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LoRa & IoT Based Automatic Disaster Monitoring & Alert System

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Abstract: In times of natural and industrial disasters, quick detection and reliable communication are essential to minimize damage and save lives. The proposed LoRa and IoT-based Automatic Disaster Monitoring and Alert System provides an efficient, low-cost, and long-range solution for real-time disaster management. The system integrates various sensors to monitor parameters such as earthquake vibrations, gas leaks, flood levels, temperature, humidity, and human occupancy. Sensor data is collected by a NodeMCU (ESP8266) and transmitted through LoRa communication to a base station for further processing and cloud upload via platforms like ThingSpeak or Ubidots.

In critical conditions, the system triggers automatic alerts through GSM modules (SMS/calls) and local alarms, ensuring communication even during internet failures. Additional features such as automatic door control and people counting enhance safety and assist rescue operations. The system operates efficiently with low power consumption and solar backup, making it suitable for remote and disaster-prone areas.

This project demonstrates a scalable, energy-efficient, and internet-independent approach to disaster monitoring, offering early warnings, reliable alerts, and enhanced safety for communities, industries, and public infrastructures.

Keywords: LoRa (Long Range Communication), IoT (Internet of Things),Automatic Disaster Monitoring, Alert System, NodeMCU ESP8266, Sensor Network ,GSM Module, Thing Speak / Ubidots, Real-Time, Monitoring Cloud Connectivity

I. INTRODUCTION

During disasters, quick action and communication can save lives. Existing monitoring systems often fail due to internet breakdowns or lack of local automation. This project integrates LoRa (long-range communication) with IoT cloud services to provide dual-path alerting. At the field side, a NodeMCU-based module collects sensor data and sends it via LoRa transmitter. At the base station, another NodeMCU with LoRa receiver processes data, uploads it to the cloud, and sends SMS/Call alerts via GSM.

Additionally, a motorized door control automatically closes the bunker during emergencies, while people counting sensors provide rescue teams with real-time occupancy information.

A. Earthquake

Earthquakes devastate human life by causing immediate destruction from ground shaking, landslides, and tsunamis, as well as prolonged suffering from economic collapse, disease, and psychological trauma. The severity of the impact depends on factors such as the earthquake's magnitude, the time of day it strikes, and the quality of local infrastructure.

• 2015 Gorkha earthquake (Nepal): A 7.8 magnitude earthquake killed over 8,800 people and triggered landslides and avalanches. Field observations found that approximately 70% of urban and 95% of rural homes were severely damaged in the affected area.

• Earthquakes dramatically affect life through immediate, medium, and long-term consequences that cause death, destroy infrastructure, and disrupt society. Secondary disasters like landslides, tsunamis, and fires can be just as deadly as the initial ground shaking. The 2014 Malin landslide in India, which was likely caused by a combination of tectonic instability, deforestation, and intense rainfall, serves as a tragic example of these catastrophic effects.

B. Flood

Cataracts do when an overflow of water submerges land that's generally dry. They're the most frequent type of natural disaster and can be caused by natural events like heavy downfall and surfs or mortal factors like deforestation and shy structure. cataracts have ruinous impacts on mortal life, husbandry, and the terrain, though natural flooding can also have some ecological benefits.

• The 2019 flood tide saw over 7 lakh people affected and further than 200 casualties reported, with the sections of Kolhapur and Sangli among the hardest hit.

C. Gas Leak

Gas leaks can beget a wide range of short- and long- term health problems for humans and are extremely dangerous to the terrain. A gas leak is the unbridled escape of gas from a channel, vessel, or other constraint system. The inflexibility of the goods depends on the type of gas, the leak's duration, and the position.

• he Bhopal gas tragedy The 1984 Bhopal gas tragedy is a vital illustration of how a disastrous chemical leak affects legal systems and insurance fabrics.

• The Visakhapatnam gas leak The 2020 styrene gas leak in Visakhapatnam(Vizag), India, shows how insurance and liability principles evolved after Bhopal.

II. METHODOLOGY

1) Sensor Deployment and Setup: Sensors for detecting vibration, gas, temperature, humidity, and water level are installed in disaster-prone areas such as flood zones, earthquake fault lines, and industrial sites. Each sensor node is connected with a LoRa module for long-range communication.
2) Data Collection via LoRa Network: The sensor nodes collect data periodically and transmit it through the LoRa network to the LoRa gateway using low-power, long-distance communication.
3) Data Reception and Preprocessing: The gateway receives data from multiple sensors, filters out noise, and validates sensor readings before forwarding them to the microcontroller or IoT cloud for analysis.
4) Data Analysis and Disaster Detection: The system analyzes data based on predefined thresholds. For example, high water levels indicate floods, excessive vibrations indicate earthquakes, and high gas concentration indicates leaks.
5) Automatic Alert Generation: Once a disaster condition is detected, the system sends automatic alerts through GSM (SMS/call), IoT dashboard, and local alarms or buzzers. It also activates automatic door control for safety.
6) User Interface and Monitoring: A web or mobile dashboard allows users to monitor real-time data, view alert history, and acknowledge warnings.
7) System Maintenance and Updates: Regular calibration of sensors, firmware updates, and system health checks ensure reliable long-term operation.

III. LITERATURE SURVEY

1) Prof. Vijay Kumar et al. (2023) – Developed an IoT-based flood monitoring and alarm system; highlighted IoT's role in early disaster alerts.
2) Mr. Justine Mathew et al. (2023) – Designed an IoT-based human detection system; useful for people counting and safety monitoring.
3) Berkay Kaplan & Buhe Li (2024) – Created PyroGuardian for IoT-based health and location monitoring in firefighting; showed IoT's use in real-time tracking.
4) Ishrath Ahamed et al. (2024) – Implemented AI-based people tracking and counting; improved occupancy monitoring accuracy.
5) Yultrisna & Rahmawati Fitriyan (2025) – Proposed an IoT-based flood early warning system; focused on home safety applications.

IV. PROPOSED SYSTEM

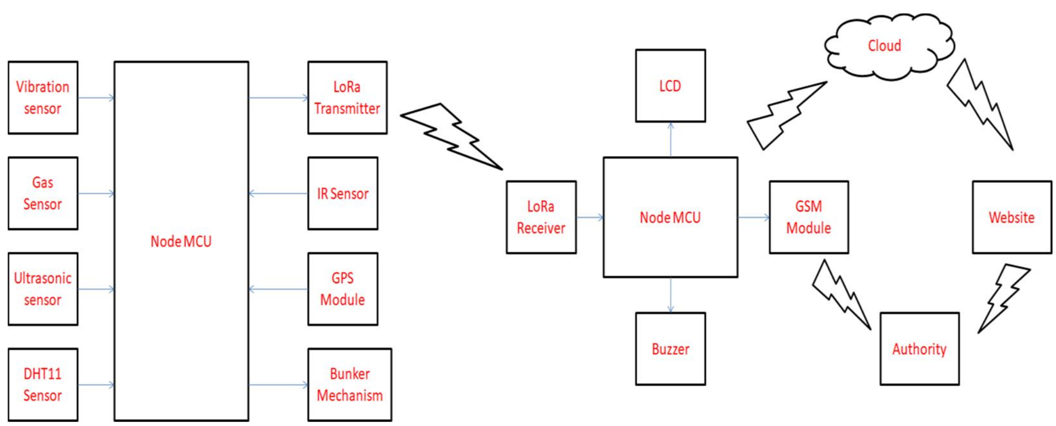

Fig. 1 Block Diagram

1) Sensor Block: This unit includes vibration, gas, ultrasonic, temperature, humidity, GPS, and IR sensors. It continuously senses parameters like ground tremors, gas leaks, flood levels, temperature, humidity, and people count.
2) Microcontroller (NodeMCU ESP8266 – Field Side): The NodeMCU collects all sensor data, compares it with preset threshold values, and prepares data packets containing sensor readings, GPS location, and occupancy information.
3) LoRa Transmitter and Receiver: The LoRa transmitter sends the collected data to the base station wirelessly over a long range (up to 10 km). The LoRa receiver at the base station receives this data for further analysis.
4) Base Station (NodeMCU + LoRa Rx): The received data is processed and displayed on an LCD or LED screen. It is also uploaded to IoT cloud platforms such as ThingSpeak or Ubidots for real-time remote access and monitoring.
5) Alert System: When any disaster condition is detected, the system immediately sends emergency SMS or calls via the GSM module and activates a buzzer or voice alarm to warn nearby people.
6) Automatic Door Control: This unit uses a motor and L298N driver to automatically close the door during emergencies to protect occupants. Manual control is also provided for safety.
7) People Counting Unit: IR sensors detect the number of people entering and exiting a building or bunker. This data is stored in the cloud and sent in alert messages to assist rescue teams.
8) Power Supply Unit: The entire system is powered by a battery with solar backup, ensuring continuous operation even during power failures.

V. FUTURE SCOPE

1) AI & Machine Learning Integration
2) Drone-Based Disaster Assistance

VI. CONCLUSION

The LoRa and IoT-based automatic disaster monitoring and alert system provides a reliable, low-cost, and efficient solution for disaster management. By integrating various sensors with NodeMCU, LoRa communication, and IoT cloud platforms, the system ensures real-time monitoring of earthquakes, floods, gas leaks, and environmental conditions. The dual alert mechanism using IoT dashboards and GSM fallback guarantees continuous communication even during internet failures. Features like automatic door control and people counting enhance safety and support rescue operations. Overall, this project demonstrates a scalable and energy-efficient approach to disaster preparedness, capable of saving lives and minimizing damage during emergencies.

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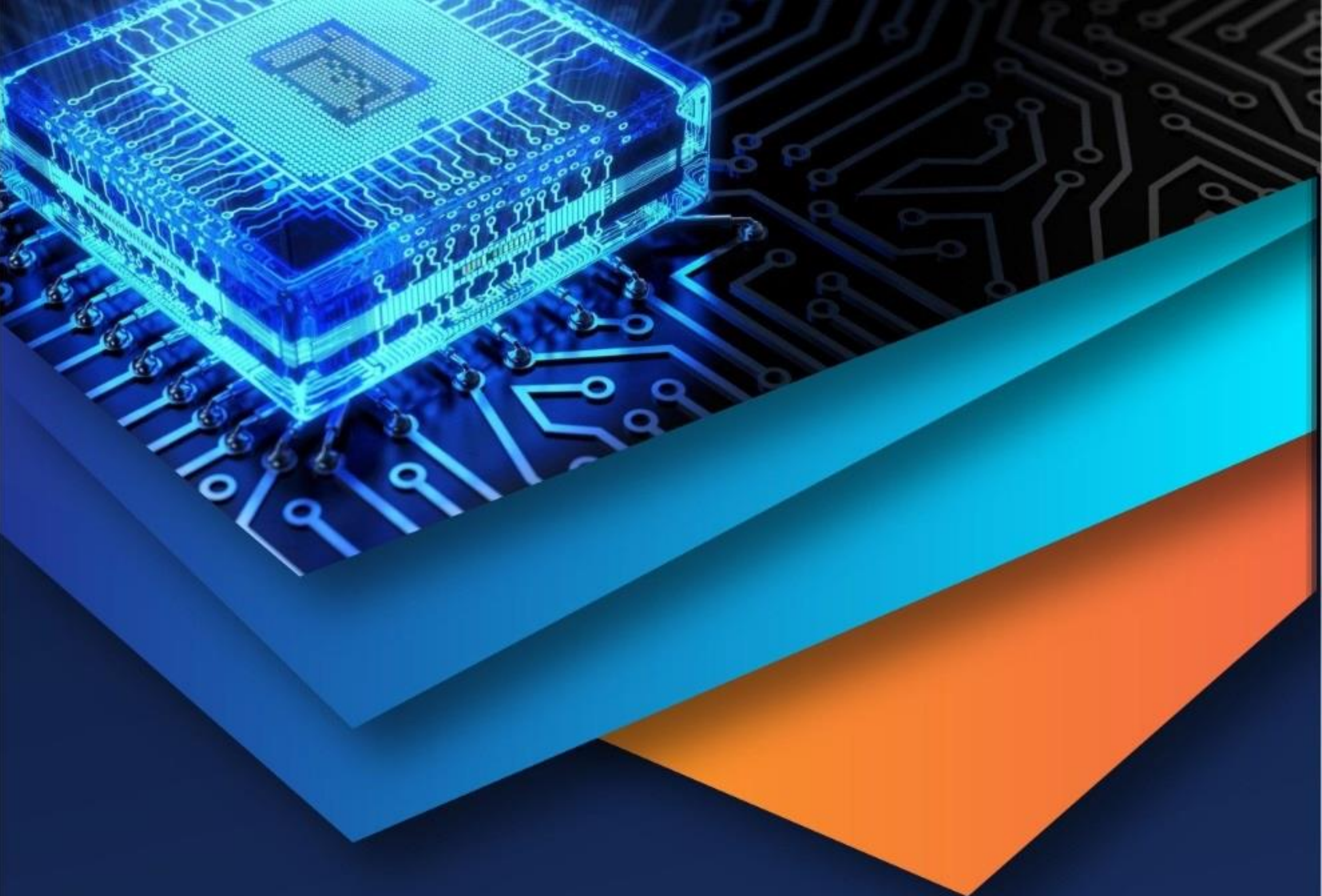

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