Multi-Input Based Post Natural Disaster Alert System

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***Abstract*— Earthquakes pose significant threats to human life, infrastructure, and the environment. Rapid detection and timely dissemination of earthquake alerts are crucial for minimizing the impact of seismic events. In this paper, a developed earth-quack alert system has been presented that aimed to provide early warnings to reduce the possible harm caused by earthquakes.**

Keywords—Alert Systems, Earthquake, IoT, Natural Calamity, Piezo sensor, Rescue system.

I. INTRODUCTION

Natural disasters wreak havoc worldwide each year, claiming thousands of lives lost and millions of dollars in property damage, not to mention the profound and enduring social disruptions they leave in their wake. Among these, earthquakes and the potential tsunamis stemming from underwater seismic activity pose grave concerns due to their often sudden and minimal forewarning. Consequently, the strain on emergency services to promptly initiate effective mitigation measures is considerable, with developing nations bearing the brunt, as their response capabilities may already be lacking even during less tumultuous periods [1].

The current study's key goal is to evaluate the effectiveness of an earthquake early warning (EEW) system—a critical lifesaving tool—in India, using both synthesized data and seismic records obtained from Taiwan [2]. India recently constructed an EEW system within the primary seismic gap along the Himalayan Belt, which includes roughly 100 low-cost Primary Alert devices. This region, where these instruments are stationed, was extremely vulnerable to earthquakes, with the potential for big, major devastation. In the absence of Himalayan seismic data required for analysis such a system, recorded waveforms from Taiwan have been leveraged to assess the EEW's performance.

Various early warning systems, such as Shake-Alert in the United States, Mexico's Early Warning and Monitoring System, and Taiwan's Earthquake Early Warning System, have been implemented globally, relying on networks of seismometers to detect initial, less destructive seismic waves and issue alerts before more perilous tremors strike [2]. Earthquakes stand out as one of the most catastrophic and unpredictable natural disasters. Directly acquiring observational data proves challenging due to its entanglement with numerous complex factors. For instance, one observation revealed five minor tremors preceding the primary event—these foreshocks typically manifest as small-magnitude seismic activities along with P and S waves. The S wave, being the principal event wave and the most destructive, travels at a slower pace than the Primary waves. Thus, if a detector can gauge the intensity of the Primary wave, it affords valuable time for evacuation [3].

Consequently, this paper delves into the development of an IoT-based system utilizing Arduino technology, designed to detect various natural disasters such as earthquakes, landslides, and avalanches, while promptly notifying relevant authorities and individuals at risk. A cost-effective earthquake warning system capable of discerning non-destructive tremors has been devised [4]. Furthermore, it issues alerts to occupants within structures and remotely notifies rescue teams or designated personnel via Wi-Fi, while also furnishing real-time fire and earthquake data [5].

II. NATURAL DISASTER ALERT SYSTEM

An Internet of Things (IoT) based system for detecting natural disasters utilizes both a Piezoelectric Trigger System and a Visual Human Detection System to sense vibrations generated by occurrences such as earthquakes and landslides. Subsequently, a microcontroller processes this data and executes predefined actions or dispatches alerts based on set thresholds via an alert mechanism. The integration of this alert functionality with smartphones is achieved using Embedded C programming language. Facilitating communication within the system is the GSM module, which transmits data retrieved from the Arduino to the respective emergency services.

This module operates using a SIM card for communication and employs a serial communication interface. User-provided codes determine both the content of the warning message and the receiver's mobile number. Upon detection of an earthquake or human presence, an SMS notification is promptly dispatched to the designated recipient, ensuring timely alert dissemination [6].

During an earthquake event, the piezoelectric sensor activates upon sensing applied pressure. If the pressure surpasses predetermined voltage thresholds, the sensor relays this information to the Arduino, which in turn forwards it, along with the data through piezoelectric sensors are sent to the coordinator. This coordinator receives the data and sends it to the selected device via serial connection [7].

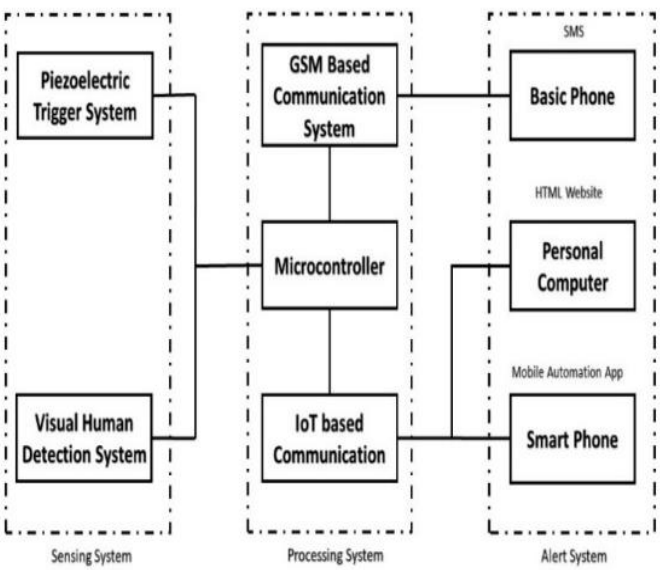

Fig.1: Block Diagram to describe the developed prototype

III. WORK METHODOLOGY

1. Sensing System

The sensing system is responsible for collecting data from the environment, consist of sensor systems distributed around the region, a central control centre, and locations where warning alerts are to be issued [8]. In our case, it involves two components:

a) Piezoelectric Trigger System

Utilize a piezoelectric sensor to detect physical changes such as pressure or force. The sensor can be embedded in various contexts, such as doorways, floors, or other surfaces. When triggered (e.g., by someone stepping on the floor), it generates an electrical signal.

b) Visual Human Detection System

A wide range of rescue, monitoring, and surveillance systems rely heavily on visual analytics [9]. Implement a visual detection mechanism using cameras and image processing algorithms. Our proposed approach can drastically minimize recorded video storage space while also significantly speeding up evidence video retrieval for selected suspects [10]. Camera capture images or video frames. Image processing algorithms analyze these frames to identify human presence. This system complements the piezoelectric trigger by providing additional context.

2. Processing System

The processing system handles data processing, decision-making, and communication. Key components include:

a) Microcontroller

Use a microcontroller (e.g., Arduino, Raspberry Pi) to process signals from the sensing system. The microcontroller acts as the central processing unit. It receives input from both the piezoelectric trigger and visual detection system. Develop software algorithms within the microcontroller to:

- Combine data from both sensors.
- Make decisions based on predefined rules (e.g., if both sensors detect human presence simultaneously).
- Trigger alerts when necessary.

b) GSM-Based Communication

Integrate GSM (Global System for Mobile Communications) technology. When an alert condition is met (e.g., unauthorized entry detected), the microcontroller sends an SMS (Short Message Service) to a predefined phone number. GSM ensures reliable communication even in remote areas.

c) IoT-Based Communication

Leverage Internet of Things (IoT) protocols for enhanced connectivity. The use of lightweight semantics for metadata is meant to improve rich sensor data collecting. This approach is demonstrated by identifying both system-related metrics and using an advanced prototype system of the semantic on the spot, paired with a deployed network [11].

Establish communication with a central server or cloud platform. Transmit data related to human presence, sensor status, and alerts. Allows for real-time monitoring and remote management. Creating robust and adaptable evaluation and processing models, as well as learning mechanisms capable of interpreting massive amounts of dynamic data of varying quality, necessitates coordination and collaboration across various approaches and solutions [12].

3.Alert System

The alert system ensures timely notifications to relevant parties. It includes multiple channels: The alarm circuitry consists of a pair of LEDs to warn the user of a possible earthquake event through the use of light [13].

a) Basic Phone (via SMS)

Send SMS alerts to basic mobile phones. Recipients receive concise messages indicating the alert type (e.g., “Unauthorized entry detected”).

b) Personal Computer (via HTML Website)

Develop an HTML-based website interface. Users can access this interface from their personal computers. Receive real-time notifications about detected events (e.g., “Human presence detected in restricted area”). Smart Phone (via Mobile Automation App) Create a mobile app for smartphones (iOS/Android). Users install the app and configure it to receive alerts. The app provides detailed information, including location, timestamp, and sensor details.

Here's a list of Components used in this Prototype.

Table.1: Component List

Serial Number	Item	Specifications
1	Microcontroller	Arduino Uno ATmega328P
2	GSM based Communication System	GSM 900A
3	Voltage Sensor	Vcc < 25 volts
4	Power Supply	5 volt, 2 amperes
5	Piezoelectric Trigger System	Piezoelectric Sensor
6	Connector	Programming Cable
7	IOT based Communication System	Node MCU ESP8266
8	Visual Human Detection System	ESP Cam Module

The first step is to Initialize the Sensing System. There are two sensor inputs: the Piezoelectric Trigger System and the Visual Human Detection System. If a high electrical signal is received, it proceeds to the next step. Both sensor inputs connect to an Arduino for processing. If the “Visual Human Detection System” provides a high signal, it triggers the alert system, if the flow proceeds through the Piezoelectric Trigger System having high signal. The “Trigger Alert System” is activated. There are two communication options: GSM-Based Communication (alerts sent via mobile network to devices like basic phones, personal computers, or smartphones) and IoT-Based Communication (alerts sent via the Internet of Things to devices like smart home systems or other connected devices). For the sake of readers understanding working of the Prototype has been demonstrated using a flowchart as shown in fig 2.

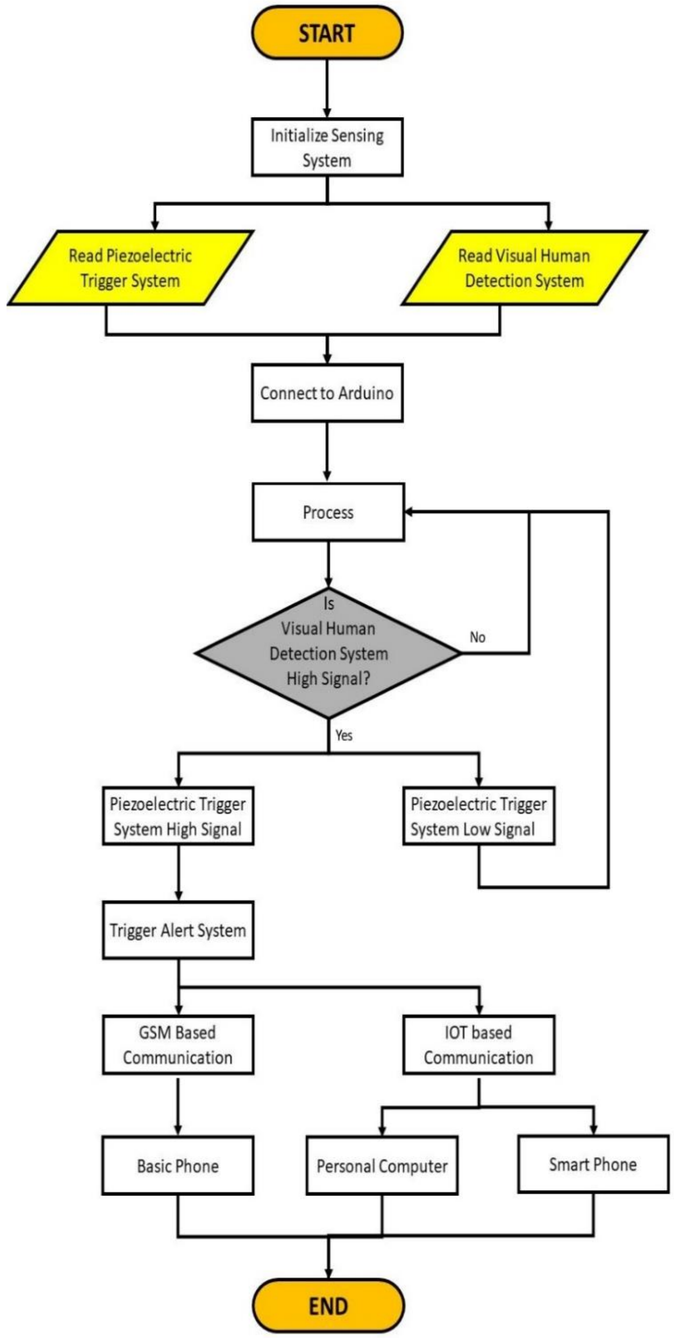

Fig. 2: Flowchart of working of Prototype

IV. RESULT

The fig.3(a) shows the working project under normal condition. When it normally operates the BLUE light is ON and the GREEN light which indicates the human detection is normally OFF. In fig.3(b) the human has been detected by the ESP Cam and a display warning of "Human Alert!" has been shown and a GREEN light gets ON, indicating that a human is detected as shown in fig.3(c). After human is detected and at the same time earthquake occurs, the BLUE led turns into RED indicating that earthquake is detected as shown in fig.3(d) and an alert message is sent to smartphones via SMS and in Blynk IOT app and through Gmail. When a normal human being steps into piezoelectric sensor, it generates less than 5V and when the building gets collapsed due to any natural calamity and falls into piezoelectric sensor, it generates greater than 5V as shown in fig.4.

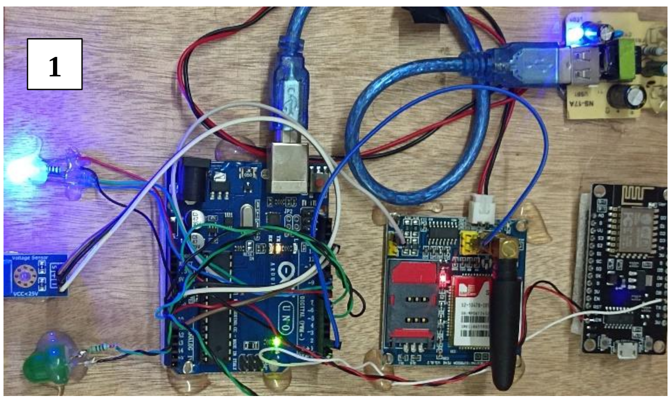

Fig. 3(a): Normal Condition

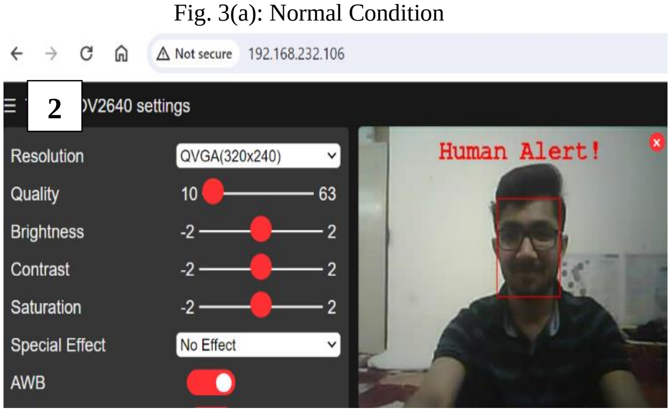

Fig. 3(b): Human Detection

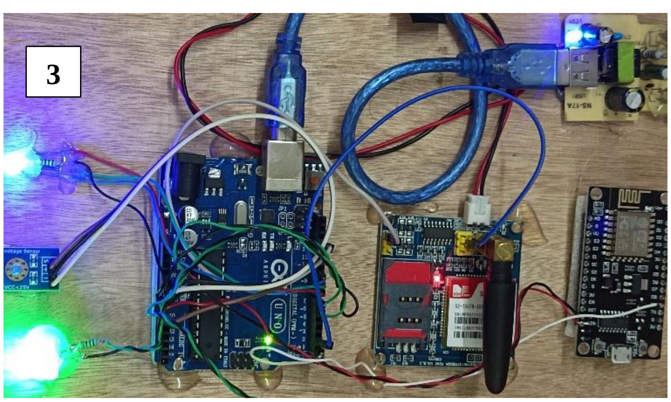

Fig. 3(c): Indication of Human Detection

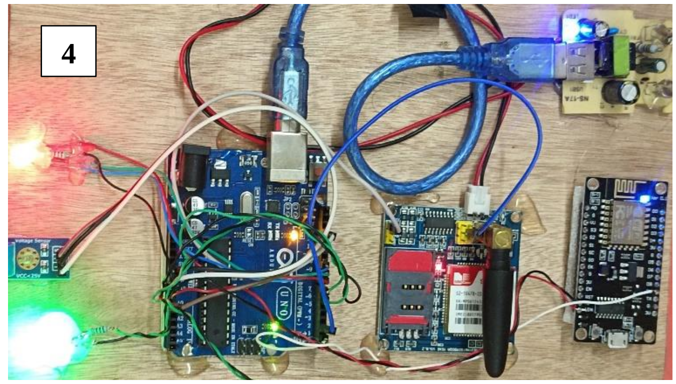

Fig. 3(d): Earthquake Detection

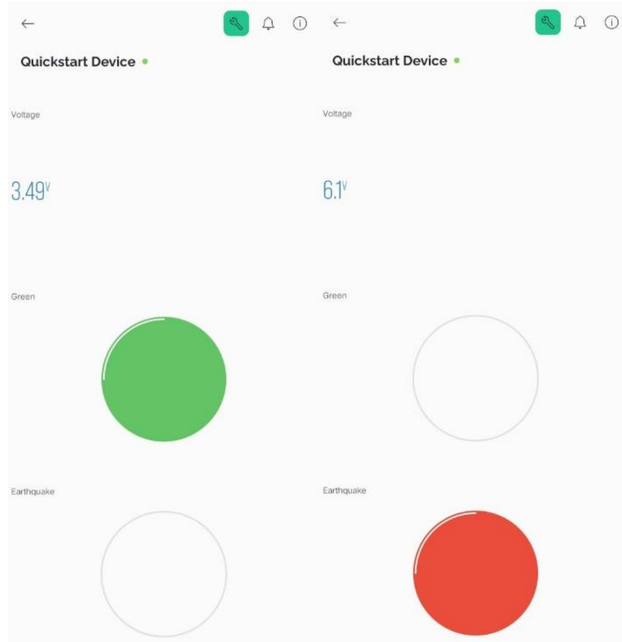

Fig.4 : Voltage Indication using Blynk Iot app

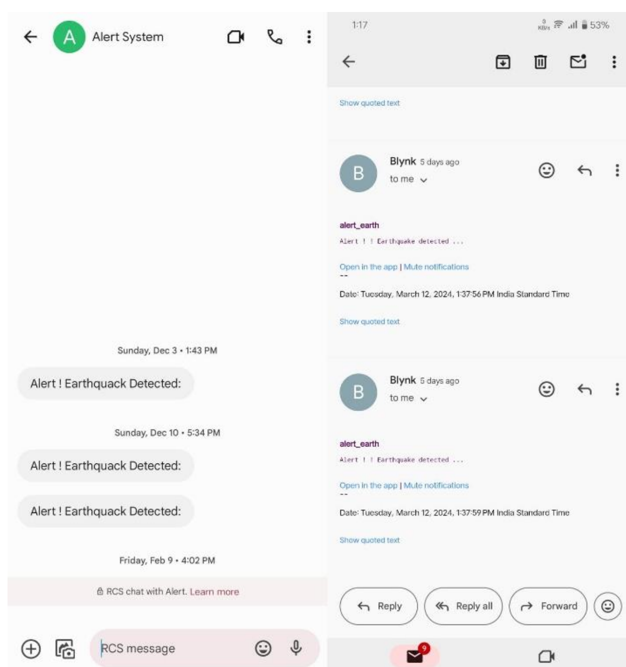

Fig.5: Alert Message via SMS & Gmail

V. CONCLUSION

The process involved in this project can be classified into four main conditions. The first is that when the Piezoelectric Trigger System Signal and the Visual Human Detection System Signal both have low signals, the Alert System Signal will also be low. The second is that when the Piezoelectric Trigger System Signal is low while the Visual Human Detection System Signal is high, the Alert System Signal will be low. The Third one is when the Piezoelectric Trigger System Signal is having High signal and the Visual Human Detection System Signal is having Low signal then the Alert System Signal will be Low. The Fourth and the final is when the Piezoelectric Trigger System Signal is having High signal and the Visual Human Detection System Signal is having high signal then the Alert System Signal will be High.

VI. FUTURE SCOPE

There are several future scopes in which the system can be integrated with early warning detection of earthquake as well as human detection acting as both early warning and on the spot detection. It can be further be integrated with AI so that it can predict various outcomes that are possible in case of earthquakes and can thus acts as a smart earthquake detection and rescuing system. It can also be used to navigate and locate the possible anomaly regions where destruction due to earthquake has been caused and has resulted in mass destruction of infrastructures.

VII. REFERENCES

[1] United States Geological Survey Map. 1999. Preliminary Determination of Epicenters, 358,214 Events, 1963–1998.

[2] Himanshu Mittal, Yih-Min Wul, Mukat Lal Sharma, Benjamin Ming Yang, Sushil Gupta “Testing the performance of earthquake early warning systemin northern India” Springer 6 October 2018

[3] Jeeva C, Porkumaran K, C. S. Boopathi, D. Karthikeyan, Sai Ganesh CS, Krithika B “Smart Earthquake Detector and Rescuing System for Differently Abled Person” IEEE 2022

[4] A. Karaci, “IoT-based earthquake warning system development and evaluation,” Mugla J. Sci. Technol., vol. 4, no. 2, pp. 156-161, Dec. 2018.

[5] Md Rysul Kibria Badhon, Anadi Ranjan Barai, Fatematuz Zhora Remote “Real Time Monitoring and Safety System for Earthquake and Fire Detection Based on Internet of Things” 3rd ICECTE, Dec 26-28, 2019

[6] N N Mahzan, N I M Enzai, N M Zin and K S S K M Noh Design of an Arduino-based home fire alarm system with GSM module l 2018 J. Phys.: Conf. Ser. 1019 012079

[7] Rahinul Hoque*, Shoaib Hassan, MD. Akter Sadaf, Asadullahil Galib and Tahia Fahrin Karim “Earthquake Monitoring and Warning System” Proceedings of 2015 3rd International Conference on Advances in Electrical Engineering 17-19 December, 2015, Dhaka, Bangladesh

[8] Yogesh Sherki, Nikhil Gaikwad, Jayalakshmi Chandle, Anil Kulkarni “Design of Real Time Sensor System for Detection and Processing of Seismic Waves for Earthquake Early Warning System” Conference Paper · August 2015

[9] H. Li et al., “Dynamic, data-driven processing of multispectral video streams,” IEEE Aerospace and Electronic Systems Magazine, vol. 32, no. 7, pp. 50–57, 2017.

[10] Z. Shao, J. Cai, and Z. Wang, “Smart Monitoring Cameras Driven Intelligent Processing to Big Surveillance Video Data,” IEEE Transactions on Big Data, vol. 7790, no. c, pp. 1–1, 2017.

[11] S. Poslad, S. E. Middleton, F. Chaves, R. Tao, O. Necmioglu, and U. Bugel, “A semantic IoT early warning system for natural environment crisis management,” IEEE Trans. Emerg. Comput., vol. 3, no. 2, pp. 246-257, Jun. 2015.

[12] P. Barnaghi, A. Sheth, and C. Henson, ‘‘From data to actionable knowledge: Big data challenges in the Web of Things’’ IEEE Intell. Syst., vol. 28, no. 6, pp. 6–11, Nov./Dec. 2013.

[13] NN Venkatesh Gupta Mr. s. rinesh, iot based earthquake detection by thing speak International Journal 2018.