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Cloud Burst and Early Warning Alarm System

Siddaram, Savita, Sangamesh Kadadi, Sangamesh Patil, Dr. Rekha S
Dept,of Electronics and communication Sharnbasva University Kalburagi ,India

Abstract: ***Cloudbursts are sudden and intense rainfall events that can cause severe flooding, landslides, and damage to human life and infrastructure. Traditional weather monitoring systems are not capable of providing localized and real-time alerts during such emergencies. This project presents an IoT-Based Cloudburst Early Warning Alarm System designed for smart bridge safety and flood monitoring. The system uses sensors such as rain sensor, ultrasonic sensor, and DHT11 sensor to continuously monitor rainfall intensity, water level, temperature, and humidity. The collected data is processed using NodeMCU ESP8266 and transmitted to the Blynk IoT cloud platform for real-time monitoring. During dangerous conditions, the system activates buzzer and LED alerts, displays warning messages on LCD, and automatically controls the bridge barrier using a DC motor through a motor driver. The proposed system helps reduce accidents and improves public safety during cloudburst and flood conditions.***

Keywords: IoT, Cloudburst Detection, Flood Monitoring, Smart Bridge Safety, NodeMCU, Blynk IoT, Early Warning System.

I. INTRODUCTION

One of the impact of global warming is unexpected natural phenomenon. In some countries in Asia, climate changes and sudden heavy rainfall are not uncommon. Especially in Indonesia, flood often occurred because there are many places where the water flow is obstructed. This causes much harm including material loss - sometimes even endanger lifes - to the communities who live around the flood area. Although the flood can not be completely prevented, but the loss can be reduce if the announcement of the possibility of the flood is given to the society early. Because of that, there is a need to make a system which can provide advance warning of flooding. Not only can the society prepare themselves in advance for the coming disaster but also the local government can take the appropriate decision to solve the problems because of the flood. In the previous studies, the early flood warning system only designed to send a warning message to the client and over the development, the system was designed to be able to regulate the water level via SMS It has a fixed early-flood water level and can only detect one meter of water height. After various researches, this system has undergone some development: the water level can be customized by the client through SMS (Short Message Service) and the water height which can be detected reach four meters.

This system can also detect three types of water level: early flood level, flood level and low tide level after the flood with a maximum water level detection of four meters. Early flood alerts system aims to create a water height gauge equipped with a microcontroller and a GSM modem that can transmit data in the form of SMS to the specified phone numbers when conditioned in an area prone to flooding. This system also designed to predict the time of flooding when it is already prone to flooding. The research is also being developed and designed to be able to tell a safe condition after the flood. Some advantages with using this systems i.e.: it is easier to set this system at various spots or areas prone to flooding with various alert levels because the user will be able to customize the water level boundaries; even the gauge is in the middle of a flood, it can still be manage well without the need to send any worker to the area. The use of GSM modem in this measurement tool gives the benefit for the clients so that the user can receive the warning message wherever they are as long as they covered with GSM signal.

II. PROBLEM STATEMENT

Cloudbursts are sudden and intense rainfall events that can cause rapid flooding, bridge overflow, road damage, and significant loss of life and property. Due to the unpredictable nature of these events, people and vehicles often do not receive timely warnings, leading to accidents and unsafe situations, especially in flood-prone and bridge areas.

Existing flood monitoring systems mainly depend on weather stations and manual observation methods, which are unable to provide accurate real-time local monitoring and immediate alerts. Most traditional systems lack IoT-based remote monitoring, automatic warning mechanisms, SMS notifications, and bridge safety control systems. As a result, delays in identifying dangerous conditions increase the risk of disasters and infrastructure damage.

To address these challenges, there is a need for an intelligent, low-cost, and real-time monitoring system capable of continuously measuring rainfall intensity, water level, temperature, and humidity.

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The system should provide instant alerts through buzzer alarms, LED indicators, LCD messages, GSM-based SMS notifications, and IoT cloud monitoring. Additionally, it should automatically control bridge barriers to prevent vehicles and pedestrians from entering flooded areas.

Therefore, the proposed IoT-Based Cloudburst Early Warning Alarm System for Smart Bridge Safety utilizes a rain sensor, ultrasonic sensor, DHT11 sensor, NodeMCU ESP8266, GSM module, Blynk IoT cloud platform, buzzer, LCD display, LED indicators, and motor-controlled bridge barriers to provide real-time monitoring, early warning alerts, remote accessibility, and automatic safety control during cloudburst and flood conditions. This system aims to improve public safety, reduce disaster-related risks, and support efficient disaster management.

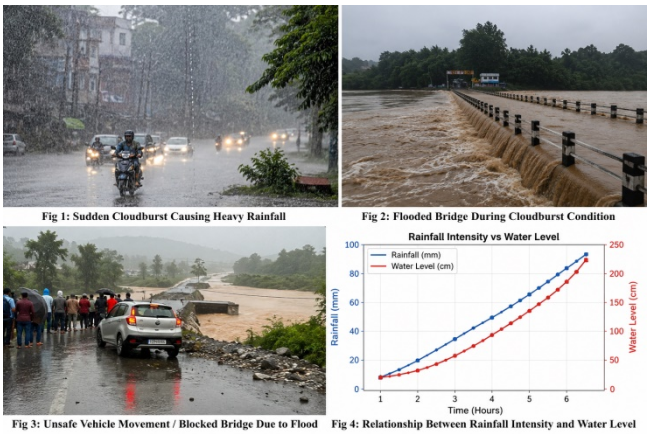


Fig 1: Sudden Cloudburst Causing Heavy Rainfall
Fig 2: Flooded Bridge During Cloudburst Condition
Fig 3: Unsafe Vehicle Movement / Blocked Bridge Due to Flood
Fig 4: Relationship Between Rainfall Intensity and Water Level

Fig 1–4. Heavy rainfall, flooded bridge, unsafe flood area, and rainfall versus water level conditions during cloudburst events

III.

IV. LITERATURE REVIEW

Several researchers have proposed flood monitoring and early warning systems using sensors, GSM communication, and Internet of Things (IoT) technologies. In **2018, S. V. R. K. Prasad** et al. developed an IoT-based flood monitoring and alerting system that utilized ultrasonic sensors and wireless communication to monitor water levels and provide timely warnings to users. Their work demonstrated the effectiveness of real-time data collection and remote monitoring in flood-prone areas.

In 2019, M. S. Hossain and G. Muhammad presented a cloud-assisted IoT framework for flood monitoring. The system integrated environmental sensors with cloud computing services, enabling remote access to flood-related information and improving disaster response capabilities. The study highlighted the importance of cloud-based platforms in managing large volumes of sensor data.

A GSM-based flood warning system using Arduino was proposed by A. K. Verma and R. Singh in 2020. Their system employed ultrasonic sensors to detect rising water levels and used GSM technology to send SMS alerts to registered users during emergency situations. The proposed approach provided a low-cost and reliable solution for flood warning applications.

In 2022, P. Sharma et al. developed a smart flood monitoring and early warning system using IoT technology. The system integrated multiple sensors with cloud connectivity and web-based dashboards for real-time monitoring. The research demonstrated that combining sensor networks with IoT platforms significantly improves flood detection accuracy and information accessibility.

More recently, in 2024, R. Kumar and S. Gupta introduced a multi-sensor IoT-based flood detection and alert system. Their work combined rainfall sensors, water level sensors, and environmental monitoring devices to provide comprehensive flood prediction and warning capabilities. The study emphasized the importance of integrating multiple sensing parameters for enhancing the reliability of flood monitoring systems.

From the literature review, it is observed that most existing systems focus on water level monitoring, GSM-based alert generation, or cloud-based remote monitoring. However, the integration of multiple environmental parameters, real-time data

V. EXISTING SYSTEM

Traditional flood monitoring systems mainly depend on manual observation, weather forecasts, and periodic inspections of rivers, dams, and drainage channels. These methods often fail to provide timely warnings during sudden heavy rainfall and flood conditions. In many areas, flood information is collected manually and communicated through local authorities, resulting in delays in alert dissemination and emergency response.

Several existing flood monitoring systems use individual sensors to measure water levels and generate local alarms. Some systems employ GSM technology to send SMS notifications, while others use IoT platforms for remote monitoring. However, most of these systems focus only on water level detection and do not integrate multiple environmental parameters such as rainfall intensity, temperature, humidity, and water flow rate. Additionally, many existing systems lack real-time cloud monitoring, remote configuration capabilities, and comprehensive data analysis features.

The existing system shown in the block diagram utilizes an ATmega328 (Arduino UNO) microcontroller as the central processing unit. It receives input data from the ultrasonic sensor, rain sensor, and temperature-humidity sensor. The processed information is displayed on an LCD screen and transmitted through GSM and ESP8266 modules for alert generation and IoT monitoring. Although the system provides flood monitoring and warning capabilities, its functionality is limited to basic alert generation and monitoring operations. Further enhancements are required to improve system intelligence, scalability, and real-time disaster management support.



Fig 2. Flooded Bridge During Heavy Rainfall

VI. PROPOSED SYSTEM

The proposed. system is an IoT-Based Cloudburst Early Warning Alarm System designed to monitor rainfall and flood conditions in real time and provide automatic safety alerts for bridge protection to provide real-time monitoring of water levels and environmental conditions in flood-prone areas. The system integrates an Arduino UNO microcontroller with multiple sensors, including an ultrasonic sensor, rain sensor, DHT11 temperature and humidity sensor, and water flow sensor. These sensors continuously collect data related to water level, rainfall intensity, temperature, humidity, and water flow rate. The collected information is processed by the Arduino and compared with predefined threshold values to identify normal, warning, and flood conditions.

When the measured water level exceeds the predefined threshold limits, the system automatically generates warning alerts through a GSM module and a buzzer. The GSM module sends SMS notifications to registered users, enabling timely action during emergency situations. Simultaneously, the buzzer provides a local audible alert to nearby people. The current system status and sensor readings are displayed on a 16×2 LCD display for on-site monitoring and observation.

To enable remote monitoring, the system incorporates an ESP8266 Wi-Fi module that uploads sensor data to an IoT cloud platform. Through the cloud dashboard, users can access real-time information, monitor historical trends, and receive updates from any location using a computer or mobile device. The system also supports remote configuration through SMS commands, allowing authorized users to update threshold values and retrieve system information without physical access to the monitoring station. The proposed system offers a low-cost, reliable, and efficient solution for flood monitoring, early warning, and disaster management applications.

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VII. BLOCK DIGRAM

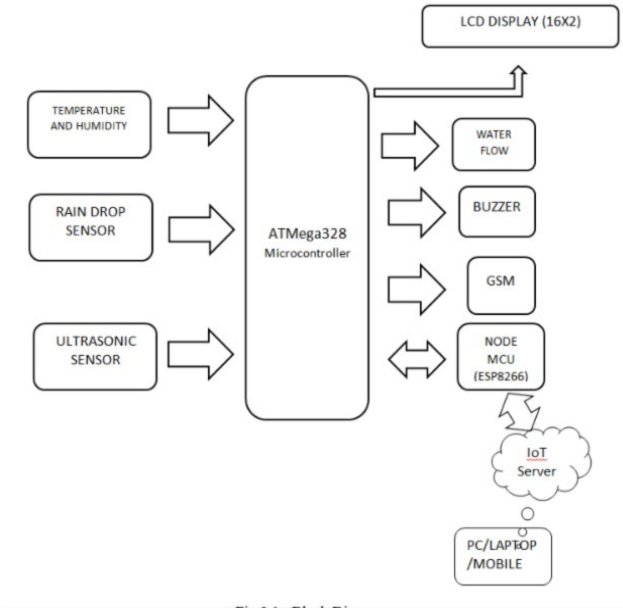


Fig 2. Working Methodology of Proposed System

VIII. FLOW CHART

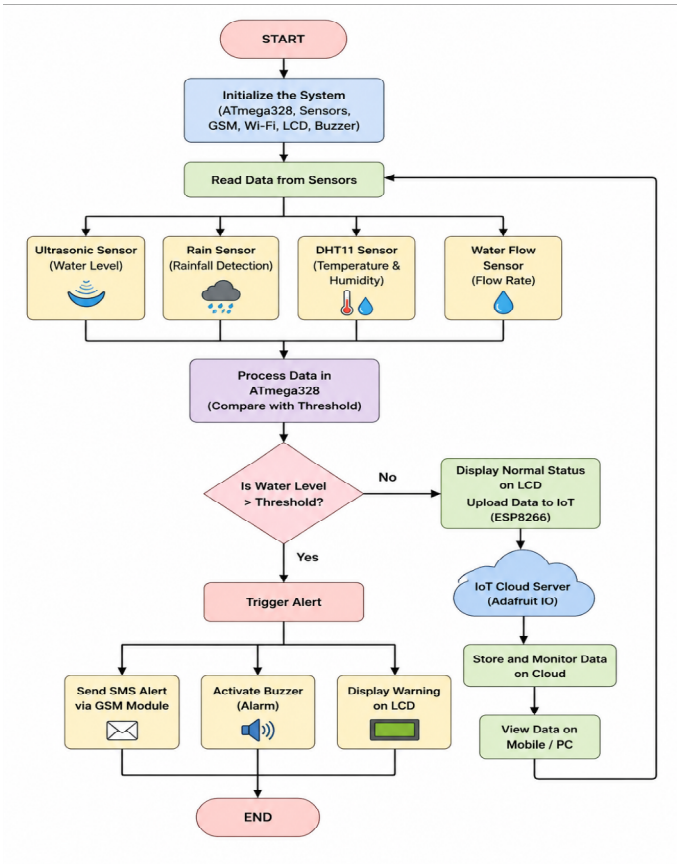


Fig 3 Flow Chart

IX. WORKING

The Early cloud Warning System operates by continuously monitoring environmental and water-related parameters through a network of sensors. When the system is powered ON, the Arduino UNO microcontroller initializes all connected devices, including the GSM module, ESP8266 Wi-Fi module, LCD display, ultrasonic sensor, DHT11 sensor, rain sensor, water flow sensor, and buzzer. The predefined threshold values for water levels are loaded into memory, and the LCD displays a startup message indicating that the system is ready for operation.

During operation, the ultrasonic sensor continuously measures the water level by transmitting ultrasonic pulses and calculating the distance between the sensor and the water surface. At the same time, the DHT11 sensor records temperature and humidity values, the rain sensor detects rainfall intensity, and the water flow sensor measures the flow rate of water. The Arduino processes all sensor data and compares the measured water level with predefined threshold values corresponding to early flood, flood, and safe conditions. Based on these comparisons, the current status of the area is displayed on the LCD screen for local monitoring.

Whenever the water level reaches a warning or danger threshold, the Arduino activates the GSM module to send SMS alerts to registered users and simultaneously triggers the buzzer to generate an audible alarm. The alert messages contain information about the current water level and flood status. In addition, sensor readings are transmitted to the ESP8266 NodeMCU module, which uploads the data to the IoT cloud platform through a Wi-Fi connection. Users can monitor real-time and historical data through a web dashboard or mobile application. The system also supports remote configuration through SMS commands, allowing authorized users to modify threshold values or request status updates. After flood events, collected sensor data can be used to estimate affected areas and assist authorities in flood assessment and disaster management activities.

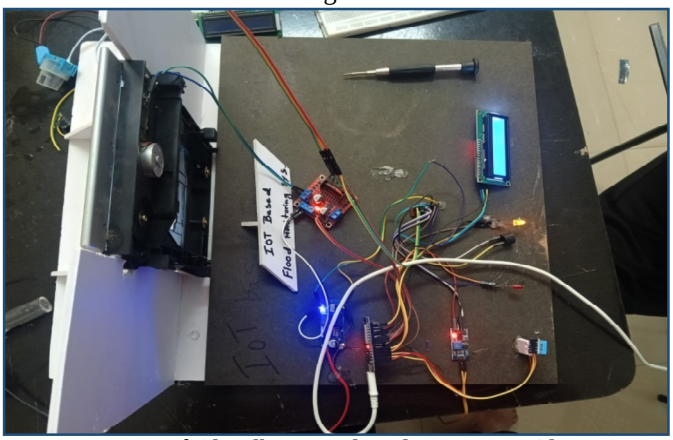


Fig 4 :Prototype of Cloudburst and Early Warning Alarm System

X. COMPONENTS

Sl. No.	Component	Function
1	ATmega328 Microcontroller (Arduino UNO)	Main Controller
2	ESP8266 Wi-Fi Module	IoT Communication and Cloud Connectivity
3	GSM Module (SIM800/SIM900)	Sends SMS Alert Notifications
4	Ultrasonic Sensor	Measures Water Level
5	DHT11 Sensor	Measures Temperature and Humidity
6	Rain Sensor	Detects Rainfall Intensity
7	Water Flow Sensor	Measures Water Flow Rate
8	16×2 LCD Display	Displays System Status and Alerts
9	Piezo Buzzer	Generates Audible Warning Alarm
10	IoT Cloud Server (Adafruit IO)	Stores and Monitors Sensor Data
11	PC/Laptop/Mobile Device	Remote Monitoring and Data Access
12	Power Supply Unit	Provides Power to the System

TABLE I :Hardware Components

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Sl No	Software	Purpose
1	Arduino IDE	Programming & Uploading Code
2	IOT Server	Cloud Monitoring
3	Embedded C	Programming Language

TABLE II – Software Requirements

XI. RESULTS AND DISCUSSION

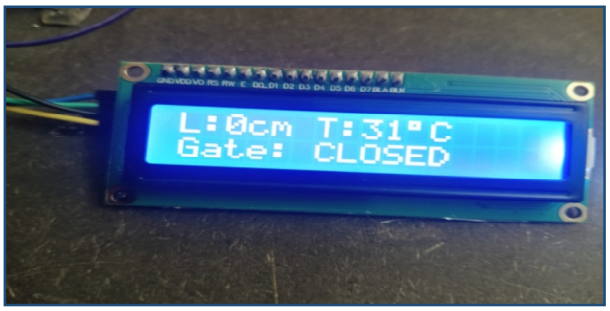


Fig 5 :Temperature and Normal Condition Display.

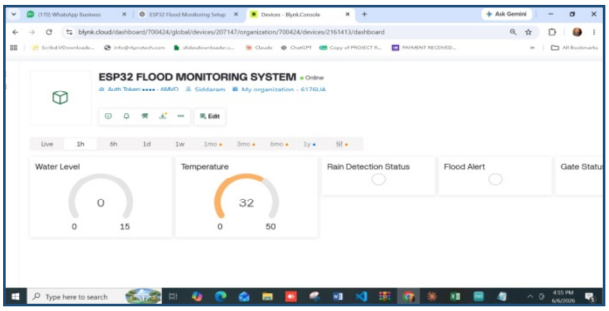


Fig 6 :Blynk IoT Dashboard Monitoring.

The proposed Early cloud Warning System was successfully designed and implemented using an ATmega328 microcontroller, ultrasonic sensor, rain sensor, DHT11 sensor, water flow sensor, GSM module, ESP8266 Wi-Fi module, LCD display, and buzzer. The system was tested under different environmental and water level conditions to evaluate its performance and reliability.During testing, the ultrasonic sensor accurately measured the water level and continuously transmitted data to the microcontroller. The rain sensor successfully detected rainfall conditions, while the DHT11 sensor monitored temperature and humidity variations. The water flow sensor provided real-time information regarding water movement in the monitored channel. The collected data was displayed on the LCD screen and simultaneously uploaded to the IoT cloud platform through the ESP8266 module.

When the water level exceeded the predefined threshold values, the system generated warning notifications through the GSM module and activated the buzzer. SMS alerts were successfully delivered to the registered users, enabling timely action during potential flood situations. The IoT dashboard provided real-time monitoring and historical data visualization, allowing users to access flood-related information remotely through mobile devices and computers.

The experimental results demonstrated that the system can effectively monitor environmental conditions and provide early flood warnings with minimal delay. The integration of GSM communication and IoT technology improved the reliability and accessibility of flood-related information. The proposed system is cost-effective, easy to deploy, and suitable for flood-prone regions where continuous monitoring and rapid alert generation are essential for disaster management.

XII. DISCUSSION

The obtained results indicate that the proposed system is capable of providing accurate water level monitoring and efficient flood warning services. The combination of multiple sensors improved the overall reliability of flood detection compared to systems that rely on a single parameter.

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The GSM module ensured alert delivery even in areas with limited internet connectivity, while the IoT platform enabled remote monitoring and data logging. The system can assist local authorities, farmers, and residents in taking preventive measures before flood conditions become critical. Therefore, the developed system offers an effective solution for enhancing public safety and reducing the impact of flood-related disasters.

XIII. CONCLUSION

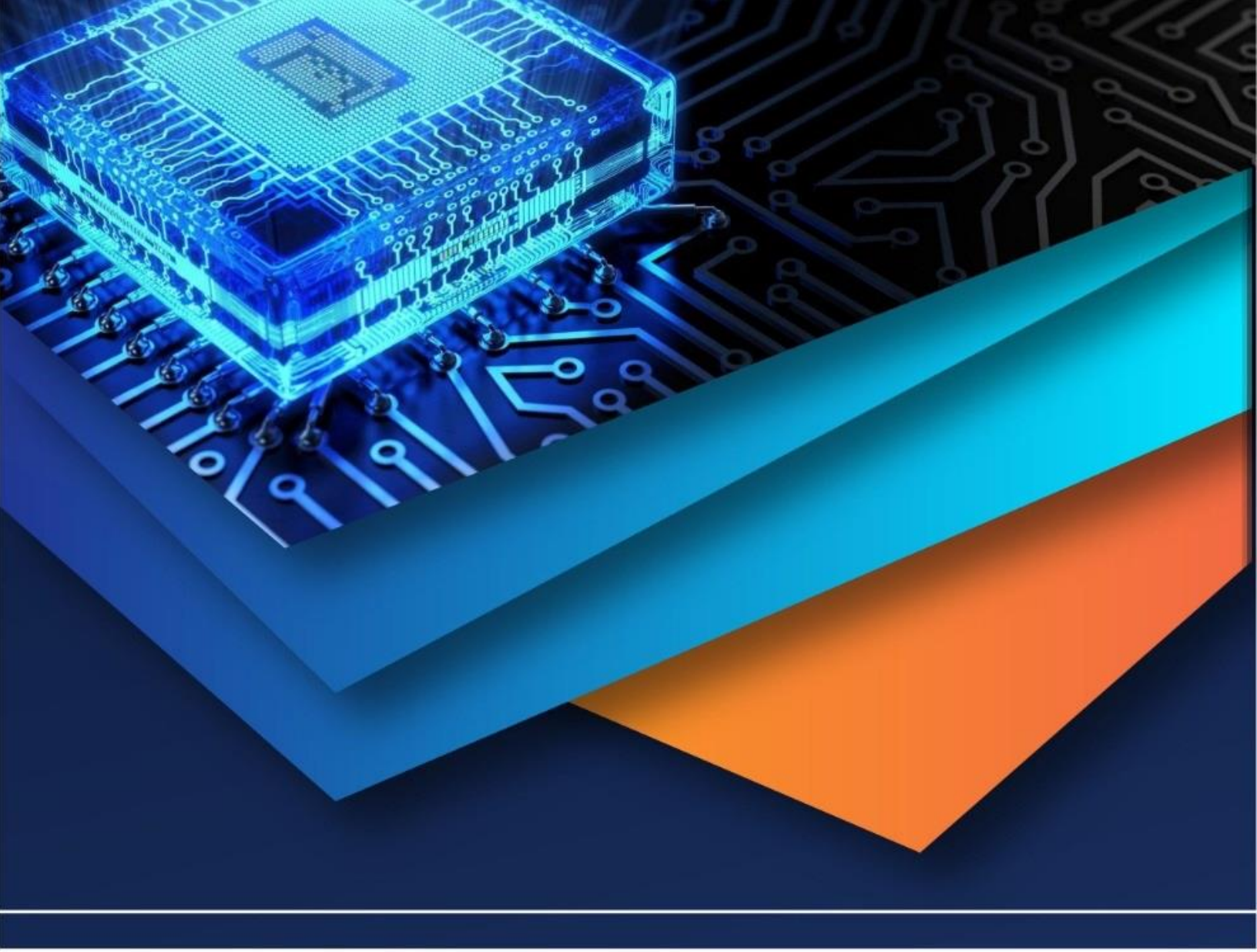
This early cloud alerts system has been successfully researched and well-designed as expected. It will continue to be refined so that it has the reliability and small error rate. This system can be put at various flood prone spots, because the water boundaries can be set via SMS. It is designed to send SMS only to two clients whose numbers have been registered and will send a warning SMS three times for each warning for every client. Early flood alerts system will also automatically notify the client if the flood is being in a safe condition. The integration of IoT technology through the ESP8266 Wi-Fi module enables real-time remote monitoring of all sensor data via the Adafruit IO cloud platform, making the system accessible from anywhere in the world through a web browser or mobile application. The system also incorporates environmental sensors such as DHT11, rain sensor, and water flow sensor to provide a comprehensive view of flood conditions.

An additional feature of crop loss prediction using the ultrasonic sensor ensures that the impact of flooding on agriculture can be assessed rapidly and communicated to the relevant authorities. Overall, this project demonstrates a cost-effective, scalable, and reliable approach to flood disaster management. With further development, the number of registered clients can be expanded, solar power backup can be integrated for uninterrupted operation, and machine learning algorithms can be incorporated for more accurate flood prediction, making this system a valuable tool for saving lives and minimizing the socioeconomic impact of flooding.

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