready for the disruption and lessen its effects. The geotechnical engineer's task is to develop safe and cost-effective designs for structures like embankments, earth dams, excavation and soil piles, landfills, etc. The factor of protection can be used to determine the relationship between the sliding mass's shear stress and the soil's shear strength (FOS). When FOS exceeds 1, driving force is less than resisting force, which is regarded as stable. Resisting force equals driving force if FOS is equal to 1, which is a limit equilibrium condition. If FOS is less than 1, the slope will collapse if resisting force is smaller than driving force. In this work, an effort is made to create a laboratory-scale early warning system using soil from the Choral Ghat location, which is 800 meters above sea level and located on the borders of Goa, Karnataka, and Maharashtra. Choral Ghat is a component of the Western Ghats in the Sahyadri mountain range. For both models created in labs, further numerical analysis of the slope vulnerable to rainwater infiltration will be done.

Objectives:

1. To check the possibility of this sensor to work as an early warning system for slope failure (particularly Landslides).
2. To build a system (model) that can monitor water content in soil present on slope.

3. To study the landslide detection to prevent the natural calamity by detecting its early movement and this will reduce or save the human loss caused by the landslide.
4. To use the programming language to monitor the rainfall data.

Methodology:

- A prototype that stimulate actual landslide effect as in real life condition.
- We collect the soil (Landslide affected) from the hilly slopes
- To know about the properties or behavior of the soil, we basically perform tests on soil by two methods i.e., in-situ and laboratory tests depending on where the tests are performed.
- Fill the glass frame with soil we collected and set the frame based on the slope criteria.
- Now we can create an artificial rainfall system.
- This is the setup at which we have connected 1-inch pipes and submerged water pumps.
- Marking of level of water.
- It will be controlled by Arduino module with ATmega328 microcontroller type.
- Now connecting the soil moisture sensor to the slope then warning system is connected to it.
- The sensor i.e., Soil Moisture Sensor is used to detect the Percentage of water content in the soil.
- Supply of water through the artificial rain is provided to slope.
- Once the experiment start the warning system gets activated.
- When the system reaches its limit, the LED & buzzer turn
- Failure of slope will occur. Moisture content at failure is recorded on the LED display.
- Warning Levels are given by LED indications to provide SAFE levels, ALERT levels and HAZARD Levels.
- HAZARD level will be added alarm as a sign of Potential Landslide occurs.
- Spontaneous movement for ground shifts will be directly indicated as the highest level of danger so that the Alarm will immediately sound.

Results and Conclusions:

.EXPECTED OUTCOME

BEHAVIOUR/STATE	READING SOIL MOISTURE	READING TILT SENSOR	MESSAGE	BUZZER
BELOW THE LIQUID LIMIT OF SOIL			SAFE	OFF
			SAFE	OFF
AT LIQUID LIMIT OF SOIL			ALERT	ON
			ALERT	ON
ABOVE THE LIQUID LIMIT			DANGER	ON
			DANGER	ON

Innovation Of the Project:

There are also various direct methods of preventing landslides; these include modifying slope geometry, using chemical agents to reinforce slope material, installing structures such as piles and retaining walls, grouting rock joints and fissures, diverting debris pathways, and rerouting surface and underwater drainage.

Scope:

Analyzing soil slope instability due to rainfall necessitates a thorough site characterization, encompassing soil properties, slope geometry, groundwater table, and rainfall patterns. This data forms the foundation for subsequent analyses. Employing limit equilibrium analysis, potential failure surfaces are identified and the factor of safety is calculated by comparing resisting forces to driving forces. Concurrently, partial numerical modeling is utilized to simulate rainfall infiltration and pore water pressure distribution within the slope. Numerical methods such as finite element or finite difference analysis are applied to model rainfall infiltration, considering soil hydraulic properties and boundary conditions. The resultant rise in pore water pressure due to rainfall infiltration is analyzed to evaluate its impact on slope stability over time. Integrating these analyses offers a holistic understanding of rainfall-induced slope instability, aiding in informed decision-making regarding slope design and risk mitigation strategies.

References:

1. barasu K 2010Rainfall thresholds for the initiation of landslide at Lanta Khola in north Sikkim India Natural hazards Jan 152(1)31-42 Keefer DK Landslides caused by earthquakes. Geological Society of America Bulletin. 1984 Apr 1 95(4)406-21

2. Malamud BD, Turcotte DL, Guzzetti F and Reichenbach P 2004 Landslides, earthquakes, and erosion. Earth and Planetary Science Letters Dec 30229

3. Collins BD and Znidarcic D2004Stability analyses of rainfall induced landslides Journal of geotechnical and geoenvironmental engineering Apr130(4)362-72

4. Tsaparas I, Rahardjo H, Toll DG and Leong EC2002Controlling parameters for rainfall-induced landslides Computers and geotechnics Jan 1 29(1)1-27

5. Wang G and Sassa K 2003Pore-pressure generation and movement of rainfall-induced landslides: effects of grain size and fine-particle content Engineering geology Apr 1 69(1-2)109-25

6. Chandrasekaran SS, Owaise RS, Ashwin S, Jain RM, Prasanth S and Venugopalan RB2013 Investigation on infrastructural damages by rainfall-induced landslides during November 2009 in Nilgiris India Natural hazards

Feb 1 65(3)1535-57

7. Nthinkumar V, Chandrasekaran SS and Maji VB 2018Rainfall-induced landslides: case study of the Marappalam landslide Nilgiris District Tamil Nadu India International Journal of Geomechanics18(9)05018006

8. Dikshit A, Sarkar R, Pradhan B, Segoni S and Alamri AM 2020 Rainfall induced landslide studies in Indian Himalayan region: A critical review Applied Sciences Jan10(7)2466