

Landslide Monitoring Using Flux Sensor by Wireless Technique

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ABSTRACT:

Landslides have always been one of the most catastrophic natural phenomena. Continuous monitoring and warning as early as possible about the beginning of such disaster may lead to avoid of losses of human lives. With this aim we have developed a monitoring system structured as WSN equipped with very sensitive sensors capable of measuring real time direction and magnitude of the landslide displacement. The sensors are placed in order to measure the accurate value about the parameter of the landslide. Here GPS is used in order to determine the location of the landslide occurrence. The movements are observed and the collected data sets are automatically transmitted to a connected system and the FLUX SENSOR which is used in this paper provides a real time information about the current state of the monitored slope. More such sensors are mounted on a certain area more in advance for a landslide prone and connected in a network able to wirelessly communicate and transmit online data to a monitoring centre. Details related to network construction as well as the involved protocols are provided in the paper.

INTRODUCTION:

Real time monitoring of environmental disaster are one of the prime necessity of the world. WSN is one of the major technology that can be used for real time monitoring . WSN has the capability of large scale deployment, low maintainence, scalability, adaptability for different scenarios. WSN has its own limitation such as low memory, power and bandwidth.

This paper is involved This paper describes the evolution of a wireless sensor network system for landslide detection in the **southern state of Kerala, ooty, kodaikanal etc.**, a region known for its heavy rainfall, steep slopes, and frequent landslides.

The deployment and data retrieval or collection from geophysical sensors, the design, development and deployment of WSN, the development of data collection and data aggregation algorithms needed for the network, and the network requirements of the deployed landslide detection system, data analysis system etc has been disused in this paper.

Along with the WSN technique the sensors called temperature, flux and force are used in order to determine the change in temperature, pressure, humidity and vibration of the surface where the sensors play a better role which is a major device in electronics for measuring physical data from the environment. Techniques for landslide hazard assessment generally require the collection of highly detailed information over large areas. The remainder of the paper is organized as follows. The section defined here are related work of landslide monitoring, landslide phenomena, sensor column design, deployment of field and sensor and landslide detection. The assessment of landslide behaviour is usually taken by means of monitoring. In the last few years the GPS has become fully operational. New procedures, methods and software have been developed to assist in the field data capture and in the post processing. As a consequence, the GPS equipment is progressively more and more used for a wide movement, the response to the triggering conditions or the efficiency of corrective measures. Landslides are gravitational movements of soil or rock down that can cause severe damage to the civil structures. Numerous fatalities and structural failure caused by landslides have been

reported over the years. In this paper we describe a WSN architecture for a landslide monitoring whose measurement nodes are equipped with specific SENSORS are devoted to measure the landslide parameters like soil layer displacement and soil temperature, humidity and pore water pressure. The sensors are employed with highly sensitive strain gauges specially designed accurately determine the soil layer displacement in depth.

RELATED WORK:

In the previous methods the optical fibre sensing system along with OTDR method and in another system WSN is related with algorithms where mathematical calculations are determined. Likewise INSAR techniques are utilized for the collection of data about landslide. In this paper the evolution of WSN has fostered the development of real time monitoring and emergency applications. One of the major area of focus is environmental monitoring, detection and prediction. The APR module alert system has been proposed and developed in this paper. This system uses mobile communication to alert the users whereas the deployed system uses only the process of data collection and transmission using the wireless notes through the broadband connectivity. This paper also discusses about the reception of real time measurement. GPS technique is used with some other technique to provide the information about the landslide deformations. WSN is used for remote monitoring of soil condition in areas conducive to slope stability failures.

In this paper a real time deployment for landslide detection has been discussed. This study incorporates both theoretical and practical knowledge from diverse domains such as landslides, wireless sensor, power saving solutions and electronic design which developed the design and deployment of landslide detection system using a wireless sensor network.

An experimental soil monitoring network using a wireless sensor network is determined which explores real time measurements which were previously impossible. Research has shown that other than Geo physical sensors other technique such as flux sensor monitoring and GPS technology along with APR module can also be

used to provide information about the land deformation. The sensors used here is to provide measurement to perform deformation monitoring.

LANDSLIDE:

Landslide is a commonly occurring hazard which causes the down slope of soil and soil displacement which occurs due to influence of gravity. It can be triggered by gradual process such as weathering or any external mechanism. Landslide usually moves in three dimensions. The landslide is mainly caused due to soil erosion, glaciers or by human activities such as road building construction of infrastructure and mainly due to deforestation and also due to prolonged rain fall, earthquakes, shocks or vibration of any construction activities. Landslide is a major hazard in India which creates loss of life and damage to communication routes, agricultural fields and forest lands. In India landslide occurs mainly due to heavy rain fall. The occurrence of landslide may be due to natural or unnatural movement. The climatological condition is subjected to varying degree of landslide hazard. High rainfall intensity accelerates the sliding and slumping in the existing hazard zone. The annual loss due to landslide in India is equivalent to 400 million. The downslope of soil causes instability, reduction in the factor of safety, pore pressure responses, changes in water table height and a reduction in the angle of repose. Three distinct physical events occurs during landslide

- 1.) The initial slope failure
- 2.) The subsequent transport
- 3.) The final deposition of the slide materials

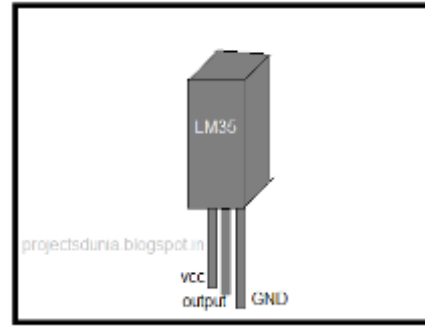
The initial slope failure can occur due to increase in pore pressure and soil moisture content which are detected by sensors and the warning system is developed for the landslide detection. The types of landslide vary with respect to rate of movement, type of material and nature of movement.

SENSORS NEEDED FOR MONITIRING LANDSLIDE:

The sensor is a mechanical device which is a part to determine the land displacement. FLUX SENSORS are involved in this paper for large

coverage area which is used in landslide detection. For the networking of sensor a wireless technique, standard configuration and software are selected on the basis of the utility and application. Sensors are chosen according to their functionality through signal processing capability, compression and encryption. In this paper FLUX SENSORS are used in suitable for mountainous area and the flux sensors are flexible to use in every situation. As it bends it indicates the displacement. After the slope failure the transport of the material happens which generates slope change, vibration which has to be measured and monitored for effective issue of warning. This vibration can be identified by the flux sensors and the warning system includes the APR module alert system. The structure of the sensor column varies according to the terrain conditions and the geological and hydrological parameters of the deployment of site. This sensor parameters are used to measure the deformation parameter. When the rainfall intensity is larger the slope saturated conductivity, runoff occurs. In addition to that the TEMPERATURE and FORCE SENSORS are also indulged here verifies the variation in the temperature and humidity of the environmental conditions. **Temperature Sensors** measure the amount of heat energy or even coldness that is generated by an object or system, allowing us to “sense” or detect any physical change to that temperature producing either an analogue or digital output. Here the LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

The high-accuracy version of the LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range.



WSN ARCHITECTURE:

The WSN architecture includes the deployment of the sensor column where the condition of sensors is given to the arduino which is connected to it. Then these data are transmitted to the wireless system which consists of alert module GPS and GSM. The geological and hydrological properties of whole landslide prone area differ in each location, so it can be divided into regions having unique properties. Usually, the architecture of a WSN is established according to the application needs. In our case, taking into consideration the specific actions to be taken, quantities to be monitored and the fact that the land topography is very irregular, we have chosen a mix between star and mesh architectures in order to cover an as large as possible area. As known, the optimization of power consumption in a WSN is an important task. In our power source and hence power management must be carefully achieved. Thus, when assessing the number of nodes for establishing the WSN architecture, the land configuration needs to be analyzed with care so that the number of NRs is reduced as much as possible. This analysis is not, however, the subject of this paper. The WSN uses four algorithms for implementing clustering, distribution of data, energy efficient, data aggregation and time synchronization which will contribute for the development of an efficient landslide detection system.

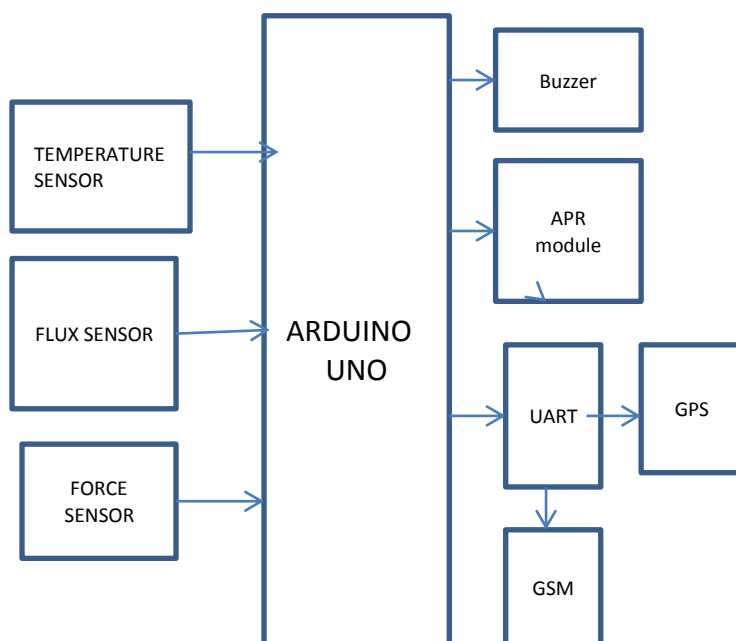
The real time monitoring networks are constrained by energy consumption, due to the remote location



of the deployment site and the non-availability of constant power. Considering these factors, the wireless sensor network at the deployment site implements a totally innovative concept for distributed detection, estimation and consensus to arrive at reliable decisions, more accurate than that of each single sensor and capable to achieve globally optimal decisions. The sensors in WSN collectively detects small movements consistent with the formation of a slip surface separating the sliding part of hill. Since the study concentrates on the detection of rainfall and vibration induced landslide, the most relevant data will be arriving during rainy season. So alert levels have been developed which will influence the rate of flux, temperature, force sensors and the transmission of data to higher layers based on the threshold value. This will reduce the energy consumption and transmitting large amount of data.

The design and development of a wireless sensor network for the landslide scenario involves consideration of different factors such as terrain structure, vegetation index, climate variation, accessibility of the area etc. The prerequisites of wireless sensor network development are selection of sensor column location, sensor column design and its data collection method, understanding transmission range.

BLOCK OF LANDSLIDE MONITORING:



DESCRIPTION:

The sensor called the temperature sensor which is used to determine the change in temperature and the flux sensor determines the vibration of the field where the threshold value is about 1000 and the force sensor determines the humidity and pressure of the environmental conditions.

When the threshold value of the flux sensor reaches the range of 700 then it notifies the occurrence of the landslide and through the APR module which is the voice module used to alert the nearby people through a recorded voice. The buzzer which is placed over there used to alert the vehicle passers who are travelling on the road. These information are transferred through the IOT which acts as a cloud to store the information accordingly.

FIELD DEPLOYMENT:

The existing infrastructure evolved through several iterative phases in its implementation. Important research focal points were deciding the sensor locations, designing and constructing the sensors, sensor deployment methods, interfacing circuitry, wireless sensor network and power solutions regarding soil tests and data analysis.

Extensive field investigations were conducted for identifying the possible locations for sensor deployment.

After analyzing the parameters of the soil and finding the frequently occurring landslide area, the sensors are placed in that place to determine the landslide possibilities. If the soil displacement occurs in accordance with the change in temperature and pressure due to environmental conditions the sensor called flux sensor placed in the field sense the vibration in the area. If the landslide is going to occur an IOT is used in order to transfer the data through GPS.



DEPLOYMENT OF SENSOR , WSN , IOT:

One of the sensor is deployed at the toe region where various water seepage lines converge. This fact is lead to the installation of pore pressure sensors at different depths of the sensor column. Both the flux sensor and force sensor are sampled at every 5 minutes. The wireless sensor node is connected to the sensor column which transmits the digitized data values to the upper layer of the network.

The other sensor is attached with the movement of attached with movement sensors since the location of it is an unstable region. This sensor column is used to capture the movement of the earth from the sensor column bending. The wireless sensor nodes sample these sensors at every minutes and sent to upper level nodes in the network.

The design and development of a wireless sensor network for the landslide scenario involves consideration of different factors such as terrain structure, vegetation index, climate variation , accessibility of the area. The pre requisities of wireless sensor network development are selection of sensor location, sensor column design and its data collection method, understanding transmission range and necessity of external factors or additional nodes, identification of the communication protocol.

The sensor column is physically attached to a wireless sensor node which is integrated with a data acquisition board. The IOT is used to transfer the data from the gateway and it uses external nodes to the access point for the same. Since the

southern region experiences frequent landslides and has several landslide prone areas within every meter which can be utilized as future extension via IOT.

MONITORING:

The system consists of the data base server and an analysis station using the software called proteus which has the capability to determine the factor of real streaming of data and its result over internet which will provide the greater capability of effective warning issues at minimum delay. It also has the capability to compare and analyse the value of different sensors for the comparison. Then the data is successfully received from the deployment site.

CONCLUSION AND FUTURE WORK:

Wireless sensor network for landslide detection is one of the challenging research areas available today in the field of geophysical research. This paper describes about an actual field deployment of a wireless sensor network for landslide detection. This system uses heterogeneous network composed of wireless sensor node and IOT terminals for efficient delivery of real time data to the data management center.

The data management center is equipped with softwares and hardwares needed for sophisticated analysis of the data. The results of the analysis in the form of landslide warnings and risk assessments will be provided to the inhabitants of the region.

The pilot deployment of this system is already in place future, this work will be extended to a full deployment with increased spatial variability, and the work in this regard is progressing. Field experiments will be conducted to determine the effects of density of the nodes, vegetation, location of sensor columns etc., for detecting rainfall induced landslides, that may help in the development of low cost wireless sensor network for landslide detection.

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