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Surveillance System Powered by Internet of Things for Possible Mass Waste

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ABSTRACT: A landslide is movement of a mass of rock, debris, or earth down a slope. Continuous improvement and work on remaining problems is continuing and will be approached in the near future. By applying machine learning accuracy can be increased. In the future, this work will be extended to a full deployment with increased spatial variability. Field experiment will be conducted to determine the effects of density of the nodes, vegetation, and location of sensors for detecting rainfall induced landslides, that may help in the development of low cost system. Machine learning can be implemented in the system through python programming in future work. In monsoons the rain water percolates and develops hydraulic pressure which exceeds the elastic limit of the soil or rocks. Landslide detection can be done by using diverse methods like visual inspection using image/video processing, satellite remote sensing, using statistical methods or using machine learning algorithms. Landslide detection can also be based on data driven approaches using wireless sensor networks (WSN). The main objective to study the landslide detection is to prevent the natural calamity by detecting its early movement.

KEYWORDS: Internet of Things; wireless sensor networks; smart city; wasteland management

I. INTRODUCTION

A landslide is movement of a mass of rock, debris, or earth down a slope. In monsoons the rain water percolates and develops hydraulic pressure which exceeds the elastic limit of the soil or rocks. Due to this the strain gets accumulated which forces the soil and rocks to loosen their adhesive strengths entailing landslides [1]. Landslides can also be said of "Mass Wasting", which refers to any down slope movement of soil and rock due to gravity. It causes property damage, injury and death. Also, it adversely affects a variety of resources such as Water supplies, fisheries, dams and roadways for years after a slide event. The landslides occur when the slope changes from a stable to an unstable condition. This change in the stability of a slope can be caused by many factors together or alone. The natural causes, such as, ground water pressure acting to destabilize the slope, erosion at the bottom of a slope by rivers or ocean waves, earthquakes adding loads to barely stable slope, earthquake caused liquefaction destabilizing slopes.

The manmade causes such as, deforestation and construction which destabilizes the already fragile slopes, vibrations from machinery or traffic. Landslides occur in rocky mountainous regions like Himalayas, konkan railways [2], lonavala Ghats and marshy regions of Kerala in India. Landslides are hazards all over the world. Hillsides with steep slopes are prone to landslides. In the last few years Kerala also faced the loss of human landslide. Mainly landslide season in Kerala starts with the onset of the south-west monsoon every year. Landslides include debris flows, rock slides and mud slips. Apart from claiming human lives it destroys hills and vast tracts of agricultural lands, buildings, roads, economic and infrastructure.

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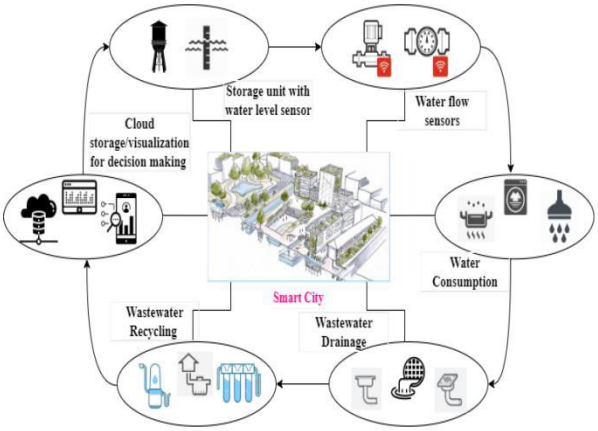

Fig 1: IOT based Waste management

Researchers are still doing different case studies on landslide prediction, detection and monitoring. Landslide detection can be done by using diverse methods like visual inspection using image processing [3], digital aerial photographs [4], and laser projector [5], using statistical methods. Landslide detection can also be based on data driven approaches using wireless sensor networks (WSN) [6]. The main objective to study the landslide detection is to prevent the natural calamity by detecting its early movement and this will reduce or save the human loss caused by the landslide. Also, the objective is to find a certain way in which the sensing elements should respond quickly to rapid changes of data and send this sensed data to data analysis center. The proposed Internet of things (IoT) based landslide detection and monitoring system is a low cost, robust and delay efficient.

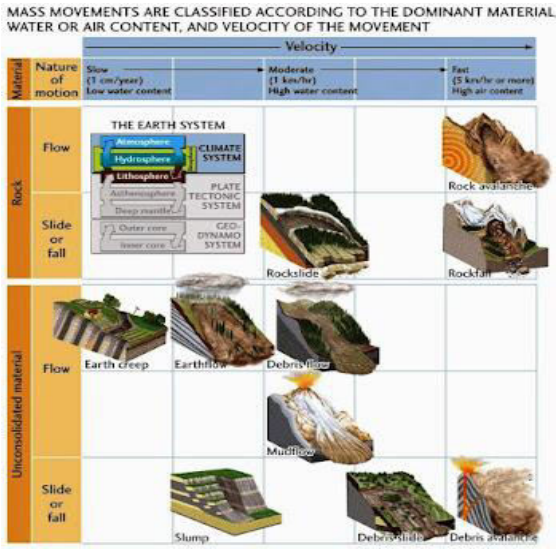

Fig 2: types of land slides

A landslide is movement of a mass of rock, debris, or earth down a slope. In monsoons the rain water percolates and develops hydraulic pressure which exceeds the elastic limit of the soil or rocks. Due to this the strain gets accumulated which forces the soil and rocks to loosen their adhesive strengths entailing landslides. Landslides destroy agricultural/forest lands, road transports, destroys earth's natural environment as a whole causing great loss to life. Landslides can also be said of "Mass Wasting", which refers to any down slope movement of soil and rock due to gravity. It causes property damage, injury and death. Also, it adversely affects a variety of resources such as water supplies, fisheries, sewage disposal systems, dams and roadways for years after a slide event. The landslides occur when the slope changes from a stable to an unstable condition. This change in the stability of a slope can be caused by many factors together or alone. The Natural causes, such as, ground water pressure acting to destabilize the slope,

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erosion at the bottom of a slope by rivers or ocean waves, earthquakes adding loads to barely stable slope, earthquake caused liquefaction destabilizing slopes. The Manmade causes, such as, deforestation, cultivation and construction which destabilizes the already fragile slopes, vibrations from machinery or traffic. Rock avalanches, debris flows, soil movement, mud flows are the various forms of landslide.

II. SURVEY

Landslides occur in rocky mountainous regions like Himalayas, konkan railways, lonavalaghats and marshy regions of kerala in India. Lanslides are hazards all over the world. Hillsides with steep slopes are prone to landslides. Landslide prediction, detection and monitoring have been done by researchers for different case studies all over the world. Landslide detection can be done by using diverse methods like visual inspection using image/video processing, satellite remote sensing, using statistical methods or using machine learning algorithms. Landslide detection can also be based on data driven approaches using wireless sensor networks (WSN). The main objective to study the landslide detection is to prevent the natural calamity by detecting its early movement. This will reduce or save the human loss caused by the landslide. Also, the objective is to find a certain way in which the sensing elements should respond quickly to rapid changes of data and send this sensed data to data analysis center. The proposed WSN/Internet of things (IoT) based landslide detection and monitoring system is a low cost, robust and delay efficient.

The landslide detection system is successfully implemented as a prototype. All the sensors and other stuff works as per the expectations. 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 Wi-Fi tries to connect with Wi-Fi it consumes 1.6 Watt (i.e. 320mA current is drawn with 3.3V supply voltage) and when NodeMCU gets connected to Wi-fi and sends data it consumes 0.49 Watt (i.e.98mA current at 3.3V supply voltage). To minimize power consumption and increase the battery backup, the NodeMCU can be operated in duty-cycled mode. The system takes 10 ms time to collect data from sensor and transmit it to microcontroller, additional 10 sec time is required to upload data from microcontroller to ThingSpeak cloud. In order to cover large area, say 1000 sq. ft., approximately 375 nodes are required where one node consist of one soil moisture and one accelerometer. The proposed system uses 8-bit multiplexer, considering this, approximately 188 multiplexers and NodeMCU's are required to cover the aforementioned area. If the system uses 16-bit multiplexer, then approximately 94 multiplexers and NodeMCU's 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. We can use the same technique for iot based automatic dam level monitor and control system. By just replacing input single soil moisture sensor with float type multiple float sensors to acknowledge water level in dam. If level is full or overflow automatic controller door opens and water flows to decrease water level in dam. Microcontroller commands to wi-fi module to upload dam water level to the server. Graphical data shows on thing spak server to represent the water level. This type of project can be used in automatic irrigation systems to view the agricultural parameters in graphical format on things speak server and control the automation parameter like automatic watering system, automatic waterlevel controlling system.

III. METHODS

The soil moisture sensor [7] and accelerometer sensor [8] which measure movement of land and moisture content in the soil. The collected data from the sensors is given to the microcontroller through Arduino Nano. The controller accepts the data from sensor nodes. If these sensed data cross threshold values, it gives an alert to local citizens by using the GSM. Apart from giving alerts to the local citizens, controller also transmits all the sensed data towards the monitoring station. The sensed data are also transmitted from NodeMCU to the Raspberry Pi (Rpi) used in the control room via MQTT protocol. The Raspberry pi is interfaced with a laptop to display the SAFE, MIDDLE and DANGER zones. All the readings from Rpi are also uploaded on IoT cloud to analyze them and give alert to the rescue team. Soil moisture sensor measures the volumetric water content in the soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. An accelerometer is a device that measures proper acceleration. Proper acceleration, being the acceleration (or rate of change of velocity) of a body in its own instantaneous rest frame, is not the same as coordinate acceleration, being the acceleration in a fixed coordinate system. ADXL335 is used, it is a triple axis accelerometer with extremely low noise and power consumption. It measures acceleration within range ±3 g in the x, y and z axis. The output signals of this module are analog voltages that are proportional to the acceleration. It contains a polysilicon surface-micro machined sensor and signal conditioning circuit. This structure is suspended by

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polysilicon springs. It allows the structure to deflect at the time when the acceleration is applied on the particular axis. Due to deflection the capacitance between fixed plates and plates attached to the suspended structure is changed. This change in capacitance is proportional to the acceleration on that axis. The sensor processes this change in capacitance and converts it into an analog output voltage.

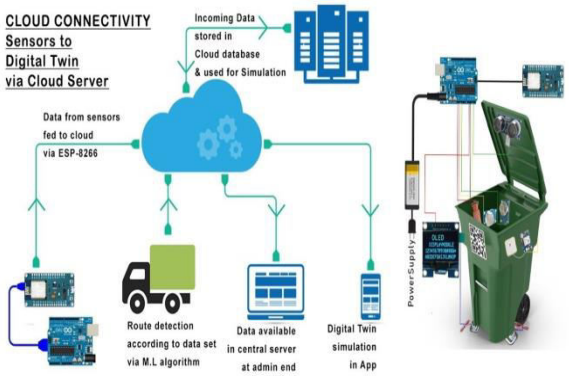

FIG 3: MICROCONTROLLER BASED WASTE MANAGEMENT

ESP8266 is low cost microchip with full TCP/IP stack and microcontroller capability. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. ESP8266 is already pre-programmed with a set of AT commands. GSM stands for global system for mobile communication. It is a mobile communication modem and it is widely used mobile communication system in the world. The GSM was developed at Bell Laboratories in 1970. It is an open and digital cellular technology, it used for transmitting mobile voice and data services and operates at the 85 sensors is given to the controller through Arduino Nano This is done because the controller used here is NodeMCU(esp8266) which has only one analog input pin and in-build Wi-Fi module which is required for transmission of data towards monitoring station. The controller accepts the data from sensor nodes. If these sensed data cross threshold values, it gives an alert. The entire data range is divided in three classes; SAFE zone, MIDDLE zone and DANGER zone. Alert is given for the DANGER zone. When the system is powered up, the NodeMCU configures itself to the Wi-Fi and the MQTT server. After making these connections successfully, it initializes arduinonano. Then, it starts accepting readings from soil moisture and accelerometer sensors. If these sensed data cross threshold values, it gives an alert to local citizens by using the GSM. Alert about the danger zone is passed in the form of message to the local citizens by using the GSM. Apart from giving alerts to the local citizens, controller also transmits all the sensed data towards the monitoring station. The Raspberry pi is interfaced with a laptop to display the SAFE and DANGER zones.

IV. RESULT ANALYSIS

The system consists of sensor nodes, controller at the landslide site and raspberry pi at the monitoring station as shown in Figure 1. Usually several sensor nodes are needed to cover 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 sensor [11] operating on 3.3 to 5 V. It has two plates which measure the water content in the soil. The electric current through the plates is proportional to the amount of water content. When there is more moisture around the sensor, it draws more current which results in less output resistance and the corresponding output voltage is low. In another case, when there is low moisture around the sensor, it draws less current which results in high output resistance and the corresponding output voltage is high. The output of soil moisture sensor used can be both analog and digital, but analog output is preferred for analog input channel of multiplexer. The accelerometer used for vibration sensing (slope displacement measurement) is ADXL335 [12] which contains a polysilicon surface-micro machined sensor and signal conditioning circuitry. The basic structure of accelerometer has a fixed plate and a moving plate. The moving plate deflects due to the acceleration which in turn unbalances the differential capacitance and gives the output voltage proportional to the accelerations. ADXL335 accelerometer provides analog voltage at the output X, Y, Z pins which are proportional to the acceleration in respective directions i.e. X, Y, Z. The collected data from the sensors is given to the controller through multiplexer CD4051B [13] . This is done because the controller used here is NodeMCU (esp8266) [14] which has only one analog input pin and in-build WiFi module which is required for transmission of data towards

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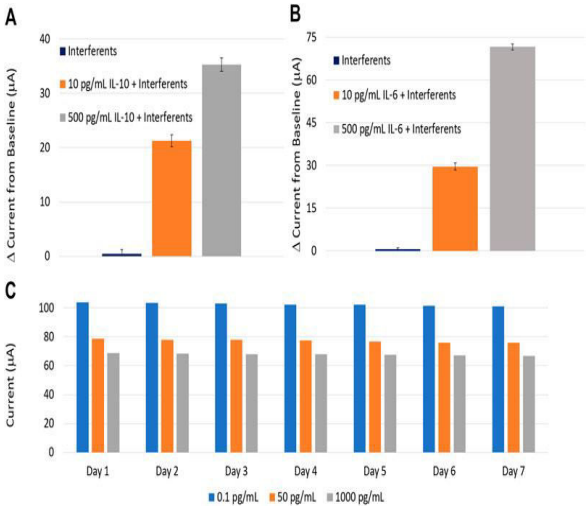
monitoring station. The multiplexer block can be eliminated if other controller having more analog input pins and suitable for interfacing of Wi-Fi module is used.



FOG 4: WASTE RESULT ANALYSIS

The controller accepts the data from sensor nodes. If these sensed data cross threshold values, it gives an alert. The entire data range is divided in three classes; SAFE zone, MIDDLE zone and DANGER zone. Alert is given for MIDDLE and DANGER zone. Pattern of alert for both classes is different and for different purpose. First alert is thrown when sensed values lie in MIDDLE zone. This alert informs local citizen to be alert as there might be chances of landslide occurrence in future. This alert also informs citizens to keep their important belongings such as first aid kit, clothes, water bottle and eating stuff ready as these are the things people need in hazardous situations. The second and the final alert is given as the sensed values lie in DANGER zone. This alert informs citizens to leave the place immediately. Apart from giving alerts to the local citizens, controller also transmits all the sensed data towards the monitoring station. The monitoring station does the work of monitoring and analyzing of data. The sensed data is communicated to monitoring station via NodeMCU using MQTT protocol. The data reception and transmission by raspberry pi towards cloud is done using python script. During DANGER zone, it sends alert to the rescue team as well. “ThingSpeak” is used as the IoT platform (cloud storage). The sensed data is graphically represented at ThingSpeak website which will make analyzing easy

V. CONCLUSION

Real-time monitoring of landslides is one of the challenging research areas available today in the field of geophysical research. The IoT based landslide detection system is to detect those conditions which lead to the occurrence of landslide and notify it well before time and able to save the human loss. The current landslide detection systems are less accurate. Here the proposed system is a real-time monitoring system and more accurate too. It is also very easy to set up. All the current systems are not completely automatic. They all require human interaction at some point. Here the proposed system is completely free of human interruption. The system is a robust and delay efficient system. It predicts occurrence of landslide at early stages thereby reducing the fatalities due to landslide.

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