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GSM Based Real-Time Wireless Sensor Network for Landslide Detection

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Abstract*—The planet Earth has hundreds of impact events, with some occurrences causing both in terms of human casualty as well as economic losses. Such attitudes of earth pushed the frontiers to develop innovative monitoring strategies for the earth system. To make that real, although, will require coherent and real-time data by observing the earth behaviour contiguously. Wireless Sensor Network (WSN) appears to be the best suitable infrastructure to sense environmental parameters of our interests. In this event of earth observation, another important issue is the monitoring system with high level of precision. There are different types of sensors to measure the behavioural aspects of earth. The sensors integrated with WSN, provide an accurate and contiguous data for analysis and interpretation. This paper briefly addresses earth observation and areas of critical importance to people and society. The system monitors the changing geo-technical condition using various geo-technical sensors like soil moisture sensors, weight sensor, and tilt meter. This paper also touches upon the aspects of data transmission over Global System for Mobile Communication (GSM) to a remote data center.

***Keywords*—Wireless sensor network, Landslide monitoring, Landslide pre-warning, GSM, Sensors**

I. INTRODUCTION

Landslide also known as a landslip, is a geological phenomenon that includes a wide range of ground movements such as rock falls, deep failure of slopes and shallow debris flows. India is being affected by hydro-geological hazards like landslide since years ago. History depicts that, it has happened mostly in Himalayan regions, Hill ranges of Northeast, Western & Eastern Ghats of India. The North East (NE) region of India is badly affected by bewildering varieties of landslides; specifically the state of Arunachal Pradesh. This make the landslide monitoring as an important aspects and challenges for the geo-scientists in India. Most of the landslides in India are caused due to heavy rainfall. Rainfall events can cause slope failures in areas of limited extent or in large regions. Developing an early warning system for the monitoring of landslides requires its domain expertise, not just to build the instruments but to use them properly and interpret their output for rational purpose.

The main causes of landslides are:1) Geological causes: Rainfall and snow fall, Earthquakes 2) Morphological causes: Slope angle, Erosion 3)Physical causes: Volcanic eruption, Ground water changes 4) Human causes: Quarrying, Deforestation. Few major landslides of India are listed as: 22 September 1893 -- a huge slide completely blocked the river Birahi Ganga at village Gohna, 11 – 12 July 1996 -- massive landslide in Jaldhaka valley and South Kalimpong hills -- 32 lives lost, damages to huge property, 9th June 1997 --Widespread devastation of Gangtok town, 7th July 1999 -- Kurseong town devastated, 8 August 1998 - major landslide at Malpa, Uttaranchal- 200 people perished.

Section II shows the block diagram of the system. Section III describes the detailed types of sensors used for detection. Section IV shows the mathematical modelling of project. Section V shows the hardware development of the system. Section VI and VII show the conclusion and references respectively.

II. HARDWARE DEVELOPMENT

The system consists of field unit and base unit.

Field Unit-This unit is divided into the following sections.

ATmega32—It is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.ATmega32 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals.

LCD display—utilizes sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. LCD technology has advanced very rapidly since its initial inception over a decade ago for use in lap top computers. Technical achievements has resulted in brighter displace, higher resolutions, reduce response times and cheaper manufacturing process. The liquid crystals can be manipulated through an applied electric voltage so that light is allowed to pass or is blocked.

Zigbee—Zigbee is new wireless technology guided by IEEE 802.15.4 Personal Area Network standard. This Zigbee transmitter and Zigbee receiver module is interfaced with AVR microcontroller and ARM 7 (LPC2148) microcontrollers respectively and they communicate serially through MAX232.

Sensors—Soil Moisture Sensor- Soil moisture sensors measure the water content in soil. Fig.1 given below shows the soil moisture sensor.

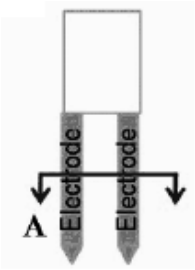

Fig.1 Soil Moisture Sensor

Weight sensor (load cell) —A load cell is a transducer that is used to convert a force into an electrical signal. Fig.2 given below shows the weight sensor.

Fig.2 Weight Sensor

Tilt meter-A tilt meter is used to monitor changes in inclination of a structure. Tilt meter data can provide an accurate history of movement of a structure and early warning of potential structural damage.

III. SYSTEM BLOCK DIAGRAM

This section describes the block diagram of the system.

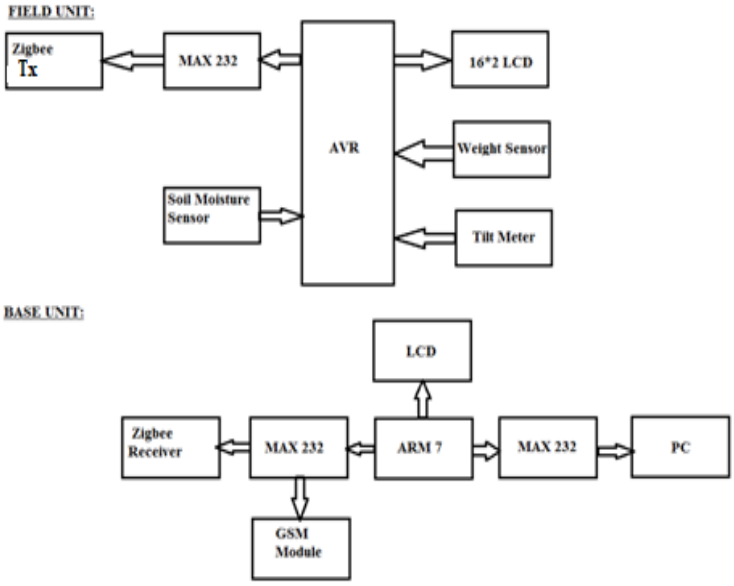

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Fig. 3 Block Diagram of System

IV. TYPES OF SENSORS USED FOR DETECTION

This section describes different types of sensors used for detection of different parameters such as soil moisture, the initial slope failure and the final deposition of the slide materials.

Heavy rainfall conditions, rain infiltration on the slope causes instability, a reduction in the factor of safety; transient pressure responses, changes in water table height, a reduction in shear strength which holds the soil or rock, an increase in soil weight and a reduction in the angle of repose.

The initial slope failure can occur due to the increase in soil moisture content, under heavy rainfall, which necessitates the inclusion of geophysical sensors for detecting the change in pore pressure and moisture content with the warning system developed for landslide detection.

The table 1 shows the sensors used and their tasks.

Table I Sensor & related task for landslide detection system

S .No	Sensors	Task
1	Soil Moisture	Measure moisture in the Soil
2	Tilt Meter	Calculate angle of sensor column
3	Load Sensor	Measure deformation across slope

V. CONCLUSION

Landslide detection is one of the challenging research areas available today in the field of geophysical research. This paper discusses the design and deployment of a landslide detection system for laboratory experiment. The main goal of this effort is to detect rainfall induced landslides which occur commonly in India.

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