Hardware Integration of a Real-Time Disaster Management Alert System Using Arduino, MAX7219 Display, and Bluetooth Communication

Koushiki Choudhary[1], Subhojeet Mitra[2], and Dr. Shiv Charan Puri[3]
[1,2]*Student, Asansol Engineering College*
[3]*Associate Professor, Asansol Engineering College*

***Abstract*-The increasing frequency and intensity of natural disasters such as floods, fires, and earthquakes necessitate the development of real-time alert systems that can efficiently warn the public and help minimize casualties. As these disasters often occur without warning, timely communication of danger is essential to ensure public safety. This project presents the design and development of a Bluetooth-based announcement system that integrates water sensors, smoke sensors, and vibration sensors to detect environmental hazards and display alert messages on nearby devices. By using advanced sensor technologies, the system is capable of providing early warnings to mitigate the risks associated with these natural calamities. The water sensor is responsible for detecting rising water levels during floods, providing early indications to avoid potential flooding. The smoke sensor is employed to identify fire outbreaks, while the vibration sensor monitors seismic activity related to earthquakes. Upon detecting any of these hazards, the system wirelessly transmits a text message via Bluetooth to nearby displays, indicating the type of emergency—flood, fire, or earthquake—along with necessary safety instructions. The information is communicated instantly, ensuring the safety of individuals in high-risk areas. This Bluetooth-based announcement system offers a cost-effective, scalable solution for disaster management and early warning. It is especially beneficial in areas with limited infrastructure or in emergency situations where traditional alert systems may be unavailable or ineffective. The integration of Bluetooth technology ensures mobility and real-time information dissemination, which significantly enhances disaster preparedness and public safety. The system's simplicity and efficiency make it an ideal tool for both urban and rural areas, contributing to a safer environment for all**

INTRODUCTION

Natural disasters, such as floods, fires, and earthquakes, pose significant threats to human life, property, and infrastructure, often resulting in catastrophic loss and disruption. These events are inherently unpredictable and can occur with little to no warning, making it difficult to prepare or respond effectively. The devastating impact of such disasters highlights the urgent need for efficient, real-time disaster alert systems that can provide early warnings to communities and individuals. In many regions, especially in remote or underdeveloped areas, current disaster management systems can be inefficient, inaccessible, or completely non-existent, leaving people vulnerable to the destructive forces of nature. In such situations, there is a critical need for accessible, affordable, and reliable systems that can offer timely and accurate warnings to mitigate the adverse effects of these disasters. This project seeks to address this pressing issue by focusing on the design and development of a Bluetooth-based Disaster Alert System. The core objective of this system is to provide real-time notifications about potential hazards such as rising water levels during floods, the presence of smoke during fire outbreaks, and seismic activity in the event of an earthquake. To achieve this, the system integrates three essential environmental sensors: water sensors, smoke sensors, and vibration sensors. Upon detecting any of these hazards, the system wirelessly transmits an alert message using Bluetooth technology. This message is sent to nearby display units, such as MAX7219 display. Bluetooth technology has been chosen due to its broad accessibility, cost-effectiveness, and ease of integration with other devices, making it ideal for this type of disaster warning system. One of the most significant advantages of this system is its scalability and mobility. The Bluetooth-based nature of the system ensures that it can be easily deployed in both urban and rural areas, even those with limited infrastructure or where traditional communication systems may be unreliable. Furthermore, the system is designed to be easily expandable, allowing for

additional sensors or alert mechanisms to be integrated in the future as the needs of a community evolve.

II. HARDWARE IMPLEMENTATION

The hardware implementation of the Bluetooth-Based Disaster Alert System involves combining essential components such as the Arduino microcontroller, sensors, Bluetooth module (HC-05), and display to create a system capable of detecting hazards like floods, fires, and earthquakes. The Arduino acts as the central controller, processing data from the water sensor, fire sensor, and vibration sensor to determine when an emergency condition occurs. This integrated system ensures real-time alerts, providing a simple and effective solution for disaster preparedness. The setup is designed to be scalable and adaptable for different environments, making it a valuable tool for enhancing safety and awareness during emergencies.

III SYSTEM WORKFLOW

Step 1: Powering the System – The system is powered using a battery power connected to the Arduino Uno. The connected sensors and Bluetooth module are powered through the 5V and GND pins on the Arduino.

Step 2: Sensor Monitoring – The Water sensor monitors the water level by providing an analog signal to Pin A0. When the water level exceeds a certain threshold, the system recognizes a flood condition. The Fire sensor sends a digital signal to Pin D2 when it detects smoke or fire. The Vibration sensor monitors vibrations and sends a digital signal to Pin D3 when seismic activity is detected.

Step 3: Processing the Sensor Data – The Arduino continuously monitors the sensor inputs. When a sensor is triggered (e.g., water level high, smoke detected, or vibrations sensed), the Arduino processes this input.

Step 4: Displaying Alerts – Upon receiving sensor input, the Arduino sends the appropriate message to the HC-05 Bluetooth module, which wirelessly transmits it to a connected device (such as a mobile or computer). Additionally, the Arduino updates the LCD display with the corresponding alert message:

Flood Alert: “Flood Alert: Water levels rising. Evacuate immediately!”

Fire Alert: “Fire Alert: Smoke detected. Evacuate immediately!”

Earthquake Alert: “Earthquake Alert: Seismic activity detected. Take cover!”

Step 5: Bluetooth Communication – The HC-05 Bluetooth module establishes a wireless communication link with a mobile device (smartphone) or computer. It can send data like flood, fire, or earthquake alerts, providing real-time notifications to the user.

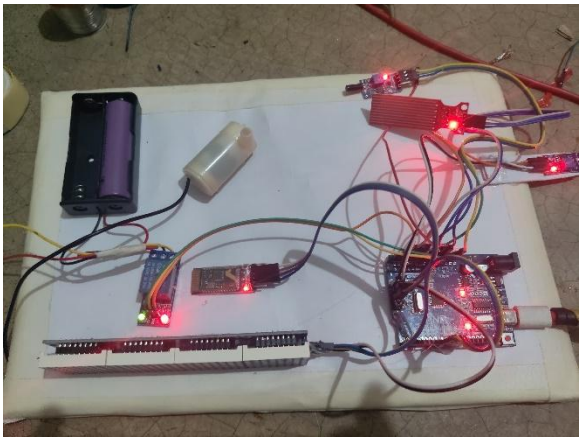

Fig. Hardware Integration Real-Time Disaster Management Alert System

IV. CONCLUSION

In conclusion, the Bluetooth-Based Disaster Alert System is a promising and innovative solution for improving disaster preparedness and response. By integrating essential components such as the Arduino Uno, Bluetooth module (HC-05), multiple sensors (water, fire, and vibration), and the dot matrix display, the system offers real-time hazard alerts that can significantly improve safety in emergency situations. This system not only provides users with visual alerts but also allows wireless communication of alerts to external devices, ensuring that timely notifications are sent to people at risk. The system's ability to detect floods, fires, and earthquakes with the help of sensors gives it great potential for use in various environments, especially in areas with limited infrastructure. The use of affordable components makes the system accessible, which is important for disaster-prone areas where resources may be scarce. Moreover, the Bluetooth communication module enhances the system's mobility and ease of installation, while the dot matrix display offers immediate visual alerts, which can be crucial during times of crisis

REFERENCE

[1] Ramya, R., Bavithra, N., & Priyanka, M. (2018). Wireless e-notice board using Bluetooth technology. International Journal of Engineering Research and Technology (IJERT).

[2] Sharma, D. K., Tiwari, V., Kumar, K., et al. (2015). Small and medium range wireless electronics notice board using Bluetooth and Zigbee. IEEE INDICON.

[3] Mary, M. A., Pavithra, B., Sangeetha, R., & Lakshmi, T. C. S. (2019). GSMbased wireless noticeboards using Arduino. International Journal of Advanced Research in Engineering and Technology (IJARTET).

[4] Pawar, P., Langade, S., & Bandgar, M. (2019). IoT-based digital notice board using Arduino ATMega328. International Research Journal of Engineering and Technology (IRJET).

[5] Banait, P. M., Bakale, N. P., Dhakulkar, M. S., & Rakhonde, B. S. (2018). Cost-effective Android-based wireless notice board. International Journal of Emerging Technologies in Engineering Research (IJETER).

[6] Bhardwaj, G., Sahu, G., & Mishra, R. K. (2020). IoT-based smart notice board. International Journal of Engineering Research and Technology (IJERT).

[7] Arun, M., Monika, P., & Lavanya, G. (2016). Raspberry Pi controlled smart enotice board using Arduino. International Journal of Computer Applications and Technology (IJCAT).

[8] Farooquie, A., Sakhre, A., Bomade, B., Badole, M., & Ughade, A. (2019). Design and implementation of wireless notice board display based on Arduino and Bluetooth technology. IOSR Journal of Engineering (IOSRJEN).

[9] Alamdar, F., Kalantari, M., & Rajabifard, A. (2014). An evaluation of integrating multisourced sensors for disaster management. International Journal of Digital Earth, 8(9), 727–749.

[10] Cui, B., Wang, C., Wu, M., Zhu, C., Wang, D., & Li, B. (2024). Integrating Bluetooth-enabled sensors with cloud computing for fire hazard communication systems. ResearchGate.