LoRa BASED LANDSLIDE MONITORING SYSTEM

J. Vetrimanikumar, M. Sowmiya, S. Sowmiya, R. Suvetha, R. Vedha

Assistant Professor, Department of Electronics and Communication Engineering, SSM Institute ofEngineering and Technology

UG Scholar, Department of Electronics and Communication Engineering, SSM Institute ofEngineering and Technology

Abstract—An early warning system for landslides, monitoring of prone areas is a long-lasting process, little human intervention, and a resource less environment. Data changes in the monitoring area may be noticed in many days, months, or years depending on the weather characteristics. Therefore, a frequent and large amount of data of monitored area is not required to send on a cloud server. Moreover, Long-range communication provided comprehensive spectrum communication protocol and low power consumption with fewer data rates. Over the advantage of LoRa technology, we designed a customized sensor node and gateway node to monitor the changes periodically with low energy power consumption. We evaluated the distinct metrics of spreading factor, sensitivity, time-on-air, energy consumption, link budget, and battery life of sensor and gateway nodes. Finally, this study concludes with challenges faced in real-time in which the sensor data received via a customized sensor node and gateway on the cloud server.

KEYWORD: LoRa, ACCELEROMATER, VIBRATION SENSOR, wireless, Internet of Things, IMU SENSOR, GSM.

1. INTRODUCTION

Landslides is a geological phenomenon that has caused numerous death toll and loss of properties every year. In regions susceptible to slope failures, land slide risk assessment must consider the available economic resources, environmental impact and safety. Once a landslide is triggered, material is transported by different components including sliding, streaming and falling. The sorts of landslides vary with respect to the type of material, rate of movement and nature of movement. Constant monitoring of environmental disasters such as landslide can reduce the number of fatalities especially in developing countries. Wireless Sensors Networks WSN is one of the innovations that can rapidly react to fast changes of information and send the information to the collector section in territories where wired or cabling is not accessible or expensive. WSN innovation has the ability to process and transferring transmission of required data continuously. There are several limitations of WSN such as low memory, limited processing capability, low power transmission and low data transfer capacity.

However, its ability to be deployed in hostile condition, energy efficient and require minimal support made it one of the most appropriate technologies for continuous monitoring of steep sided hills that are prone to landslide. In this paper, a development of an early warning system for landslide utilizing Wireless Sensor Networks WSN technology namely Zigbee protocol and Internet of Things IOT is presented. WSN enables the developed system to be distributed and deployed over a relatively vast area at relatively low cost. Unlike other landslide monitoring system, the alerting system and data collected by the proposed system is assessable through smartphone application. A study conducted by estimates that global smartphones adoption stood at 59 percent in 2017 and projected to increase by 79 percent in 2025. Therefore, the proposed system can provide an early warning to communities residing in regions susceptible to landslide. Moreover, the ground movement data can be analyzed by governmental agencies formulate effective national policy, strategy and action plan to reduce public risk and minimizing the loss of economic activities.

A landslide is movement of a mass of rock, debris, or earth down a slope. In monsoons the rain water percolates and develops hydraulic pressure which exceeds the elastic limit of the soil or rocks. Due to this the strain gets accumulated which forces the soil and rocks to loosen their adhesive strengths entailing landslides. Landslides can also be said of “Mass Wasting”, which refers to any down slope movement of soil and rock due to gravity. It causes property damage, injury and death.

In the last few years Kerala also faced the loss of human landslide. Mainly landslide season in Kerala starts with the onset of the south-west monsoon every year. Landslides include debris flows, rock slides and mud slips. Apart from claiming human lives it destroys hills and vast tracts of agricultural lands, buildings, roads, economic and infrastructure. Researchers are still doing different case studies on landslide prediction, detection and monitoring. Landslide detection can be done by using diverse methods like visual inspection using image processing, digital aerial photographs, and laser projector, using statistical methods. Landslide detection can also be based on data driven approaches using wireless sensor networks (WSN). The main objective to study the landslide detection is to prevent the natural calamity by detecting its early movement and this will reduce or save the human loss caused by the landslide. Also, the objective is to find a certain way in which the sensing elements should respond quickly to rapid changes of data and send this sensed data to data analysis Centre. The proposed Internet of things (IoT) based landslide detection and monitoring system is a low cost, robust and delay efficient.

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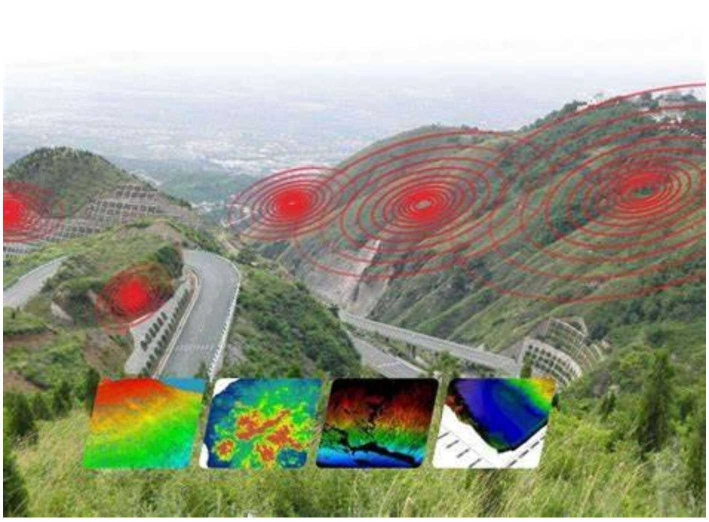


Figure 1: Landslide monitoring System in Mountain Region

1.2 RELATED WORK

1.Wei Gu, Kai Yang, Xi Wang The system will include soil moisture sensor as it has been demonstrated by various researcher. The landslide alert will be broadcast through smartphone application unlike other proposed system in literature. Communities can receive the alert in real-time thereby potentially reduce the fatality risk. IEEE 2022.

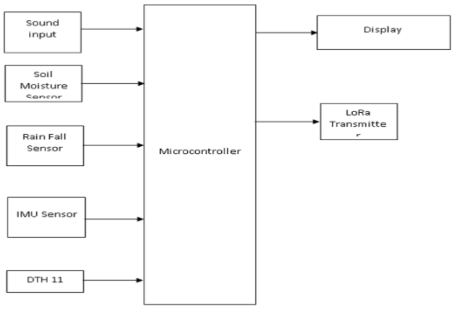
2. Kaljot Sharma, Darpan Anand, Munish Sabharwal, Prad The data and status of the terrain is assessable to other researchers and public via smart phone application developed using Blynk Internet of Things IoT platform. The landslide alert will be broadcast through smartphone application unlike other proposed system in the literature.

3. Ravi Bhushan Bhardwaj . Landslide causes extensive loss to the human lives and properties this makes important to monitor and make early warning systems. An attempt is made to create low cost and effective warning system IOT based land slide detection system. Using Arduino, Wi-Fi module, Moisture Sensors and Vibration sensors. When data is collected it is uploaded by Arduino to the cloud Thing Speak which help to monitor the real time data and send alert to the end user via SMS on the mobile phone about the Landslide when it happens.

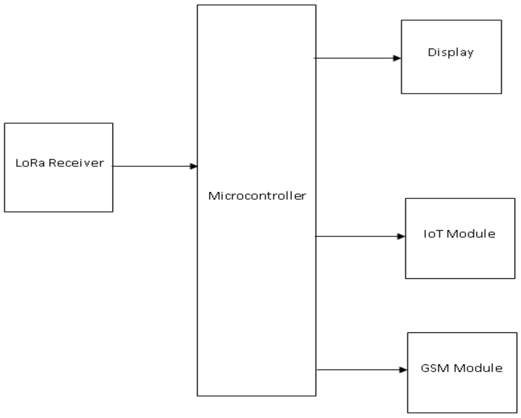
4. Sanjay , Sathish this proposed system mainly compromises of three different modules which are river slide module which is placed to check the water level, the next is the hill slide module which will check water level as well detect the moisture in the soil the last and the most important module is the main side module which will be placed at the government office this main module will continuously ask for the data from the river side module and the hill side module and will keep updating the data on the website. The website and the module is connected using GSM technology which plays a very crucial role in this proposed system.

II. WORKING

LoRa is a low-power, long-distance wireless modulation and demodulation technology which uses the spread spectrum scheme.



BLOCK DIAGRAM FOR LoRa TRANSMITTER



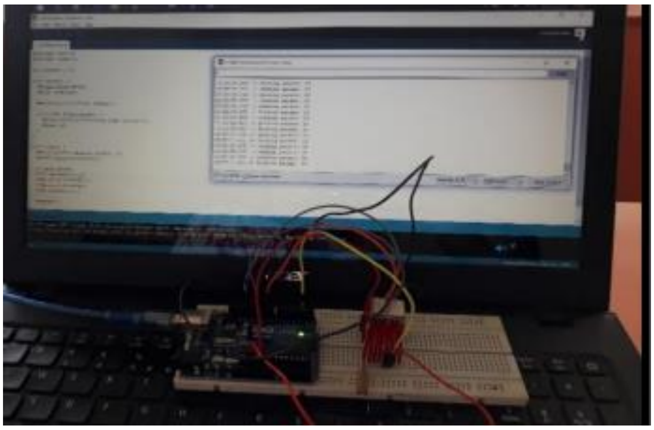
BLOCK DIAGRAM FOR LoRa RECEIVER

The Soil wet level sensing element uses the capacity to monitor the insulator the permittivity level of a encircling medium. Accelerometer Sensor a measuring device could be a device that measures correct acceleration. The module is used for sending and receiving message and calls over a network source. It is used to connect GSM to AVR as well as link the sim card to the server's. The module uses the SIM Comm process.

IV. THE HARDWARE DESIGN

Communicating using the LoRa module

Sending and Receiving of packets is done using the HPD13A LoRa module which is based on Sentech's SX1276



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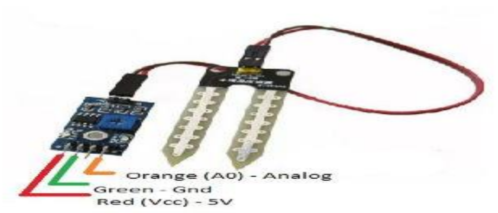
This sensor can be used to test the moisture of soil, when the soil is having water shortage, the module output is at high level, and else the output is at low level. By using this sensor one can automatically water the flower plant, or any other plants requiring automatic watering technique.

Module triple output mode, digital output is simple, analog output more accurate, serial output with exact readings. 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 Soil a capacitance sensor. Another sensor, the neutron moisture gauge, utilize the moderator properties of water for neutrons. Soil moisture content may be determined via its effect on dielectric constant by measuring the capacitance between two electrodes implanted in the soil. Where soil moisture



The readout from the probe is not linear with water content and is influenced by soil type and soil temperature. In This sensor we are using 2 Probes to be dipped into the Soil. As per Moisture We will get Analog Output variations from 0.60volts - 5volts. Input Voltage 5V DC.

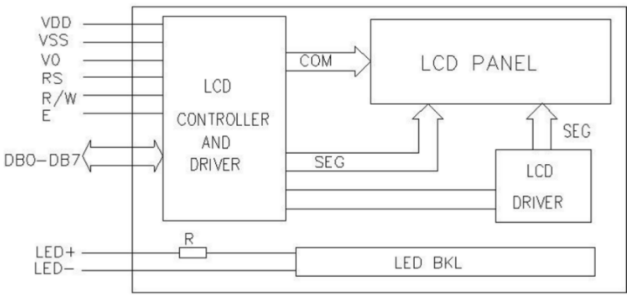


Figure 5: LCD Pin Description.

The devices may be run mostly via their own embedded software or firmware, but they can also offload a lot of the processing to cloud-based software via the Internet, where they can crunch more data. Some use advanced algorithms that let them learn from and adjust to various stimuli and patterns (letting them program themselves, to an extent). This sending and processing of the sensor data is often nearly instantaneous (thanks to the usually lightning-fast speeds of Internet communication), allowing the devices to react in real-time. These are some of the buzzwords you may have been hearing, reading & very likely talking about endlessly. These are more than just keywords; IoT (Internet of Things) is a technology concept and/or an architecture which is an aggregation of already available technologies. Similar to the way in which Internet has changed the way we work & communicate by connecting us (humans) through World Wide Web, IoT aims to take this connectivity to next level by connecting various devices to the internet – facilitating human-machine, machine-machine interactions also.

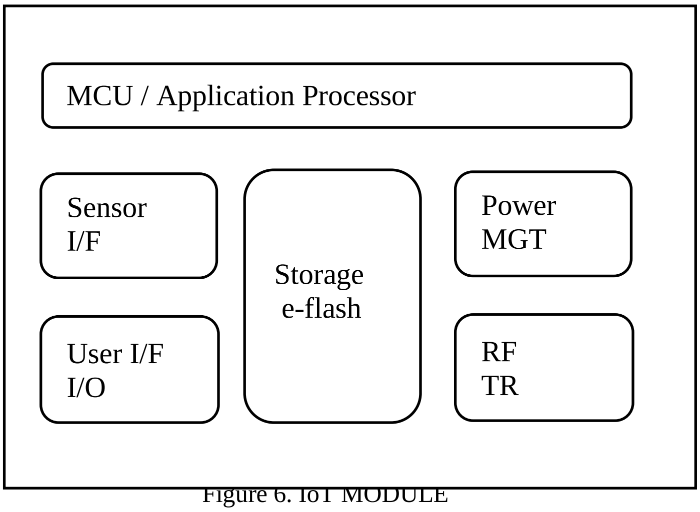


Figure 6. IoT MODULE

1.The Temperature room will be integrated with the gateway. Gateway helps to connect the temperature sensor network (things) to the Internet through Cloud infrastructure.
2. Cloud/server possesses the detailed records about the each and every device connected to it – device id, current status of the device, who has accessed the device last time, how many times the device has been accessed and more.
3. Connection with the cloud is implemented using web services such as Restful.
4. End-users like you and me interact with Cloud (and in turn devices installed in our homes) through the mobile app. Request will be sent to the cloud with the authentication and device information. Authentication is configured to ensure cyber security.
5. Cloud will identify the device with the help of the device id and will send the corresponding request to the appropriate sensor network using gateways.

LoRa transceiver module SX1276 HPD13A is oF Semtech Corporations manufactured module. It operates in the ISM band of frequencies (namely 433MHz, 868MHz, and The 915MHz), and is a transceiver module. The modulation schemes supported are FSK, MSK, and GMSk.

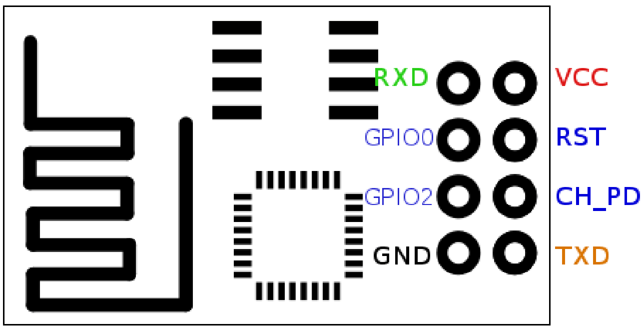


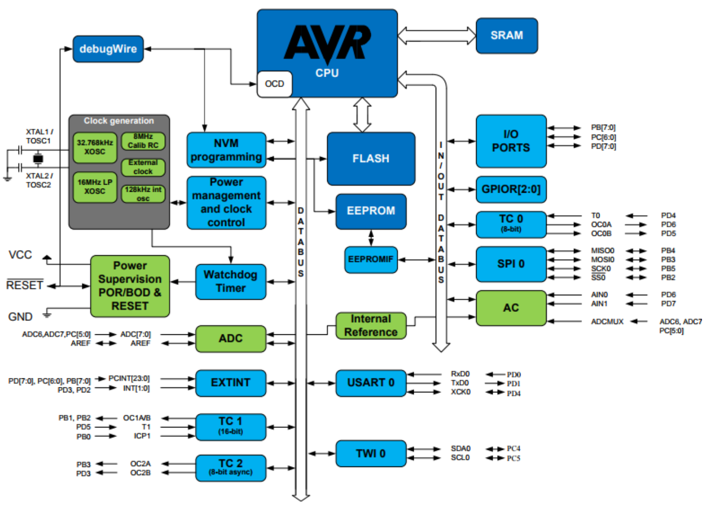
Figure 7: IoT Module

ATmega-328 is basically an Advanced Virtual RISC (AVR) micro-controller. It supports the data up to eight (8) bits. ATmega-328 has 32KB internal builtin memory. This micro-controller has a lot of other characteristics.

ATmega 328 has 1KB Electrically Erasable Programmable Read Only Memory (EEPROM). This property shows if the electric supply supplied to the micro-controller is removed, even then it can store the data and can provide results after providing it with the electric supply. Moreover, ATmega-328 has 2KB Static Random Access Memory (SRAM). Other characteristics will be explained later.

ATmega328 is an eight (8) bit micro-controller. It can handle the data sized of up to eight (8) bits. It is an AVR based micro-controller. Its builtin internal memory is around 32KB. It operates ranging from 3.3V to 5V. It has an ability to store the data even when the electrical supply is removed from its biasing terminals. Its excellent features include the cost efficiency, low power dissipation, programming lock for security purposes, real timer counter withseparateoscillator.

ATmega328 Block Diagram



Analog comparator: On-chip analog comparator is available. An interrupt is assigned for different comparison result obtained from the inputs.

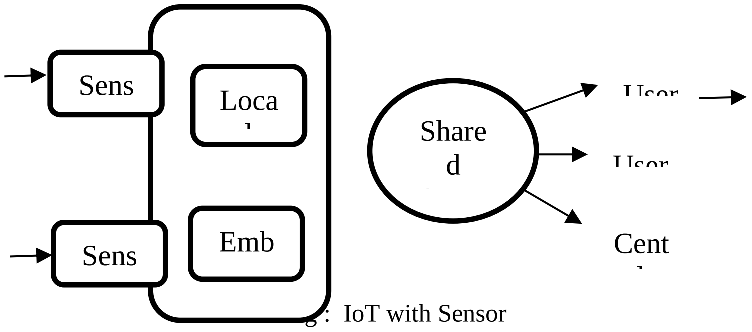
External Interrupt: 3External interrupt is accepted. Interrupt sense is configurable.

Memory: It has 32Kbytes of In-System Self-programmable Flash program memory, 1024 Bytes EEPROM, 2Kbytes Internal SRAM. Write/Erase Cycles: 10,000 Flash / 100,000 EEPROM.

Clock: It can run at a frequency from 1 to 16 MHz. Frequency can be obtained from external Quartz Crystal, Ceramic crystal or an R-C network. Internal calibrated RC oscillator can also be used. More Features: Up to 16 MIPS throughput at 16MHz. Most of the instruction executes in a single cycle. Two cycle on-chip multiplication. 32 × 8 General Purpose Working Registers

Debug: JTAG boundary scan facilitates on chip debug.

Programming: Atmega32 can be programmed either by In-System Programming via Serial peripheral interface or by Parallel programming. Programming via JTAG interface is also possible. Programmer must ensure that SPI programming and JTAG are not be disabled using fuse bits; if the programming is supposed to be done using SPI or JTAG.



g: IoT with Sensor

The digital sensor outputs data in a digital format. It may already take care of some of the data processing, like calibration and other functions. Also, it may implement sensor fusion techniques by including several different sensors and combining them to derive meaningful information, as in motion detection.

Now that we all understand the IoT concept, it would be worthwhile to deep dive in order to get familiar with the building blocks of IoT:

1.) Sensors & Sensor technology – They will sniff a wide variety of information ranging from Location, Weather/Environment conditions, Grid parameters, Movement on assembly lines, Jet engine maintenance data to Health essentials of a patient

2.) IoT Gateways – IoT Gateways, as the name rightly suggests, are the gateways to internet for all the things/devices that we want to interact with. Gateways help to bridge the internal network of sensor nodes with the external Internet or World Wide Web. They do this by collecting the data from sensor nodes & transmitting it to the internet infrastructure.

3.) Cloud/server infrastructure & Big Data – The data transmitted through gateway is stored & processed securely within the cloud infrastructure using Big Data analytics engine. This processed data is then used to perform intelligent actions that make all our devices 'Smart Devices'!

4.) End-user Mobile apps – The intuitive mobile apps will help end users to control & monitor their devices (ranging from room thermostat to jet engines & assembly lines) from remote locations. These apps push the important information on your hand-held devices & help to send commands to your Smart Devices!

5.) IPv6 – IP addresses are the backbone to the entire IoT ecosystem. Internet is concerned about IP addresses only & not if you are a human or a toaster. With IPv4 we were running out of IP addresses, but with IPv6 (launched in 2012) we now have 3.4*10^38 IP addresses!

VI. CONCLUSION

The following conclusions were drawn:

The landslide detection system in this research has been able to work well in identifying landslide potential status according to predetermined criteria, using LoRa and IoT based communication system. Data packets sent by sensor nodes can be completely received at a distance of 250 meters with many obstructive objects such as buildings and trees. This range can be increased Atlantis Highlights in Engineering, volume 7 498 by adjusting the LoRa physical layer, such as coding rate, spreading factor and bandwidth. An Android-based application has also been running well to get sensor data from the blink web server.

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