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An IoT-BasedRain Alerting and Flood Prediction using Sensors and Arduino for Smart Environment

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Abstract

IoT is the interconnection of physical thingswith electronics, software, hardware, and connectivity that assist to enable and extendthese things to interconnect and exchange data automatically. Each device is uniquely identified and connected to eachother.It uses intelligent devicesto sense, analyze, and predict datas. This paper proposes an IoT-basedRain Alerting and Flood Prediction (RAFP) system that senses rain, temperature, and humidity, notifying the user and predicting the flood. It uses DHT22 to sense temperature and humidity, FC-37 to sense raindrop, and SIM800C GSM Module to SMS and buzzer to notify the users. The gathered data from the environment was stored in a local storage in a csv file. It uses Weka tool to visualize, analyze, and predict flood using Multilayer Perceptron.

***Key Words*:**IoT, DHT22, FC-37, Flood Prediction, SIM800C, Buzzer.

1 Introduction

IoT is the ever-growing network of physical things that use the IP addresses for Internet-enabled connectivity, and communication between or amongthings. It extends the capability of communication between human to things, and human to human to things to things[1][2][3]. In short, it is the network of smart sensors and helps to reduce humans work load[4][7]. Now a day, it enables the users to aware of their environmental conditions using smart sensors, and micro-controllers[8]. These smart devices collect and store in a local storage in a form of csv file. The users were aware of the environmental conditions in a form of SMS, Buzzer or E-mail when they exceed the threshold limit[8][10]. The people living in the rural area are affected by the daily environmental conditions. This IoT-based system helps them to stay safe and take an essential decision before an unexpected disaster happens. The Arduino UNO R3 and Breadboard are used to manage and coordinate sensors to fetch data. The Arduino IDE[11] uses a C++ code and uploaded to the board to sense the data in serial communication format. The dataset were sensed outdoorsand automatically recorded by the range of minimum and maximum values that helps in visualizing, analyzing, and predicting using the machine learning algorithms called Multilayer Perceptron algorithm[12].

Literature Review

In this literature review, the author classified the reviewed papers into three main points. These ideas are (i). An IoT and its Applications Areas, (ii). Rain and its parameter sensing and alerting system, and (iii). Flood prediction system for the local environment[6], [7], [13][14]. The first idea describes the concepts of an IoT, three-layer IoT architecture, and areas of applications. IoT is the interconnection and communication of things using sensors, actuators, and micro-controllers that consists of perception layer, network layer, and application layer. The perception layer is the physical layer which was used to collect and identify data from the environment by using sensors. The network layer is consisting of

the protocols like MQTT, CoAP, HTTP, ZigBee[15], Bluetooth Low Energy, and Wi-Fi. It helps as an IoT middleware. The application layer is the one that was used to deliver specific services to the users[16]. It consists of applications like Smart Home, Smart Environmental Monitoring, Smart Agriculture, and Smart Health[5], [6][17].

Another class of the paper is about rain and its parameter sensing and notifying the user.The fundamental environmental parameters used were like temperature, humidity, barometric pressure, rain, and light intensity[18][19]. These parameters are sensed by DHT11[8] for temperature and humidity, BMP180[8][9]or BMP085 for barometric pressure, LM35 for temperature[11][20]and LDR[8] for light intensity, and Acoustic Sensor[13] and WXT520 Sensor[19] for raindrop. Based on the measurements, sensed rain was categorized as the clear sky, cloudy sky, and rainy sky that aware the users of the environment.[19] After the values are sensed from the environment, they are displayed via OLED[21] and LCD[9]. The sensed data were stored on the cloud services like ThingSpeak, Wunderground, and IBM Bluemix and database server like MySQL. The files were saved in a form of csv and text file that can be uploaded using Ethernet Shield W5100 or Wi-Fi Module. The users are alerted in a form of SMS, E-mail, Twitter, and Buzzer from the cloud at the threshold limit via the web browser, and a mobile app automatically[10]. The third class of the paper is about the visualization, analysis and prediction[22]. It was used the machine learning algorithm with MathLab[18]. The algorithms used to analyze the IoT-data are like SVM, KNN, LDA, NB, C4.5, C5.0, ANN, and DPANN. They were analyzed based on classification accuracy and confusion matrix that provides the results as C4.5 is 97.15%, C5.0 is 96.61%, and ANN is 96.19% average accuracy and the execution time 7.70 second for C4.5 and 7.21 for 7.21 seconds for C5.0[12]. The collaborative-IoT was used to collect heterogeneous data sources and analyzed to reduce the gap among them using SenSquare[23]. The visualization, analysis, and predictions of most the paper was from the cloud services[24].

2 Experimental Setup

In this research paper, the main IoT hardware components used are like Arduino UNO R3, Breadboard, DHT22 Sensor, FC-37 Sensor, SIM800C GSM, Buzzer, jumpers, resistor, and Adapter 12V. Additionally, the software system used are Arduino IDE, Tera Term, and Weka tool.

3 The Methodology of the System

Arduino UNO R3 -It is the hardware device which is used to provide a platform for IoT. All the sensors and modules are connected it. It is used to send and receive the fetched value from the sensors. It has an in-built memory of 32k Flash Memory 16Mhz Clock Speed and input voltage 7 to 12V, 14 digital Input-Output pins and 6 analog inputs[11][20].

DHT22 Sensor - It used to sense the temperature and humidity from the environment. It is a 3-pin device. The 10k resistor should be connected between voltage (VCC or +) and data line (out). Voltage (VCC) pin is connected to 5V, ground (GRD or -) connected to GRD, the data line is connected to D3[25], [26].

FC-37 Sensor - It is used to sense raindrop from the environment. It has four pins. They are voltage (VCC), ground (GRD), analog pin (A0), and digital pin (D0). It measures the moisture through analog pin and display values via a digital pin. The value of sensed voltage 0V to 5V related to 0 to 1023 numerical values. If the raindrop sensor plate is completely dry, the value would be 1023. As the amount of water drops on the surface of rain sensor plate increases, the value also decreases[11][27].

SIM800C GSM Module - It is a device that was used for wireless data transmission and the messaging system automatically. It supports a 4G SIM card to provide SMS, and a voice call with a frequency band of 850MHz, 900MHz, 1800MHz and 1900MHz operation service. It is used to store data of GSM cellular telephone for users[28][30].

Buzzer - It is a device which is used to provide an alarm for an input given to an electronic device. It automatically provides notification when the values exceed the threshold limit[29], [28], [31], [32].

4 The Architecture of the RAFP System

This research paperarchitecture consists of sensors, connectors, Arduino UNO R3, and users. It helps in identifying each component that used within the system that makes the system to accomplished accordingly[15]. The architecture is designed to describe how the components were communicated with each other serially to fetch, process, and predict. In such way that, it will be easily understandable by every user[11][21]. It is shown inthe figure below.

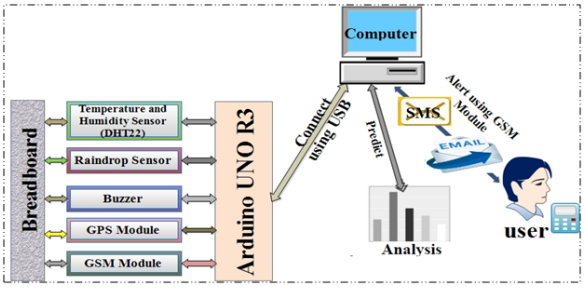

Figure 1 - The architecture of the system

The purpose of each component in the Architecture

Table 1 - The purpose of components in the system architecture

Component(s)	Purpose
Breadboard	It is used to interconnect the pins ofsensors, and modules with Arduino using jumpers.
DHT22 Sensor	It is a device used to fetch temperature and humidity from the environment.
Raindrop sensor	This sensor is used to collect rain values from the environment.
Buzzer	It is a device used to notify the user when the values exceed the threshold limit by ringing.
GSM Module	It is used to notify the user in a form of SMS when the values fetched exceeds the threshold limit.
Arduino UNO R3	It is used to interconnect and exchange information between sensors, and modules with computers. It is also used to upload data fetched to exactly fetched using Arduino IDE.
Weka Tool	It is a tool used to provide analysis on the dataset fetched and perform the prediction.

5 Alerting Algorithm

Input - DHT22_D3, FC-37_D0, SIM800C_D9 & D10 Output - Buzzer_D11, Mobile-SMS

```
1. Start
2. Declare variables rain, temparature, humidity and pins
3. Set the baud rate in the setup()
4. Repeat the steps until you get required values
    4.1. If serial available is greater than 0
           Display measured values of rain, temperature, & humidity
    4.2. If SMS pin availabe is greater than 0
           Write the serila and Read the SMS pin
    4.3. If the count value is greater than 20
           Alert by buzzer
           Send SMS to the user
    4.4. If the fetched value exceeds threshold limit
           Increment the count value
    4.5. ELse
           Turn off the buzzer
           Stop sending SMS
5. End
```

6 Results and Analysis

1113 entries of data were recorded in the RAFP system. This dataset has been used to determine and ensure that the system would be executed and produce for visualizing, analyzing, and predicting the system. The status and values of the environmental parameters are determined based in the following table[10].

Table 2 - The decision observed for the environmental parameters status

Parameter	Collected Values	Status
Rain	<350	Heavy Rain
	350 - 480	Raining
	480 - 640	Drizzle Rain
	640 - 880	Warning
	> 880	No Rain
Temperature	> 38	Very High
	34 - 38	High
	25 - 34	Medium
	<25	Low
Humidity	> 70	Very High
	60 - 70	High
	40 - 50	Medium
	< 40	Low

csv File FormatIn this proposed system, the recorded data of the environmental parameters wereanalyzed to predict the flood. The sample data format of the csv file was shown in the table below[20][22][10].

Table 3 - The sensors data fetched and saved in csv file format.

A	B	C	D
Rain	**Temperature**	**Humidity**	**Envtal Condition**
672	32	50	Rain Warning
1022	42	30	No Rain
255	26	70	Raining
360	29	60	Drizzle
222	27	72	Raining
1000	40	32	No Rain
666	31	62	Rain Warning

7 Alerting Results

By using the above alerting algorithm, the users are notified in a form of SMS automatically as soon as the environmental parameters fetched exceeds the threshold limit. Its contents of the messages are rain, temperature, and humidity[8][11][15]. It is shown in the figure below.

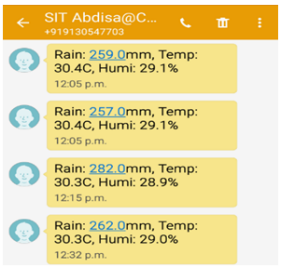

Figure 2 - SMS to the user

8 Visualization and Flood Prediction

The recorded data is all a numerical. The attribute of environmental condition range of values was differentiated with different color in the visualization figure 3 using Weka[13][19][20]. The system uses a Multilayer Perceptron algorithm with a 10-fold cross validation that classifies the data into training, testing, and validation data. The confusion matrix was used to determine the system accuracy and flood prediction. The flood was predicted using mean of the fetched data[1].The rainmeansare 562.417, temperature 30.571, and humidity 57.505. Then, comparing the mean to a table 2 above, the status of environmental parameters. The system accuracy is 84.37% of the total dataset 1113.Therefore, based on the recorded data there is no flood[33]. It is shown in a figure below.

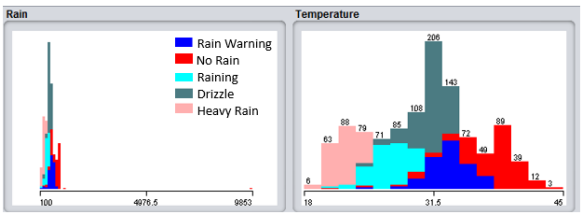

Figure 3 -The overall visualization of rain and temperature in the system

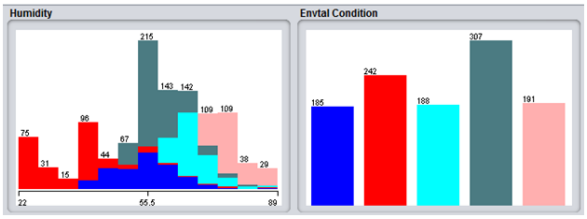

Figure 4 - The overall visualization humidity and environmental conditions

9 Conclusion and Future Work

In this system, the author proposed an IoT-basedRAFP systemto aware the people living in rural area. The peoples living in the rural areas are like forestry, pastoralism, hunting, and livestock raising.An IoT extends the capability of environmental monitoring with the help ofIoT-based devices. The rain has a direct impact on every living. The environmental parametersused in this research are measured using IoT devices like raindrop sensor, temperature and humidity sensor. The sensors collect data from the environment and store in a form of a csv file on a local storage using Tera Term. The users are notified in a form of SMS, and Buzzer. The stored data were analyzed using Multilayer perceptron to predict flood with Weka.This proposed system uses the data from the local environment, stores it in local storage and perform the analysis. The author proposes to extend this research idea forcomparing the accuracy of locally collected data using IoT devices with the satellites images and display information using OLED (Organic Light Emitting Diode) display and store, visualize, and analysis using the cloud.

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