Ad-hoc network for Landslide & Forest Fire Detection

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***Abstract*-The topic is an idea inspired from a disaster happened at Malin, Pune. This paper emphasizes on the methods to detect landslide and club it with the multiple ad-hoc network to detect forest fires, earthquakes to efficiently detect the natural and manmade disasters occurring in a forest and mountainous scenario. The methodology is to make small and cost effective modules of sensors and plant multiple modules at the strategically prone areas. And gather the data from the sensors to send it to a control room for further real time processing of the parameters and generate a warning signal as the system sends the value greater than the defined value.**

Keywords- wireless sensor network, landslide, MANET, Zigbee

INTRODUCTION

Environmental disasters are largely unpredictable and occur within very short spans of time. Therefore technology has to be developed to capture relevant signals with minimum monitoring delay. Wireless sensors are one of the cutting edge technologies that can quickly respond to rapid changes of data and send the sensed data to a data analysis center in areas where cabling is inappropriate.

Landslides are the major cause of loss of life, human settlements, agriculture, forestland, and lead to damage of communication routes. The term landslide describes many types of downhill earth movements ranging from rapidly moving catastrophic rock avalanches and debris flows in mountainous regions to more slowly moving earth slides. It occurs as gravitational forces exceed the strength of material in a slope. Rocks, debris and slumps slide on a weak, fractured, slick, clayey or water-saturated planar or curved slip surface. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that those can demolish property and lives suddenly and unexpectedly. As landslide moves down slope, the ground surface cracks, tilts, and drops. The causes of landslides in India are mainly due to extreme rainfall and earthquake. Landslides affect approximately 15% of land area of Indian subcontinent and reaching around 0.49 million km^2. India has a sensational record of catastrophes due to landslides.[1]

The selection of this topic was due to the mishap happened in Malin village. On 30 July 2014, a landslide occurred in the village of Malin in the Ambegaon taluka of the Pune district in Maharashtra, India which killed at least 134 people. In addition to those dead, more than 160 people, and possibly up to 200, were believed to have been buried in the landslide in 44 separate houses.[1]

LITERATURE SURVEY

In this chapter we give a literature review on the different landslide detection techniques, and real time techniques used for the detection in past. It helped us to decide the actual scenario and implementations of the project. There has been various ways in which landslide detection system has been realized in past.

Few methods are listed

I. LiDAR

LiDAR (Light Detection And Ranging) can be used to obtain a more accurate and detailed topographic survey. LiDAR generates accurate 3D coordinates of discrete measurements. Subsequently, DEM (Digital Elevation Model) and DSM (Digital Surface Model) can be produced with high efficiency. One of the most important advantages of airborne LiDAR only needs a single laser pulse to penetrate through the trees to measure the ground beneath. LiDAR will have far fewer areas where the terrain is obscured by trees that block the lines of sight. The geomorphometric features become good tools for landslide detection[2]

II OTDR

In the OTDR (Optical Time Domain Reflectometry) method the sensor is a mechanical device in which part of an optical fiber bends in response to landslide displacement. Several sensors are installed along the optical fiber measurement line, and the OTDR detector detects the transmission loss of the light caused by bending of the optical fiber, at the locations of several sensors simultaneously. The landslide displacement is calculated from the change of transmission loss.[2]

III Terrestrial Laser Scanning Method

The multitemporal monitoring of a landslide is a fundamental tool for its knowledge and the prediction of its possible spatial or temporal evolution. Several surveying methodologies are used to investigate the activity of existing landslides. Two main classes are identifiable: point based (Total Station, GPS) and area based techniques (Photogrammetry, Laser Scanning and Remote Sensing, in particular spaceborne radar interferometry.[2]

IV Wireless Sensor Network (WSN)

Wireless sensor network(WSN) technology has the capability of quick capturing, processing, and transmission of critical data in real-time with high resolution. However, it has its own limitations such as relatively low amounts of battery power and low memory availability compared to many existing technologies. It does, though, have the advantage of deploying sensors in hostile environments with a bare minimum of maintenance. This fulfills a very important need for any real time monitoring, especially in hazardous or remote scenarios. Wireless sensor networks (WSN) is one of the emerging technology that can be used for real-time locally distributed information monitoring of the landslides.WSN has the capability of large scale deployment, low maintenance, scalability, adaptability for different scenarios and low maintenance requirement which made it one of the best suited technologies for real-time monitoring [3]. A sensor network normally constitutes a wireless adhoc network, meaning that each sensor supports a multi-hop routing algorithm i.e. several nodes may forward data packets to the base station/coordinator. A landslide detection system with the use of a wireless sensor network can detect the slight movements of soil or slope instability due to the several reasons such as dielectric moisture, pore pressure etc. that may occur during a landslide. We used the method of wireless sensor networks (WSN) in this project for construction of network sensors for the detection of landslide, earthquake and forest fires.[3]

SYSTEM OVERVIEW

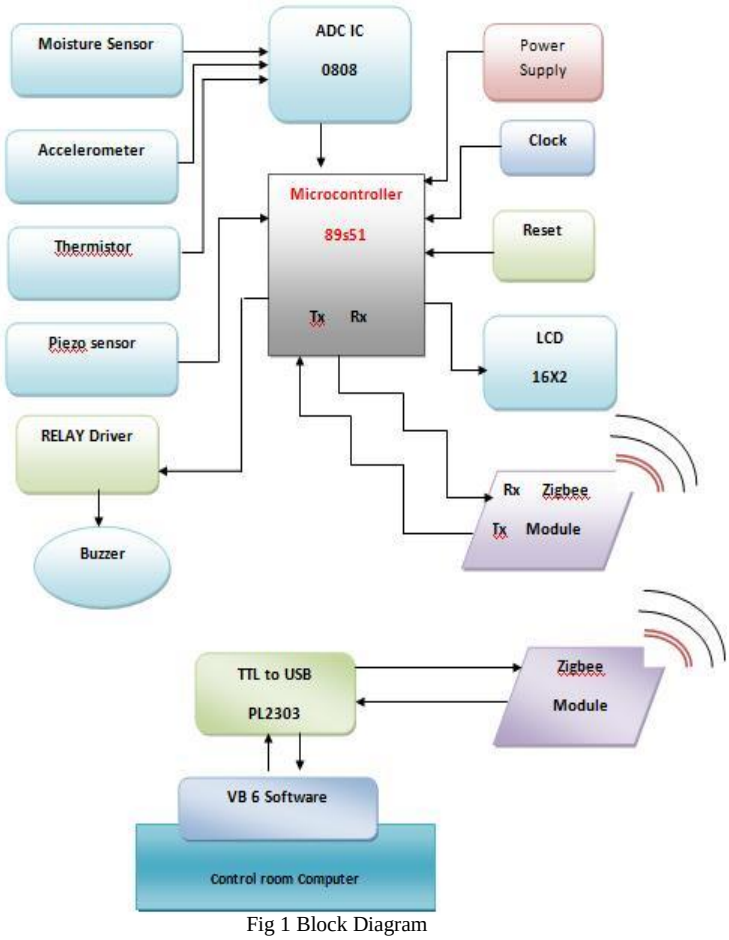

Fig 1 Block Diagram

I LCD Display

Various display device such as seven segment display. LCD display, etc can be interfaced with microcontroller to read the output directly. In our project we use a two line LCD display with 16 characters each. Liquid crystal Display (LCD) displays temperature of the measured element, which is calculated by the microcontroller. CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption.

Fig 2 LCD Display

II ADC0808

ADC0809 of National Semiconductor (8-Bit µP Compatible (A/D Converters with 8-Channel Multiplexer). The ADC0808, ADC0809 data acquisition component is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique.

III Microcontroller AT89S51

The AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of In System Programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry- standard 80C51 instruction set and pin out.[7]

Fig 3 Atmel 89s51 microcontroller

IV Sensors

i. Acceleration/Vibration/Tilt Sensor – 3 Axis

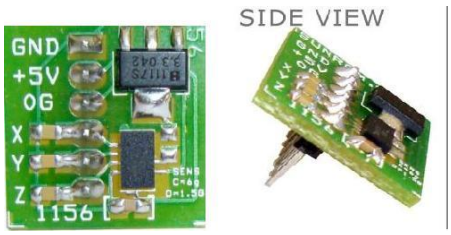

Fig 4 Accelerometer

Accelerometer sensor can measure static(earth gravity) or dynamic acceleration in all three axis. Application of the sensor is in various fields and many applications can be developed using this sensor. Accelerometer sensor measures level of acceleration where it is mounted this enable us to measure acceleration/deceleration of object like car or robot, or tilt of a platform with respected to earth axis, or vibration produced by machines. Sensor provides 0G output which detect linear free fall. Sensitivity can be adjusted in two ranges. Acceleration is a vector force which has direction and measured in meters per second. Earth produces gravitational acceleration on all objects on earth. By monitoring the three axis acceleration one can measure the level of tilt of any platform.[6]

ii. Piezo Sensor

Transducer materials convert one form of energy into another, and are widely used in sensing applications. The tremendous growth in the use of microprocessors has propelled the demand for sensors in diverse applications. Today, PIEZOELECTRIC POLYMER SENSORS are among the fastest growing of the technologies within the $18 billion worldwide sensor market. Like any new technology, there have been an extraordinary number of applications where "PIEZO FILM" has been considered for the sensor solution. In the 20 years since the discovery of piezoelectric polymer, the technology has matured, practical applications have emerged from a long list of possibilities, and the rate of commercialization of the technology is accelerating.[6]

iii. Thermistor

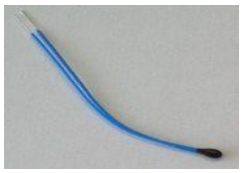

Fig 5 Thermistor

A **thermistor** is a type of resistor with resistance varying according to its temperature. Thermistors can be classified into two types depending on the sign of *k*. If *k* is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (**PTC**) thermistor, or **posistor**. If *k* is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (**NTC**) thermistor. Resistors that are not thermistors are designed to have a *k* as close to zero as possible, so that their resistance remains nearly constant over a wide temperature range.[6]

iv. Moisture Sensor

A soil moisture sensor is a water conservation accessory for conventional automatic irrigation controllers or "time clocks" with the potential for eliminating excessive irrigation cycles. As it is efficient to generate real time values of moisture content in soil, hence it is used in our project[4]

V Zigbee module

Zigbee is a wireless standard based on 802.15.4 developed by the zigbee alliance (an organization of semiconductor manufacturers, technology providers, and OEM's). Sensor systems for controlling utility systems have become ZigBee's main applications. A zigbee network may have as many as 65,536 nodes. The name zigbee comes from the zigzag dance that bees use to communicate the location of a pollen source. In a zigbee network, messages find their way across nodes to a destination the same way data traverses the Internet. Zigbee supports star, mesh and cluster-tree network topologies. One of the advantages adopting the commutation technology of zigbee is the low power consumption compared to that of Wi-Fi or Bluetooth. A few AAA batteries can keep a zigbee device running for more than a year. Another advantage is the low cost.[5]

Fig 6 Zigbee

ADVANTAGES

- Robust circuitry
- Less Power consumption
- Can be deployed in any terrain
- Fast and real time processing
- Bare minimum maintainance
- Wireless and mobile infrastructure
- Smarter routing protocols

FUTURE SCOPE

The microprocessor used is fast and cost effective but it have less ports, so for expansion of module and to add sensors, an upgraded version of microprocessor with higher RAM and ROM can be used like ARM, PIC.

The Adhoc network can be improved by

1. Adding new modules of RFID for animal tagging for tracking purposes thereby modifying the configuration to MANET .
2. Adding piezo plates on the upper strata of the earth layer for the intruder detection at the hilly and remote locations.
3. For more accurate detection of landslides a combination of WSN and OTDR method can be implemented but the cost of the system will gradually increase.
4. The zigbee modules can be replaced by GSM modules at the Router and End Device level of the infrastructure.

CONCLUSION

The project entitled “Ad-hoc Network for Landslides and Forest Fire Detection” can be efficiently implemented for landslide detection and forest fire detection. The method is cost effective, relatively fast, mobile and reliable. The advantage is that the data can be processed in real time. The power requirement is low and the circuitry is robust.

REFERENCES

[1] http://en.wikipedia.org

[2] www.safeland-fp7.eu/results/Documents/D4.1_revised

[3] M. V.Ramesh, N. Vasudevan and J. Freeman,“Real time landslide monitoring via wireless sensor network”,*Geophysical Research Abstract, Vol. 11*, 2009, EGU2009-14061.

[4] http://www.intechopen.com/books/smart-wireless-sensor-networks

[5] http://www.memsic.com/products/wireless-sensor-networks/wireless-modules.html

[6] Wireless Sensor Network for Disaster Monitoring, Dr. Maneesha Vinodini Ramesh www.intechopen.com

[7] www.atmel.com/images/doc2487.pdf