International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

IOT Based Flood Monitoring and Alerting System

Sivakumar Muthusamy[1], Sugumaran Ganesan[2], Prasad Chandramohanan[3], Sameeullah Kaja Hussain[4]

[1,2,3,4]Lecturer, Engineering Department, University of Technology & Applied Sciences-Nizwa, Oman

Abstract

The primary objective of this project is to create a reliable system for ongoing water level monitoring in dams or Wadis, ensuring timely alerts are sent to nearby residents and the Royal Oman Police (ROP) when levels approach hazardous thresholds. Although preventing floods may not always be feasible, implementing an early detection and alert system through continuous monitoring can significantly reduce the impact on communities. This initiative introduces an Internet of Things (IoT)-enabled flood detection and warning system, utilizing a NodeMCU board, an ultrasonic sensor (HC-SR04), temperature and humidity sensors (DHT11), and the Blynk app. The system diligently tracks water levels, transmitting sensor data to the Blynk Server at regular intervals, allowing for global access and oversight. Should water levels exceed predetermined safe limits, an immediate notification is dispatched via email to designated contacts, warning individuals in the vicinity of the dam or Wadi and the ROP of the potential danger.

Keywords: NodeMCU, Ultrasonic sensor, DHT11 sensor, I2C LCD display, Blynk application.

1. INTRODUCTION

Floods represent a critical challenge necessitating thorough preparation, administration, and public awareness to mitigate their adverse effects. These natural disasters can strike several locations within a region simultaneously during periods of intense precipitation. As engineering students, we understand the threats floods pose to human safety across all potentially affected areas. Our goal is to devise a groundbreaking technological solution to significantly diminish the dangers associated with flood hazards in various parts of our community. Various factors, including excessive rain, river overflows, and dam failures, trigger flooding. In Oman, flash floods are particularly alarming due to their abrupt onset across multiple areas without prior notice, posing extreme risks. These events are deemed the most perilous form of flooding in Oman, occurring swiftly after heavy rainfall. The rapid rainfall overwhelms the soil's absorption capacity, leading to swift rises in water levels. Urban areas, especially those with dense populations and extensive construction, face a higher risk of such flooding. Additionally, dams overloaded with water during substantial rainfalls may malfunction, causing water to surge into adjacent urban areas, endangering lives, especially without prompt warnings. Experts argue that climate change, through its role in increasing global temperatures, is exacerbating flood risks worldwide, especially in coastal and lowland regions. Our project's significance lies in its potential to protect individuals in flood-vulnerable zones and boost the efficiency of emergency services, allowing for simultaneous alerts and responses to flooding in various locations. This initiative aims to deter people from entering or approaching flood-stricken zones, thereby protecting them from the hazards of such calamities. Although complete flood prevention is unachievable due to their natural occurrence, the integration of cutting-edge technology in this project promises to elevate human safety standards. Employing modern technology, notably the Internet of Things (IoT) equipped with two NodeMCU units, enhances our capacity to detect and manage flood risks in different areas more effectively. This project offers crucial benefits to the community, providing extensive information about flood conditions during heavy rains and advising on the safety of visiting areas near their homes at risk of flooding.

2. WORKING OF PROJECT

The flowchart depicts the operational framework of our developed system, initiating with the activation of the power supply. This action powers up the NodeMCU and activates the sensors located at two distinct points within the system to commence their monitoring activities. The ultrasonic sensor is the first to start, utilizing ultrasonic sound waves to measure water levels and relay this information to the NodeMCU. Additionally, the DHT11 sensor is tasked with recording humidity and temperature data. The information gathered by the sensors at both locations is then transmitted to their respective NodeMCUs, which are pivotal in analyzing the incoming data. These NodeMCUs compare the sensor data against predefined reference values. Should the water level exceed the established maximum threshold, the system triggers an audible alert via a buzzer and illuminates a red LED to signal that water levels have reached a critical peak. Concurrently, the LCD screen will display "HIGH" to indicate this urgent condition, and the alarm remains activated. Conversely, if the water flow is within normal parameters, the LCD will show "NORMAL," and the alarm system will be deactivated. Figure 1 provides a visual representation of the system's operation through a flowchart.

The flowchart presents the configuration of the system we have constructed, starting with the activation of the power supply. Engaging the switch powers up the NodeMCU and initiates the operation of sensors deployed at two separate locations within the system. The process begins with the ultrasonic sensor, which detects water levels by emitting ultrasonic sound waves that are then transmitted to the NodeMCU.

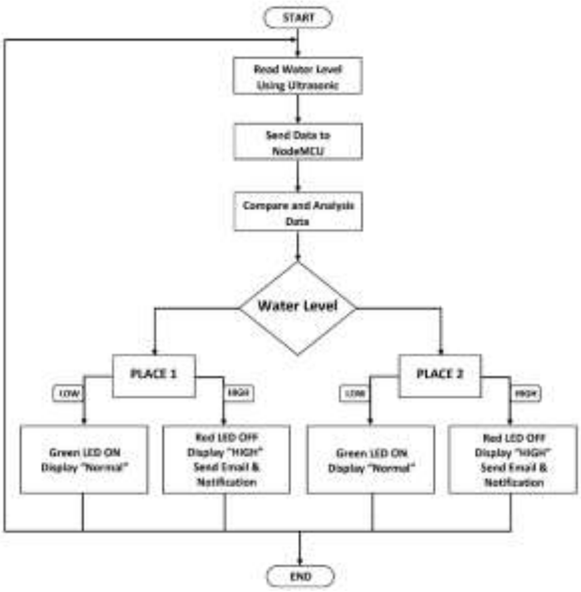

Fig.1 Flowchart

Measurements of humidity and temperature will be captured by the DHT11 sensor, a device designed for tracking both humidity and temperature. The sensors positioned at both locations will transmit their data to the respective NodeMCU units. These NodeMCUs are crucial for the analysis of sensor data, comparing it against predefined benchmarks. Should the water level hit its upper threshold, an alert will sound via the buzzer, and a red LED will illuminate to signal that the water has reached a critical level. Additionally, the LCD will read "HIGH," indicating an active alarm state. Conversely, if the water level is within acceptable limits, indicating a normal condition, the LCD will show "NORMAL," and the alarm system will be disengaged.

3. SYSTEM DESIGNAND IMPLEMENTATION

A. Block Diagram

To develop the flood detection management system, our prototype is built with two circuits positioned in separate locations, each powered independently by a self-sustaining source comprising a solar panel, solar charge controller, and battery. The solar panels harness solar energy during daylight, converting it into electrical energy, while in the absence of sunlight, power is drawn from the batteries, which are recharged during the day. This entire process is managed by a solar charge controller, ensuring a steady flow of power from the solar array to the battery bank. Subsequently, a 7805 regulator IC supplies a stable +5V power to the circuits. Both circuits are equipped with Ultrasonic Sensors, I2C LCD displays, Buzzers, LEDs, and Temperature and Humidity Sensors (DHT11). The ultrasonic sensor gauges the distance to the water surface, displaying readings on the I2C LCD screen. Concurrently, the DHT11 sensor assesses humidity and temperature, showcasing these metrics on the LCD. The Blynk application facilitates remote management of the NodeMCU units within each circuit, enabling the storage of alert messages. Upon receiving data, the NodeMCU processes it, comparing against set thresholds. Exceeding the safe water level triggers the activation of a red LED and dispatches a warning message. An alarm sounds in response to this alert, with "ALERT" displayed on the LCD and the alarm activated. Conversely, when water levels are deemed safe, "SAFE" is displayed, and a green LED illuminates. The system's architecture is depicted in Figure 2 block diagram.

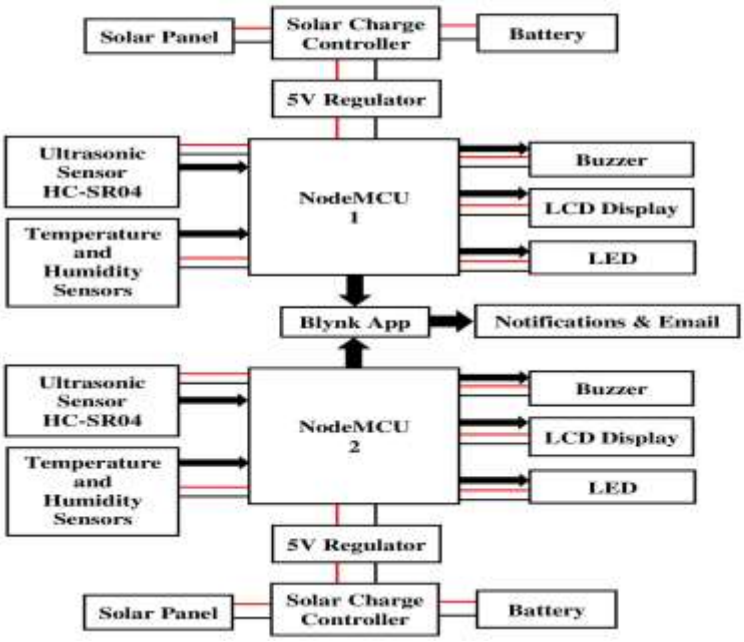

Fig.2 Block diagram

International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Circuit Diagram

The circuit diagram of IoT Based Flood Monitoring and Alerting system for TWO Place is shown in fig.3.

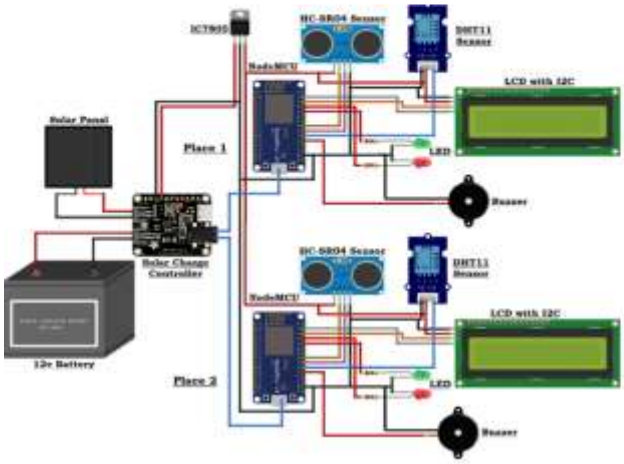

Fig.3 Circuit Diagram

In our project, we've crafted a solar-powered IoT-based Flood Monitoring and Alert System for two distinct locations, aiming to reduce the human and economic impacts of flooding across various areas. This setup utilizes dual NodeMCU units, pivotal for IoT device prototyping, and integrates with the Blynk application for real-time monitoring and alerts. Central to our system is the ultrasonic sensor, which uses ultrasonic waves to determine water levels accurately. This cost-effective sensor offers non-invasive measurement capabilities from 2cm up to 400cm, achieving precision within 3mm. It operates by emitting an ultrasonic wave that reflects off surfaces back to the sensor, which then calculates the distance by analyzing the time interval between sending and receiving the wave. The sensor is equipped with four pins: VCC, GND, ECHO, and TRIG. The VCC pin is connected to a shared 5V source from the voltage regulator, while the GND pin links to the NodeMCU's communal ground. The TRIG and ECHO pins are connected to the D5 and D6 pins on the NodeMCU, respectively. Additionally, the DHT11 sensor is deployed for ambient temperature measurement, featuring three pins: VCC, data, and GND. The VCC pin is attached to a common 5V supply from the regulator, the GND pin to the NodeMCU's shared ground, and the data pin is connected to the D7 pin on the NodeMCU.

The I2C LCD display is utilized to exhibit data gathered from all sensors. It connects through the SDA and SCL pins to the D2 and D1 ports of the NodeMCU, respectively. Power is supplied to the VCC pin from a communal 5V source for power management, while the GND pin is linked to the shared ground (GND) pin of the NodeMCU.

The Green and Red LEDs, each with two pins, have their anodes connected to the D3 and D4 pins on the NodeMCU, respectively, via a 640-ohm resistor, while their cathodes are connected to a shared ground (GND). Similarly, the Buzzer is connected to the D8 pin of the NodeMCU and also to the common GND.

The primary energy source for this project is provided by a 12V Battery, which is recharged via a solar panel, with a charge controller overseeing the charging process. The solar panel and the battery are both connected to the charge controller, which serves as their input, and its output is then routed to a 5V voltage regulator. This regulator is designed with three pins: input, output, and GND. The input pin is affixed to the charge controller's output positive terminal, and the output pin distributes a uniform 5V power supply to all sensors and the LCD at both sites. Meanwhile, the GND pin is tied to a communal ground (GND) pin that is shared by the two NodeMCUs.

After programming both NodeMCU units for locations 1 and 2 with a slight modification in the virtual pin settings for the Blynk App, the sensor data from location 1 is directed to NodeMCU 1, while data from location 2 is sent to NodeMCU 2. This information is then processed and evaluated against predefined safety thresholds in both the program and the Blynk App. For both locations, should the water level surpass the designated maximum, a red LED will illuminate, an alarm will sound, and the message "WATER LEVEL HIGH" will be displayed on the LCD, accompanied by the dispatch of an email and a notification. Conversely, if the water levels are within safe limits, the LCD will read "WATER LEVEL NORMAL." Additionally, temperature readings are shown on the I2C LCD display, and should they exceed specified thresholds, an email and a notification will be sent as well.

B. Arduino Program

Arduino is an open-source electronic platform that combines user-friendly hardware and software. It enables Arduino boards to process inputs—such as light on a sensor, a press on a button, a received message, or a Twitter update—and turn them into outputs, like starting a motor, lighting an LED, or posting online. Users can program their board to perform specific tasks by sending it instructions through the board's control interface. This is achieved using the Arduino programming language (based on Wiring) and the Arduino Integrated Development Environment (IDE) (based on Processing).

Once the complete program for the system has been written, it undergoes a verification process. Following successful verification, the program is uploaded to the two NodeMCUs.

4. RESULTS AND DISCUSSION

Experimental results were achieved for all components following the successful assembly and testing of the circuit.

- **PLACE 1**

TABLE.1 ULTRASONIC (1) RESULT PLACE 1

Ultrasonic measure distance(m)	LED (Red)	LED (Green)	Buzzer	LCD Display	Alerts
Distance > 4	OFF	ON	OFF	Water level low	Notifications Blynk app & Email. (Place 1: Water level High)
Distance <= 4	ON	OFF	ON	Water level high	

TABLE.2 DHT11 (1) RESULT PLACE 1

Temperature (°C)	Alerts
Temp >= 45	Email.
Temp < 45	--

International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

- **PLACE 2**

TABLE.3 ULTRASONIC (2) RESULT PLACE 2

Ultrasonic measure distance (m)	LED (Red)	LED (Green)	Buzzer	LCD Display	Alerts
Distance > 4	OFF	ON	OFF	Water level low	Notifications Blynk app & Email. (Place 2: Water level High)
Distance <= 4	ON	OFF	ON	Water level high	

TABLE.4 DHT11 (2) RESULT PLACE 2

Temperature (°C)	Alerts
Temp >= 45	Email.
Temp < 45	--

Fig.4 Final Results

5. CONCLUSION AND FUTURE SCOPE

Our goal is to safeguard individuals and their properties against flood threats. We have identified an affordable and efficient approach for flood detection, public alerting, and authority notification. Our solution employs sensor technology and the Internet of Things (IoT) to monitor water levels and dispatch warnings through email, which has been successfully tested in real-time scenarios. The system could be further refined to quantify flood depths in meters, especially when positioned adjacent to rivers. This initiative holds promise for significantly benefiting communities in the future. Throughout this project, we have worked together to develop a device that uses sensors and various components to identify flood risks, relay information about nearby river water levels, and alert the populace. While predicting or preventing floods outright is unfeasible, our system is designed to detect them early. Additionally, we have enhanced our project by integrating more sophisticated modifications, including the construction of an additional device. This expansion allows for broader area coverage, ensuring the project is equipped with more effective and comprehensive features.

This project has the potential for further enhancements. Firstly, it could be incorporated into broader smart city initiatives to enhance flood response mechanisms. For instance, linking the flood monitoring system with traffic control networks could help divert vehicles from flood-impacted zones, or with emergency services to expedite the mobilization of aid to those areas. Additionally, the scope of the project could be widened to adopt advanced data analysis and visualization technologies. Machine learning techniques, for example, could analyze flood trends to forecast future occurrences. Moreover, integrating the system with social media platforms could offer instantaneous updates and warnings to residents in affected locales, necessitating partnerships with these platforms to maximize the reach of such alerts. Introducing new sensor types could also enrich the data collected on flooding, such as devices measuring water flow speed and direction, to enhance predictions of flood paths and support evacuation strategies.

REFERENCES

1. Sukanth Behera , Saradiya Kishore Parida "IoT-based Flood Monitoring and Alerting System using Arduino Uno", Turkish Journal of Computer and Mathematics Education, Volume 09,No.03,2018.
2. Kiran Jadhav, Aniket Patil, Ajay Yamkar, Mrunmai Nagtode "IOT based flood monitoring and alerting system" International Research Journal of Modernization in Engineering Technology and Science, Volume 04, Issue 04, April-2022.
3. Emil Daniel Maer, Adrian Augustin Pop "Design of IoT based flood monitoring and alerting system", 2022 IEEE 20th International Power Electronics and Motion Control Conference (PEMC), 25-28 Sept. 2022.
4. Abhishek Raj, Nancy Hazra, Dr. Manoj R. HansIOT based Flood Monitoring and Alerting System, IJRASET Journal For Research in Applied Science and Engineering Technology, Volume 10, Issue VI, June 2022.