ISSN [Online]: 2583-2654

Automatic Disaster Detection: A Case Study on Wayanad Landslides

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Abstract:- The Wayanad region in Kerala, India, faced a significant landslide in 2024, highlighting the need for efficient, automated disaster detection systems in disaster-prone areas. This study presents the design and implementation of a landslide detection system utilizing modern sensor technologies. To develop a cost-effective and efficient automatic landslide detection and alert system using a variety of sensors and microcontroller-based components. The detection system is powered by an Arduino UNO microcontroller, which integrates severalcritical sensors, including: AXDL335 Accelerometer, Soil Moisture, Rain Sensor, GSM Module, and 16x2 LCD with I2C. All components are powered by a 12V adapter, withassembly facilitated through a Zero PCB for efficient wiring and connections. The system automatically sends notifications via GSM to alert authorities and local communities. It also broadcasts emergency alerts using a public address (PA) system for immediate dissemination. The system would substantiate high reliability in real-time detection and alerting. This technology can significantly enhance disaster preparedness in vulnerableregions like Wayanad.

Keywords: Arduino uno, landslide, sensor, alert.

I. INTRODUCTION

History of Project This project focuses on developing an Automatic Disaster Detector using Arduino technology and environmental sensors to monitor conditions leading to landslides. The system integrates an ADXL335 Accelerometer for ground vibration detection, a Soil Moisture sensor to assess soil saturation, and a Rain sensor to measure precipitation. Real-time alerts are provided through a GSM module (SIM800) for SMS and voice calls, along with a 16x2 LCD with I2C interface for on-site visual feedback. Powered by a 12V supply, the system enhances disaster preparedness and response in vulnerable areas like Wayanad.

Reason for Selecting the Project Wayanad is highly prone to landslides, especially during the monsoon season, due to its hilly terrain and heavy rainfall. Establishing an effective monitoring system using affordable technology like Arduino and sensors can improve early warning systems. Real-time data and alerts can enable timely evacuation, reducing the impact of disasters on lives and property. This integrated system provides a reliable detection mechanism, empowering residents and authorities with critical information.

Case Study on Wayanad Landslide Wayanad, located in the Western Ghats of Kerala, frequently experiences landslides, notably the 2019 disaster caused by heavy rainfall, deforestation, and soil erosion. This event led to environmental degradation, loss of life, and displacement of residents. It highlights the need for sustainable land practices and advanced monitoring systems to mitigate risk

Problem Statement Frequent landslides in Wayanad threaten local communities, causing loss of life and property. Existing monitoring systems are often inadequate, delaying timely warnings.

ISSN [Online]: 2583-2654

Objective To develop an Automatic Disaster Detector using an Arduino UNO integrated with an Accelerometer, Soil Moisture, and Rain sensor, providing real-time alerts via a GSM module and visual feedback on an LCD, enhancing community safety.

II. LITERATURE SURVEY

Angelo A Beltran Jr et al. (2020) proposed an Arduino-based Disaster Management Alarm System with SMS notifications. It was tested using simulated disasters and proved effective in providing real-time alerts. Integration of IoT and AI was suggested for future improvements.

G Naveen Kumar et al. (2024) developed a Flood Detection and Monitoring system using Arduino sensors for water levels and rainfall. It provided real-time data and alerts, helping reduce flood impacts. Future enhancements could include data analytics and machine learning.

Fendi Aji Purnomo et al. (2019) created a Landslide Early Warning System using Arduino with soil movement and humidity sensors. It accurately detected soil shifts and issued siren alerts for hazard levels.

A Vijaya Lakshmi et al. (2021) designed an IoT Early Flood Detection and Alerting System using Arduino and sensors like DHT11, ultrasonic, and float sensors. Data was sent wirelessly, and alerts were triggered upon exceeding thresholds.

Juthi et al. (2022) implemented an Earthquake Early Detection Alarm System using Arduino, aimed at providing low-cost early warnings in seismic regions

Prof Anand Ingle et al. (2023) developed an affordable Arduino-based Flood Detection System using water level sensors, offering early warnings and improving disaster preparedness.

Cruz et al. (2024) built an Automated Flood Water Level Sensor and Alarm System with Arduino, showing high accuracy in detecting floods and alerting individuals through sensors and alarms.

Prof Borhade B M et al. (2021) proposed an IoT-based Disaster Management System using wireless sensor networks to detect floods, fires, and landslides, sending alerts to coastal residents

Okeke Remigius Obinna et al. (2024) designed an IoT-based Early Flood Detection System integrating a solar panel and a third-party app for public water level updates, improving accuracy with custom water level measurement.

Triveni Dhamale et al. (2022) introduced a Disaster Management System using IoT and wireless sensor nodes for real-time data and mobile alerts, reducing development costs and enabling large-scale deployment

III. FLAWS IN THE EXISTING SYSTEM

The increasing frequency of landslides in Wayanad poses a significant threat to local communities, leading to loss of life and property. Current monitoring systems are often inadequate for providing timely warnings, leaving residents unprepared for such disasters

IV. PROPOSED SYSTEM

To develop an Automatic Disaster Detector for Wayanad that utilizes an Arduino UNO and integrates multiple sensors (Accelerometer, Soil Moisture, and Rain sensor) to monitor conditions leading to landslides, providing real-time alerts via a GSM module and visual feedback on an LCD, ultimately enhancing community preparedness and safety.

The project involves designing an Arduino-based disaster detection system tailored for landslide-prone areas like Wayanad. The system integrates sensors to monitor critical environmental parameters such as Soil Moisture, vibration, and temperature. These sensors continuously collect

ISSN [Online]: 2583-2654

data, which is processed by the Arduino microcontroller to detect anomalies indicative of potential landslides. The detected data is then relayed to a connected system for realtime analysis and notification. A thorough field study and testing are conducted to validate the system's accuracy and effectiveness, ensuring it meets the requirements for early disaster detection and timely alerts.

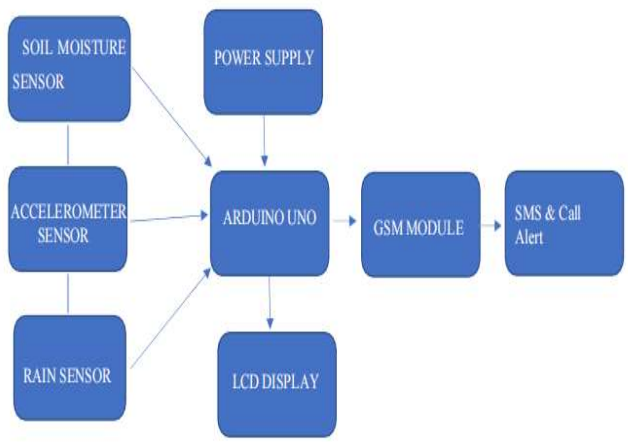

Fig 1 Block diagram

Objective: To address the challenges posed by recurring natural disasters (e.g., landslides, floods) in Wayanad. Approach: Conducted a literature review on disaster-prone regions and the impact Of landslides in Wayanad. Identified the need for a real-time detection system to minimize response time and mitigate damage.

Study Area and Data CollectionStudy Area: Focused on Wayanad, a district in Kerala prone to landslides due to heavy Rainfall, hilly terrain, and deforestation. Data Collection: Gathered historical data on landslides, Rainfall patterns, and Soil erosion from government and research reports. Conducted site visits and interviews with local residents to understand specific triggers and high-risk zones.

Hardware Components: Selected Arduino microcontroller as the core processing unit. Integrated sensors: Soil Moisture Sensor: To measure Soil saturation levels. Vibration Sensor: To detect ground movement indicating possible landslides. Rainfall Sensor: To monitor real-time precipitation levels. Power Source: Solar panels/batteries for sustainability in remote areas. Software Components: Designed a program to process sensor data and trigger alerts when thresholds are exceeded. Integrated GSM/GPRS module for real-time communication with authorities and residents.

V. SYSTEM ARCHITECTURE

Thesystemiscomposedoffollowingcomponents:

1. ***Arduino uno:***

The Arduino UNOis a widely-used microcontroller board based on the ATmega328P chip, known for its simplicity and versatility, making it a favorite among hobbyists and educators. It features 14 digital input/output pins (6 of which can produce PWM signals) and 6 analog input pins, providing ample connectivity for various sensors and actuators. With 2 KB of SRAM, 32 KB of flash memory, and 1 KB of EEPROM, it supports sufficient data storage for most projects. The board can be powered via USB or an external power supply, allowing for flexible deployment. The Arduino IDE offers a user-friendly programming environment, complemented by extensive libraries that facilitate quick integration of components. Its strong community support and vast online resources make it an ideal platform for a wide range of applications, including robotics, home automation, and environmental monitoring, enabling users to easily prototype and learn about electronics and programming.

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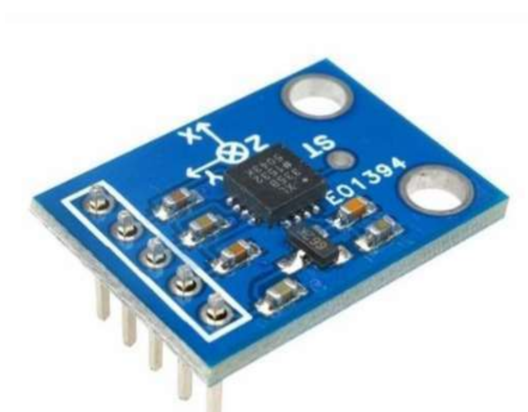
2. ***GSM module sim800l:***

GSM moduleis a crucial component for enabling mobile communication in electronic projects, allowing devices to send and receive data over cellular networks. Typically used in conjunction with microcontrollers like Arduino, the GSM module can send SMS messages, make voice calls,

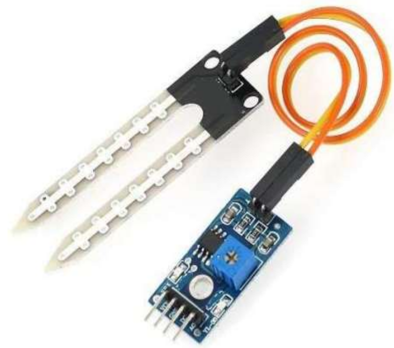
and establish a data connection, making it ideal for remote monitoring and control applications. Popular models, such as the SIM800 or SIM900, offer functionalities that include sending alerts, receiving commands, and even connecting to the internet. The module operates on standard GSM frequencies, making it compatible with most cellular networks globally. Its ease of integration, along with libraries available for common programming environments, simplifies the development of applications in fields like home automation, vehicle tracking, and disaster management, where real-time communication is essential for timely responses

3. *AXDL accelerometer 335*



The **AXDL335 accelerometer** is a versatile sensor designed to measure acceleration forces in three axes (X, Y, and Z), making it ideal for applications involving motion detection and tilt sensing. This sensor is compact and lightweight, enabling easy integration into various electronic projects, particularly those involving robotics, gaming, and wearable technology.

4. Soil Moisture Sensor:



A Soil Moisture sensor is a device designed to measure the water content in Soil, providing crucial data for agriculture, gardening, and environmental monitoring. Typically consisting of two main components—a sensor probe and a transmitter—these devices operate by detecting the electrical conductivity of the Soil, which varies with Moisture levels.

5. Rain sensor

When Rain is detected, the sensor can trigger alerts or automate actions, such as shutting off irrigation systems to conserve water. Rain sensors are easy to integrate with microcontrollers like Arduino, allowing for real-time data collection and response.

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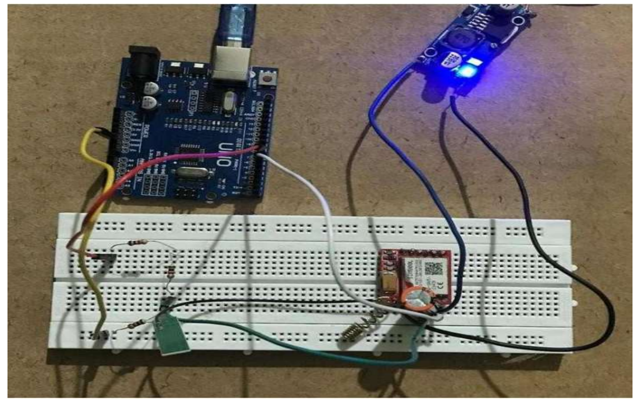
6. Rain sensor

The lcd display various function such as sensor reading and status message, providing real time feedback to user. In application like automatic disaster detector.

VI. IMPLEMENTATION

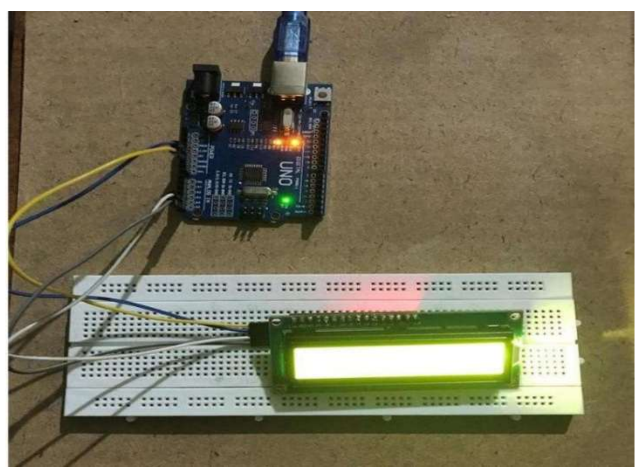
Open Arduino IDE version 2.3.3 or later, click on file then followed by sketch, where you can type the code to upload in to the Arduino UNO. After opening Arduino IDE click on tools where you can see board, where board is the type of Arduino your using currently e.g. UNO, Nano etc. once we seletected the tools then board, we have to select the respective Arduino board. Our Arduino board is Arduino UNO. After selecting the board we have to select and confirm in which port we have inserted the A-B cable to transfer the data into Arduino e.g. COM3.

1. GSM module to Arduino uno



GSM Module SIM800L works in the voltage of 3.3-4.4V with 2A of current, where we used a DCDC Buck Converter, the input voltage is 12V and using the potentiometer the set the voltage to 4.3V and 2A current using a 12V power supply adopter. TX of GSM Module works good but the RX of GSM Module receives the voltage of 5V from the Arduino UNO. So we used a level shifter with three 1k ohm resister, 1 resister series with the TX of Arduino UNO and other 2 resister are parallel to GND, from between the parallel resistor GSM module RX is connected.

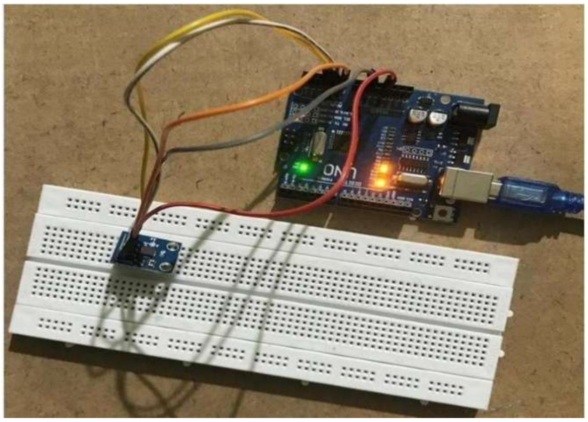
2. LCD Display to Arduino



16x2 LCD Display works with 5V, which is provided by the Arduino UNO, where 16x2 LCD Display using I2C Interface to connect all the output and input pins of LCD only with 4 working pins respectively.

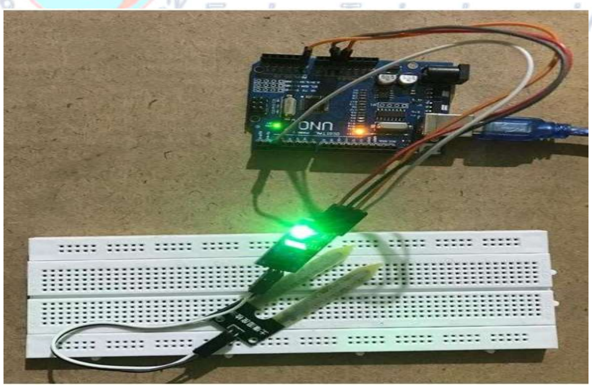
ISSN [Online]: 2583-2654

3. ***AXDL Accelerometer 335 to Arduino uno***



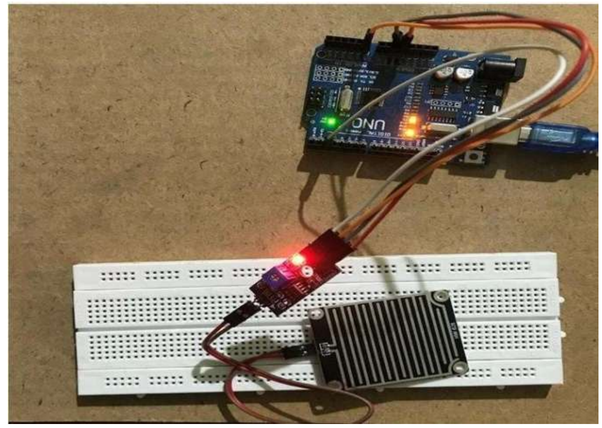
AXDL335 Accelerometer is a sensor which detects the motion of the ground or in detects the vibration which occurs under the earth, which causes the earthquake. This sensor operates at 3.3v which is provided by Arduino UNO. We use this sensor to detect and react if there is any earthquake or landslide. Where the AXDL335 Accelerometer as 5 pins namely VCC, GND, X, Y and Z-pin. VCC – 3.3V

4. ***Soil Moisture sensor to Arduino uno***



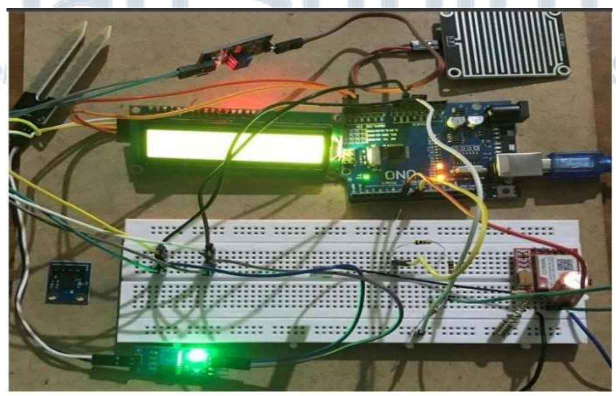
This is the Soil Moisture sensor which detect the water content in the Soil or which detects the saturation level in the Soil. These sensor used to find whether Soil is capable of holding the land and it as the capacity to withstand the landslide, earthquake or any other natural disaster. It works with 5V, which is provided by the Arduino UNO, it has 4 pins namely VCC, GND, A0, and D0.

5. ***Rain sensor to Arduino uno***



The **Rain sensor** is a device designed to detect the presence of Rainfall and measure its intensity, making it valuable for various applications, including automated irrigation systems,
weather monitoring, and environmental research. Typically consisting of a water-sensitive conductive pad, the sensor works by detecting changes in conductivity when Rainwater bridges the gaps between it.

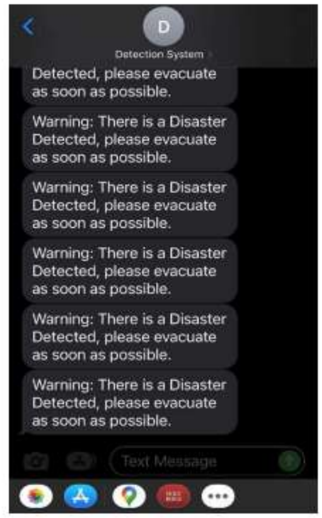
VII. RESULT



The **Automatic Disaster Detection System** implemented in this mini project aimed at detecting potential landslideconditions in the Wayanad region, using various sensors interfaced with an Arduino UNO board. The system successfully integrated a combination of hardware components to monitor environmental conditions that are indicative of a landslide, including Soil Moisture, Rainfall, and ground acceleration. The **Soil Moisture Sensor** and **Rain** Sensor provided real-time environmental data, which, when exceeding preset thresholds, could suggest conditions

ISSN [Online]: 2583-2654

favorable for a landslide. For example, high Moisture content in the Soil, combined with heavy Rainfall, was used as an indicator for potential disaster risk. The **ADXL335 Accelerometer** was employed to detect unusual ground movements, such as those that would occur during a landslide. The sensor output was processed by the Arduino to detect changes in the ground's inclination or sudden vibrations, which might signal the onset of a landslide. Data collected from these sensors were displayed on the **16x2 LCD with I2C Interface** for real-time monitoring. Additionally, when dangerous thresholds were crossed, the system triggered an alert via the **SIM800L GSM module**, sending an SMS to the designated authorities or emergency responders with the exact location and status of the potential disaster. The system was tested under simulated conditions where values from the sensors were manipulated to represent changes in weather, Soil Moisture, and ground movement. The system effectively detected these changes and displayed the appropriate warnings, demonstrating its potential to function as an early warning system for landslide-prone regions.



VIII. CONCLUSION

The **Automatic Disaster Detection System** developed in this project has proven to be a functional and effective prototype for monitoring and detecting potential landslide hazards in the Wayanad region. By leveraging a combination of **Soil Moisture sensors, Rain sensors, Accelerometers, and GSM communication**, the system can effectively monitor critical environmental conditions that contribute to landslides, such as Soil saturation and ground movement.The integration of these sensors with the **Arduino UNO SMD** microcontroller enabled real-time data collection, which was displayed on the **16x2 LCD with I2C interface** for easy monitoring. Moreover, the **SIM800L GSM module** facilitated immediate notifications via SMS, providing a crucial early warning system to alert authorities and residents about potential disaster threats.

This project demonstrated the practical application of low-cost, easily accessible technology for disaster management, which could potentially save lives and reduce damage in landslide-prone areas. While the system performed well in detecting critical conditions, there is scope for future improvement. Enhancing the accuracy of the sensors, refining the threshold values for triggering alerts, and incorporating additional environmental factors such as seismic activity or wind speed could make the system even more reliable. Furthermore, the system could be expanded to include remote monitoring capabilities or integration with local weather stations to provide more comprehensive early warning solutions.

Overall, this project highlights the significant potential of **Arduino-based disaster detection systems** in addressing environmental hazards, offering a cost-effective, scalable solution that could be applied to other natural disaster monitoring systems worldwide. The successful implementation of this prototype marks a step forward in using technology for better disaster preparedness and response.

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