International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 10, October- 2014

Wireless Sensor Network for Detecting Vibrations Before Landslides

Pawan Nandkishor Hinge
Electronics Telecommunications
Sinhagad Academy Of Engineering
University Of Pune

Rohit Ramesh Bawage
Electronics And Telecommunication
Smt.Kashibai Navle College Of Engg
University Of Pune

Pallavi Nandkishor Hinge
Computer Science Engineering
Smt.Kashibai Navle College Of Engg
University Of Pune

Abstract— **Wireless sensor network technology has provided the capability of developing large scale systems for real-time monitoring. The recent years, people were unknown for all kind of natural disaster and calamities. Natural calamities like Earth movers (earthquake), Heavy rainfall, Flood, Tsunami, Hurricane, Cyclone etc. People, who were suffered through, had myth of GOD's anger. There were different methods found to understand the danger from natural calamities. In ancient time, methods were less accurate which leads to heavy damage to mankind. As the time pass by new methods have been developed with more accuracy which gives correct intimation about the dangers. The advanced systems developed are more durable and reliable to understand the danger of destructions. In this paper, we have proposed theory to monitor landslides which occurs all of sudden and destroys village and mankind. In this theory, we have used accelerometer sensors to detect the small vibrations right before the avalanche occurs. The sensor module detects the vibrations from the field and sends the data to monitoring station through GSM module. Hence the data is observed on monitoring system and the alarm goes on hit whenever data crosses the threshold. These modules are more durable and accurate to understand unknown danger to mankind and it also helps from heavy damage and destructions.**

Keywords— ***Accelerometer, GSM, Star network, Monitoring Station.***

I. INTRODUCTION

Events occurred due to environmental activities sometimes may turned to disasters which creates heavy damage to mankind as well as economy disturbance. Wireless sensor networks (WSN) is one of the major technology that can be used for real-time monitoring of these events.WSN has the capability of large scale deployment, low maintenance, scalability, adaptability for different scenarios. WSN has its own limitation such as low memory, power, bandwidth etc., but its capability to be deployed in hostile environment made it one of the best suited technologies for real-time monitoring. This paper discusses the design and deployment of a landslide detection system using wireless sensor network. The modules which were used for detecting the small vibration generated before the avalanche comes. The sensor node senses those vibrations by geographic sensor and we have used 3-axis sensor to detect the vibrations. The data from sensing node is gathered at the master node, master node upload that data to server via GSM. The data can be observed or checked through website across the world. The following sections II describes related work in WSN systems and other methods for landslide prediction. In Section III, we describe about landslide phenomena and Section IV details about the network design used along with this system. Section V explains network algorithm. Section VI includes the test results of sensor nodes. Section VII explains warning indications. References used for this paper are given in Section IX.

Finally we conclude in Section VIII and in the same section future work is also discussed.

II. RELATED WORK

The evolution of wireless sensor networks has fostered the development of real-time monitoring of critical and emergency applications. Wireless sensor technology has generated enthusiasm in Computer and Electronics Telecommunications scientists to learn and understand other domain areas which have helped them to propose or develop real-time deployments. One of the major areas of focus is environmental monitoring, detection and prediction. The Drought Forecast and Alert System (DFAS) has been proposed and developed in paper [1]. This system uses mobile communication to alert the users, whereas the deployed system uses real time data collection and transmission using the wireless sensor nodes, Wi-Fi, satellite network and also through internet. The real streaming of data through broadband connectivity provides connectivity to wider audience.

Research has shown that other than geotechnical sensor deployment and monitoring, other techniques such as remote sensing, automated terrestrial surveys, and GPS technology, etc. also can be used by themselves or in combination with other technologies to provide information about land deformations. A durable wireless sensor node has been developed [2], which can be employed in expandable

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

wireless sensor networks for remote monitoring of soil conditions in areas to slope stability failures. In this paper, real time deployment of a heterogeneous network in India for landslide detection has been discussed.

This study incorporates both theoretical and practical knowledge from diverse domains such as landslides and geo mechanics, wireless sensor, GSM and satellite networks, power saving solutions, and electronic interface and design, among others, which paved the design, development and deployment of a real-time landslide detection system using a wireless sensor network.

III.LANDSLIDES

Landslide is a general term used to describe the down-slope movement of soil, rock and organic materials under the influence of gravity. It can be triggered by gradual processes such as weathering, or by external mechanisms including:

- **Undercutting** of a slope by stream erosion, wave action, glaciers, or human activity such as road building,
- **Intense** or prolonged rainfall, rapid snowmelt, or sharp fluctuations in ground-water levels,
- **Shocks** or vibrations caused by earthquakes or construct activity,
- **Loading** on upper slopes

Once a landslide is triggered, material is transported by various mechanisms including sliding, flowing and falling. The types of landslides vary with respect to the:

- **Rate** of movement:

  – This ranges from a very slow creep (millimeters/year) to extremely rapid (meters/second).

- **Type** of material:

  – Landslides are composed of bedrock, unconsolidated sediment and/or organic debris.

- **Nature** of movement:

  – The moving debris can slide, slump, flow or fall.

In India, landslides mainly happen due to rainfall which leads to landslides. Earthquakes can also cause landslides, however in India this is primarily confined to the Himalayan belt. An intensive vibration accelerates the sliding and slumping in the existing hazard zones. The annual loss due to landslides in India is about to $400 million in recent years.

IV. NETWORK DESIGN

Commercially available wireless sensor nodes do not have implanted sensors to measure pore pressure, moisture content, vibration, earth movements, etc. This constraint has leaded us to implement data acquisition boards to connect the external sensors to the master sensor node. The geological sensors were placed on a sensor node and they were connected to the wireless sensor node via a data acquisition board as shown in Figure 1. The sensor node design discussed in this paper is an enhanced version of the sensor node, which uses a homogeneous structure, whereas our design uses a heterogeneous structure which differs with respect to the terrain conditions and the geological and hydrological parameters of the deployment site. Also, in this sensor design all the geological sensors are not placed inside but are connected to the same master sensor node.

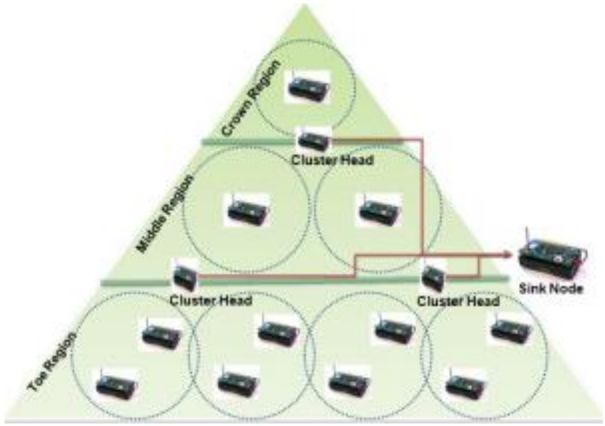


Fig. 1: Regionalized Wireless Sensor Network Architecture for Landslides

The geological and hydrological properties of the whole landslide prone area differ in each location, so it can be divided in two regions having unique properties. Our deployment area is divided into three regions such as crown region. The region has been affected by rain fall which leads to landslides. To avoid such heavy damage the sensor network has been deployed over the prone zones or regions.

V. WIRELESS SENSOR NETWORK ALGORITHM

The wireless sensor network uses four algorithms for implementing clustering, distributed consensus among the data, vibration 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 as discussed in research.

In landslide scenario, the implementation of this algorithm imposes a constraint of handling heterogeneous sensors in each sensor node. The methods that can be used for implementing this algorithm are referred from [4],[5] and [6].

The decentralized algorithm will be executed for each type of sensors, one by one, for all homogeneous sensor node deployed at each region. After initial set of sensors achieve its consensus, the next set of sensors will execute the decentralized algorithm meaning the two sensor which are communicating via zigbee, sensing the vibrations sends the data to master node. The data is then centralized at master node and again the data is decentralized accordingly to verify each node. Each node has been assigned by specific IP address and according to that the data has been decentralized by the algorithm.

The master node gathers the all data from the given sensor nodes and that data is then fetched to GSM module. This module is then tries to connect the base station nearby the area

IJERT

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

and after getting confirmation the module starts firing the data signals constantly.

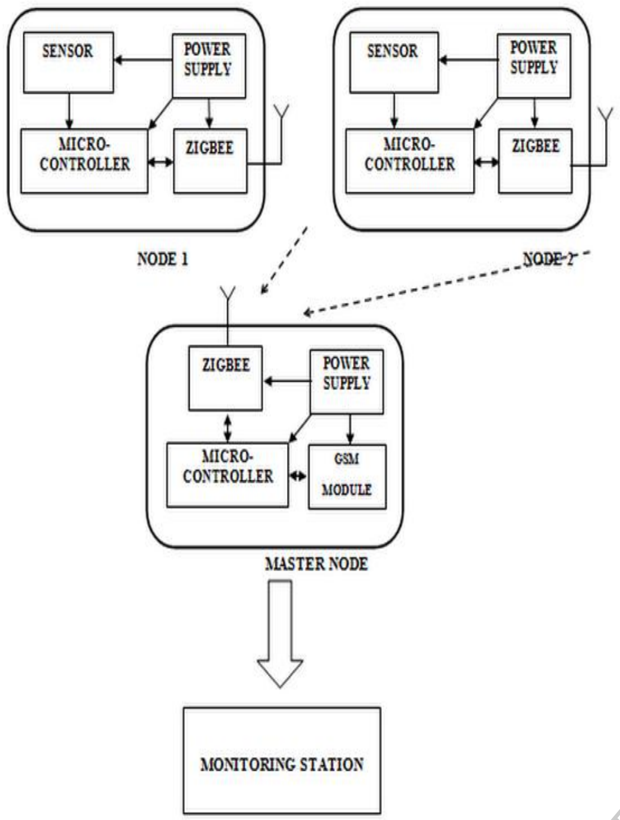


Fig. 2: Block diagram

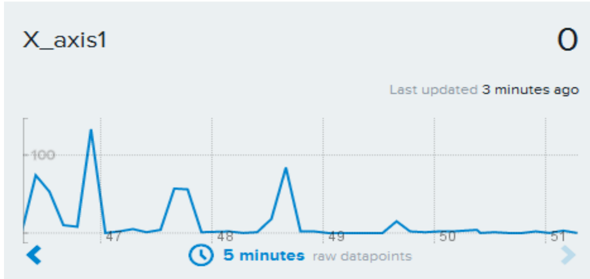
The other designs demand prior knowledge of correlation between different geophysical sensors, whereas this method does not require this prior knowledge, but the processing delay will be more compared to other methods, due to the multiple execution of same algorithm. Since the study concentrates on the detection of vibration, the most relevant data will be arriving during rainy season. So alert levels have been developed which will influence the sampling rate of the geological sensors and the transmission of data to higher layers as discussed in the threshold based algorithm [3].

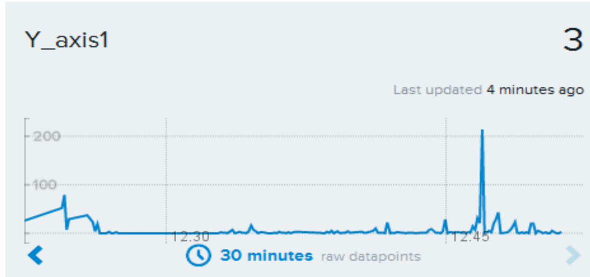
The algorithm used will help to reduce the energy consumed during the low alert levels and also in collecting and transmitting large amounts of data, only when the environmental and geological conditions demand the same. The zigbee modules used for communication in the network are worked on signified protocols which are discussed in papers [7], [8].

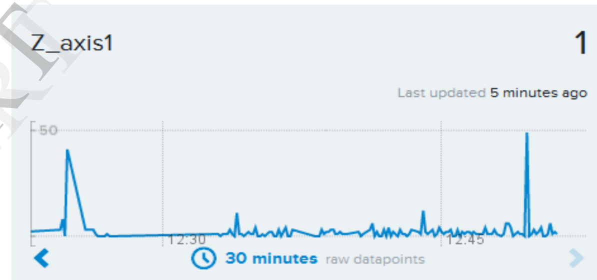
IJERT

VI .TEST RESULTS OF SENSOR NODES

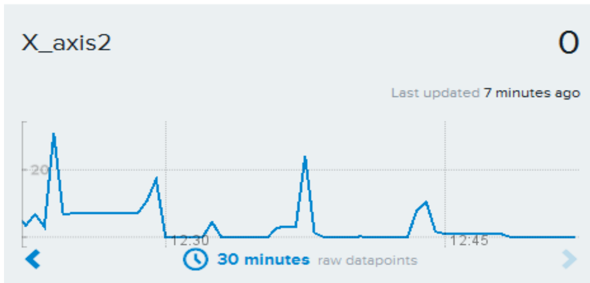
Sensor Node 1:

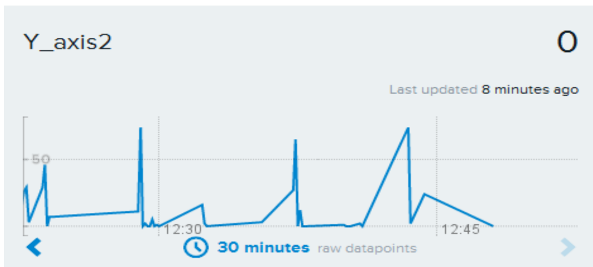




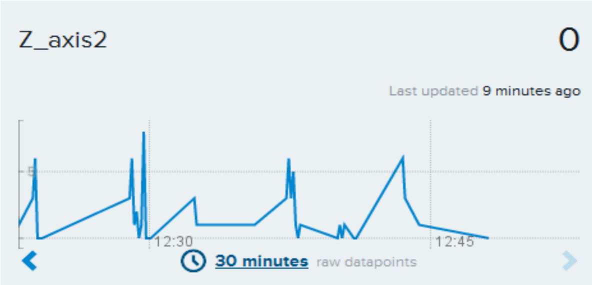


Sensor Node 2:



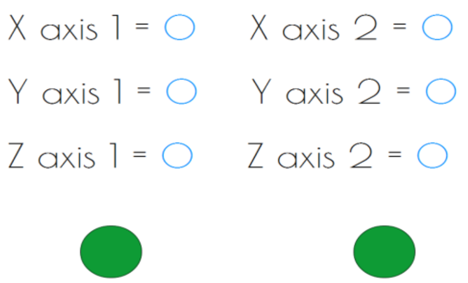


(This work is licensed under a Creative Commons Attribution 4.0 International License.)

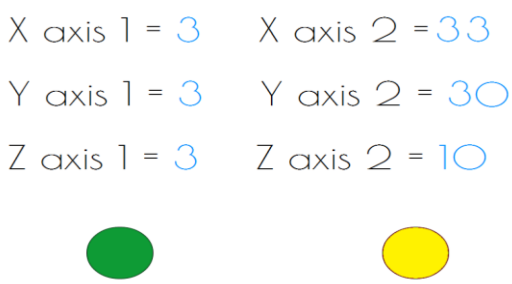


VII. WARNING INDICATIONS

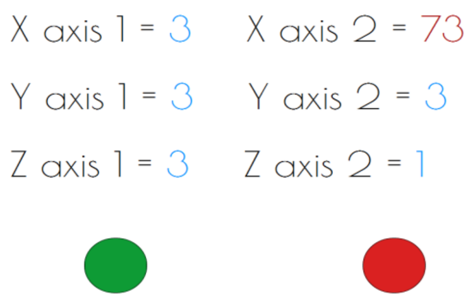
Normal state



Alert zone (below threshold)



Danger state (above threshold)



VIII. 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 a heterogeneous network composed of wireless sensor nodes, zigbee, GSM, satellite terminals for efficient delivery of real time data to monitoring station. The monitoring station is equipped with Software and hardware 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. In the future, the modules which are now working on batteries going to work on solar panels also some other features like GPS, Gyroscope etc will be added on the module. Field experiments will be conducted to determine the effects of density of the nodes, vegetation, location of sensor node etc., for detecting vibrations before the landslides.

IX. REFRENCES

1. Kung. H., Hua. J.,Chen. C., Drought Forecast Model and Framework Using Wireless Sensor Networks,Journal of Information Science and Engineering, Vol 22, Pages 751-769, 2006.
2. Garich. E. A., Wireless, Automated Monitoring For Potential Landslide Hazards, Master Thesis,Texas A& M University, May 2007.
3. Ramesh. M. V.,Ushakumari. P., Threshold Based Data Aggregation Algorithm To Detect Rainfall Induced Landslides, in Proceedings of the 2008 International Conference on Wireless Networks (ICWN'08),Vol. 1, Pages 255-261, CSREA Press, July, 2008.
4. Barbarossa. S.,Scutari. G., Decentralized Maximum-Likelihood Estimation for Sensor Networks Composed of Nonlinearly Coupled Dynamical Systems, IEEE Transactions on Signal Processing, Vol. 55, No. 7, July 2007.
5. Barbarossa. S.,Scutari. G., Swami. A., Achieving Consensus in Self-Organizing Wireless Sensor Networks: The Impact of Network Topology on Energy Consumption, IEEE, 2007.
6. Scutari. G., Barbarossa. S.,Distributed Consensus Over Wireless Sensor Networks Affected by Multipath Fading, IEEE Transactions on Signal Processing, Vol. 56, No. 8, August 2008.
7. Research on Zigbee wireless communication technology, 2011 IEEE.
8. Routing in ZigBee: benefits from exploiting the IEEE 802.15.4 association tree,2007 IEEE.
9. Performance Comparison Of Routing Protocols For Zigbee, 2011 ISSN.
10. ZigBee Alliance, http://www.ZigBee.org
11. Behrouz A. Forouzan ,Data Communication and Networking, Fourth Edition by McGraw- Hill Publications.

IJERT

(This work is licensed under a Creative Commons Attribution 4.0 International License.)