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A Review: Wireless Sensor Network Based Landslide Detection

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Abstract - Wireless sensor networks, which allow for real-time monitoring of areas that are disaster-prone, are one of the most promising new technologies. Massive solutions for real-time monitoring at scale have been made available because to the promise of wireless sensor network technology. Landslides are a serious geological danger that occur when substantial amounts of rock, mud, and debris slide down a steep slope during periods of intense rain and rapid snowmelt. This study shows the potential of wireless sensor networks for disaster mitigation by focusing on landslide detection. Real-time monitoring requires the design, development, and deployment of a wireless sensor network (WSN), as well as the development of the essential algorithms for efficient data collection and data aggregation.

Key Words: Flex sensor, Bluetooth, Accelerometer, Landslide.

1. INTRODUCTION

Environmental disasters typically come about without warning and happen quickly. A landslide is a sort of mass wasting that can happen in offshore, coastal, and onshore environments due to gravity. It can encompass a wide range of ground movements such rock falls, deep slope failures, and shallow debris flows. An unstable but potentially harmful event is a landslide. Toe cutting, a steep slope angle, and saturated soil are its contributing causes. In a location thought to be unstable due to a history of landslides, these elements are more probable. It is possible to quickly capture, process, and transmit important data in real-time with high resolution using wireless sensor network (WSN) technology. However, it has some drawbacks, namely the comparatively small volumes. However, compared to many other technologies already in use, it has its own drawbacks, such as low memory availability and relatively low battery power. Landslide detection is the only problem that currently has a solution. An alarm is sent off when a trip wire put along landslide-prone areas breaks because of falling rocks and debris. Although this method of landslide detection is less expensive, it is ineffective at alerting people to an impending landslide.

A control unit that oversees the system's entire operations makes up the landslide early warning and monitoring system. A microcontroller such as an Arduino board, an ESP8266 board, an ESP32 board, or any other application-specific board created for monitoring purposes can serve as this control unit. The effectiveness of these boards depends primarily on the number of sensors being used, as well as their internet connectivity for presenting or graphing the collected data online. A control unit that performs better and responds more quickly must be used if there are more sensors being used. If internet access is necessary, a control unit that supports this capability must be used.

2. LITERATURE SURVEY

Garje et al [1] have presented a development of Wireless Sensor Networks (WSNs) with integrated different sensors was used in lab tests to identify landslides. Major alterations to the earth's natural ecosystem are caused by landslides. WSN is another trustworthy and reasonably priced new technology that allows for real-time surveillance across great distances and challenging terrain. To scan heterogeneous data with a digital sensor, the multipurpose Integrated Risk Information System (IRIS) remote was connected to a wireless module in this instance. One may track the movement and acceleration of the slide and take corrective action by studying the data the system generates.

Ramesh et al [2] have presented the implementation of WSN in a real-time system for landslide detection and warning systems. A landslide is when rocks and earth slip downhill. This can endanger lives and damage property and is typically brought on by torrential rain or snowmelt. Real-time monitoring identifies landslides, and an appropriate alert system is used to warn of them. This system makes use of an ARM7 microprocessor with wireless sensors and Zigbee technology. The purpose of this network is to comprehend the potential and value of wireless sensor networks for vital emergency applications.

Maneesha et al [3] have presented A landslide monitoring system based on wireless sensor networks, GSM, and the microcontroller also detects whether someone is driving through an earthquake-induced landslide. Nevertheless, to do this, it is necessary to continuously monitor Earth behaviour in order to gather consistent, real-time data. Here, a highly potent tool for real-time monitoring is the sensor. Choose GSM and a sensor network to get rid of this. Sensors are a crucial component of electronic devices that are used to measure environmental physical data. A significant part in landslide prediction can be played by sensors. In remote places, landslides can be mapped, found, analyzed, and predicted using sensors connected to the wireless protocol.

Nandakishor et al [4] have proposed IOT – based landslide detection system has been proposed as a low cost and efficient warning System . It makes use of an Arduino ,a Wi-Fi module, vibration and moisture sensor . Arduino uploads data as it is gathered to the cloud computing platform which aids in monitoring real time data and sending notification to users' mobile device when a landslide happens.the final one directs the robot's mobility using a PI controller .

Das et al [5] have proposed real-time monitoring using a rainfall landslide forecasting system WSN. The suggested work uses a number of wireless sensors to continuously monitor and gather data on the surroundings, moving it to the centre. The hub then calculates the landslide and delivers an alarm and an index depending on the data gathered. The landslide index surpasses the predetermined threshold landslide prevention in the case of a potential landslide to the remote cloud server. In this study, a rod embedded in the soil had an accelerometer, a load cell, a soil moisture sensor, and a rain detection sensor in addition to a hub. The soil moisture sensor detects the amount of water in the soil, while the detection sensor gauges the strength of the downpour. The load cell sensor detects the difference in pressure at a specific location. Accelerometer detects any form of rod movement of the rod through the sensors.

Mehta et al [6] have proposed WSN design for avalanche expectation in the rough mountain locales of the Kankan railroads. Wear levelling, fault tolerant energy efficient routeing protocol and distributed decision on the possibility of a landslide occuring are two important components of the whole concept. Data on landslide strain and subsequent statistical modelling are used in this paper's distributed decision technique. Simulate the strain caused by the pressure difference on and off stone samples in the test bed at IIT-Bombay. Using data from the Variable Mean Gaussian Process (VMGP), this strain is modelled. Check this out to learn more about distribution determination techniques. In terms of chance of missed detection, likelihood of false alarm, and power consumption on nodes, Distributed Scalar Based Detection (DSBD) performs better than Centralized Detection (CD) schemes.

Kunnath et al [7] have presented wireless sensor network for landslide detection systems uses heterogeneous wireless networks for dependable data delivery while operating constantly in real time. This method makes use of a wireless network to track and keep an eye on any possible ground vibrations that could occur before, during, or after a landslide. It is intended to use a layered wireless geophone technique to collect and analyse the relevant signals. The suggested method uses state-of-the-art signal processing to find landslides. Following the completion of a trial deployment with a single axis geophone, the new design of nested 3C geophones will be placed and validated in the current system. The recently developed wireless geophone network records the earthquakes brought on by slope instability .Following analysis, this information is used to provide landslide alerts. Additionally, the suggested signal processing method provides a means of reducing the load that selected receiver data sampling places on the WSN. The three-level warning system has a distinct sample rate for each level. These suggested design modifications will help develop a system for landslide warning that is more reliable.

Haining Shu et al [8] have Networked sensing differs from conventional centralised networks in that it can perform a variety of information processing tasks, such as event detection, target tracking, and data classification increased scalability and robustness. Performance requirements for these roles are quite specific, including the identification of false alarms or misses, inaccurate classifications, and track quality. An easy performance analysis of event detection in WSN is described in this work. The effectiveness of a cutting-edge detection approach called Double Sliding Window (DSW) detection is examined in this article, and it is fictitiously compared to the fixed threshold event detection methodology. The data show that the DSW detection method outperforms fixed threshold detection in a number of situations.

Ventisette et al [9] have shown multiple examples of landslide detection, mapping, and monitoring using radar interferometric techniques in a variety of geological environments and operational circumstances. Ground-based and satellite-based sensors were used to collect data. The use of radar interferometers for landslide detection, monitoring, developing hazard scenarios, and emergency management is discussed in this work.These methodologies can be versatile and adaptable to deal with a variety of operating settings, phenomena, geological contexts, and aims as seen by the numerous applications.

Gian et al [10] have A wireless sensor network for ground movement detection has been successfully built after the test demonstrated that the system could detect the ground movement and the observation data was precisely sent to the server. It consists of a coordinator, three nodes, and a wireless sensor network that connects the coordinator to the server using the General Packet Radio Service (GPRS) shield and the Zigbee Pro Series 1 as communicators.

Uchimura et al [11] have proposed approach mostly involves monitoring the tilting angles of the top layer of the slope. At the first stage of the scaled model slope, numerous patterns in the tilt angles captured on the slope's surface prior to its collapse were visible. The result was the creation of a set of tools with a tilt sensor and a volumetric water content sensor made of Micro Electro Mechanical Systems (MEMS) for use in actual environments. A different tilt sensor setup has been developed in order to study the deformation of the deeper layers. Performances have been recorded, and various pieces of equipment have been set up at various slope positions. The slope failure on a natural slope was also investigated using high-rainfall simulations.The recommended method discovered distinctive traits in the tilting degrees at these places during the early phases of failure. Based on the tilting behaviours observed on the slopes' surfaces, it is advised to issue a caution at a tilting rate of 0.011 per hour and a warning at a tilting rate of 0.11 per hour to be safe.

Alimuddin et al [12] have proposed the early warning accelerometer sensor for use on trains was created and tested. Landslides are easily and quickly detected by using sensors, a microprocessor, an accelerometer, and an Arduino. The early warning system is intended to function digitally, with a real-time and effective response time of less than 1 second and an average inaccuracy in the reading from the catalytic sensor of 0 to 3.84 percent. The first of several steps in the application design for a landslide warning system is the design of an accelerometer sensor for a collision caused by an early warning system collision caused by a landslide on a railway. The cliff sensor accelerometer also accounts for the grade at railroad crossings. The test results are typical based on the design and testing of the early warning system against seismic disasters using an acceleration sensor and an Arduino microcontroller. The accelerometer sensor's percentage inaccuracy ranges from 1 to 3.84 percent. The speed at which snow falls increases with an object's mass as it lands. Similar to this, the faster an object covered in snow fell, the steeper the cliff's slope became.

Chapagai et al [13] was suggested that an Early Warning System (EWS) based on prototypes be implemented to recognise and provide early warning of landslide activities.The implementation of the prototype using a cheap sensor network is the primary goal of this effort. To investigate the capacity and efficacy of the system, simulation setups and table-based prototype setups were used. A table-based landslide scenario with several varying angles between 30° and 90° makes up the setting. Many sensing components were used, a rain sensor for rain detection, a soil moisture sensor for soil moisture measurement, a temperature and humidity sensor for ambient humidity measurement, and a vibration sensor for soil movement monitoring. The microprocessor receives the information gathered by the sensor element and sends it to a light-emitting diode (LED), buzzer, SMS, or phone call as an early warning signal.

Ping Lu et al [14] have presented an early warning system for landslides based on low-cost WIFI sensor networks and microcontrollers PIC12F683 and ATmega328. The foundation for estimating is flawed after landslides. It is a challenging process to select a simple and effective framework for landslide warning. As a result, the vibration values are detected by the sensors, and a cheap WIFI module subsequently sends the information to the server framework. The results demonstrated that when there are variations from the limit value, the framework can transfer information across the WiFi network as a result.

Thekkeyil et al [15] have analysed the geophone data and created a proposed technique to automatically detect the landslide signal. The landslide initiation point's location using an innovative technique is described. The technique is based on the time delay that occurs naturally when waves travel through the earth's surface. The geophones are self-excitatory, therefore the method described here doesn't need any extra power. When compared to other localization techniques, the approach's error rate is significantly lower. Testing and validation of the suggested algorithm are underway.

Ravi et al [16] have discussed developing an earthquake early warning system using IOT and WSN. On the surface of the earth, the sensor is located. The gateway, which serves as an IOT and has a Zigbee receiver, notifies a smartphone when there is an earthquake.

As a result, the early warning message is received. If the sensor is linked to this programme, it may record and identify the sensor's three square axes. The IOT movement has made smartphones possible, and the hardware component is responsible for accurately detecting and interpreting the signal. Software portion sends alerts as a result of the Laboratory Virtual Instrument Engineering Workbench (LABVIEW) programme, which is very useful for connecting hardware kit and controlling and monitoring the readings provided by this.

Takayama et al [17] have proposed Different host hubs in the wireless sensing node network system are sent in the detecting hubs for landslide detection, speed increase detection, and GPS. Area data from GPS, network geography analysis by the framework, and crisis detection by the framework by checking hub mode. Speed enables this framework to notice gradual mass development that may cause landslide events by increasing sensor arrangement. Once sent, detecting hubs form a self-organized remote spontaneous organisation. Through the hub and cloud systems, the estimation boundary information from the detecting hubs is transmitted to the host system. In the local sensing node network system, the operation of several host hubs advances risk management for ongoing monitoring of landslide disasters.

Qiang et al [18] have proposed a system has been built that provides comprehensive introductions to early warning approaches, real-time monitoring techniques, intelligent LEWS, various criterion warning models, warning release, and emergency mitigation tactics and performance. In China in 2012, eight landslides, including six in Heifangtai, were accurately anticipated and prevented. This study offered a helpful and informative recommendation for HeiFangtai's early warning system for landslides caused by loess. At HeiFangtai, there were two well-known loess landslides with accurate early warnings. Given the intricacy of landslide behaviours and failure processes, the effective implementation may serve as a model for more severe cases of more rapid slope collapse elsewhere in the world.

Dai et al [19] have A range of methods for estimating landslide risk are discussed, as well as new developments in landslide risk assessment management. It is suggested to use a framework for landslide risk assessment and management to lower the risk of landslides. The present status of study on determining the likelihood of land sliding, run out behaviour, and vulnerability is critically reviewed after this. Effective management techniques for lowering landslide-related economic and social losses are discussed. The management of landslide risk issues are also looked at.

Biansoongnern et al [20] have demonstrated a low-cost Wi-Fi-based early warning system for landslides using the PIC12F683 and atmega328 microcontrollers sensor system. The measurement system was harmed by the landslide. It is challenging to choose an effective, inexpensive solution for the landslide warning system. The costly Wi-Fi module transmits data to a server system and displays the vibration value that the sensor has captured. The outcomes demonstrate that when the threshold changes, the system can automatically transfer data across the Wi-Fi network. The development of landslide early warning systems is one of the most difficult geophysical research problems. The data is read from the microcontroller on the sensor node by the early warning system for landslides described in this work.

3. CONCLUSIONS

Wireless sensor networks are one of the best ways to continuously monitor disaster-prone locations. This project contributes knowledge by developing, building, and deploying a wireless sensor network for landslide detection. In this research, a wireless sensor network is set up in the real world to detect landslides. To efficiently transfer real-time data to the data management centre, this system takes advantage of a heterogeneous network made up of satellite terminals, Wi-Fi, and wireless sensor nodes.

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