

IOT-based Flood Detection, Monitoring, Control & Alerting System using Fuzzy Logic

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Abstract: This paper presents a method of alert flood detection. This paper focuses on the development of the system which will determine the current level of water by employing sensors and by using a wireless sensor network that will provide notification via ESP32 Wi-Fi module. The system also sends a notification of an alert through the IoT mechanism to all stakeholders. As the parameters of a flood are uncertain hence fuzzy logic is used to develop a flood detection system. Fuzzy logic produces results that resemble human results. It reduces the time and complexity of the system. This flood detection is controlled by using a servo motor. This system is used to help the community to take quick decisions and plan against disaster.

Keywords -- Ultrasonic Sensor, ESP32 module, IOT, Water sensor, Rain sensor, Servo Motor, water flow sensor, DHT11.

I. INTRODUCTION

The flood arises every year somewhere in the world. Flood has a bad impact on society as it destroys the infrastructure, crops, and precious lives of human beings and animal. Flood is an unavoidable natural disaster all over the world causing the heavy flow of water and also severe damage to properties lives. Material, Human, Economic, and social losses in flood areas, and infection from water are the main effects of the flood. As well as the risk of life suffered by families in these areas, the economic damage has also imposed the burden of having to recover their financial losses. Flash floods and massive traffic jams on roads are also caused by heavy rain. Thus, it is important to be able to warn the people who are most at risk, so that the effects of these disasters can be reduced. Hence, this situation does not arise in the future this implementation has been made to alert, monitor, detect and control the situation. In this framework, we use the ultrasonic sensor, rain sensor, water sensor, and Moisture sensor Which measure the current situation of the environment and give the data in a fuzzy state which predicts the flood situation? All this data is given to the MQTT cloud which gives an alert and sends a message to other's cell phones and emails. When the Flood is detected and gives alerts, this situation is controlled by a servo motor which automatically opens the door by giving 0 and 1 states. This will be able to control the situation and saves the life of many people and animals. As precaution is better than cure, hence it is better to take precautionary measures to save lives.

II. RELEVANCE

Flood is among most disasters that cause widespread destruction to human lives, properties, and the environment every year and occur at different places with varied scales across the globe. Flood disasters are caused by natural phenomena, but their occurrence and impact have been intensified through human action and inaction, so it becomes necessary to have a system to give an early prediction and alert about floods.

III. LITERATURE SURVEY

In hydrology and water resources a basic review of a fuzzy logic application. The fuzzy is a technique to embody human-like thinking into a control system. [1]

In 2015 states the IOT Enabled Water Monitoring System IEEE Explore proposed an IOT-based water monitoring system that measures the water level in real-time. [2]

A smart IOT device that acts as an alarm and monitoring system during natural disasters that operates by communicating over the internet. [3]

IOT cloud platform helps to control, monitor, and manage the device. The device senses its local value when it finds a disaster situation. It is also able to receive such warning alarms from other devices available on the internet and provide the user with SMS and Email notification.[4]

IV. METHODOLOGY

• **Block Diagram**

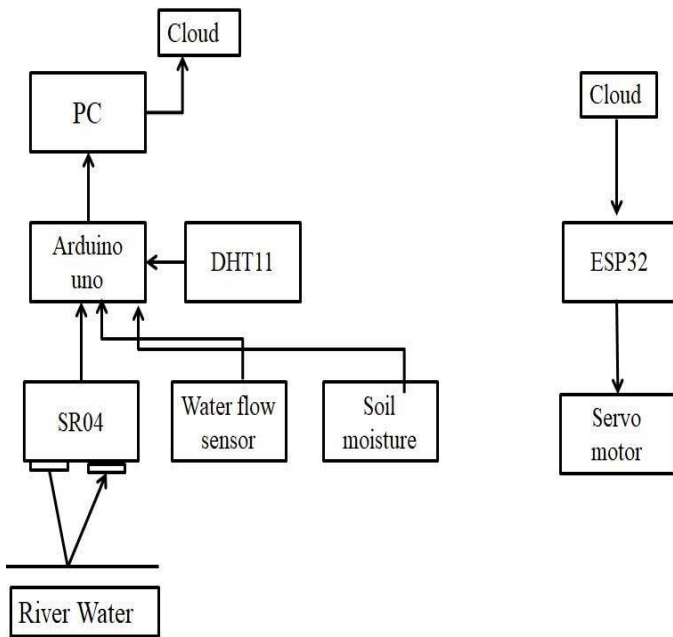


Fig. 1 Block Diagram

Implementation

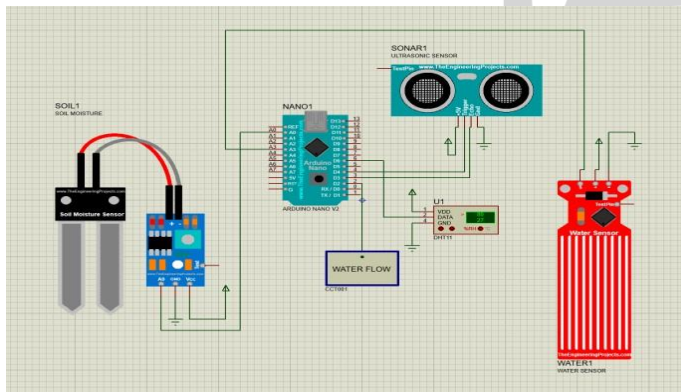


Fig.2 Circuit Diagram

Flood situation also depends on different parameters like flow rate, rainfall, temperature and humidity, and water flow. From the weather station setup, we receive information about rainfall, humidity, and temperature by using the DHT11 sensor. This weather station has a wired connection with Arduino. For detecting surface run flow we use an ultrasonic sensor and for sensing running water flow speed, we use a water flow speed sensor, both of which also have a wired connection with Arduino.

Connectivity:-Using Arduino which is connected to the PC, we collect data from sensors. For storing data collected from different sensors and results produced from this data on secondary storage i.e. on the cloud we use the MQTT platform which is an IOT.

It requires a computing unit with a low power requirement. Use of fuzzy logic along with member functions and rules. This fuzzy logic is implemented using python 3.8 or above.

This processing unit is not only acting as a computing device but also acts as a primary storage unit. All data from sensors including wireless sensors and wired sensors is collected into the processing unit. In the processing unit, fuzzy logic with MF and rules developed for fuzzy logic were applied to sensor data, and the result is produced. After that, all the outputs are displayed on the web server. As the transmitter emits the output based on environmental conditions. It transmits to the receiver where the ESP32 Wi-Fi module and servo motor are connected.

If flood detection is above the threshold value, it detects that a flood is arising and gives the alert to the other dam to open the door. A servo motor is used to control it and open the door of the dam from 0 to 180. This degree of rotation can be controlled by applying the electrical pulse of proper width to its control pin.

• **Hardware**

- Arduino Nano Water Flow Sensor
- Ultrasonic Sensor
- DHT11
- Moisture Sensor
- Rain sensor
- ESP32
- Servo motor

• **Software**

FUZZY LOGIC:

Fuzzy logic is a software tool that refers to things that are not clear or are vague. Whether the state is true or false their fuzzy logic provides very valuable flexibility for reasoning. Hence, we can consider the inaccuracies and uncertainties of any situation.

Fuzzy logic measures the truth of any statement in a matter of degrees. Many modern control systems today apply fuzzy logic to practice. It combines both linguistic terms by experts in their domain that can be easily coherent with numerical fuzzy sets.

These approaches include modeling rainfall amount to detect flood, utilizing water level sensors at different river depths to detect river water level, and obtaining both rainfall amount and river water level from weather or river stations.

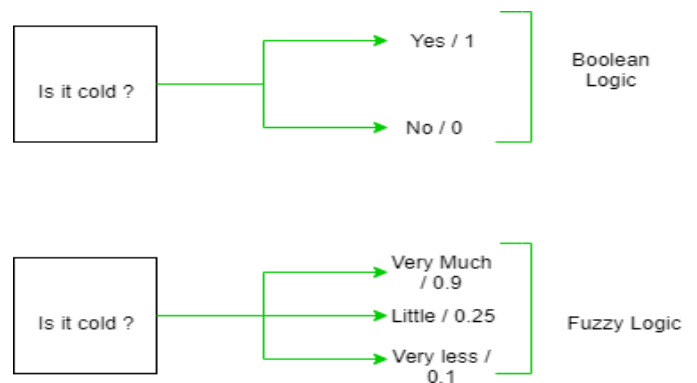


Fig. 3 Fuzzy Logic

Its Architecture contains four parts:

Rule base:-Based on linguistic information the set of rules and the IF-THEN conditions provided by the experts govern the decision-making system. Newly development in fuzzy theory offers several effective methods for the design and tuning of fuzzy controllers. It reduces the number of fuzzy rules.

Fuzzification:-It is a process of converting crisp input

I.e. crisp numbers into fuzzy sets. Crisp inputs are the exact inputs dignified by sensors and passed into the control system for processing, such as temperature, pressure, rpm's, etc.

Inference engine:- It controls the matching degree on going fuzzy input regarding each rule, and according to the input field, it resolves which rules to be fired. Then the fired rules are merged to form the control action.

Defuzzification:-The fuzzy set obtained by the inference engine is converted into a crisp value by defuzzification. There are different types of defuzzification methods available, and one is used with a specific expert system to control all the errors. With a specific expert system to reduce the errors.

MQTT:-

MQTT manages all the following requirements and speeds up all the big public clouds like Amazon Web Services, Google cloud platform, and Microsoft Azure. In this paper, we will examine why the use of MQTT is a much more popular choice of messaging protocol.

MQTT was developed by IBM and was first realized in 1999. The most important thing is that it is a lightweight messaging prototype. It translates messages between devices, servers, and applications.

V. RESULT

Figure 4 shows the side of the transmitter side which has a soldered connection with Arduino. From this ultrasonic sensor, moisture sensor, and Rain sensor will sense the environmental situation which is further processed by Fuzzy logic to give flood prediction.

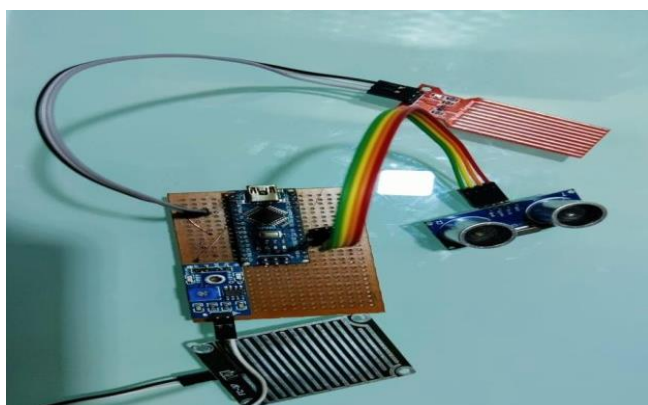


Fig. 4 Transmitter side

Figure 5 shows the graph of fuzzy output. This shows the prediction of a flood in a graphical manner.

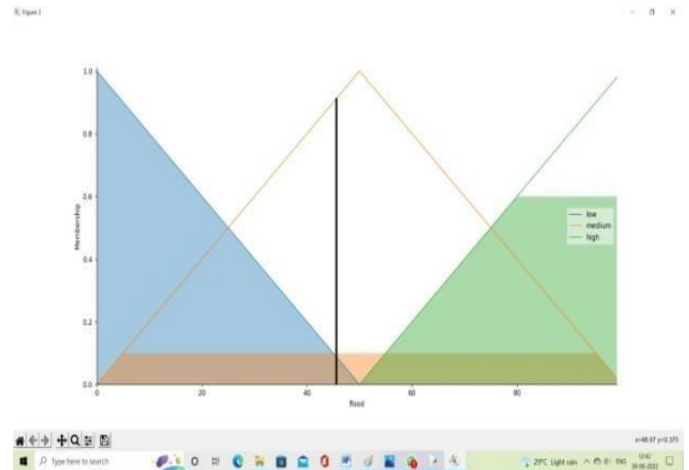


Fig. 5 Fuzzy Graph

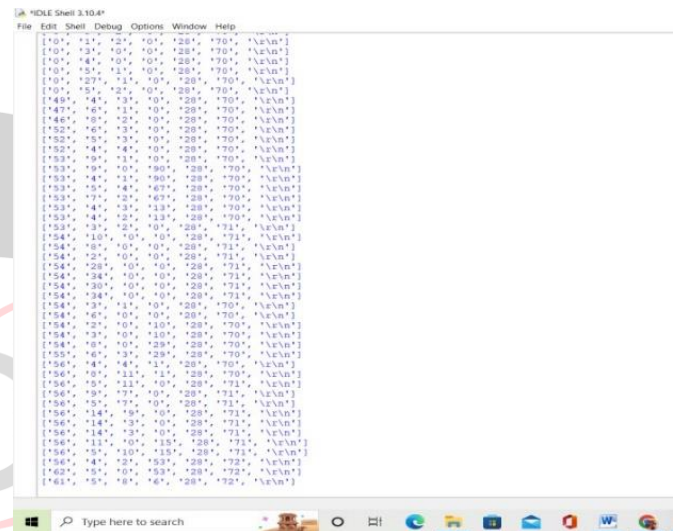


Fig.6 Reading of the parameters

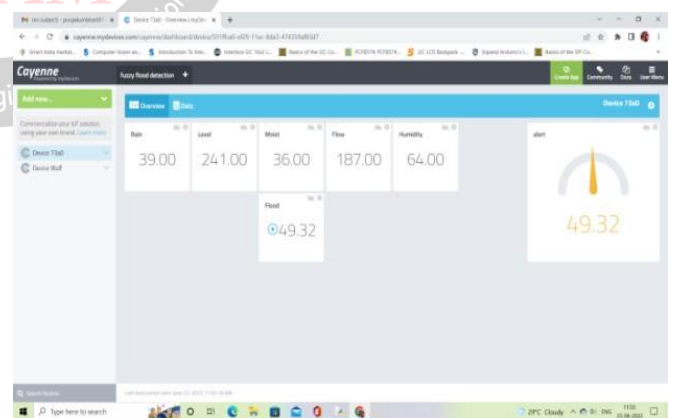


Fig.7 Cayenne Window

Figure 7 shows the window of the cloud from where the message from the client and message to the subscriber is sent, and also it shows the real-time reading and flood situation. From this window, we can add as many devices as we want and set the trigger value. From the trigger option, we can change or update or add triggers. This window works like an MQTT broker whom is responsible

to connect between client and subscriber.

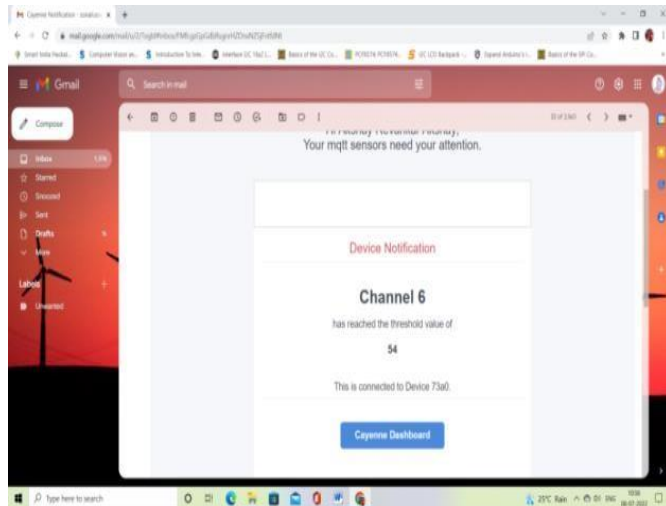


Fig.8 Message sends through Email

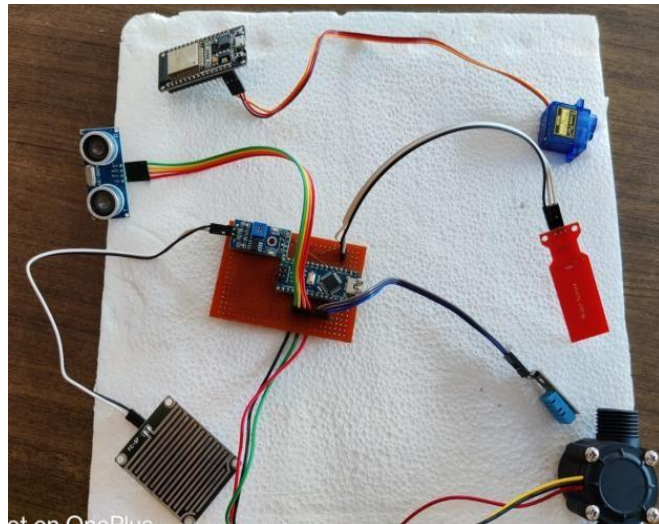


Fig.9 Final implementation

This is how we have worked and build this prototype from figure 9.

The advantages of this implementation are having timely detection of a possible flood. Highly reliable and available real-time data. Having 24/7 Sensing. Using the existing sensors, we can also predict that water is deficient in the river bed, and accordingly, we can send a message to the dam. Low power is consumed by this system. The chances of flooding are decreased. The Disadvantages are it should take proper maintenance of the system. As it gives messages every 5 min, we have checked it every time and Internet connection is needed every time.

VI. CONCLUSION

Rainfall along with other parameters is responsible for flood. This prototype is used to help the community to take quick decisions and plan against disaster. It is also useful to alert people and government authorities as early as possible to help them to save lives of people and the infrastructure. Flood is controlled by using decisions based on fuzzy logic system which automatically opens and closes the doors of

dam in between 0^0 to 180^0 .

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