EMBEDDED SYSTEM BASED DESIGN OF DATA LOGGER FOR LAND SLIDE DETECTION IN HILL AREAS

VIKALP JOSHI¹, JEETENDER SINGH CHAUHAN²

¹Research Scholar, Instrumentation & Control Engineering, Graphic Era University, Dehradun, India  
²Research Scholars, Instrumentation & Control Engineering, Graphic Era University, Dehradun, India

¹Joshi890vikalp@gmail.com, ²jeetuec@gmail.com

ABSTRACT

Landslide is a general term used to describe the down slope movement of soil, rock and organic materials under the influence of gravity. Land slide is very serious cause of accident, road block & traffic jams in hilly areas. World faces landslides every year with a large threat to human life. Detection of land sliding is a new research area with the help of data logger system. A data logger system able to detect various physical parameters of soil is responsible for landslides in hilly areas. This paper describes the evolution of the system for landslide detection in the Uttarkashi district of the Uttarakhand state, India, a region known for its heavy rainfall, steep slopes, and frequent landslides. This project design a Data Logger for Land Slide Detection System, we can measure the physical variable of soil, which play important role to prediction of landslide in hilly & mountain areas. Data logger for detection in the landslide areas for estimating the chance occurrence of landslide. The proposed work is to detection of landslide using a data logger in real time system.

Keywords: Microcontroller, Sensor, ADC, Landslide, Data logger

1. INTRODUCTION

Landslides are a serious geological hazard caused when masses of rock, earth, and debris flow down a steep slope during periods of intense rainfall and rapid snow melt. The Uttarkashi district of the Uttarahrind state, India and the Himalayan region of India are subject to many such landslides every year. 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.

Fig 1: Landslide (2003) & National highway in Uttarkashi District

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 km² India has a sensational record of catastrophes due to landslides. Landslides are geological phenomena causing significant loss of life and billions of dollars in damages each year. Al- though a basic understanding of the causes and behavior of landslides is available, systems that predict the occurrence of a landslide at a specific site do not exist. However, development of a landslide is a temporal process, which can take as long as a year to develop. Second, the phenomenology of landslides is fundamentally spatial in nature.
2. SENSORS FOR LANDSLIDE DETECTION

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. When the rainfall intensity is larger than the slope saturated hydraulic conductivity, runoff occurs.

Three distinct physical events occur during a landslide:
- The initial slope failure,
- The subsequent transport, and
- The final deposition of the slide materials.

The initial slope failure can occur due to the increase in pore pressure and 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.

Table 1: Sensor & related task for landslide detection system

<table>
<thead>
<tr>
<th>S.No</th>
<th>Sensor</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture sensor</td>
<td>Measure moisture in the Soil</td>
</tr>
<tr>
<td>2</td>
<td>Vibration Sensor</td>
<td>Measure vibration across slope</td>
</tr>
<tr>
<td>3</td>
<td>Strain gauge</td>
<td>Measure deformation across slope</td>
</tr>
<tr>
<td>4</td>
<td>Tilt meter</td>
<td>Calculate angle of sensor column</td>
</tr>
<tr>
<td>5</td>
<td>Resistive piezometer</td>
<td>Measure soil pore pressure</td>
</tr>
</tbody>
</table>

3. HARDWARE DEVELOPMENT

Whole circuit can be divided into following sections:

(a) Data logger (data recorder) - Data logger is an electronic device that records data over time or in relation to location either with a built in instrument or sensor or via external instruments and sensors. Increasingly, but not entirely, they are based on a digital processor (or computer). They generally are small, battery powered, portable, and equipped with a microprocessor, internal memory for data storage, and sensors. Some data loggers interface with a personal computer and utilize software to activate the data logger and view and analyze the collected data, while others have a local interface device (keypad, LCD) and can be used as a stand-alone device. Data loggers vary between general purpose types for a range of measurement applications to very specific devices for measuring in one environment or application type only. It is common for general purpose types to be programmable; however, many remain as static machines with only a limited number or no changeable parameters. Electronic data loggers have replaced chart recorder in many applications. One of the primary benefits of using data loggers is the ability to automatically collect data on a 24-hour basis. Upon activation, data loggers are typically deployed and left unattended to measure and record information for the duration of the monitoring period. This allows for a comprehensive, accurate picture of the environmental conditions being monitored, such as air temperature and relative humidity. The cost of data loggers has been declining over the years as technology improves and costs are reduced. Simple single channel data loggers cost as little as $25. More complicated loggers may costs hundreds or thousands of dollars.

(b) Power supply modules - This module is basically designed to achieved 5V, 500mA. This consists of a transformer which is used to step down the AC voltage, IN4007 diodes used to form a bridge rectifier to convert AC to DC, capacitor 1000uF which used as a filter circuit, 7805 regulator to obtain a 5V at the output of the regulator, 330 ohm resistance, LED as indicator.

(c) LCD Display - LCD is a type of display used in digital watches and many portable computers. LCD displays utilize 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 display, 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.

Fig 2: Diagram of power supply section
By carefully controlling where and what wavelength (color) of light is allowed to pass, the LCD monitor is able to display images. A backlight provides LCD monitor’s brightness. Over the years many improvements have been made to LCD to help enhance resolution, image, sharpness and response times. One of the latest such advancement is applied to glass during acts as switch allowing control of light at the pixel level, greatly improving LCD’s ability to display small-sized fonts and image clearly. Other advances have allowed LCD’s to greatly reduce liquid crystal cell response times. Response time is basically the amount of time it takes for a pixel to “change colors”, in reality response time is the amount of time it takes a liquid crystal cell to go from being active to inactive. Most of the LCD modules conform to a standard interface specification. A 14-pin access is provided having eight data lines, three control lines and three power lines.

**d) PIC Microcontroller** - The PIC microcontroller was originally designed around 1980 by General Instrument as a small, fast, inexpensive embedded microcontroller with strong I/O capabilities. PIC stands for “Peripheral Interface Controller”. General Instrument recognized the potential for the PIC and eventually spun off Microchip, headquartered in Chandler, AZ to fabricate and market the PIC microcontroller. A microcontroller is an integrated chip that is often part of an embedded system. The microcontroller includes a CPU, RAM, ROM, I/O ports, and timers like a standard computer, but because they are designed to execute only a single specific task to control a single system, they are much smaller and simplified so that they can include all the functions required on a single chip. PIC 16F877 is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability.

**e) Soil Moisture Sensor** - Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. One common type of soil moisture sensors in commercial use is a frequency domain sensor such as a capacitance sensor. Another sensor, the neutron moisture gauge, utilizes the moderator properties of water for neutrons. Most soil moisture sensors are designed to estimate soil volumetric water content based on the dielectric constant (soil bulk permittivity) of the soil. The dielectric constant can be thought of as the soil’s ability to transmit electricity. The dielectric constant of soil increases as the water content of the soil increases. This response is due to the fact that the dielectric constant of water is much larger than the other soil components, including air. Thus, measurement of the dielectric constant gives a predictable estimation of water content. The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil. The sensor averages the water content over the entire length of the sensor.
4. SYSTEM PIN DIAGRAM

Fig 5: Schematic Pin Diagram of the system

5. RESULT & ANALYSIS

- Calibration
  Moisture in Wet soil = volume of water / volume of soil
  Density of wet soil = (mass of soil + mass of water to be added in soil) / (volume of soil container)
  Volume of wet soil = mass of soil / density of wet soil
  Volume of water = mass of water / density of water

<table>
<thead>
<tr>
<th>S.No</th>
<th>Sample</th>
<th>Weight</th>
<th>Density</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wet soil</td>
<td>302gm</td>
<td>2.33gm/cc</td>
<td>129.61cm³</td>
</tr>
<tr>
<td>2.</td>
<td>Initial weight of Water jar</td>
<td>84gm</td>
<td>1gm/cc</td>
<td>84cc</td>
</tr>
<tr>
<td>3.</td>
<td>Final weight of Water jar</td>
<td>56gm</td>
<td>1gm/cc</td>
<td>56cc</td>
</tr>
<tr>
<td>4.</td>
<td>Weight of water</td>
<td>28gm</td>
<td>1gm/cc</td>
<td>28cc</td>
</tr>
</tbody>
</table>

- Theoretical results:
  Volume of soil container = \( \pi r^2 h \)
  = 3.14 \( \times \) 3 \( \times \) 3 \( \times \) 5 cm³
  = 141.3 cm³
  Density of wet soil = 302 + 28 / 141.3 gm/cm³
  = 2.33 gm/cm³
  Density of water = 1 gm/cc
  Volume of wet soil = 302/2.33
  = 129.61 cm³
  Moisture % in soil = 28cc/129.61
  = 0.2160 or 21.60%

So, the content of moisture in soil container is 21.60%
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. We aim to use the data logger system in the landslide scenario for estimating the physical variable of soil of slope which affect to factor of safety. The main goal of this effort is to detect rainfall induced landslides which occur commonly in India.

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REFERENCES

BIOGRAPHY
Vikalp Joshi received his B.Tech degree in Instrumentation from School of Engineering & Technology Srinagar (Garhwal) affiliated to H.N.B Garhwal University Uttarakhand, India and pursuing M.Tech. in Instrumentation and Control Engineering from Graphic Era University Dehradun, Uttarakhand, India. He is lecture in electrical & electronics department in DBGI Dehradun ,India

Jeetender Singh Chauhan received his B.Tech degree in Electronic & Communication from Sagar Institute of Technology and Management Barabanki affiliated to Uttar Pradesh Technical University U.P., India and pursuing M.Tech. in Instrumentation and Control Engineering from Graphic Era University Dehradun, Uttarakhand, India. He has published 04 papers in national/ international conferences/ journals.