Design of a wireless sensor network in early landslide detection

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Abstract: In this paper, an innovative technique (hardware prototype) is described by using wireless sensor network. The sensor which is the main component of the hardware measures the changes in the sloped or forced mass during the course of its action. The analog data thus obtained from each sensor is converted into the digitized form , interfaced and then processed the same to the host node by using Zig Bee wireless protocol and finally processing the same to the remote monitoring center. The monitoring center is equipped with warning information so that necessary action can be taken in proper time. Thus the system operates through a proper combination of hardware and software & also simultaneous display of data in LCD and Lab VIEW are also a part of the system.

Keywords: Wireless sensor network, Zig-Bee protocol ,Lab VIEW

INTRODUCTION

I. Landslide is characterized by an abrupt change of slope or down slope under the influence of gravity. Being a natural calamity we cannot prevent its occurrence but we can design such a system that can be able to detect its occurrence much earlier it is going to trigger. Wireless sensors can quickly respond to the rapid changes of data and has the capability of quick capturing, processing transmission of critical data in real time ,where cabling is inappropriate [1]. So. Here a hardware system is designed using wireless sensor network i.e. capable of capturing the relevant signals with minimum monitoring delay. It is working successfully in detection and to process the critical data to the monitoring center at a remote place.

II. The wireless sensor network is composed of 'n' numbers of sensor node as per our requirement. The prime component of the sensor node is the 'sensor' which is composed of a rotational potentiometer and a customized pendulum attached the potentiometer. The phenomenon of landslide is initiated with slight down slope of the loaded mass or the rocks and the soil particle and it takes a certain time period to trigger down or to force down the loaded mass ranging from a few to several hours, from the hillside to the plain area. The plain area can be a road, a river or can be a cultivation land etc. For early landslide detection, The wireless sensor network measures the changes in the sloped or forced mass during the course of its action. The changes in the slope of the wasted mass is measured in terms of the inclination angle of the pendulum attached to the potentiometer. In fig; these are denoted by pot xy & pot yz. This is the proportional analog output of the made by the pendulum. If the angle enters the threshold zone, then the system sends the warning information with necessary alarm.

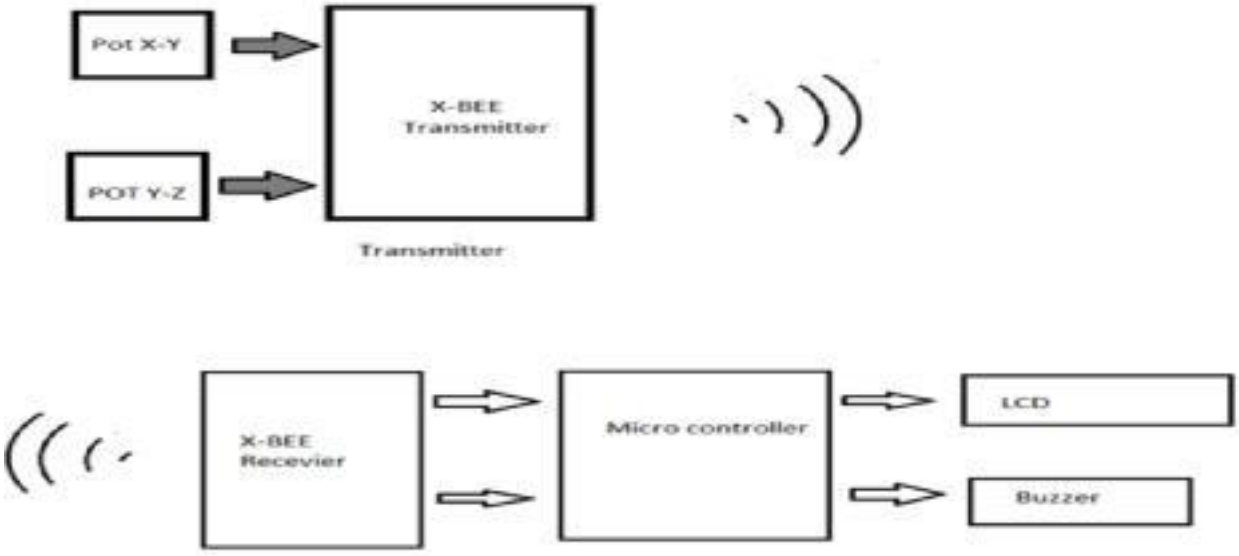


Fig: Block diagram

The analog data obtained from each sensor is converted into the digitized form , interfaced and then processed the same to the host node by using Zig Bee wireless protocol. The use of Zig-Bee turns the system minimization of power.

The term 'host' is named as it collects all data from the other nodes and finally processing the same to the remote monitoring centre. Thus it is responsible to establish the network between the sensor system and the monitoring centre again by using or via Zig Bee communication protocol. Unlike the other wireless sensor network, here use of a single microcontroller for 'n' nos. of nodes makes this a cost-effective system up to a considerable amount.

Before starting the operation, the flowchart of the working can be given as;

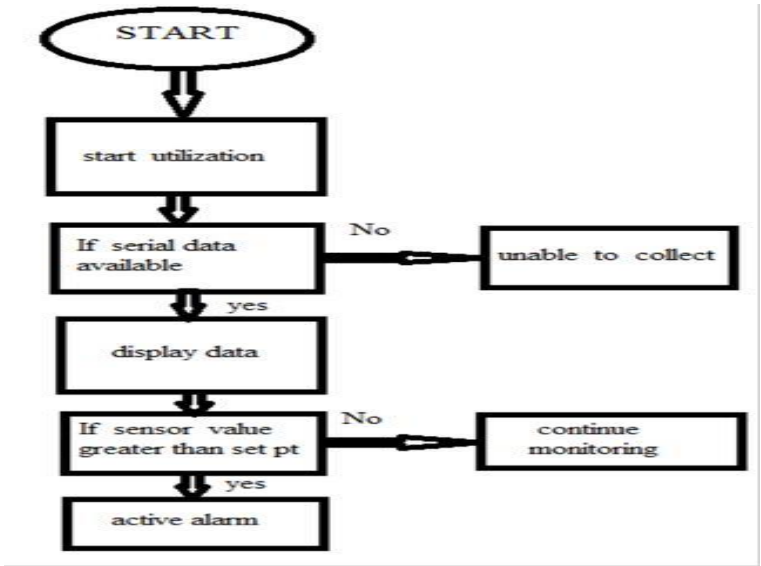


Fig: flowchart

III. NETWORK SYSTEM DESIGN

The operation of the wireless sensor network is executed in the following steps.

- Hardware design
- Software simulation

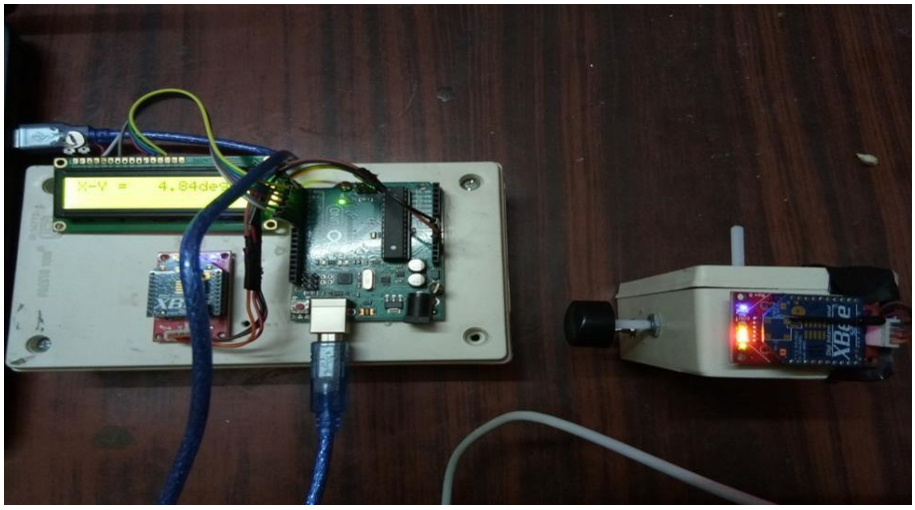


Fig: Hardware set up

III. HARDWARE DESIGN

At the transmitter:

The system composed of coordinator X-BEE (Receiver) and a series of router X-Bee [2].in our project we simply used two X-Bee a router (transmitter), node -1 and node -2. The radio module is programmed in a software called XCT-U which is specially designed for programming radio module. Pan ID and channel is kept same for all radio module. Chanel verification is enabled.

As the pendulum get inclined to a certain angle, during the course of landslide, proportional amount of the electrical voltage output is obtained across potentiometer .

If the above angle enters the threshold zone then, the system is equipped with the necessary warning by setting audible alarms.

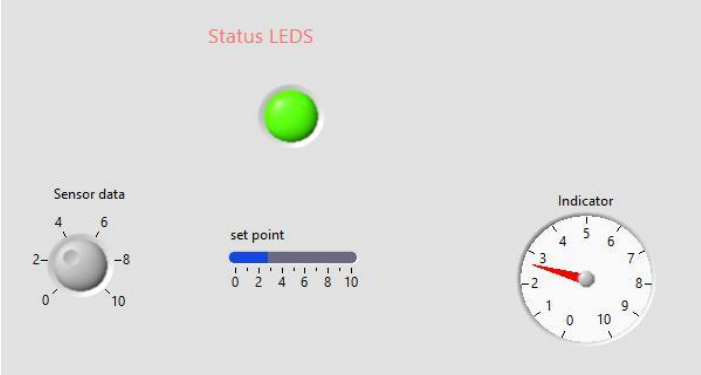
The analog output thus obtained is now converted into digital signal ,processed and transmitted through Zig-Bee wireless protocol i.e. done by X-BEE.

At the receiver:

At the receiving end, the X-Bee receiver receives the signal(digital), goes to the Arduino –Uno microcontroller . There, after some successive operations it is converted to corresponding analog signal[4].
Then, it is being displayed in the LCD(liquid crystal display).Thus , the detection part is done through the above process.

IV. SOFTWARE SIMULATION:

The simulation for a single node is shown in Lab VIEW :



As shown in the figure, the VI simulation consist of sensor data and set point value as the input. This input is fed back to a comparator circuit where the output is a Boolean function. This output is used to glow the status led. Now the LED will remain green if the set point value is higher than the sensor data , otherwise it became red, indicating a critical state in the node[3].

V. MONITORING USING LAB VIEW:

The system can be monitored using lab VIEW , which make the system more versatile in the field of analysis and research. The data obtained from the sensor section are transmitted wirelessly and received by the controller, the controller fetch the received signal and send it to the secondary microcontroller present in the system. In the secondary controller LIFA(Lab VIEW implementation for Arduino) is deployed. The signal received by the secondary controller is finally transmitted to the Lab VIEW itself . where it is analysis and is plotted in a graphical way. Since the controller send PWM signal to Lab VIW , the graph obtained in the wave chart if lab VIEW is of PWM (pulse with modulation) having the width of pulse proportional to the inclination.

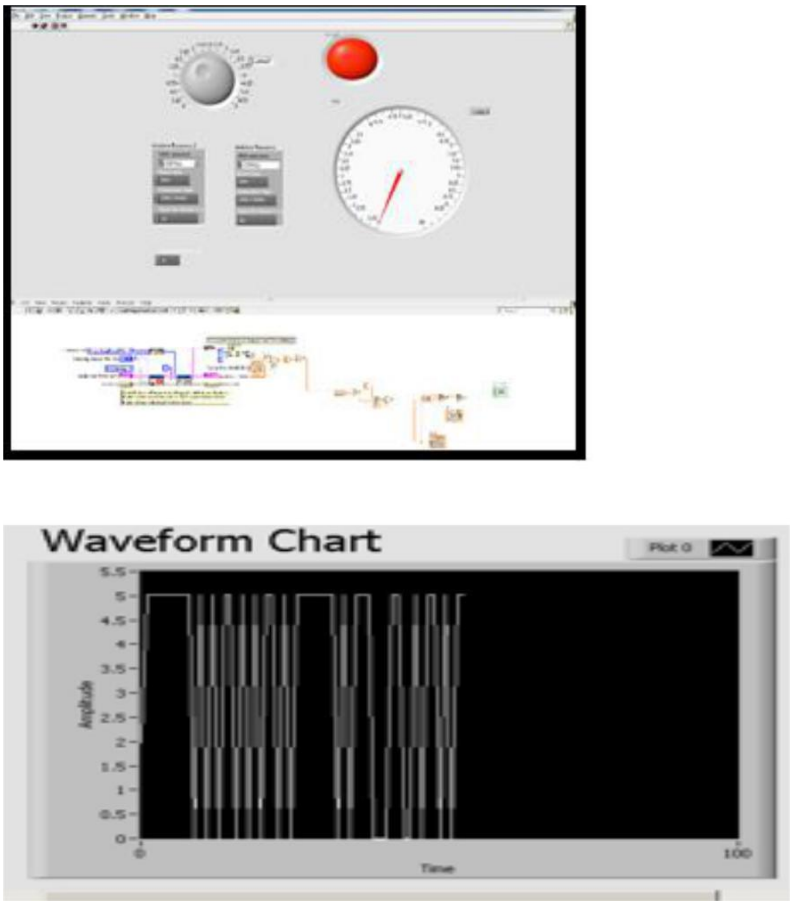


Fig: Lab View output

As shown in the figure, the system needs to connect with Arduino using proper communication port, once the port is successfully connected the data can be observed from the device in a continuous manner.

VI.RESULT AND OBSERVATION

The system is designed, implemented in field level and made some observation to study the response of the designed system. By taking multiple observation, following data are obtained, which are *tabulated* below.

SL no	*Actual inclination*	*Sensor value*	*Accuracy of the sensor*
1	*2.5*	*2.4*	*96%*
2	*3.1*	*3*	*96.77%*
3	*6*	*5.5*	*91.67%*
4	*7*	*6.8*	*97.14%*
5	*4.2*	*4.1*	*97.6%*
6	*6*	*5.8*	*97.6%*

7	*5.2*	*5*	*96.1%*
8	*6.2*	*6*	*97.7%*
9	*6*	*5.8*	*96.7%*
10	*1.2*	*1*	*83%*

IV. CONCLUSION

Conclusion: from the observation table it is seen that the accuracy of the sensor is almost 96% which is quite satisfactory. more over the system is stand alone and consumes very less amount of power. wireless networking makes the system mesh free. Over all we can say that the system can be implemented successfully and definitely will be use as landslide monitoring system in real scenario.

REFERENCES

[1]Kim, Hyoung Woo…proceedings of the APAN-research workshop 2016,ISBN 978-49905448-67..”’development of wireless sensor node for landslide detection .’”

[2]Maneesha V. Ramesh …department of computer science, Amrita school of Engineering..Amrita Vishwa Vidyapeetham (AMRITA University)..”Real time Wireless sensor Network for Landslide Detection”..2009 Third International Conference on sensor Technologies and Application.

[3]Zhang Wenlong Guo Qing Liu Baoshan(1 Gui Lin University of Technology and Science, Gui Lin in,541004,China;2 Ji Lin Institute of Standards information, Ji Lin, 132000, China)longerwelly@163.com..”Design of Landslide Warning System”.

[4]Joel S.MarcianoJr.,Mark Albert H.Zarco , Marc Caesar R. Talampas;Sandra G.catane ,Calvin G.hilario ,Mary ann Zabanal , Catherine Ruffa C.Carreon,Earl A.Mendosa,Roy N Kaimo and Cathleen N. Cordero…Electrical and Electronics Engg. Institute.Institute of Civil engg,National Institute of Geological Sciences University of the Phillippines Diliman.”Real World Development of a Locally-Developed Tilt and Moitsure Sensor for Landslide Monitoring in the Philippines”…2011 IEEE Global Humanitarian Technology Conference.