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DISASTER MANAGEMENT USING WIRELESS SENSOR NETWORKS

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Abstract: ***The frequency of extxxcsreme climate phenomena is rising due to global climate change, and these phenomena are becoming more severe in terms of both human casualties and economic losses. To handle these tragedies, authorities need to be better prepared. A reliable system for catastrophe detection and alerting can aid in minimizing the destruction of lives and property. Wireless sensor networks are quite helpful in this area and play a significant role in wireless data transfer. With wireless sensor networks, we can instantly start the rescue effort and lessen the impact of natural disasters like floods, tsunamis, and hurricanes. With the use of a disaster detection and warning system that uses wireless sensors, Tectonic shifts in the Earth's crust that occur suddenly are what generate earthquakes and landslides. Telecommunications infrastructures suffer severe losses after major disasters. Location of the largest earthquakes by magnitude: Sumatra, Indonesia, and the Indian Ocean 9.2 magnitude. While measuring the earth's shock waves, such as p- and s-waves and soil water levels, earthquake sensors and soil moisture sensors are employed. These sensors are connected to sensor nodes, which are connected to cluster nodes, which are connected to base stations. Wireless sensor network is the name of this network (WSN). This study will examine technical possibilities for disaster management. WSN can take the position of the conventional network for disaster management, which uses a lot of expensive infrastructure like landlines and optical cable networks. Wireless networks have many benefits over conventional wired networks, including being inexpensive and simple to maintain.***

Keywords: Sensing Node, Wireless Sensor Network (WSN).

I. INTRODUCTION

Now that WSN technology has advanced, it is able to detect and keep track of a variety of environmental indicators. We can monitor and keep tabs on the numerous characteristics with the aid of a network's sensors. To mention a few, these parameters include temperature for detecting fires, flow measurement for detecting floods, and Global Positioning System (GPS) for tracking locations. We can spot any crisis by keeping an eye on these variables, and by implementing a network, we can disseminate the knowledge. Since sensors are a key component of many gadgets, programmers, and technologies, disaster management is a very vital objective for which they were utilized. This paper examines the impact of sensors on the disaster management process and highlights the types of sensors used in detecting the occurrence of these disasters or accidents as well as how sensors are used to detect the presence of living things. This is due to a large number of accidents and disasters of all kinds that occur constantly around the world, as well as their negative effects on people's lives and health, in addition to economic and psychological losses and disruption of public life. With proactive monitoring and timely reporting of emergency situations to base stations, sensor networks can offer an effective solution to these issues. Wi-Fi Sensor Networks (WSN) aids in the catastrophe warning and detection system for rescue and search efforts. Using WSN in place of the established system for disaster management, involves extensive hardware, including landlines and a network of optical cables. Using wireless networks is simple, maintainable, affordable, and full of benefits versus conventional wired networks. After the WSN network implementation in disaster, the management system has advanced more quickly, accurately and effective, and this is due to the employment of the position of the sensors. Currently, two data-transfer devices are required to send data from one node to another. Simple wireless communication networks are what we require. There are numerous such devices, including 1) Vibration Sensor, 2) Soil Moisture Sensor, 3) 3-Axis Accelerometer, 4) Humidity Sensor, 5) Water level Sensor and 6) STM 32 Microcontroller.

II. RELATED WORKS

1. *Natural Disaster Management using Wireless Sensor Network:*
Wireless sensor network is used here, the nodes are separated into sensing node, intermediate node & controlling node. Sensing node has the sensor to sense the disaster with Bluetooth &Arduino. The other two nodes consist of Arduino and Bluetooth. Bluetooth is used to connect these three nodes and the output as a alert is displaced in PC.

2. *Disaster Management Using Multi-Hop ADHOC Wireless Sensor Network and IOT* :
This project is totally based on WSN & IoT technology. From wireless node which consists of sensors (earthquake, temperature & water level sensor), microcontroller & transceiver module the collected signals are been transmitted to the base station. The base station has ESP8266 module and transceiver which receives the signal and send an SMS via Webhook. This work has successfully used the wireless sensor networks to monitor physical parameters like vibration, temperature and water level. These WSNs being very small can be easily deployed and used in a distributed way. The IoT connectivity has given the system an added dimension. It has allowed the system to send the alert to the disaster management team which can be housed anywhere across the world. But we have implemented only four types of sensors. A variety of other sensors can be used as there are a wide spectrum of natural disasters which endanger our planet.

3. Implementation of Wireless Sensor Network (WSN) for Earthquake Detection:
The earthquake is been sensed by WSN technology. It has nodes, gateways, and software. The node serves to detect or collect data in the

field. The gateway serves as a medium for sending and receiving data from the node to the software, and then the data sent will be processed in the software. It uses microcontroller, piezoelectric & vibration sensor, transceivers as sensor nodes. Transceiver & ESP32 as sink node, the data is uploaded to cayenne monitoring website.

4. *IoT based Landslide Detection and Monitoring System*:

This project uses Node MCU(ESP8266) module as microcontroller and connected with the sensors (Gyro & soil sensor) which provides the input to the controller. The input is been processed by the controller and then the landslide detection is been monitored and intimated through the Blynk app.

III. SYSTEM OVERVIEW

A transmitter and receiver are part of the proposed system, and the transmitter is responsible for detecting the disaster and relaying information to the receiver. The STM32 microcontroller allows us to monitor a big region while utilising very little electricity. Each sensor node in this network has a very sensitive sensor module for detecting minute vibrations that occur beneath the earth, as well as water levels and soil temperatures. A 32-bit microprocessor can assist in data processing. The entire system is based on ADHOC technology, which enables us to add other networks to this network or remove existing networks from it without disrupting dataflow. We can provide the safest position for each mobile device connected to the ADHOC method.

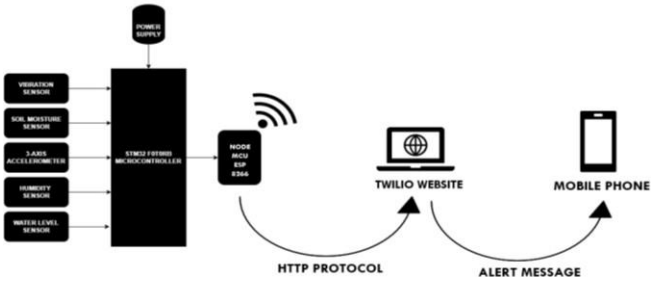

Figure 1: Block Diagram

Transmitter consists of i) Vibration Sensor, ii) Soil Moisture Sensor, iii) 3-axis accelerometer iv) Humidity Sensor v) Water Level Sensor, and vi) STM32 Module.

i) *Vibration Sensor*: An electrical instrument called a vibration sensor is used to identify and quantify mechanical vibrations in a system. These sensors have a variety of uses, including detecting earthquakes and monitoring the vibration levels in industrial machines. The frequency, amplitude, and direction of vibration in a system are all measured using vibration sensors. They can be used to track the health of equipment over time and to help detect mechanical defects such as misalignment, unbalance, or bearing wear. For the purpose of identifying changes in the vibration levels of buildings, bridges, and other structures, they are also utilised in structural health monitoring systems.

ii) *Soil Moisture Sensor:* An electrical gadget is known as a "soil moisture sensor" and it is used to gauge the moisture content of soil. These sensors can be applied to a variety of tasks, including environmental monitoring and agriculture. In agriculture, soil moisture sensors are used to assist farmers in managing nutrients and irrigation for higher crop yields and water saving. Soil moisture sensors can be used in environmental monitoring to track changes in soil moisture levels and pinpoint regions prone to drought or other environmental stressors. Some soil moisture sensors can wirelessly transfer data, which makes them perfect for applications requiring remote monitoring and control.

iii) 3-*axis Accelerometer:* A 3-axis accelerometer is an electronic device that is used to measure the acceleration of an object in three dimensions: x, y, and z. These sensors are used in a variety of applications, from monitoring the movement of vehicles to detecting changes in orientation and position of electronic devices. The term "accelerometer" refers to the sensing element that detects acceleration, which is typically a micro-electromechanical systems (MEMS) device. A 3-axis accelerometer can measure acceleration in three dimensions, allowing for the calculation of the orientation, velocity, and displacement of an object. They are commonly used in mobile devices, such as smartphones and tablets, to detect changes in orientation and to control the screen rotation. They are also used in sports and fitness monitoring devices to track movement and activity levels, as well as in automotive systems to detect changes in speed and direction.

iv) *Humidity Sensor:* Controls the humidity levels in a building to monitoring the moisture content in industrial processes. Humidity sensors are used in a variety of applications, including HVAC systems, food and beverage production, and pharmaceutical manufacturing. They can help to maintain optimal humidity levels for comfort, product quality, and process efficiency. Some humidity sensors also have the ability to transmit data wirelessly, making them ideal for remote monitoring and control applications.

v) *Water Level Sensor*: A water level sensor is an electronic device that is used to measure the water level in a container or a body of water. These sensors can be used for a wide range of applications, from monitoring the water level in a tank or reservoir to detecting flood conditions in a river or stream. Water level sensors are used in a variety of applications, including water treatment plants, irrigation systems, and aquaculture. They can help to ensure that water levels are maintained at optimal levels for efficient operation and to prevent flooding or other damage caused by excessive water levels. Some water level sensors also have the ability to transmit data wirelessly, making them ideal for remote monitoring and control application

vi) *STM32 Module:* The STM32 is a family of microcontrollers developed by the semiconductor company STMicroelectronics. These microcontrollers are based on the ARM Cortex-M processor architecture and are widely used in a variety of embedded systems applications, including industrial automation, consumer electronics, automotive, and IoT devices. The STM32 family of microcontrollers includes a wide range of devices with different features and capabilities, such as different clock speeds, memory sizes, and I/O interfaces. STMicroelectronics provides a comprehensive development ecosystem for STM32 microcontrollers, including development tools, software libraries, and application .

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Receiver consists of i) ESP8266, ii)Twilio Server

i)*ESP-8266* : ESP8266 is a low-cost Wi-Fi module developed by Espressif Systems. It is designed for use in embedded systems and IoT devices that require wireless connectivity. The module features a 32-bit microcontroller and supports 802.11 b/g/n Wi-Fi standards. The ESP8266 has become a popular choice for DIY electronics projects due to its low cost, small size, and ease of use. It can be easily programmed using the Arduino IDE, making it accessible to both beginners and advanced users. The module has several GPIO pins that can be used to interface with sensors, actuators, and other electronic components. It also has built-in support for TCP/IP networking, making it easy to connect to the internet and communicate with other devices. One of the most popular uses of the ESP8266 is in home automation and IoT projects. It can be used to control lights, thermostats, and other home appliances through a web or mobile application. It can also be used to monitor and control sensors such as temperature, humidity, and air quality. Overall, the ESP8266 is a versatile and cost-effective module that has become a staple in the DIY electronics community.

ii) *Twilio Server*: Twilio is a cloud communications platform that provides APIs and services for building communication applications. It offers a wide range of communication channels, including voice, SMS, and video, that developers can use to create and integrate communication features into their applications. When you use Twilio to send SMS or make voice calls, you send requests to Twilio's servers, which then route those requests to the appropriate carrier or service provider. Twilio's servers also handle incoming communication requests and route them to your application. Twilio offers a variety of APIs and services for developers to use, including the Programmable SMS API, the Programmable Voice API, and the Twilio Client SDK. These APIs and services provide developers with the tools they need to integrate communication features into their applications quickly and easily. Overall, Twilio's servers provide the backbone for the communication features that developers build using the Twilio platform. By relying on Twilio's servers, developers can focus on building their applications without having to worry about the complexities of managing communication infrastructure.

IV. WORKING OF THE SYSTEM

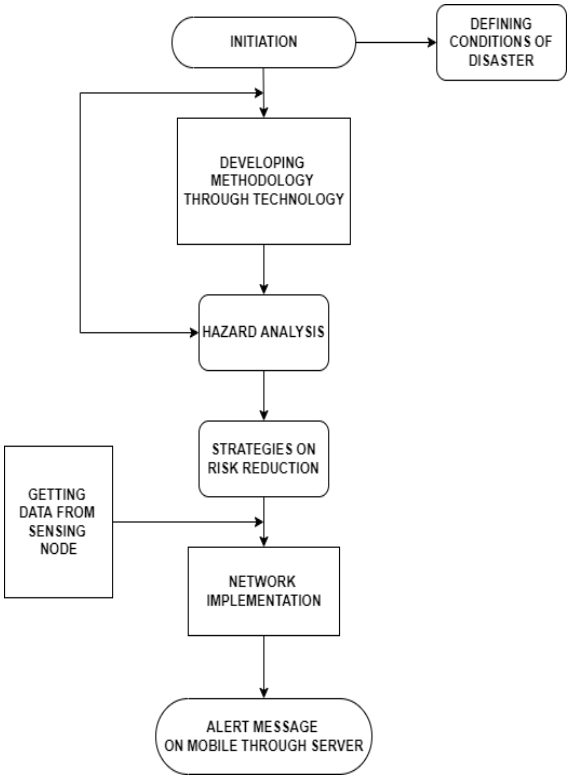

Figure 2: Flow Diagram

A communication strategy that describes how information will be distributed to the public before, during, and after a disaster should be part of the disaster management plan. Technology-stage approach development entails spotting potential risks and taking action to lessen their effects. It comprises consideration-related tasks like hazard analysis and risk assessment. Creating plans and processes for handling emergencies is a component of risk reduction techniques. Sending them an alert message allows us to lower the chance of losing life even while controlling the crisis is difficult. This plan also calls for the deployment of cutting-edge technology to spot crises coming and alert the populace in time.

Installing sensors, for instance, can detect and provide early warning of imminent calamities like earthquakes, floods, and landslides. It takes rigorous planning, design, configuration, testing, deployment, and maintenance to successfully construct a network. The process of implementing a computer network within a business or community is known as network implementation. Identifying the needs and goals of the organization is the first stage in implementing a network. This entails determining network security regulations, determining hardware and software needs, and evaluating the network's breadth. The Twilio website server, a gateway server, is the

foundation of the network architecture. It is crucial to properly test the network once it has been configured to make sure it satisfies the needs of the organisation. This includes doing tests to evaluate the dependability, security, and speed of the network. The network can be implemented within the company when it has undergone testing and validation. Installing network hardware and software is part of this. Establishing a maintenance schedule is crucial to maintaining the network's security and functionality. Using Twilio's APIs, developers can create and incorporate communication capabilities like audio, video, and messaging into their apps. Twilio is a cloud communications platform. Developers can create and deploy applications with Twilio's serverless architecture without worrying about infrastructure maintenance.

The Twilio API receives queries from the application and routes them to the relevant Twilio service. After processing the request, the Twilio service replies to the application with its findings. Twilio is a well-liked option for developers wishing to incorporate communication features into their projects because of its serverless design and selection of services. To incorporate communication elements into an application, Twilio offers a variety of services, including:"Programmable SMS" Applications can send and receive SMS messages using this service. Applications can place and receive calls using the programming voice service. Programmable video: This feature enables video calls between programmes. Real-time chat capabilities can be added to apps using the "Programmable Chat" API.

Verify: Applications can use this service to add phone number verification to their submissions. Applications can manage and route tasks to agents depending on their skills using the service known as "Task Router."

Mobile applications, push notifications, and SMS (Short Message Service) messages are just a few of the ways alert messages can be delivered to mobile devices. SMS alerts are text messages that are delivered to mobile devices. Both using an SMS gateway provider and straight through a messaging platform are options for sending them. Emergency messages like weather warnings, natural disasters, or security alerts are frequently sent out by SMS. Push notifications are messages that a mobile app sends to a user's phone. Even when the app is not active, these notifications are displayed on the phone's screen. For app-related alerts like fresh messages, breaking news, or appointment reminders, push notifications are frequently employed. We must decide who the target audience is and the best channel to use before delivering an alert message to a mobile phone. Additionally, we must develop the message content and structure it for the channel of choice. In order for the notifications to be sent promptly and accurately, we must lastly make sure that the alert system has been tested and is dependable.

V. CONCLUSION

Over the past few years, wireless sensor networks (WSNs) have garnered a lot of attention. As technology advances, WSN is becoming more prominent due to its unrealized potential and importance. This project describes how to put into practise method for managing disasters utilising wireless sensors networks (WSN). The sensor network wireless. Consequently, architecture greatly aids us in predicting the causes of both natural and man-made disasters, as well as if possible, offering rescue and preventative actions. The natural calamities can occur everywhere. So, it aids in safeguarding several priceless people and animal's lives saved from the death that might have otherwise impacts brought on by these catastrophes. Application of WSN lowers the expense and labour requirements. This approach helps us to accelerate the timeliness of disaster management and can reduce loss of property and loss of lives to a large extent. Successful implementation of the wireless sensor network system implemented.

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