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Landslide Detection and Alert System Using PSoC

Mr. C. C. Dakave, Dr. M. S. Gaikwad

***Abstract*— Landslide mainly happens especially due to heavy rainfall which leads to considerable loss of life, communication damage, damage to agricultural and forestlands, In this paper we are implementing with PSoC development hardware which contains an accelerometer sensor which means MEMs sensor and other environment monitoring sensors like Ultrasonic sensors. The details are monitored and send through wireless communication module Zigbee to Another node called as access point which receives the alert message from land slide detector and enables a voice for alarming civilians. Continuous monitoring enables pre-detection of landslide. Also it is able to gather other details like the rate of land slide etc.**

***Index Terms*— PSoC, Sensors, Zigbee.**

I. Introduction

In India mass of failure slide mainly happens especially due to heavy rainfall which leads to considerable loss of life, communication damage, damage to agricultural and forestlands. The annual loss sometimes even crossed around $400 million. Most repeatedly at north-eastern region including Himalayan region and a section of Western Ghats including Vindhya mountain range has a significant problem of land-slide[1].

Land Slide Detection and Monitoring System using Wireless Sensor Networks (WSN): Mass failures of slope, which includes movement in soil, rock, ice which cause a considerable damage to the natural habitat, environment, economy and other resources. Detection, monitoring and control are the three major issues regarding Real-Time applications. For a large scale of fault and monitoring the faults is one of the important applications that lead to advancement of many kind of technologies. In this paper A Land-Slide detection system is being developed at Bidholi (village), Dehradun, India, a region with high rainfall and versatile climatic behavior most of the year. Integrating Geophysical ensors forming a heterogeneous wireless network helps in identifying the fault and this paper also includes development, deployment (analysis) and data retrieval of the sensors information using WSN.

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Real-time Wireless Sensor Network for Landslide Detection: Wireless sensor networks are one of the emerging areas which have equipped scientists with the capability of developing real-time monitoring systems. This paper discusses the development of a wireless sensor network(WSN) to detect landslides, which includes the design, development and of a WSN for real time monitoring, the development of the algorithms needed that will enable efficient data collection and data aggregation, and the network requirements of the deployed landslide detection system. The actual deployment of the test bed is in the Idukki district of the Southern state of Kerala, India, a region known for its heavy rainfall, steep slopes, and frequent landslides.

Landslide Monitoring with Sensor Networks: Experiences and Lessons Learnt from a Real-World Deployment: Wireless sensor networks have the potentials to be a very useful technology for engrained monitoring in remote and hostile environments. This paper reports on the implementation and deployment of a system for landslide monitoring in the Northern Italy Apennines, and analyzes the positive results we have achieved with it. Yet, the paper also critically analyzes the problems and the inherent limitations/difficulties we had to face in developing and deploying such a system, challenging many of the \big claims" that are often heard around wireless sensor networks.

An Autonomous Landslide Monitoring System based on Wireless Sensor Networks: Landslides cause significant damages to civil infrastructure. Over the years, methods and technologies have been proposed to determine the risk of landslides and to detect hazardous slope movements. There have been increasing interests in developing and landslide monitoring systems to observe movements using sensors installed on the slope. Although providing accurate data, many landslide monitoring systems are not operating in an automated fashion and lack the ability to analyze the collected data in a timely manner. This paper presents an autonomous landslide monitoring system based on wireless sensor networks. Self-contained, autonomous software programs (“software agents”) are embedded into the wireless sensor nodes. In cooperation with each other, the software agents are continuously collecting and analyzing sensor data, such as recorded ground acceleration and the orientations of the sensor nodes along the slope. If movements are observed, the collected data sets are automatically transmitted to a connected server system for further diagnoses. The landslide monitoring system presented in this paper is remotely accessible via Internet and provides real-time information about the current state of the monitored slope. Laboratory tests have been conducted to validate the reliability and the performance of the monitoring system.

II. PROPOSED WORK

1. Existing System:

- Safety measures are taken only after landslide occurs.
- Need human help for checking position to detect weather Fall can occur or not.

2. Proposed System:

A wireless sensor networks used to alarm the effects of landslides well in advance before land sliding occurs. The proposed work considers a sensor node for the application with base station or the access point. The wireless transceiver receives the data's from the sensors and transmitted to the access point or the base station. Continuous monitoring can also be done. When the angular sensor gets tilted some voltage gets produced when this voltage reaches or increases the threshold value it will produce an alert. It can be monitored from the base station.

3. Block Diagram:

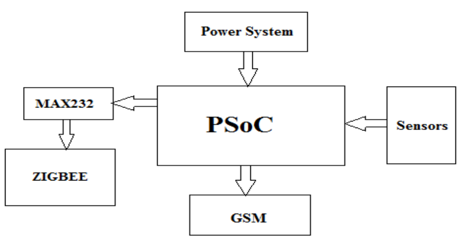

Fig 1: Transmitter

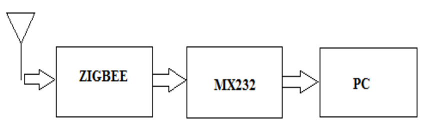

Fig 2: Receiver

This describes a PSoC 3 controller which contains a true programmable embedded system-on-chip, integrating configurable analog and digital peripherals, memory, and a microcontroller on a single chip. The PSoC 3 architecture boosts performance through:

- 8051 core plus DMA controller and digital filter processor, at up to 67 MHz .
- Ultra low power with industry's widest voltage range.
- Programmable digital and analog peripherals enable custom functions.
- Flexible routing of any analog or digital peripheral function to any pin.

PSoC devices employ a highly configurable system-on-chip architecture for embedded control design. They integrate configurable analog and digital circuits, controlled by an on-chip microcontroller. A single PSoC device can integrate as many as 100 digital and analog peripheral functions, reducing design time, board space, power consumption, and system cost while improving system quality.

Wireless sensor networks have the capability of large scale sensor deployment and have the advantages of adaptability, easy maintenance, and low installation cost with scalability for different environmental scenarios. Disaster management of various environmental activities and detecting these conditions is one of the crucial parts that any technology should perform. Real time environmental disaster detection and monitoring is one of the basic necessities of the world. Various technologies have been developed till now and wireless sensor networks are one of the technologies that can fulfill the requirement. WSN has the capability of deploying in populated areas as well as data extraction and transmission is easy with low cost and low power consumption[1].

This is basic implementation of land-slide detection and monitoring system with various geo-physical sensors forming a heterogeneous network (MOTE) and transmitting the data to a ground station.

III. HARDWARE DESCRIPTION

1. CY8C38:

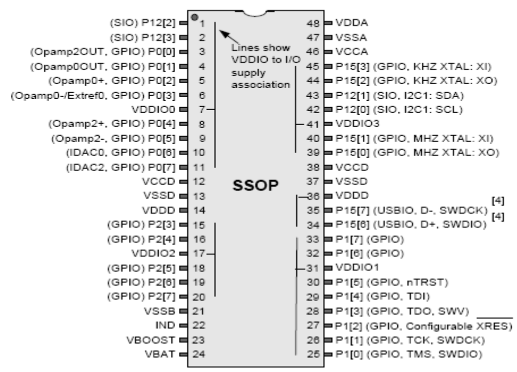

Fig 3: Pinout of IC CY8C38

The CY8C38 devices a true programmable embedded system-on-chip, integrating configurable analog and digital peripherals, memory, and a microcontroller on a single chip[8]. The CY8C38 devices use a single cycle 8051 CPU, which is fully compatible with the original MCS-51 instruction set. The CY8C38 family uses a pipelined RISC architecture, which executes most instructions in 1 to 2 cycles to provide peak performance of up to 33 MIPS with an average of 2 cycles per instruction. The single cycle 8051 CPU runs ten times faster than a standard 8051 processor. The 8051 CPU subsystem includes these features:

- Single cycle 8051 CPU
- Up to 64 KB of flash memory, up to 2 KB of EEPROM, and up to 8 KB of SRAM
- 512-byte instruction cache between CPU and flash
- Programmable nested vector interrupt controller
- DMA controller
- Peripheral HUB (PHUB)
- External memory interface (EMIF)

2. ZIGBEE:

Wireless transmission can be achieved by a device which an facilitate the signal trans-receiving. This 2.4GHz frequency is un-pain frequency for general purpose as well as educational purpose. This can be further developed by integrating ETHERNET service along with zigbee for optimum data conversion and transmission. The size of the module is so small which can be easily portable for this application.

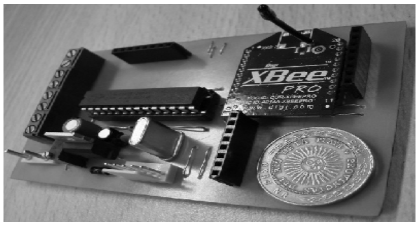

Fig 4: Zigbee Module

There were many wireless modules available in the market, but the low cost, high transmission range capability, ease of interfacing and low power consumption with regarding to NODE turns the views of the project to use the ZIGBEE module as a medium of communication.

3. SENSORS:

***a) Geophone*:** This is a device which converts the ground displacement or movement into some voltage which may be recorded at a ground station for monitoring.


Fig. 5: Mechanical Geophone

Under fault conditions if the measured voltage is more than normally measured then that responses are called 'seismic response' and this can be collected for analyzing the structure of earth under various dependent conditions. The geophone works with normal operating voltage of 30V and ground activities can be collected for every 30V change in voltage variation. But this is hard to design a NODE with this mechanical sensor forming a heterogeneous network for this condition we can use 'seismometer' on behalf of geophone which can fulfill the purpose. Thus this modification of geophone to seismometer converts the entire heterogeneous model into a 'smart NODE' which has even better advantage of direct interfacing with the controller based on requirement. Deployment of this sensor is extended to maximum depth of 0.5 to 1.8 mts.

b) Pore Pressure Sensor: this is a sensor refers to the pressure of underground water during high rain conditions and even normal conditions held with in the soil.

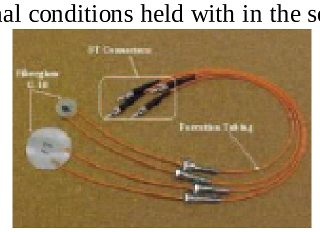
Fig. 6: Pressure Sensor

This sensor mainly helps in to calculate the stress state of the ground with regarding to the soil mechanics.

***c) Dielectric Soil Moisture Sensor*:** This sensor determine the amount of moisture content by measuring the dielectric constant of the soil.

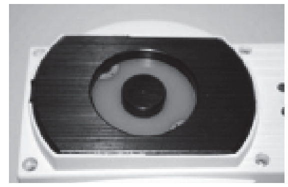
Fig. 7: Moisture Sensor

The constant value for the dry soil is around 3 to 5, 80% for water and about one for air. Thus the changes in moisture content cause a substantial change in the moisture content value of the soil. Range of moisture content of 176 gms of water level of 1kg i.e., 28% to 46% for stability. Deployment of this sensor is extended to maximum depth of 0.8 to 5.5 mts.

d) Strain Gauge: strain is the deformation due to applied force i.e., the frictional change due to physical pressure leads to deformation in length. Deployment of this sensor is extended to maximum depth of 5.5 to 6.8 mts.

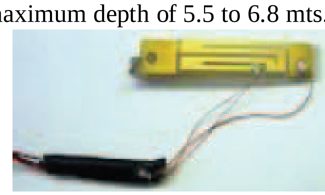
Fig. 8: Strain Gauge

e) Tilt Sensor: we can measure the tilting angle in two directional references. Accelerometer is the reference tilt sensor with ground variation.

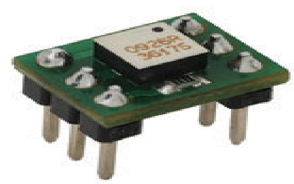
Fig. 9: Tilt Sensor

With the help of these sensors once the moisture, pressure, tilt is calibrated then requirement of soil deformation can be estimated.

f) MAX232:

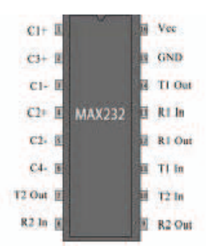

Fig. 10: MAX-232

USART (Universal Synchronous Asynchronous Receiver Transmitter) is a communication protocol for transmitting the data between to control station. The internal RS-232 logic helps in creating the path by maintaining frequency and baud-rate.

g) Power Supply:

Any NODE or any controller circuit requires power supply based on the requirement. For this NODE a battery can be used for fulfilling the requirement or an on-board power supply with a bridge rectifier circuit can be used for this purpose, which converts the AC supply to 12VDC supply and then 5V DC for running the controller, even for some sensors which require 5V as their operating voltage. For this purpose an on-board power supply is being developed which supply electrical signals to run the circuit. This bridge rectifier converts the AC to DC. All the controller components and sensors use 5V, 500ma DC as the source for power supply. But some sensors like pore pressure and strain gauge transducer requires 12V requirement. So the bridge circuit developed in requires the fulfillment of both the power circuit at same time and a 9V-0-9V battery can be used as a source of power supply.

IV. Software Description

1. PSoC Creator:

PSoC Creator is a free Windows-based Integrated Design Environment (IDE). It enables concurrent hardware and firmware design of PSoC 3, PSoC 4, and PSoC 5LP based systems. Create designs using classic, familiar schematic capture supported by over 100 pre-verified, production-ready PSoC Components. With PSoC Creator, you can[8]:

- Drag and drop component icons to build your hardware system design in the main design workspace.
- Co-design your application firmware with the PSoC hardware, using the PSoC Creator IDE C compiler.
- Configure components using the configuration tools.
- Explore the library of 100+ components.
- Review component datasheets.

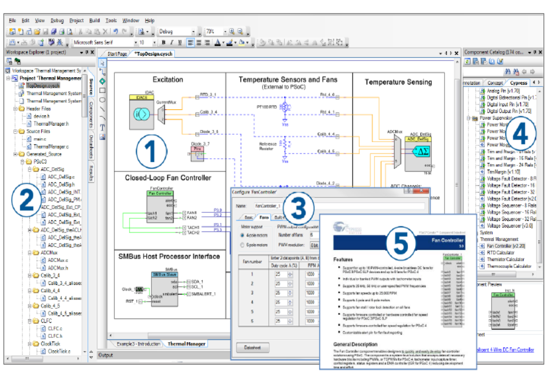

Fig 11: PSoC Creator Tool

V. Node Fabrication

Transmitter Node is the master node that will control all the sensor information that is being gathered through various sensors and transmits to the data to the Receiver Node across two intermediate nodes that helps in efficient transmitting of the gathered data without any missing information.

1. Transmitter Node:

Transmitter node consists of The CY8C38 devices a true programmable embedded system-on-chip, integrating configurable analog and digital peripherals, memory, and a microcontroller on a single chip and transmit the information using ZIGBEE and as well compare the obtained values with stored values, that helps in stability and time with respect to rate of change[1].

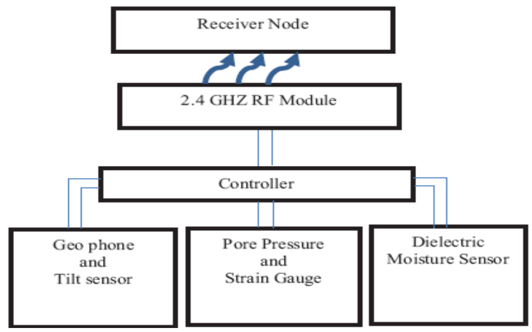

Fig. 12: Transmitter node

2. Receiver Node:

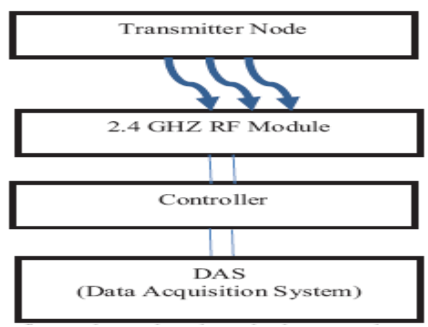

Fig. 13: Receiver node

The flow chart developed above only explains how the information is transmitted by the Transmitter Node to the Receiver Node and receiving end analysis. Intermediate nodes Node1 and Node2 comprises communication module (zigbee) and acts as Trans/Receiver Nodes[1].

VI. Conclusion

This proposed work is for detect disaster like landslide, measuring different parameters using physical sensors and PSoC. If defect is present then alert through wireless sensor network. Data Acquisition System at the control station is equipped with all the necessary protection equipment for all necessary measures which can be easy for the officials to take necessary steps for disaster protection like landslide.

By use of Wireless Sensor Network any mechanical or geo-physical sensor can be interfaced easily for protection of our on livelihood as well as nation's wealth.

VII. FUTURESCOPE

This paper discussed a proto-model of NODE design for 'Land-Slide Monitoring' which of great importance especially in heavy rainfall and hilly areas. The WSN deployment leads to access many of the sensor information and by using Ethernet, Wi-Fi, Satellite or any other wireless protocol the danger intimation can be passed to the nearby villages and to the government officials.

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