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Landslide Detection and Warning System using WSN

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Abstract - *Wireless Sensor Network is one of the most promising field and has innumerable applications in the real-time systems. Implementation of WSN in real-time system for landslide detection and warning system is discussed in this paper. Sliding of rocks and soil is called landslide. It is triggered mostly because of heavy rainfall or melting of snow and can cause loss of lives and property. Using real-time monitoring the landslide can be detected and with the help of suitable warning system people can be warned. For this system we proposed the use of LPC2148 ARM microcontroller and zigbee for warning system.*

Key Words: **Zigbee, Microcontroller, Accelerometer and Sensor.**

1. INTRODUCTION

Landslides mostly occur during monsoons in India, causing great loss of life and property. They cause considerable damage to highways, railways, and pipelines. They generally occur with other major natural disasters such as earthquakes, volcanic activity and floods are caused by heavy rainfall. In many cases, expanded development and human activities, such as modified slopes of land and deforestation, can increase the incidents of landslide. An early warning system for landslide prediction can reduce these losses to a great extent. We intend to use the wireless sensor networks in the landslide prone areas for estimating the chance occurrence of landslides.

Wireless sensors are one of the technologies with great advancements that can quickly respond to rapid changes of data and send the sensed data to a data monitoring center via zigbee. Sensors are easy for rapid installation, which can be positioned directly upon the landslide body, or in the surroundings, to provide real time data on the landslide activity.

Landslide is a frequently occurring natural disaster in hilly regions. Major landslide prone areas in India are the Himalayas, Indo-Burmese Range, Western and Eastern Ghats, Nilgiris, and Vindhya Range. It affects approximately 15% of land area of India, which accounts nearly 0.5 million square kilometer [1-3].

2. PROPOSED SYSTEM

In the proposed system we have the modules of Zigbee for remote correspondence and three sensors for information retrieval. The sensors utilized are Soil moisture sensor, Humidity sensor and accelerometer sensor. There will be warning system at the remote place which will be activated when the sensor values cross threshold value.

The information gathering and monitoring unit gathers the information through different sensors and control utilizing LPC 2148 microcontroller .The information is transmitted from the gathering and control segment, consequently it go as transmitting unit. In this unit we have the diverse sensor, for example, Soil moisture sensor, Humidity sensor and Accelerometer sensor.

The diverse parameters, for example, dampness in air, soil moisture and soil movement are identified utilizing this sensors. These sensors are combined to a frame which is controlled by ARM7 controller.

Monitoring, forecasting and warning of landslides are the important features for saving the lives and assets from catastrophic devastation. There are mainly three fundamental ways for monitoring the landslide such as visual, surveying and instrumentation. Each monitoring technique has its own pros and cons and application range. Ground based visual inspection and sampling of this data on continuous basis may be one of the effective ways of monitoring the landslides. Surveying includes all type of physical measurements such as levels, theodolites, electronic distance measurement (EDM), and total station provide some of the prominent landslide features [5, 6]

The real-time monitoring networks are restricted by energy consumption, due to the remote location of the implementation site and the unavailability of constant power.

Considering these factors, the wireless sensor network at the implementation site implements a totally innovative concept for distributed detection and estimation to arrive at

dependable decisions, more accurate than that of each single sensor and capability to achieve universally optimal decisions.

In landslide scenario, the implementation of this algorithm imposes a constraint of handling various sensors in each sensor node. The techniques that can be used for implementing this algorithm are referred from [7], [8] and [9].

3. WORKING

The transmitter circuit consists of power supply, soil moisture sensor, humidity sensor, and accelerometer sensor and zigbee module blocks. The sensors are connected to the ADC 0 and ADC 1 of microcontroller. The signal conditioning circuit is used for sensors to get appropriate output. The data collected from the sensors is in voltage form thus we convert it in suitable format to display the results. The power supply is designed for 3.3V for microcontroller and 5V for peripheral modules. The transmitting of data is done using zigbee. Zigbee has range of 500m approximately.

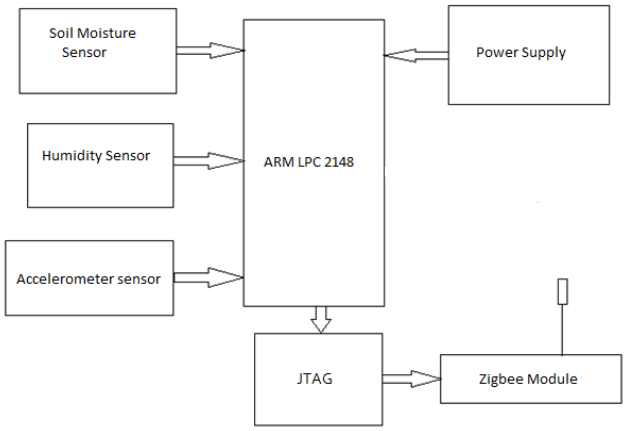

Fig.3.1. Transmitter

The receiver consists of zigbee and computer for monitoring the data. The warning system is activated when the threshold value is crossed. The data shown by soil moisture sensor and humidity sensor is in the form of percentage.

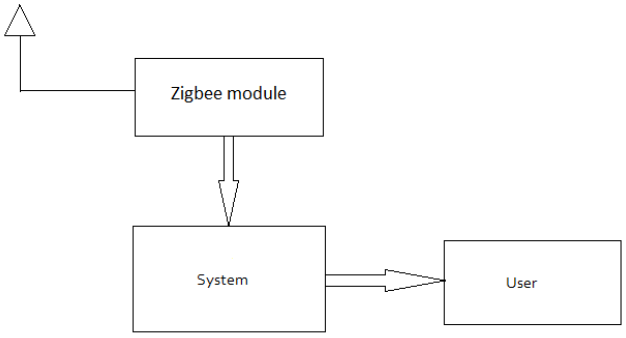

Fig.3.2.Receiver

The flowchart of the process is as shown below. The system is turned on at first then the real-time monitoring is started. The monitoring takes place for every 1 second, that is, the data is checked every second. Then the threshold value is set on the device by the user. The microcontroller processes the data and it is checked constantly if it crosses the threshold value. If the threshold value is crossed then the buzzer alerts are given.

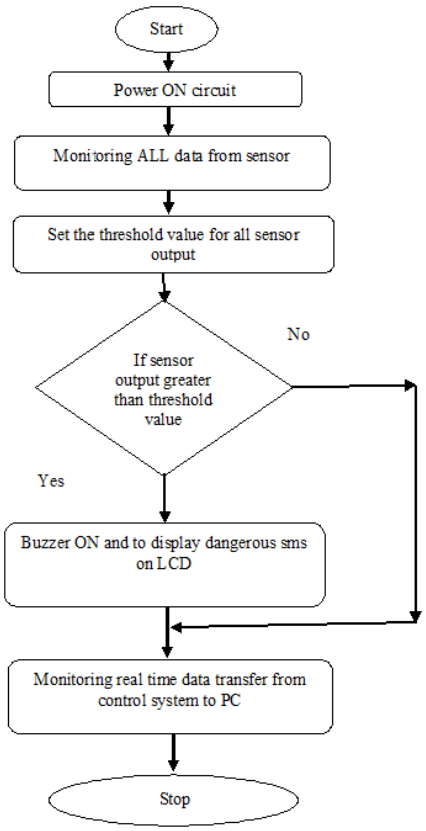

Fig.3.3. Flowchart

4. COMPONENTS

4.1 Microcontroller

Here we used ARM LPC2148 microcontroller. The LPC2148 microcontroller is based on a 32 bit ARM7TDMI-S CPU with real-time emulation and trace support, that combines the microcontroller with embedded high speed flash memory up to 512 kb. A 128-bit wide memory interface and a unique accelerator. To this microcontroller Zigbee and sensors are attached. Microcontroller performs the tasks of collecting data and transferring data from sensors to Zigbee and display the output on LCD screen.

4.2 Humidity sensor

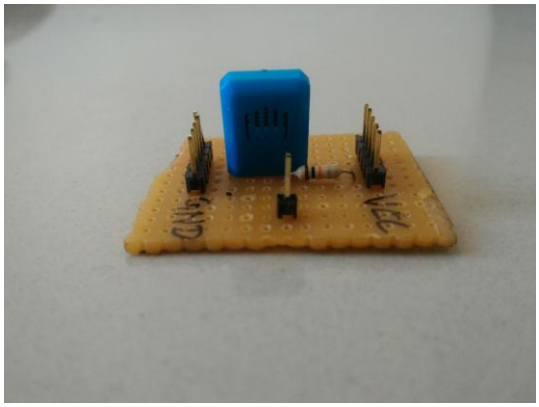

Fig.4.1. Humidity sensor

Humidity is the presence of water vapor in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries and it also increases the chance of landslides. Humidity measurement in disaster management is critical because it may affect the landslides. Hence, humidity sensing is very important, especially in the control systems for landslide detection.

4.3 Accelerometer

An accelerometer is a dynamic sensor capable of vast range of sensing. Accelerometers are available that can measure acceleration in one, two, or three axes. They are typically used in one of three modes:

- As an inertial measurement of position and velocity;
- As a sensor of inclination, tilt, or orientation in 2 or 3 dimensions, as taken from the acceleration of gravity (g = 9.8m/s^2);
- As a vibration or impact (shock) sensor.

4.4 Soil moisture sensor

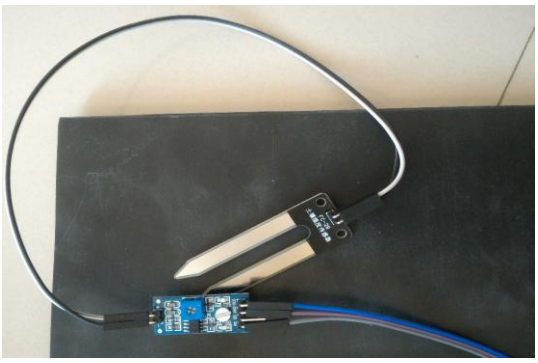

Fig.4.2. Soil moisture sensor

Soil Moisture sensor FC-28 comes with a pair of probes that can be inserted in the soil. A small current flow through the probes and the level of resistance will be measured. If the resistance more, the soil is drier. The output from the sensor is an analog output that can be connected to one of the analog to digital port (ADC) available on the microcontroller [11].

4.5 Zigbee

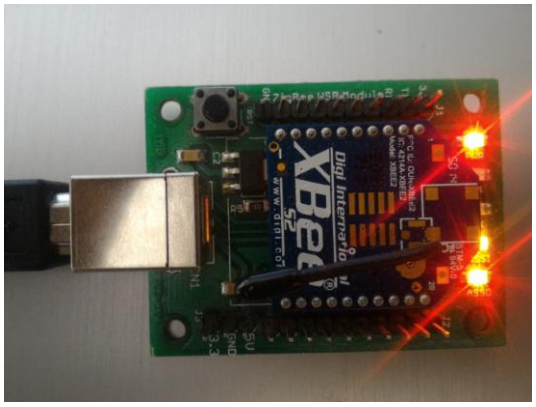

Fig.4.3.Zigbee

Zigbee is the main hardware module used in this project for communication purpose. We have two zigbee modules one at transmitter side, another at the receiver side. Using zigbee we can communicate at high data rates. External signal is not needed for this communication, so we can use this zigbee modules anywhere even in forests, mountains etc. using peer to peer communication. One zigbee can communicate with any other zigbee present in the surrounding area. The transmitter zigbee sends the data obtained from transmitter side processor it transmits without any delay. Then receiver side zigbee receives the data transmitted from transmitter. In this there is no data loss so it is secure form of communication. In this zigbee there is no need of human involvement to send or receive data as it automatically sends and receives data. In this we use IEEE 802.15.4 protocol stack.

5. POWER SUPPLY

The power supply circuits are constructed using rectifiers, filters, and then voltage regulators. Starting with an AC voltage, a varying DC voltage is obtained by rectifying the AC voltage, then filtering to a DC level, and finally, regulating to get a desired fixed DC voltage. The regulation is usually obtained from a voltage regulator unit, which receives a DC voltage and supplies a lower DC voltage as required, which remains the same even if the input DC voltage varies, or the output load connected to the DC voltage varies.

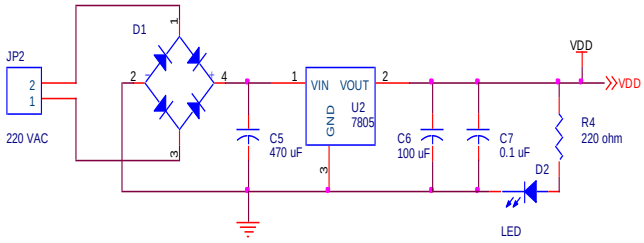

Fig.5.1. Power Supply

6. EXPERIMENTAL RESULTS

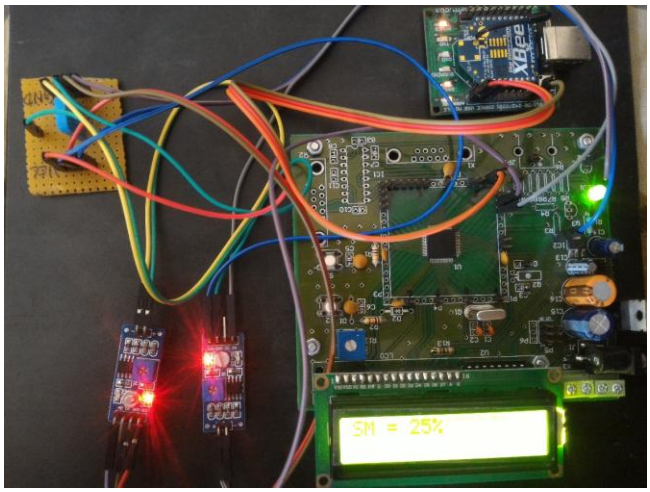

Fig.6.1. Experimental kit

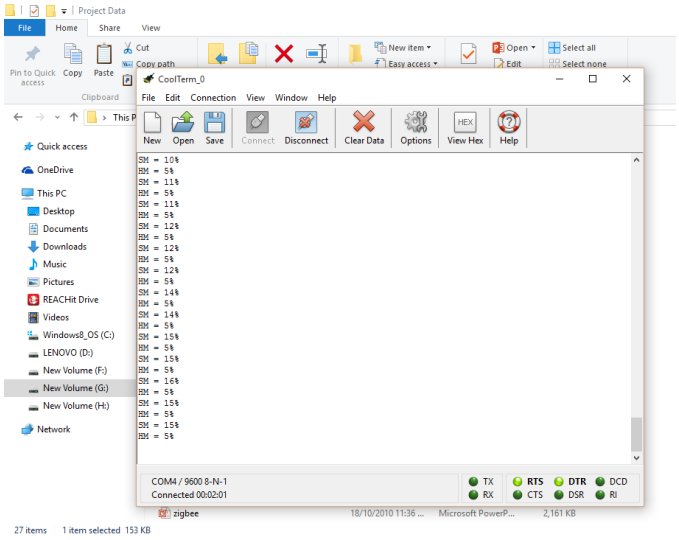

Fig.6.2.Results

Humidity sensor and Soil moisture collect data in analog form and they are connected to ADC through signal conditioning circuit. We use signal conditioning because both side impedance is high. LPC 2148 convert this data in digital form and convert it into percentage and display this value in percentages on LCD.

Sensor readings are sent to base station through wireless connection using Zigbee. Zigbee transfers all data to base station and it can be observed on terminal.

7. CONCLUSIONS

In this paper, wireless sensor network based landslide detection system is discussed. This system uses a zigbee wireless technology and ARM7 microcontroller composed of wireless sensors. This network will be used for understanding the capability and utility of wireless sensor network for critical and emergency applications.

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