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The Field Of Natural Disaster Management Encompasses Concepts Such As Risk Migration And Pre-And Post-Disaster Planning.

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ABSTRACT:

Volcanic hazards, such as lava flow disasters, are common during periods of excessive rainfall on volcanic summits. The lava flows downhill in this torrent, contaminating locations far from the volcano's top that are home to people. Thus, it is undeniably critical to have a sophisticated early warning system for cold lava flows. With the use of its catastrophe communication system, this study intends to provide a dependable, remote Early Warning System (EWS) developed especially for the detection of lava floods. Lava flood detection and catastrophe communication systems are the two primary components of the suggested system. It makes use of an automated rain gauge that has been tweaked, a newly designed vibration sensor, an algorithm for fuzzy tree decisions, Internet of Things (IoT) microcontrollers from ESP, and crisis communication tools including WhatsApp, SMS, and radio communication. The experimental findings show that the tipping bucket rain gauge sensor prototype has an accuracy of 81.5% for measuring moderate and heavy rainfall intensities.

At the same time, the geophone-based earthquake vibration detection prototype can accurately monitor vibrations of high and medium intensity with an accuracy of 89.5% while simultaneously filtering out background noise from vehicle vibrations using a Kalman filter. The website receives readings from the sensors. Data from the website allows the disaster mitigation team to employ the disaster communication strategy to evacuate populations. With the help of the local Disaster Deduction Risk (DDR) forum, the suggested approach was effectively put into place on Mount Merapi in Indonesia.

INTRODUCTION

Indonesia is situated in a region prone to natural disasters, which may have social, economic, and environmental consequences. These catastrophes can range from small to medium in magnitude. The frequency of volcanic eruptions in Indonesia is inversely proportional to the frequency of natural catastrophes. Many people pay less attention to the dangers of cool lava flows during volcanic eruptions than they do to the scorching clouds and hot lava itself. Even in the absence of volcanic eruptions, lava flows are a common occurrence during the wet season. Volcanic debris is transported downstream by this flood. Even far from the volcano's top, populated places may feel its effects. There is, without a doubt, an absolute need to create a state-of-the-art cold lava flood early warning system.
For their suggested methods or implementations of disaster management systems, several researchers mostly used generic flash flood instances. One such example is the technique for flash flood detection that Ghasemigoudarzi et al. [1] suggested using CYGNSS data. At the same time, Khan et al. (2020) [2] conducted research to compile a thorough factual review for first flash flood investigations. In the past, researchers have used radar devices to remotely monitor or investigate catastrophes caused by flooding. Sherpa et al. (2020) [3] suggested a probabilistic mapping approach that will make use of Spaceborne Synthetic Aperture Radar to study the Indian floods. At the same time, Landuyt et al. (2019) [4] investigated a flood mapping technique that used Synthetic Aperture Radar with a thresholding approach. Following the development of satellite

systems, the majority of researchers relied on them for either basic communication or instruments related to mapping and flood detection. Using geo-information and methods like the level set approach, Sui et al. (2018) [5] investigated the use of satellite imagery—specifically, pulsar satellite imagery—to identify floods. To identify places that have been flooded, Ohki et al. (2015, 2020) suggested a method that would use the amplitude and coherence data from PALSAR-2 satellite images. Subsequently, they created an interferometric phase statistical algorithm [6-5].

The use of satellite pictures in image processing algorithms is becoming more widespread in research, as seen in studies like Monti-Guarnieri et al. (2018) [9] and Zhao et al. (2019) [8]. In the recovery phase of flood disaster management systems, satellite systems have been used in addition to flood mapping, as shown in studies such as Chen et al. (2020) [10]. There are still significant drawbacks to disaster management systems that rely on satellite imagery, despite their many benefits. Satellite photos, like those used by other image-based disaster management systems, sometimes have poor quality or need human intervention in processing and operations; sophisticated image processing is still necessary. More complicated instruments are also needed from time to time by satellite-based communication systems. In an effort to address this problem, several researchers—for example, Amitrano et al. (2018) [11]—sought to integrate AI with satellite systems for flood detection and mapping.

Literature review

Since then, however, several IoT-based disaster management solutions have arisen, thanks to the popularity of big data and the Internet of Things [12, 13]. Internet of Things (IoT) devices have the same data-interconnection and remote-sensing capabilities as satellites, but they are easier to develop and put into practice. Alagha et al. (2019) [15] proposes radiation localization as a specialized localized system, whereas Mouradian et al. (2018) [14] proposes large-scale catastrophe management using it. As shown in Liu (2019) [16-18], a combination of UAV with a reliable and energy-efficient remote-surveillance system is possible to create. Unfortunately, unmanned aerial vehicles (UAVs) aren't made for detecting lava floods; their primary use is in image-based systems. An early warning system for lava floods may be more effectively implemented with the use of machine learning and artificial intelligence in catastrophe situations [19] or for early prediction [20]. Examples of studies that have integrated IoT with ML and AI techniques for disaster management systems are Pandey et al. (2020) [21].

Detection systems are the primary target of these implementations [22–24]. For early warning and monitoring systems, the best artificial intelligence and machine learning approaches are fuzzy-based. Decision-making systems with many inputs and outputs, as well as fuzzy-based systems, may share conceptual information with their creators. Fuzzy logic may be used to build flood detection systems, for instance [25]. It was also suggested that flood detection and alerting might be improved by combining the Internet of Things (IoT) with a decision tree algorithm [26].

Since heavy rainfall is often the main cause of flood disasters, there is frequently a correlation between flood monitoring systems and rainfall intensity instrumentation systems. Rani et al. (2020) [27] explored a neural network method that could monitor rainfall intensity with a Raspberry PI and a water level sensor. This setup allowed for a low-cost flood monitoring system. Nevertheless, there has been very little investigation into cold lava flood detection and warning systems up until now. While most flood detection systems may be adapted to work with lava flood detection systems, some sensors and signal conditioning systems will need to be carefully selected and adjusted to work reliably. An Automated Rain Gauge (ARG) prototype based on the Internet of Things (IoT) that monitored and categorized rainfall into many categories had been suggested in previous study [28].

Since the prototype depended on a single main sensor and lacked a redundancy transducer or backup communication method, the likelihood of false positive alarms is likely significant. Seismic ground vibrations are reliable markers for lahar (cold lava) floods [30] and subglacial floods [29]. Victims of cold lava floods may be located with the use of vibration sensors. This project intends to build a dependable, remote Early Warning System (EWS) tailored to lava flood detection and its associated disaster communication system based on study findings from the aforementioned sources. The outline for the paper is as follows. A brief overview is provided in the first part. In Section 2, we shall write the theoretical review. Methods used in the study make up the third part. Following that, the findings and comments of the experiments will be documented in the part that follows. This part concludes the whole thing. The section that follows is devoted to acknowledgments. The last part of the research paper is the reference list.

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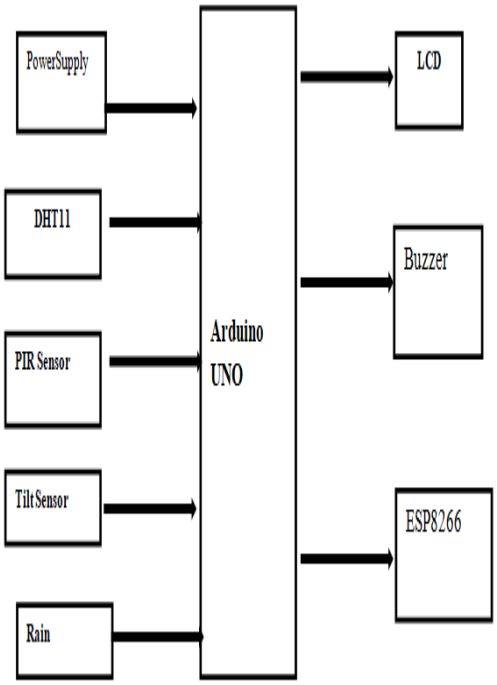
Methodology

Working



Block diagram

Arduino uno

A microcontroller board based on the Atmega328, the Arduino Uno is described in the datasheet. A 16 MHz crystal oscillator, 6 analogue inputs, 14 digital input/output pins (including 6 PWM outputs), 1 USB port, 1 power connector, 1 ICSP header, and 1 reset button are all part of it. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

Because it forgoes the FTDI USB-to-serial driver chip, the Uno stands apart from all previous boards. In its place, you'll find the Atmega8U2 configured to convert USB to serial. "Uno" signifies "One" in Italian and is chosen to commemorate the impending release of Arduino 1.0. Going forward, the Uno and version 1.0 will serve as the reference versions of Arduino. See the index of Arduino boards for a comparison with earlier generations; the Uno is the newest in a series of USB Arduino boards and the platform's standard model.

LCD

In front of a light source or reflector, a thin, flat display device called a liquid crystal display (LCD) arrays a large number of color or monochrome pixels. Pile of liquid crystal molecules held aloft by two transparent electrodes and two polarizing filters, whose polarity axes orthogonal to one another, make up each pixel.

If there weren't liquid crystals interposed, one would block the other from light. Light that enters one filter is able to pass through the other because the liquid crystal bends its polarity. A program's ability to communicate with the outside world depends on its input and output devices, which in turn rely on human communication. An LCD display is a typical accessory for controllers. The 16x1, 16x2, and 20x2 LCDs are among the most popular types of displays that are attached to the controllers. This equates to sixteen characters on a single line. The first set has 16 characters on each line while the second set has 20 characters on each line.

ESP8266 Wi-Fi Module

This project revolves on this. Given that the project relies on WIFI control of appliances, the module is a crucial part of it. This little board has an amazing MCU (Micro Controller Unit) integrated, which gives the possibility to control I/O digital pins via simple and almost pseudo-code like programming language. The ESP8266 Arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability. The Chinese company Es press if Systems is situated in Shanghai and makes this gadget. In August 2014, this chip made its debut in the ESP-01 version module manufactured by the third-party company AIThinker. The MCU can establish basic TCP/IP connections and connect to WiFi networks with the help of this little module. In his Many hackers and tech enthusiasts were interested in exploring and using it for a wide range of projects because to its tiny size and very inexpensive pricing (1.7$ to 3.5$). Since it has been so successful, Espressif has released other variants with varying proportions and technological specs. Among the following is the ESP32. Numerous projects and applications, such as home automation, may be found online.

RELAYS:

Many household and commercial equipment, as well as industrial control systems, make use of electrically

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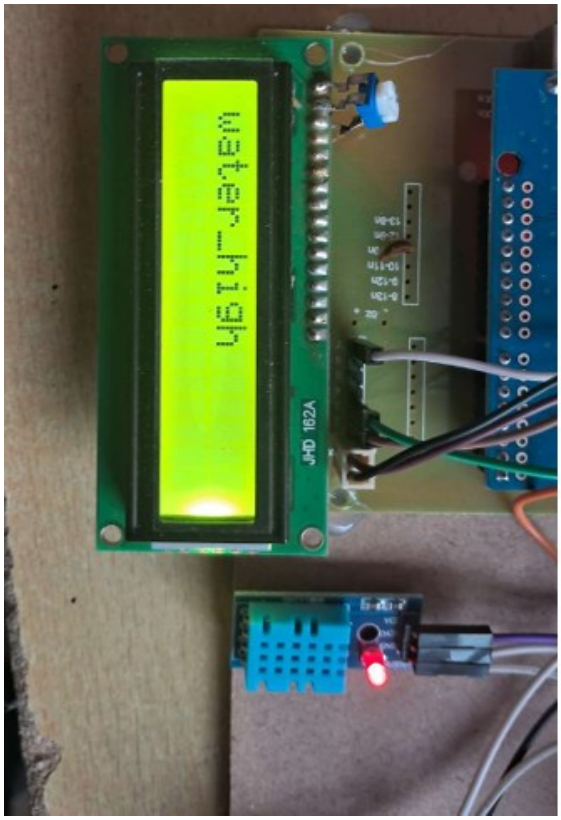
controlled switches called relays. By using a relay, two independent voltage sources may be isolated from one another; in other words, a little quantity of voltage or current on one side can manage a big amount of current or voltage on the other side, and vice versa.

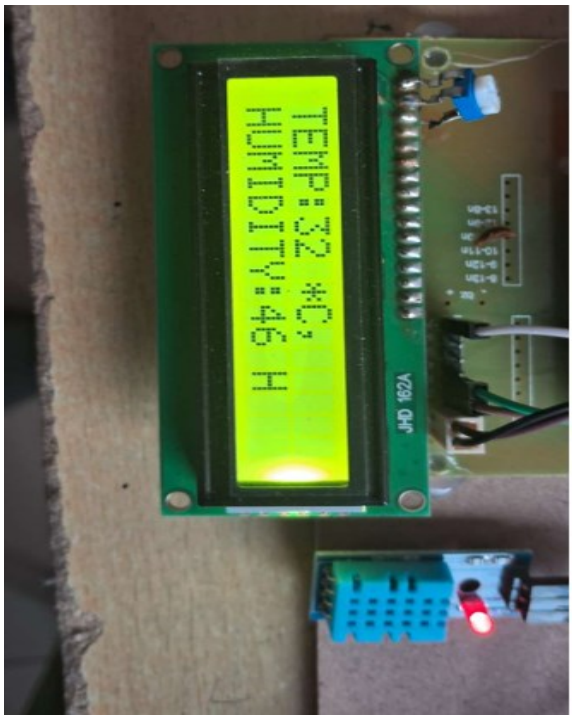
Bluetooth Module

Wireless headsets, gaming controllers, mice, keyboards, and a plethora of other consumer electronics make use of it. The range may be as little as less than 100 meters, depending on factors such as the transmitter and receiver, the weather, and terrain and metropolitan areas. One may construct a wireless Personal Area Network (PAN) using the IEEE 802.15.1 defined protocol. It transmits data wirelessly using frequency-hopping spread spectrum (FHSS) technology. To talk to other devices, it use serial communication. The USART is the means by which it exchanges data with the microcontroller.

RESULTS



Output1



Output 2

Final output

CONCLUSION

This research presents an early warning system for lava floods that consists of two interconnected subsystems. Automatic rain gauges, an innovative vibration sensor, and Internet of Things (IoT) support microcontrollers from ESP make up the suggested system. An automated rain gauge sensor with an

accuracy of 81.5% and a vibration sensor with a high sensitivity and broad frequency range are proof of the system's great performance. Because of this, the suggested system is trustworthy. In addition, the blynk.io website—an IoT platform—allows for remote monitoring of the proposed system. The system features a backup communication plan that uses WhatsApp messaging in addition to the main method of warnings, which is SMS with GSM modules. Radio communications, a disaster communication tool, was also included into the system. In order to notify the community with less confusion and terror, the local DDR forum (the FPRB members) thinks it would be helpful if the two subsystems were to merge.

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