E-ISSN: 2278–179X

JECET; June-August, 2012; Vol.1.No.2, 132-140.

Journal of Environmental Science, Computer Science and Engineering & Technology

Available online at www.jecet.org

Engineering & Technology

Research Article

Utility of Sensor Networking at Highways in Hilly Area

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Received: 6 July 2012**; Revised:** 20 July 2012**; Accepted:** 26 July

Abstract: The power of wireless sensor network technology has provided the capability of developing large scale system for real time monitoring of landslide on highways road side. This paper describes the evolution of a wireless sensor network system for detection landslide. The deployment and data retrieval or collection from geophysical sensor, the design, development and deployment of WSN, and the network requirements of the deployed landslide detection system has been discussed in this paper. The feasibility of above study is conducted in highs of the Aravalli Mountain, where the region is known for frequently falling of stones in hilly area four lanes nh76.

Keywords: Wireless Sensor networking (WSN), Highways in hilly areas.

INTRODUCTION

Real time monitoring of environmental disasters are one of the prime necessity of the world. Different technologies have been developed for this purpose. Wireless sensor network (WSN) is one of the major technologies that can be used for real time monitoring[1]. The challenges in the hierarchy of detecting the relevant quantities, monitoring and collecting the data, assessing and evaluating the information, formulating meaningful user displays, and performing decision-making and alarm functions are enormous.

India faces landslides every year with a large threat to human life causing annual loss of US $400 million. The main goal of this effort is to detect rainfall & environmental induced landslides which occur commonly in the Aravalli range of India[2].

This paper discusses the design and deployment of a landslide detection system using a WSN system at A NH-76, between Udaipur to Pindwara, Udaipur (Dist), Rajasthan (State), India. Wireless sensor network helps prevent the damages by detection Landslide near the extreme event occurrence time. With more efficient and effective observation of environmental processes using sensor, networked sensors in a large and wide scale hilly area, it is expected that near real-time landslide detection can reduce the loss of human lives and also provides information to emergency response services.

In the wide hilly area, the sensor field would be deployed at a few critical regions. Within the sensor field are sensor nodes and monitoring systems interconnected via wireless links.

This article aims to propose the wireless sensor network communication architecture for landslide detection in hilly area. It includes the hardware, communication protocols, and system architecture for landslide detection.

Fig. 1: Hill cut along the highway NH-76 Udaipur to Pindwara[14]

REVIEW OF LITERATURE

The evolution of wireless sensor networks has fostere the development of real-time monitoring of critical and emergency applications. Wireless sensor technology has generated enthusiasm in computer 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.

“Wireless vibration sensor for tunnel construction” explains a development background of small wireless vibration sensors and their applications based on RF (Radio Frequency)-MEMS (Micro Electro Mechanical System) technology. The advantages and usefulness of the wireless automatic monitoring system is addressed compared with the conventional wired or survey measurement systems. Thus, the study provides a framework of the process for monitoring, manipulating, and transferring data from MEMS sensor and explains the application of the new developed automatic monitoring system for tunnel construction and maintenance[3].

This include that the wide-area large scale soil moisture estimation and wetlands monitoring system operates under two applications scenarios, extreme event monitoring for disaster forecast and long term periodic monitoring for scientific data collecting[4].

FLOW CHART

The flow chart shows wireless sensor networking working procedure. The piezo sensors are installed at hill cut faces along the highway where it is needed to monitoring landslide detection. The signal conditioning block is used to compensate, rationalize and convert the sensor output. Sensor sense the vibration and send it to in this comparator compare the sense signal to the standard signal and pass only the signal whose strength is above to the standard signal.

Flow Chart

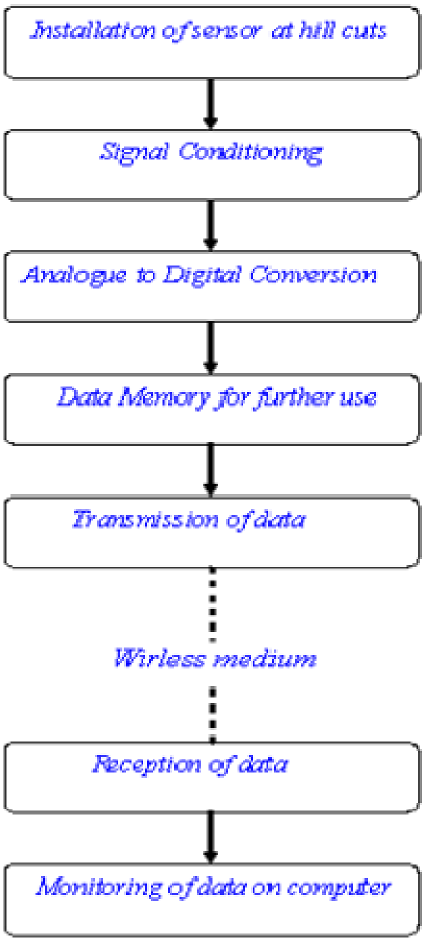

Fig.2: Schematic data flow chart.

The voltage signal goes to analogue to digital signal conversion block, here voltage signal(analogue) convert into digital signal because to store ,transmission, reception and analysis of digital signal is easy rather than analogue signal.

Digital signals stored in the storage bank where one can use this data later as and when required. The digital signals are transmitted in air medium with help of RF (Radio frequency) transmitter at a long distance. On other hand RF receiver receives the signal and passes it to the computer for analysis. This procedure is explained in the flow chart shown in **Fig.2.**

Sensor: Transducer materials convert one form of energy into another, and are widely used in sensing applications. Transducer can convert mechanical energy into electrical energy vice versa. A device for converting a physical parameter such as pressure, liquid level/depth, temperature, flow, force/load, humidity, vibration/acceleration, position / movement /speed, chemical composition, etc are called sensor. A sensor can be sourced separately as part of a logging instrumentation package or as an integrated component of a data logger. The former approach provides limitless flexibility in the number and type of sensors that can be used as long as you are prepared to ensure they are compatible with the equipment you are connecting **Fig.3.**.

There are several types of sensor in which Piezo film sensor are used for sensing the vibration in machine, guitar etc[11].

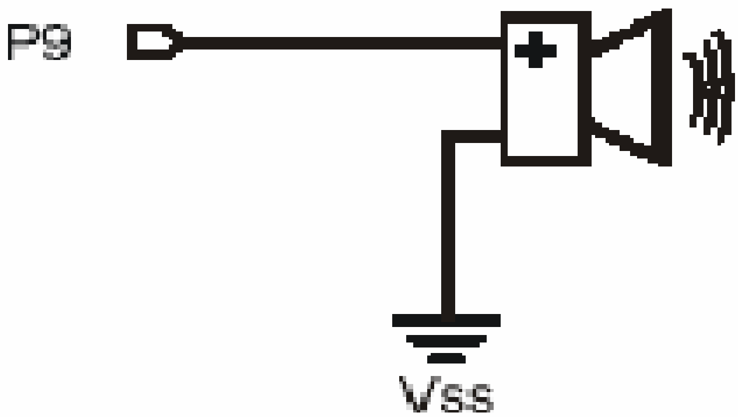

Fig. 3: Piezo film sensor[15]

The piezo speaker is connected to the input of an op amp (operational amplifier) operated as a comparator. This operation is achieved by eliminating the usual feedback resistor between the output (pin 6) and the inverting input (pin 2).

In operation, subtle vibrations cause the piezo element to generate a small voltage. The LED glows when the voltage exceeds that applied to pin 3 of the op amp by sensitivity control R2, the voltage at pin 3 can be set with the register R2. The voltage generate by sensor are compared with voltage at pin 3 and gives the output voltage signal only when sensor voltage level will exceed the voltage level at pin 3 and LED will glow. Means the comparator reject the low voltage level (vibrations) generated by sensor[12] as shown in **Fig.4.**

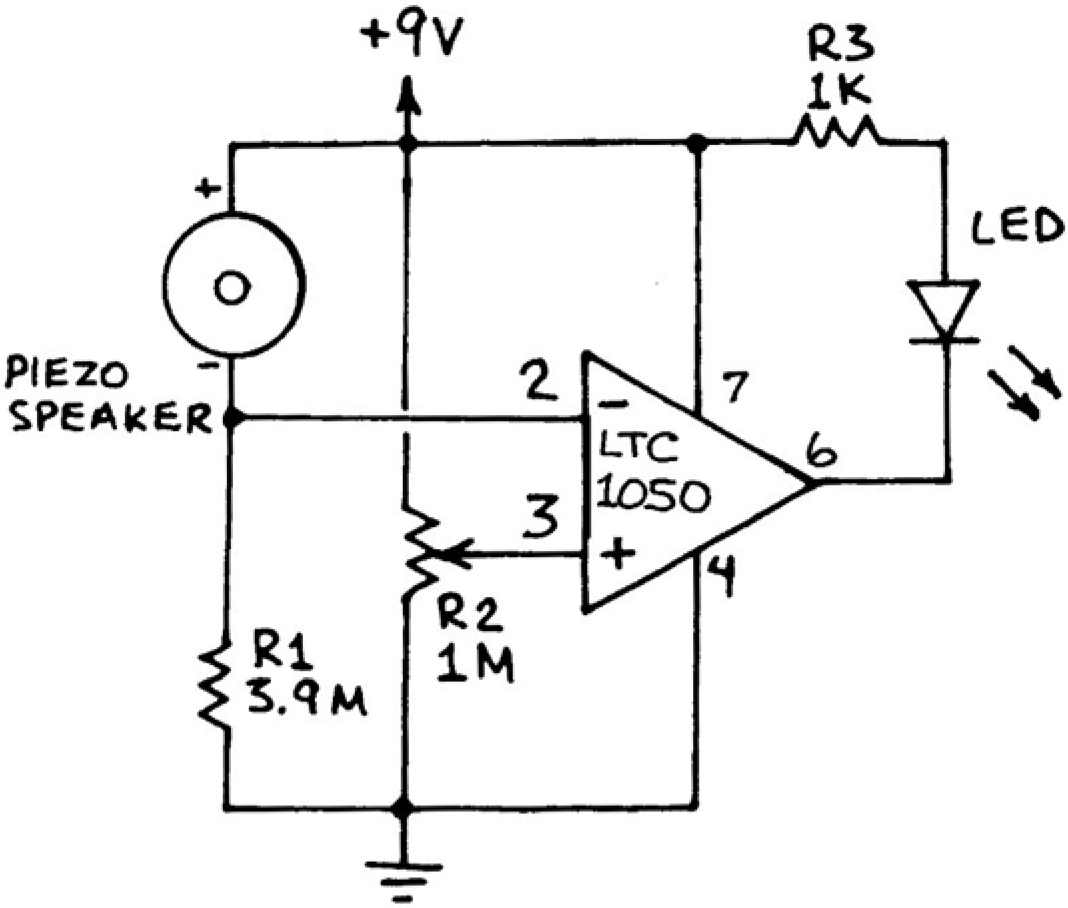

Fig. 4: Circuit diagram of sensor working with Op-amp

SIGNAL CONDITIONING

This block will accept the raw input signal from the sensor which and then process it to provide a normalised output signal which can be understood by more generic instrument with a common input / output (I/O) architecture. The process of signal conditioning steps:

- Rationalization of each sensor so that multiple sensors all have a similar output characteristic.
- Compensation to reduce errors introduced by changes in temperature, pressure, humidity or other environment or process related variable.
- Transforming the signal into one which is more widely compatible with other instrumentation.

The signal conditioning can be incorporated into a separate instrument or as an integrated part of the sensor or data logger. In some cases it may be necessary to stage the signal conditioning across more than one instrument especially with more exotic sensors where transformation of the signal is more complex [13].

Analogue-to-Digital-Conversion: In order to store the measurement results into a memory that must first be converted from a analogue voltage signal into a digital value. This part of the data logging system is usually incorporated with the data memory storage device, but in some circumstance particularly where high precision is required it will be included inside the sensor[13].

Memory: The size of data storage varies significantly across manufacturers and product type; it is normally specified as a number of Kilobytes (KB), Megabytes (MB) or Data points (dp). The way measurement readings are stored is controlled by the logging routine which is downloaded via the logging application software installed on a PC to the logger. If the memory is fully filled during logging, the memory will either stop recording or start to overwrite data previously recorded. The application software may provide the option for you to choose what action to take when the memory capacity is exceeded. The data memory is usually combined together with a signal conditioning to make a general purpose data logger which can accept analogue inputs from a range of sensor types. For more dedicated use it can also be combined with a sensor and battery power supply which provides a convenient all in one instrument.

Power Supply: The power supply is provided by one of the following methods:

- External DC power via AC/DC mains adaptor or a Power Supply Unit (PSU).
- Battery - Alkaline, Lithium or NiCd rechargeable.
- Solar Power/Battery combination

Before commencing to log data it is essential to make sure there is sufficient power to last the duration of the logging run.

Digital-Communications: The main purpose of a digital interface is for downloading instructions to the data logger from the computer and uploading stored data from the data logger to the computer. When the computer is being used as the data logging platform the digital connection is used to stream live readings. A few software protocols are used to communicate between a computer and the data logger which include:

- Modbus Serial Communications.
- SDI-12 - Serial Data Interface at a 1200 baud rate.
- CANbus - Controller Area Network.

The communications hardware / system that are used to transmit and receive the logged data include:

- Universal Serial Bus Interface (USB).
- RS232.
- RS485.
- Ethernet Local Area Network (LAN).
- WiFi / WLAN - Wireless Local Area Network IEEE 802.11.
- GSM - Global System for Mobile Communications.
- GPRS - General Packet Radio Service[13].

Wireless communication between data logging system and remote base station: Connected to a standard FM RF transceiver, the MR1200 enables to create a long-distance wireless data transmission network (several tens of kilometres). If the network includes RF repeaters, the MR1200 will control them remotely by sending standard audio frequency control tones. The MR1200 connects directly to most programmable controllers or data acquisition terminals via a RS232 or RS485 link.

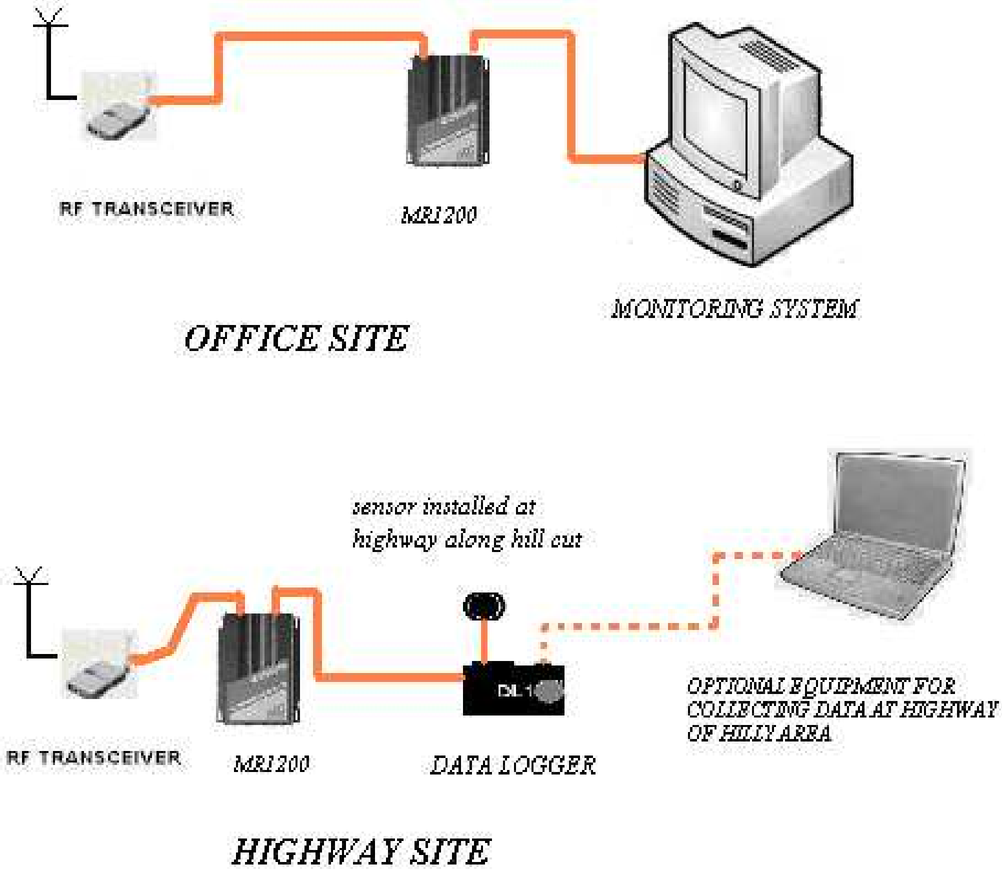

Fig.5: Block diagram of sensor networking

Computer Hardware: Primarily this is used to run the data logger application software and provide a user interface for setting up the logger and analysing the test results. Nearly all application software is compatible with Windows based PC computers but there are some packages which are compatible for Apple Mac computers and mobile device operation systems such as Windows Mobile[13].

Logging Software: A proprietary software package provided with a data logger by the respective manufacturer. Unless the data logger comes with its own visual display and user interface it is impossible to use it without compatible application software. The manufacturer will either provide the software with the product in the form of a CD / DVD or as downloadable file via their website on the Internet. Driver software should also be included to enable computer to communicate with the logger via the chosen digital interface[13].

CONCLUSIONS

This research presented an alternative solution to long distance data communications between highway at hilly area and the decision making office. This solution utilizes IEEE wireless radio standards and equipment to provide an easy to assemble and disassemble network of nodes that is characterized by flexibility and length of coverage. It is inexpensive when compared to equivalent wired alternatives since it can cover significant distance (tens and if needed hundreds of miles) with minimal investment on equipment and labour. The indoor and outdoor tests performed demonstrated the suitability of this technology for office-site data communications. However, these tests also exposed that the need for more research to further improve the reliability and data handling of this technology. Specifically, it was verified that the development of traffic monitoring, securing, interference reduction, data integration and other data administration applications can improve the way diverse types of highway are handled.

ACKNOWLEDGEMENTS

The study carried out is part of ongoing research project, sponsored by the Department of Science and Technology, Government of Rajasthan vide sanction No.P.7 (3)S.T./R&D/2010-11/3280-91 Jaipur dated 20.3.2012. We are thankful to DST, Rajasthan, for their financial support. The Director Research, MPUAT, Dean CTAE and Head Department of Mining Engineering, CTAE are sincerely acknowledged for providing necessary facilities.

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