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Utilizing IoT for Landslide Prevention: Real-Time Monitoring and Intelligent Alert Systems

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Abstract - A landslip, or mudslide, is a type of geological occurrence that involves a variety of ground motions these days, the Internet of Things supports a wide range of applications; among them, home automation, healthcare, and community development are the main areas that have grown in importance. A mudslide is an actual occurrence that seriously harms both natural and artificial resources. If appropriate intelligence systems are implemented that anticipate the event's appearance in advance, a significant loss caused by mudslides could be eliminated. The recommended approach measures the soil's moisture content in real time using an Internet of Things-connected soil humidity sensor. This sensor continuously measures the soil's moisture level, and when sensor data is received, the microcontroller is programmed. When the soil levels of moisture surpass the threshold amount, the roads inside the suspected mudslide area are automatically blocked, and the forest guards are notified of the situation. If the soil humidity levels surpass the threshold amount, the roads inside the suspected mudslide area are automatically blocked, and the forest guards are notified of the situation. A landslip is a natural occurrence where a significant quantity of rock fragments fracture or tumble down a hill, causing significant material and natural losses as well as the loss of numerous lives. In many regions of the world, landslides result in enormous losses. Landslides are a common occurrence in the southern Nilgiris Mountains and the Himalayan region of India. If there was a proper intelligence system in place, such as tectonic activity, soil water content, disturbance frequency of human-caused changes in lithology, and other factors that could alert people to landslides before they happen, such losses could be prevented. This study discusses many methods for detecting landslides.

INTRODUCTION

Comparing the last ten years to the present, the Internet of Things (IoT) has altered human life. One big advancement that is anticipated in internet case technologies is the Internet of Things (IoT) [1]. Micro-electromechanical systems, wireless technologies, microservices, and the internet all came together to form the Internet of Things. A standard definition for IoT is not formulated well and it has been used an exhortation in many scientific, marketing, social and medical fields. Wireless sensor network (WSN) is a collection of specific transducers integrated with communication mechanism for remote monitoring and recording the data at assorted locations.

Normally monitored attributes are temperature, humidity, pressure, wind direction and speed, sound, voltage and pollution rates. The main adage of WSN is to connect the objects to the internet using a gateway which acts as interface for WSN and internet [2]. This research work is an integration of IoT and WSN, which creates a greater impact and significance progress in gaining attention towards avoiding damages caused in mountain areas by mudslide. This proposed system determines a complete architecture to predict the mudslide hazard and provides a warning mechanism to alert the concern authority to take necessary precautions to reduce the damages.

One of the most important things the world needs is continuous surveillance of environmental crises. For this reason, several technologies have been created. Wireless sensor networks (WSN) are among the essential technologies that can be used for real-time monitoring.

Large-scale deployment, cheap maintenance, scalability, scenario adaptation, and other features are all possible with WSN. Although WSN has certain drawbacks, such

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low memory, power, and bandwidth, it is one of the greatest technologies for continuous evaluation due to its low maintenance requirements along with its capacity to be implemented in hostile environments. In Anthonia Colony, Munnar, Idukki (Dist.), Kerala (State), India, landslip detection system design and implementation using wireless sensor network1 are the subject of this study. The installation site has already seen a number of landslides; the most recent one was in 2005 and resulted in ten (people) losing their lives.

1.1 Internet of Things

Although it's a popular issue in the industry, the idea of the Internet of Things is not new. At MIT's AutoID lab, Kevin Ashton was developing the foundation for the Internet of Things (IoT) in the early 2020s. As he looked for ways in which the company Proctor and Gamble could use RFID data to better its business, Ashton was among the pioneers who came up with this idea. The idea was straightforward but effective. Every thing in daily life could be handled by computers and able to communicate with one another if it has an identity and wireless connectivity. Ashton authored a paper for the RFID Journal in 2019.

If computers were endowed with infinite knowledge, they could monitor and count everything, drastically lowering waste, loss, and expense through the use of data they collected on their own without our assistance. It would be able to determine if things were brand-new or had reached the end of their useful lives, as well as when they required recalls, repairs, or replacements. To see the world in all its chaotic splendour, computers need to be outfitted with autonomous information-gathering devices. Computers can now monitor, detect, and comprehend the world without being constrained by manually supplied data thanks to RFID and sensor technologies. [3].

This concept necessitated significant advancements in technology at the time. Ultimately, how might we link every single thing on Earth? What kind of wireless connectivity might be included in gadgets. What alterations to the current Internet infrastructure would be required to facilitate the communication of billions of more devices? What would supply the energy for these devices? What needs to be created to lower the cost of the solutions? In 1999, the notions of the Internet of Things raised more questions than answers. Recently, many of these issues have been rectified. Wireless radios are now much smaller and less expensive. Billions of devices can now be given a communications address thanks to IPv6. Electronics manufacturers are incorporating cellular and Wi-Fi internet connections into a variety of products. Over five billion are estimated by ABI Research in 2013[4].

The availability of mobile data has expanded dramatically, with many networks now providing broadband speeds. Though not flawless, advancements in battery technology have been made, and many products now incorporate solar recharging. Over the next few years, billions of things will link to the network. For instance, by 2020, more than 50 billion gadgets will be connected, according to Cisco's Internet of Things Group (IOTG)[5].

LITERATURE REVIEW

People who live nearby are at risk of landslides in places with significant rainfall. Furthermore, it gets harder to forecast about it. In order to create a new predictive tool that can be used to evaluate the movement of an area using sensors, telecoms has partnered with two professional laboratories, IS Terre: earth science and LCIS: embedded electronics. The fundamental idea is to ensure the sensors use the least amount of money and energy to detect movement in the field. Utilising wireless sensor networks that rely upon Lora (Long Range) communication technology, the monitoring systems employ geolocation. Having a collection of fixed (non-mobile) node and anchors with known locations is a frequent way to accomplish positioning via a network of sensors. Several methods are used to calculate the location of the sensor node. Using one such method, an anchor that gathers data obtained from each of the other anchor is chosen to assume the role of master. [6]

A different study is based on a landslip that claimed many lives in the Guizot area of China. After rain, the hazard there grows. It presents a WSN for landslip monitoring based on ZICM2410. This system consists of a PC, monitor host, base station, and acquisition nodes. A WSN is made up of multiple nodes that work together to gather data on landslip factors such displacement, temperature, moisture content, tilt angle, and local rainfall. The ZICM2410 ZigBee chip was selected by this system to create a low-cost wireless sensor network that can exchange and use the information. It may handle a various types of network topologies, including mesh, point-to-multipoint, and point-to-point. GSM technology is employed from the base station to send data from distant locations to the monitor. The GSM network provides information to the indoor monitor, which then transmits data to the PC via an RS232 interface. This allows individuals to view the landslip monitoring using the PC software. Database administration and real-time display interface are the two components of PC management software. The system designs the database using the SQL anywhere 11 databases platform and develops the human-computer interface using VC++ tools [7].

A WSN for a slide monitoring system needs to be built with a battery that can last for extended use, high efficiency, and resistance to the negative impacts of landslides. In this study, the system gathers battery life, radio link, and path statistics data via WSN. The network's fault tolerance, adaptiveness, and self-organization are particularly built into the sensor node and communication protocols. The efficacy of network protocols in handling self-organization, node failures, low link quality, and unexpected battery life is demonstrated by this system. When this technique was used as part of an experimental campaign on a landslip at Torgiovannetto, Italy, very little human assistance was required. It demonstrated an extremely high degree of resistance to the unfavourable landslide, making it appropriate for situations involving critical landslides. A distant unit processes the system's acquired data before analysis [8].

As part of an experimental effort, this method was used to a landslip near Torgiovannetto, Italy, with very little human participation. It is appropriate for crucial landslip scenarios since it demonstrated an extremely high level of resistance against the adverse landslip. The system's acquired data is processed for analysis at a remote unit [8].

The system must have sufficient power to function while monitoring a landslip, but it should also use less electricity. This involves one of the main problems with installing or implementing the WSN. Since the sensor, which is located in a remote part of the mountains, can hardly be changed. Thus, sensors are designed to quickly detect data in order to preserve the battery's precious energy. The method suggested to address this problem is known as SMARTCONE [9], and it aids in the data monitoring of landslides. These SMARTCONES are simultaneously gathering data and transmitting raw vibration by synchronously switching between their operating modes. The ARM M0-based ultra-low-power 32-bit MCU NANO102SC2AN is the foundation of the SMARTCONE. Data is transferred between the SMARTCONE and the sever using an RF transceiver Nordic NRF24L01 equipped using a 3-dBi unidirectional antenna. This system combines a digital low power temperature and humidity sensor SHT-21, a low power Micro electro-Mechanical Systems accelerometer ADXL345 and a GPS module FMP04-TLP to provide its GPS trajectory. The battery is monitored and the power supply for the GPS and RF transceiver are controlled by a battery fuel gauge, model number T1BQ2741. In standby mode, this system uses 0.5mA at 3.6V, which is lesser than the prior design. These SMARTCONES gather data and transmit it to the control room simultaneously [10].

The primary cause of the damage is the interlayer slide, which triggers landslides and generates disastrous losses. It harms not just geological engineering but also civil engineering. Piezo ceramic smart aggregates using an active sensing technique were tested in article [11]. Since marble blocks provide mechanical protection and piezo ceramic is fragile, the smart aggregate is created by enclosing a watertight piezoelectric ceramic patches with electric wire between two small marble blocks. Actuators and sensors are integrated in predetermined positions. A data gathering system (NI USB6363), two power amplifiers (Trek 2100HF), and a specimen with smart aggregates are all part of the arrangement. A laptop computer serves as the host for the data acquisition system, plus a universal hydraulic tester comes with its own acquisition system. In a different study, a WSN-based sensor columns design is suggested in [12] for the detection of landslides in the Idukki district of Kerala, India. The sensed data is transmitted by satellite INSAT 3A to the data management centre and field management centre, respectively, and via Wi-Fi. MongoDB and network of things technologies are the foundation of a recent study on a proactive land-sliding system suggested for the high-risk land-sliding zone in Tunisia.

The work suggested in [13] implements a second IEEE 802.15.4g compliant, energy-efficient, WSN-based landslip detection system that translates pressure vibrations into appropriate strain in a low-cost, energy-efficient, and routing-efficient manner. A comparative analysis of WSN-based landslip detection and monitoring systems is provided by the WSN-based landslip monitoring system. Landslides are a major global hazard, and they are frequently linked to other hazards like earthquakes or volcanic activity, as stated by Keller and Blodgett (2004). While most landslides are gentle and occur gradually, others can occur suddenly and violently, often with catastrophic consequences

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(Keller and Blodgett, 2004) [14]. Five kinds of movement in landslides are defined by Turner and Schuster (1996) as fall, topple, slide, spread, and flow.

a) A fall is a very fast vertical movement that can occur in rocks or other material. There is little moisture in this kind (Summerfield, 1991).

b) When a rock or soil mass spins around an axis or point below the centre of gravity of the displaced mass, it topples.

c) A slide is an earth or rock mass that moves downward when the surface ruptures. There are two kinds of slides: translational and rotational, with low to moderate moisture content (Summerfield, 1991).

d) Spread is the movement of a cohesive rock mass or soil over an unstable substance. Because of the many materials and the interaction of the water, the movement is extremely complex, and the moisture level is moderate to high.

e) Lastly, flow is the absence of consolidated materials in a movement that can be either fast or slow, depending on the moisture content and the materials (Summerfield, 1991). [15]

Materials, slope, climate, weather, vegetation, and water are the five elements that contribute to landslides, according to Keller and Blodgett (2004). These elements may act in concert or apart, and their effects on landslides vary. [16]

Geological components may have an impact on the kind and frequency of landslides. Two elements that are crucial to the stability of the rocks and soil mass are the material's consolidation and composition. The geological materials ought to govern the slides (Keller and Blodgett, 2004). [17]

Because the pushing force is generally higher on larger slopes, slope inclination is also significant. Fall is the more common kind when the slope is steep, whereas flows are the most common when the slope is low (Keller and Blodgett, 2004). [18]

Distinct climates around the world have distinct effects, with surface landslides being primarily affected by them. Since the layers of soil and minerals have been subjected to high erosion, landslides, debris flows, and fall occur frequently in arid areas with minimal vegetation. Nonetheless, landslides are more complicated and rich in plant and soil mass in humid and subhumid regions, which also cover the majority of slopes (Keller and Blodgett, 2004).[19] Given the many landslip kinds, weather can provide a challenging issue. Extreme weather conditions, like continuous or strong rain, might cause problems with landslides (Keller and Blodgett, 2004).[20]Vegetation has two opposing effects on the sliding of land. Vegetation adds weight to the slope, which can cause stability to be lost and cause a landslip. On the one hand, this covers the soil and reduces erosion because the roots of the plants provide stability and cohesiveness to the materials that make up the soil mass (Keller and Blodgett, 2004).[22] While the factors described above are important and the main reason for landslides, there are other threats that can be quite dangerous. In fact, mudslides linked to earthquakes and volcanic eruptions have caused mega-landslides1 and huge shifts in seabed in some places, including as Hawaii and the Canary Islands (Whelan and Kellett, 2003). Hazardous landslides are caused by storms, forest fires, earthquakes, or volcanoes (Keller and Blodgett, 2004). Mega-landslides may also result in tsunamis, which could have an impact on regions outside of the landslip area. Gran Canarias Island was impacted by a large tsunami caused by the Gui mar landslip in Tenerife, Spain (Giachetti et al., 2011).[23]

Landslides affect the islands' landscape, affecting flora, stream networks, and the distribution of human population, even if human activity may cause them owing to deforestation or urban expansion (Villalba, 1996). (Keller and Blodgett, 2004). Additionally, there is a connection between how the terrain has changed over time and the landslides brought on by erosion from both natural and human sources (Kurup, 2009).[24] According to Cendrero and Dramis (1996), landslides have played a significant role in the actual relief efforts in Europe. A unique mountain relief and significant slopes have been produced in the Alps by several forms of landslides, including rock and debris falls, landslides, debris and earth flows, and slides. This region has been impacted by elements that can cause landslides, such as weather, erosion, and rainfall. Slope, harsh weather, and geological materials of Calabria, Italy, together with the kind and scale of landslides, have also produced a unique relief.[25]

EXISTING SOLUTION

Mudslide difficulties are addressed in a variety of ways. Preventing mudslides is, of course, the next solution.

- Enhancing both surface and subsurface drainage

- Building retaining walls and piles
- Replacing and removing vegetation
- Providing rock fall protection

PROBLEM STATEMENT

- Mudslides are acknowledged as the most significant natural disaster globally.
- Mudslides have resulted in numerous losses, both financial and human, as a result of either man-made or natural causes.
- Generally speaking, individual failures of slopes are not as dramatic or expensive as large-scale floods, earthquakes, storms, or other natural disasters.
- One of the main issues in the current situation is landslides, thus the IOT-based landslide monitoring system merely helps to detect landslides.
- No significant action is taken.
- The current projects in this sector simply transmit SMS, which is easily ignored and does not allow for major action to be done to avert tragedy.
- Therefore, in the proposed system, SMS and alarm will be incorporated to ensure that the appropriate actions are made.

PROPOSED SYSTEM

This suggested solution uses a soil humidity sensor to detect the soil's level of moisture in hill stations, preventing the losses caused by mudslides. The signal to close the gate and notify the concerned authority to prevent damages is then automatically sent if the moisture content is too high.

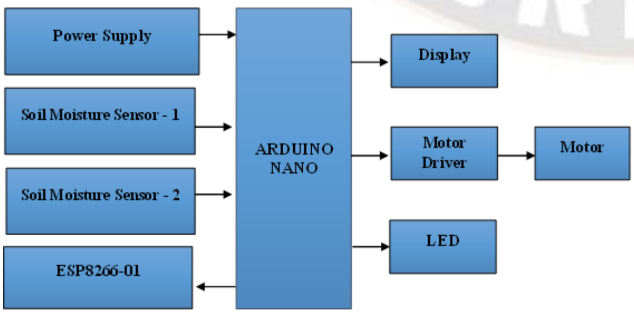

Figure 1. Architecture Diagram of Proposed System

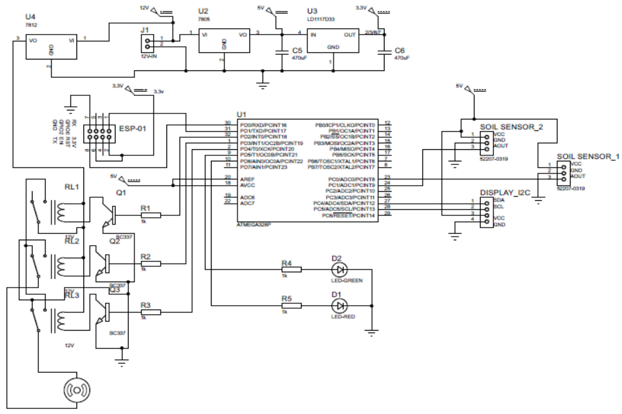

Figure 2. Circuit Diagram of Overall Architecture

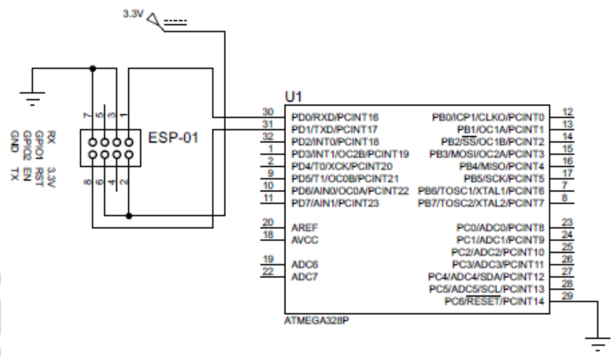

Figure 3. Circuit Diagram of ESP01

COMPONENTS REQUIRED

- ❖ Arduino Nano
- ❖ Wi-Fi Module (ESP01)
- ❖ Soil Moisture Sensor
- ❖ IC 7805
- ❖ DC PCB Plug Female
- ❖ Jumper Wires
- ❖ Transistor (BC337)
- ❖ LCD Display
- ❖ I2C Module
- ❖ USB Cable

1. Arduino Nano

Based on the ATmega328, the Arduino Nano is a compact, all-in-one board that may be used with a breadboard (Arduino Nano 3. x). Offering nearly identical functionalities to the Arduino, but in a different configuration. All that's missing is the DC power jack,

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and the USB cord is a Mini-B rather than a regular one. There are several ways in which the Arduino Nano can communicate with microcontrollers, computers, and other Arduinos. Digital pins 0 (RX) and 1 (TX) on the ATmega328 permit a UART TTL (5V) serial connection. The ATmega328P or ATmega628 microprocessor is the foundation of the diminutive Arduino board known as the Arduino Nano. In terms of connectivity, it is similar to the Arduino UNO board. A microcontroller board that is compact, sturdy, flexible, and long-lasting is called a nano board. In comparison to the UNO board, it is small. The Arduino (IDE), a platform-neutral application, is used to organize the Arduino Nano. In this case, the abbreviation IDE stands for Integrated Development Environment.

We require the Arduino IDE and a mini-USB in order to begin our projects utilizing the Arduino Nano development board. We must install the Arduino IDE software on our laptop or desktop computer. The Arduino Nano board receives its programming from the PC via a mini-USB port.

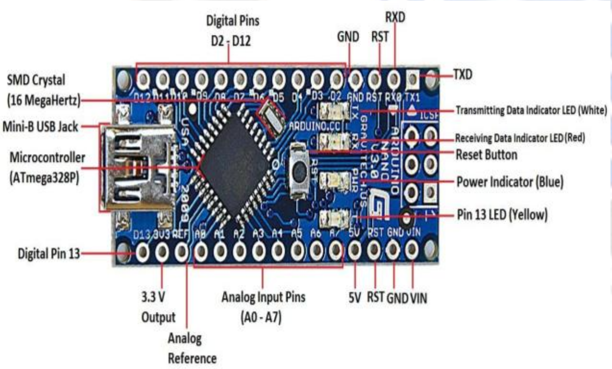

Figure4. Pin Configuration of Arduino Nano Board

2. Wi-Fi ModuleESP01

The company encapsulates developed the ESP-01 Wi-Fi module. Industrial integration with Ten Silica L106 Supported clock speeds are 80 MHz and 160 MHz. The RTOS is supported, and the embedded WiFi module complies with IEEE 802.11 standards. You can create a stand-alone network controller or expand an already-built networking system with additional devices. The sophisticated integration wireless SOC ESP8266 was created for mobile platforms with constrained power and space. For the least amount of money and space required, it provides the finest embedding possibilities for Wi applications.

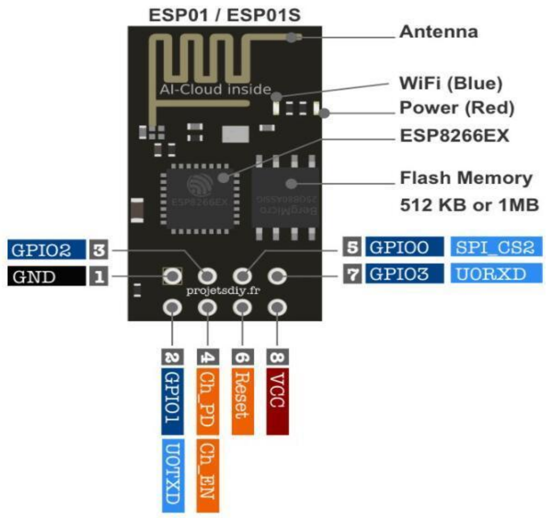

Figure 5. Pin Configuration of Wi-Fi Module (ESP01)

Alternatively, by serving as a Wi-Fi adapter, any micro controller-based device having a basic connection (SPI/SDIO or I2C/UART interface) can be made wirelessly capable of accessing the internet. Users have the option of creating their own network controller or adding modules to an already-existing device. Wireless SOCs are optimised for mobile platforms with little space and power, offering unparalleled integration of Wi-Fi functionality into other applications or operating systems at the lowest possible cost and with the least amount of physical space needed.

One application processor can host Fi networking functionalities using the Wi-Fi networking technology. The application starts up straight from a separate flash when it is hosted by ESP8266EX. In these applications, it has incorporated to enhance the system's performance. A wireless internet adapter can be added to any micro controller-based system that has a basic connection (SPI/SDIO or I2C/UART interface). A 16-bit short mode antenna (BB/RF/PA/LNA) is integrated into the smaller module bit MCU mini housing a three-core ESP8266 CPU. Full stack of TCP/IP protocols, b/g/n agreement. Users can use the wireless SOCs, which were designed for mobile platform builders with limited power and space.

3. Soil Moisture Sensor

The total amount of water in the soil is measured by soil moisture sensors. Soil moisture detectors use another characteristic of the soil, such as its resistance to electricity, dielectric value, or relationship to neutrons, in place of the moisture content to measure the amount of water in a volume, since the actual gravimetric measurement of the reading of free soil moisture requires the removal, drying out, and evaluation of a sample.

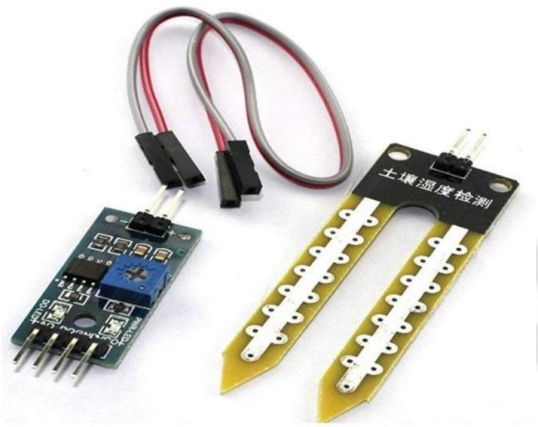

Figure6. Soil Moisture Sensor

Since environmental variables like soil type, temperature, and electric conductivity may have an impact on the relationship, the link between the measured property and soil moisture needs to be calibrated. The amount of moisture in the soil affects the reflected microwave radiation used in agriculture and hydrology for remote sensing. Portable probing instruments can be used by gardeners and farmers.

Soil moisture sensors are the general term used to describe volumetric water content sensors. Another type of sensors that identify the water potential, or another characteristic of moisture in soils, includes tensiometers and gypsum blocks. Soil water potential sensors are the common term used to describe these sensors.

4. **IC 7805**

Voltage regulators are frequently used in electrical circuits. They provide a constant output voltage over a broad range of input voltages. In our case, the majority of applications use the well-known regulator, the 7805 integrated circuit. The designation 7805 denotes a positive voltage regulator with a 5 volt output, as indicated by the phrases "78" and "05" in the name. Thus, our 7805 will generate an output voltage of +5V.

This integrated circuit's maximum output current is 1.5 amps. However, applications requiring a larger current consumption are advised to include a heat sink due to the significant heat loss of the IC. For example, if the input voltage is 12V and you are utilizing 1A, then (12-5) * 1 = 7W. Heat will be released from this 7 Watts.

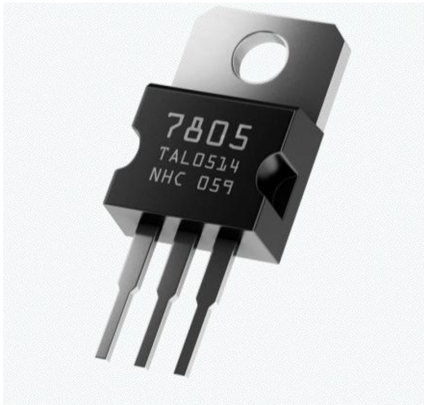

Figure7. IC 7805

5. **PCB Plug Female DC**

In the electronic industry, DC female power jacks are frequently used to link adapters to circuit boards. The 2.1 mm x 5.5 mm DC female jack is the most often used kind. where the internal pin size is 2.1mm and the external diameter is 5.5mm. An electrical connector used to deliver direct current (DC) power is called a DC connector (or DC plug, for one common form of connector). In the electronic industry, DC female power jacks are frequently used to link adapters to circuit boards. The 2.1 mm x 5.5 mm DC female jack is the most often used kind. where the internal pin size is 2.1mm and the external diameter is 5.5mm.

Figure8. PCB Plug Female DC

For correct matching, this dimension must match on the male DC plug. The majority of non-proprietary co-axial power connectors have dimensions of 2.1 x 5.5. The internal supply is the positive in most DC plugs, while the external body is the negative supply.

Basic Type of DC Female Jack

1. PCB Mounting female Jack

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2. Cabinet Mount or Panel Mount female Jack

6. Jumper Wires

Circuit components can be opened and closed using tiny metal connectors known as jumper wires. Two or more connection points control its electrical circuit board. They are used to configure the motherboard and additional computer peripherals. Assume that your motherboard served as the intrusion detection system. A jumper can be used to switch it on or off.

Jumper wires are electrical cables with connection points on both ends. In circuits, they are used to connect two points together without the use of solder. With jumper wires, you can diagnose problems with a circuit or adjust it. They also function best when used to avoid a suspected troublesome resistor-free region of the circuit.

Figure9. Jumper Wires

This covers a switch or a wire segment. Find the circuit switch, assuming all the fuses are in good working order and the component isn't receiving any power. Next, get around the switch by using the jumper wire.

7. Transistor (BC337)

For low power amplifier circuits, the NPN transistor BC337 is widely used. The BC337 boasts a high collector current of up to 800mA, a maximum gain (hFE) of 630, a base trigger voltage of only 5V, and a decent 45V collector-emitter voltage. As a result, a variety of general-purpose switching circuits can employ the BC337. due to the low base voltage of the trigger.

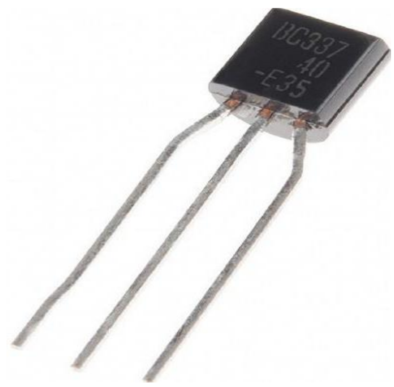

Figure10. Transistor (BC337)

This NPN silicon BJT (bipolar junction transistor) is called the BC337. This tiny transistor may be utilized in your project to assist with switching, amplifying, and driving heavy loads. The BC337 has a 50V and 800mA maximum rating.

8. LCD Display

One kind of flat panel display known as an LCD (Liquid Crystal Display) relies heavily on liquid crystals to function. Because LEDs are widely utilized in computer monitors, instrument panels, televisions, cell phones, and other devices, they offer a wide range of applications for both consumers and enterprises.

Figure11. LCD Display

LCDs were a significant improvement over the gas-plasma and light-emitting diode (LED) displays that they replaced. Compared to cathode ray tube (CRT) technology, LCD technology resulted in a considerable reduction in screen sizes. Compared to gas-display displays and LED screens, LCDs consume far less electricity because its principle of operation is to block light instead of emit it. The liquid crystal in an LED uses a backlight to produce a picture where the LED emits light.

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9. .I2C Module

An intuitive display module that can simplify display is the I2C LCD. By using it, producers may concentrate on the essential aspects of their job by making the process less complex. With just a few lines of code, users can achieve complex graphics and text display features thanks to the Arduino library for I2C_LCD that we developed.

Figure12. I2C Module

Inter-Integrated Circuit (I2C) communication gets its name from the fact that the I2C protocol is used to provide communication between two or more ICs (Integrated Circuits). It should be mentioned, though, that two ICs on the same PCB might potentially communicate with one another via I2C.

10. USB Cable

With this connection, you may connect your computer to any Arduino board as well as your USB printer, scanner, and other devices. These connections provide error-free, high-performance data transfer at fast rates.

Figure 13. USB Cable

SOFTWARE SPECIFICATION

1) Arduino IDE

The Arduino IDE software is available as open source. Use it to write code and upload it to Arduino boards. The IDE application is compatible with Windows, Linux, and Mac OS X among other operating systems. It is compatible with C and C++ programming languages. The Integrated Development Environment is referred to here as the "IDE." The boards designed for Arduino use a variety of microprocessors and controllers. Boards can be interfaced with other expansion boards (sometimes called "shields"), breadboards (used for prototyping), and other circuits using sets of digital and analogue input/output (I/O) pins. Certain board types contain Universal Serial Bus (USB) ports, which are used for software loading in addition to serial communications. The microcontrollers can be programmed in C and C++ using the standard Arduino Programming Language (API), which is based on the Processing language and is used with a modified version of the Processing IDE. In addition to using standard compiler tool chains, the Arduino project provides a Go-based command line tool and an integrated development environment (IDE).

Figure 14. Arduino IDE

Sketching is the term used to describe the code or programme written in the Arduino IDE. To upload the sketch created in the Arduino IDE software, we must connect the Arduino board and Genuino to the IDE. The "ino" extension is used when saving the sketch.

2) Blynk Application

Blynk is an Internet of Things platform that works with iOS and Android devices to provide online control of Arduino, Raspberry Pi, and Node MCU. This programme allows the creation of a graphical user interface (HMI) by obtaining and providing the right address on the widgets that are accessible.

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Figure 15. Blynk Application

Expert in both mobile and automobile user experience (UX), Pavel Bayborodin established Blynk. In 2014, the IoT framework was introduced. Using the Blynk platform, engineers may create custom mobile applications to remotely monitor and control electrical equipment by connecting MCUs and prototyping boards (like Arduino, ESP8266, or Raspberry Pi) to the Internet via Ethernet, Wi-Fi, or cellular connections. Link Cloud is available as open-source software. Smart Home, monitoring the environment, and industrial machinery remote control are a few examples of platform applications. Blynk is a software enterprise offering internet of things infrastructure. 2014 saw Blynk become a global leader in the no-code IoT app development space and acquire recognition for its mobile app editor. Our software platform is currently used by companies of all sizes, from start-ups to multinational corporations, to develop and oversee linked devices.

RESULTS& DISCUSSIONS

NORMAL CONDITION

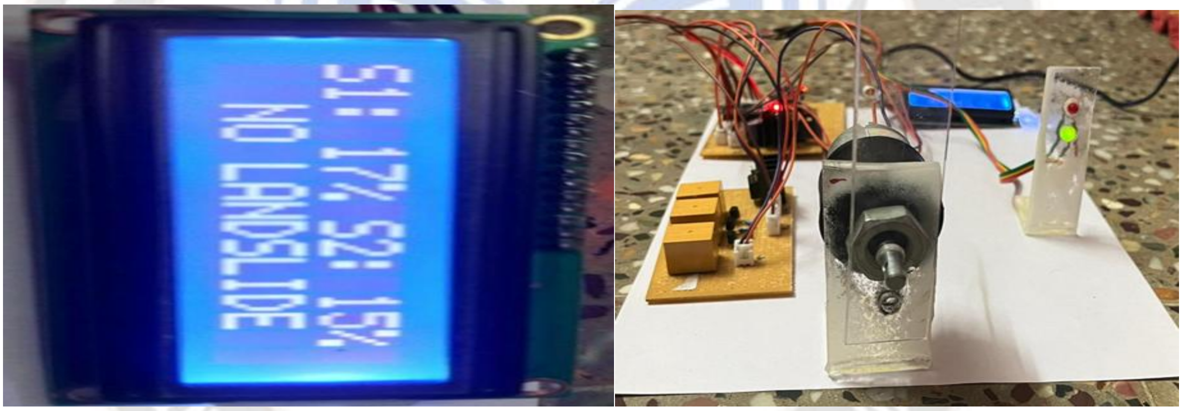

Figure 16. Normal Condition

ALERT MESSAGE OF MUDSLIDE IN BLYNK'S APPLICATION

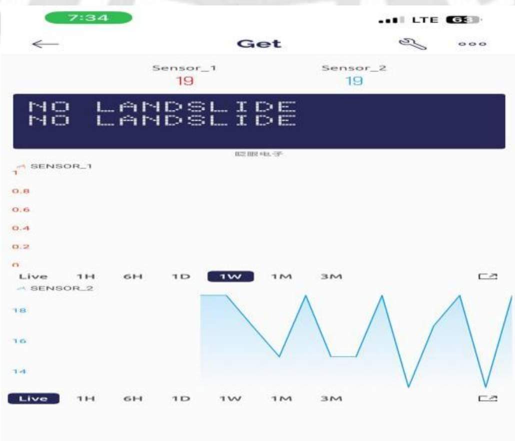

Figure 17. Alert Message of Mudslide in Blynk's Application

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DETECTION OF MUDSLIDE

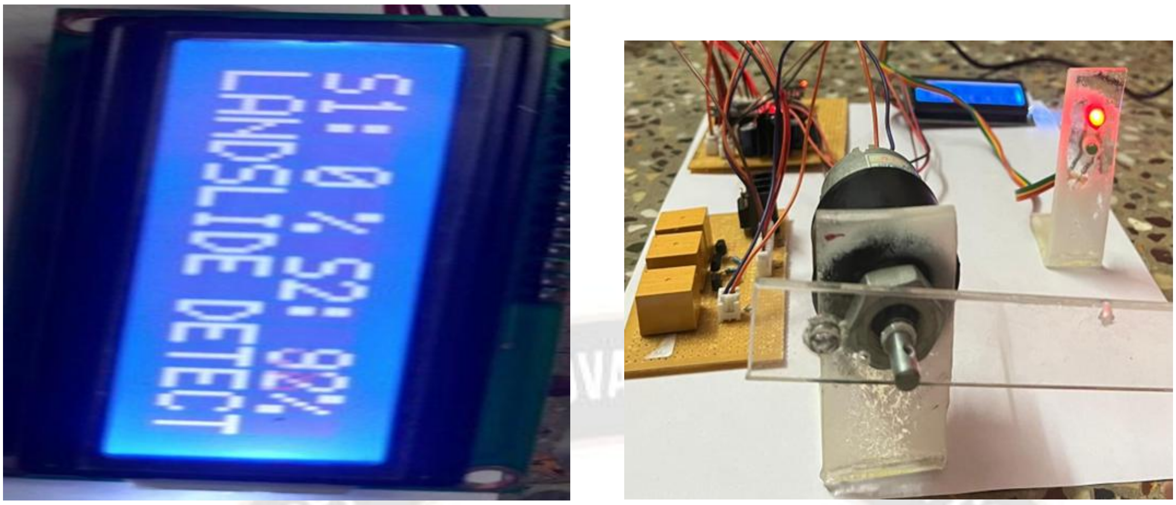

Figure 18. Detection of Mudslide

ALERT MESSAGE OF MUDSLIDE IN BLYNK'S APPLICATION

Figure 19. Alert Message of Mudslide in Blynk's Application

CONCLUSION

The main objective of the project is to use WSNs to identify mudslides in order to prevent or reduce the loss of resources and human lives. After alerting the forest ranger and displaying a message on the LCD, the automated gate closure system has finished its job. Thus, the aforementioned techniques cannot be used to continuously monitor the elements that cause landslides and their values. A more advanced approach may involve the use of sensors, the values of which are continually tracked via a graphical user interface (GUI) for readers. Environmental geology specialists will be able to make more accurate predictions thanks to graph analysis of direct values. The suggested method might quickly sound an alarm if values rise over the threshold level. Communication between the study area and the master computer can be accomplished by ad-hoc, Zigbee, or any other promising, emerging technology that utilizes less power and has a suitable transmission range and quality.

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