IoT based Smart Weather Monitoring System for Poultry Farm

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***Abstract*—The application of Internet of Things (IoT) in a poultry farm allows a real-time monitoring of the context of the farm through notification to smartphone, predicts the context in advance, advises right decision at the right time that saves poultry lives, minimize the economic loss, and improves the productivity and quality. Monitoring weather of the poultry farm is one of the important issues that involves monitoring the status of the temperature, humidity, etc. that has impact on raw materials and quality of food, health condition of the poultry, feeding in time, food management, etc. Considering the fact, to improve the management and to increase the efficiency of the farm, an IoT based weather monitoring system for a poultry farm has been proposed in this article. DHT11 is used to measure the temperature and humidity in the proposed system. The collected data is transmitted to a cloud-based server, stored in a database and compared with threshold values continuously. If the stream of data crosses the threshold values and remains higher for certain duration than the system sends an alert message to smartphone and a signal to a buzzer. To validate, the proposed system has been implemented that sends alert messages to smartphone and signals to a buzzer successfully.**

Keywords*— *Internet of Things (IoT), smart agriculture, smart poultry, weather monitoring system, sensors.

I. Introduction

State-of-the-art technologies are being applied in the agro-farming to make the system more versatile, automatic and user friendly. Smart agro-farming is a high technology system for growing agro-product in a sustainable way that expands the quantity and quality of the products. Application of IoT helps in agriculture to monitor the system and to take smart decision that can be implemented using sensors, cloud, etc. [1]. This enables farmers to know the real time condition through the relevant sensors and makes effective and informative decisions.

The main purpose of controlling the humidity and temperature in modern day poultry production is to produce a healthier bird that has the capability to grow more efficiently and to adopt themselves to live in the most desirable and least stressful environment. Healthy chicken grows rapidly and have a good demand in the market. In poultry farm, too little moisture can cause dehydration and respiratory illness, where as excessive moisture can lead to ammonia [2]. Heat stress may occur which affects the behavior, welfare, growth and immunity of the poultry adversely, resulting in the decline in the egg production, quality of egg and meat, which causes a massive economic loss. This also lowers the reproductive performance and reduces food in-take leading to lower body weight [3].

The application of IoT acts as a blessing as it makes a great contribution to the development of modern poultry farming. IoT helps to store the data in one place so that farmers can easily access the data, analyze and use it to make the right decision. This helps to reduce the risk in business and to improve business efficiency. IoT confers a better control over the internal operations that reduces production loss and at the same time it ensures a good quality of products to the customer. In poultry farm, it is imperative to maintain the correct temperature and humidity in order to keep food, medicine and chemicals from getting damaged and for many other purposes.

In this research, DHT11 sensors have been used to collect the temperature and humidity in the poultry farm that underlies the weather condition. IoT helps us to know the real time weather condition by using the sensors data that are collected from the environment [4]. The sensor monitors the condition of the poultry farm and sends the data to the ThingSpeak; this eliminates the need for physical presence of the farmer in the farm. They can access the data from anywhere using the ThingSpeak. The system offers more emphasis on precision farming. If the current weather condition crosses the threshold limit then the system starts the buzzer and sends an alert message to the smartphone, so that the farmer take necessary steps to mitigate the potential trouble.

II. Literature Review

Lot of research works have been done on the weather monitoring of Poultry farm, and the objective of this research is to integrate IoT technology to monitor the weather of Poultry farm in an automotive way. Hence, related literature has been reviewed.

IoT builds a communication between human and devices [5]. At the early stage, wireless connection between user and the system was made online by using RF, ZigBee and

Bluetooth, which was found to be slow in communication and short-range distance, and also a small amount of data transmission was possible [6]. The weather can be monitored remotely using Wi-Fi [7].

The temperature and humidity data are collected through sensor network that are analyzed to monitor the farm to maintain the quality and quantity of the poultry [8]. Poultry can tolerate temperature up to 30 degrees Celsius [9].

Different kinds of Arduino are available depending on different types of microcontrollers [10]. Microcontroller (ESP8266) has been used in this research that connects the required devices including sensor. Microcontroller helps in operating the sensors that receive the data. After processing the data, it is then updated to the internet [7].

Data is collected and shared over the network. Four different ways that helps building the connection with the sensors to transmitting the data over the internet: main thread, measurement thread, transfer thread, and send thread. Main thread helps in controlling accommodations with other sensors. Measurement thread obtains setting from Main thread. Transfer thread transmit data from sensors to microcontroller. The processed data is stored and transferred in a website function [11].

DHT11 is used for measuring temperature and humidity. The DHT11 sensor is light-weight that responds instantly without any anti-interference and gives extremely accurate results. It is an ultra-low-cost digital temperature and humidity sensor with a high cost performance advantage. It gives a high reliability and excellent long-term stability [12]. DHT11 includes thermistor and humidity sensing component. Two electrodes are present in humidity sensing components with moisture holding substance. DHT11 discloses the digital signal on the data pin using the capacitive humidity sensor [13]. It is popular for absorbing low power. It takes less than 5 seconds to respond. The size of DHT11 is 15.5mm x 12mm x 5.5mm [14]. After every 2 seconds new data can be retrieved. To correspond with the microcontroller, the sensor uses a pull up resistor of 5k to 10k ohms [15]. It is used in the environment monitoring, in controlling climate automatically, in the local weather station and others.

The NodeMCU is a low cost, low energy consumed module which is integrated to support for Wi-Fi network [16]. This is flexible to design and operate. The ESP module has 22 pins for connection. It has a frequency Range between 2.412 - 2.484 GHz. It has a programmable GPIO which is available here [17]. As it is connected to the internet both update and fetch data is possible [18]. It also has a PCB antenna. It has two buttons RST for reset purpose and FLASH for upgrading firmware [19]. It is used in the weather stations, IoT applications, wireless control system, security ID tags and many others. [20, 21]

IFTTT is a platform where it brings services of different apps and devices together. It creates chains of simple conditional statements, called applets which are connected within other web services such as Gmail, Facebook, Telegram, and Instagram. The services run on web-based applications, on iOS and Android. IFTTT helps in better functionality, improved search function, pre-bundled applet suites and others. [22]

ThingSpeak is a web based open API IoT source information platform that comprehensive in storing the sensor data of varied 'IoT applications' and conspire the sensed data output in graphical form at the web level. ThingSpeak communicates with the help of internet connection, and works on the sensed data from the connected sensor to the host microcontroller such as 'Arduino, TI CC3200 module, Raspberry-pi etc. [23, 24]

According to the research it has been found that there are many IoT based weather monitoring systems [25]. But, the systems are costly. The proposed system is cost effective and efficient that can be incorporated by Poultry farm.

III. IoT Based Weather Monitoring System

Agriculture and agro-products have a great influence inthe economic growth of the country. In Bangladesh, poultry farms enhance the production of meat and egg which can meet up to 64 to 68% of national demand [26]. The modern technology acts as a catalyst that enhances the production with good quality and quantity. IoT based weather monitoring system acts as a blessing for poultry farm, as it has the capability to monitor the environmental parameter temperature and humidity automatically.

A. Proposed Architecture

To monitor the weather in a poultry farm in an automatic way and remotely, IoT allows a system to collect the real-time data using sensor, store them in a storage system, analyze them and make decision [27, 28]. A system architecture has been proposed in this article that is shown in Fig. 1.

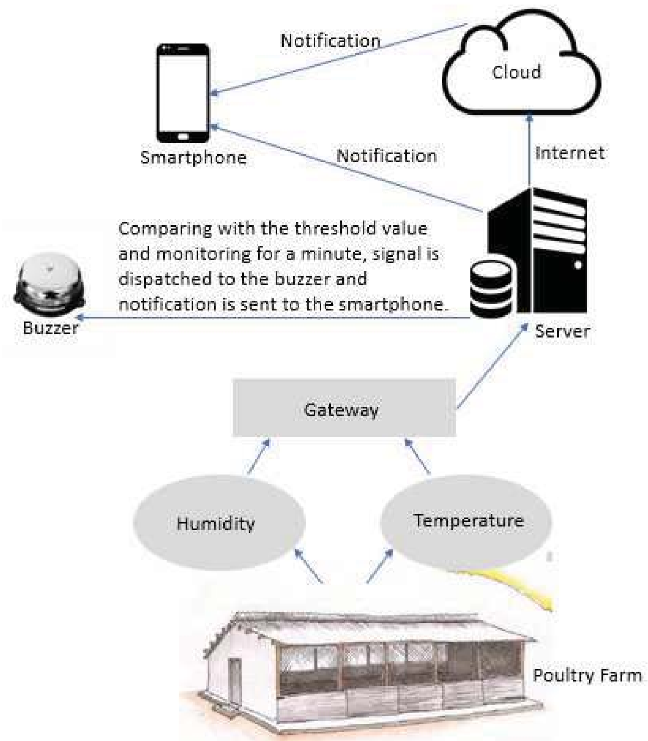

Fig. 1. Proposed system architecture

An IoT based weather monitoring system has been proposed here. In the proposed system, DHT11 sensor is connected to the NodeMCU that transmits the sensed data to the server. NodeMCU gateway acts as the main processing unit [29]. The server then analyzes the stored data and make decision based on threshold values. The server transmits data to the cloud for knowledge creation and further analysis. The cloud is included in the proposed system for the future research purpose. Based on the analysis, the server sends notification to the smartphone app, and signal to a buzzer. Every time the sensor sends the data, it is compared with the threshold value and monitored carefully. The system monitors the continuous data, compared to the threshold value for certain duration, and then sends an alert notification that helps the farmer to take necessary steps to control the temperature in the poultry farm [30, 31, 32]. The proposed system facilitates the farmer to monitor the poultry farm remotely, but he still needs to control the temperature manually, the control automation needs further research.

Functionality of the working model is shown in Fig. 2 using a flow diagram. The flow diagram shows the data transmission in the system from the sensor to the server. The procedure of sending alert notification to the user smartphone app and signal to the buzzer is shown in the flow diagram.

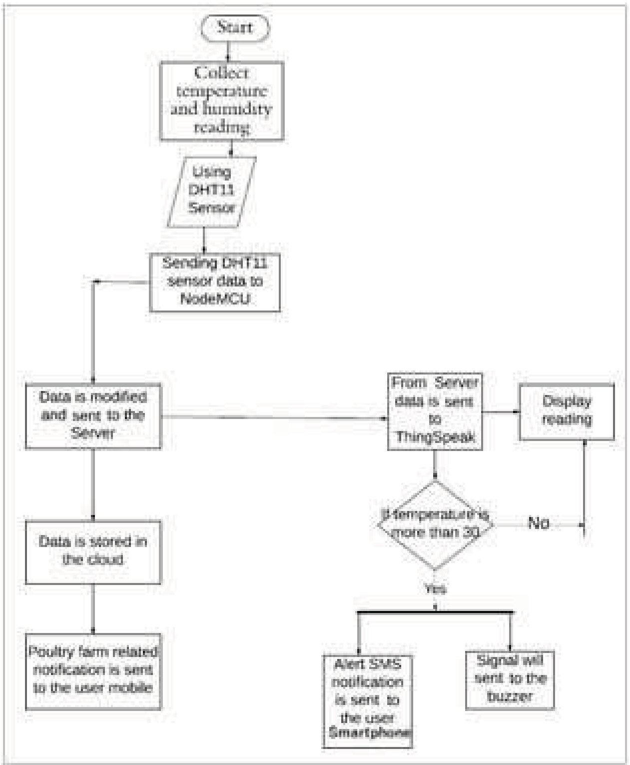

Fig. 2. Flow diagram of the system

B. Implementation

To validate the proposed system, a prototype has been implemented and tested. A smartphone application has been developed in this regard. The implementation architecture is shown in Fig. 4.

The system uses a DHT11 sensor to measure the temperature and humidity. The sensor accompanies with a devoted NTC to appraise temperature. A microcontroller outputs humidity and temperature values as serial data. While interfacing with other microcontrollers, the sensor is calibrated. DHT11 assesses temperature from 0°C to 50°C. With authenticity of ±1°C and ±1%, it measures the humidity from 20% to 90%. To interface the sensor with Arduino, ready-made library is available. In this project we are using the sensor because it's specifications can fulfill our requirements. Fig. 3 shows the architecture of a DHT11 sensor.

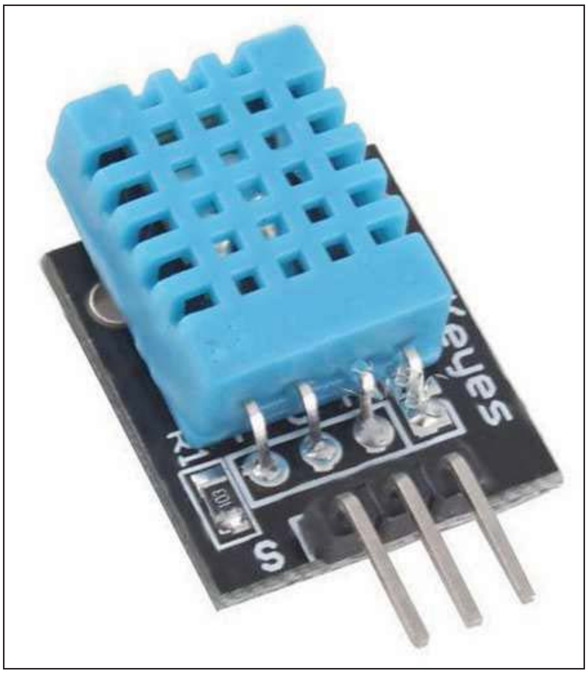

Fig. 3. DHT11 Sensor Architecture

NodeMCU ESP8266 is an inexpensive Wi-Fi microchip that can act as a microcontroller. The sensor and the buzzer are connected with the NodeMCU by using the jumper wires. Once the code is uploaded in the Arduino IDE Software, the system becomes active. Microcontroller gets the analog value from the sensor and converts it into digital value. The data is then sent to the server and stored in the database.

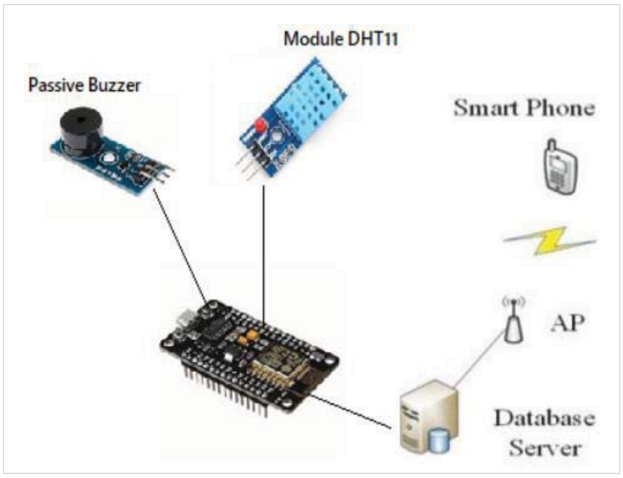

Fig. 4. Implementation architecture

The transmitted data is displayed in the serial monitor and in ThingSpeak, where it is plotted in the form of graphs with present date and time. The changes of the reading are shown in a separate dialog box. When the temperature is above 30, it will wait for a minute before sending the alert notification to the user smartphone and immediately will send a signal to the buzzer as well. The data is stored in a separate database which is created using MySQL. The phpMyAdmin is used to store the data manually in the MySQL database.

DHT11 is directly connected to the NodeMCU as shown in Fig. 5. The ground connection of DHT11 is connected with the GND of NodeMCU. The data out of DHT11 is connected with the D3 of NodeMCU. The VCC of DHT11 is connected with the 3V of NodeMCU. The connection of Passive buzzer is also shown in the diagram clearly.

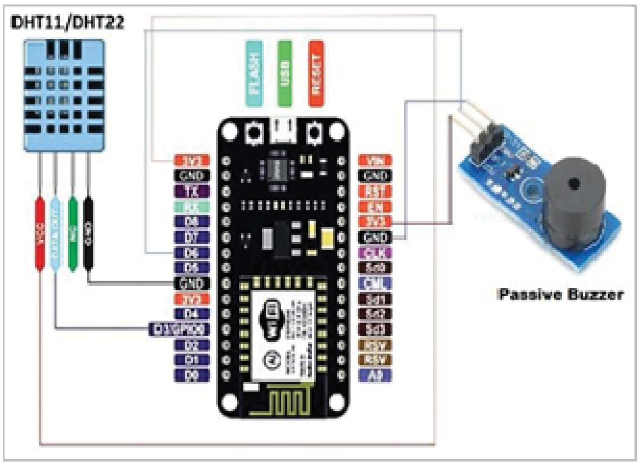

Fig. 5. Circuit Diagram

C. Notification to Smartphone Application

A smartphone application has been developed that can notify to the farmer. The server sends notification message based on the data. If the data crosses the threshold value for a certain duration, the server sends an alert notification to the user smartphone app.

For sending alert message, an applet needs to be created in the IFTTT. For building a path connection, the URL from the IFTTT and the Channel ID are set into the ThinkHTTP of ThinkSpeak. For comparison, the threshold value is set is numeric. Every time the threshold value is crossed, an alert message is sent to the user smartphone app, shown in Fig. 6.

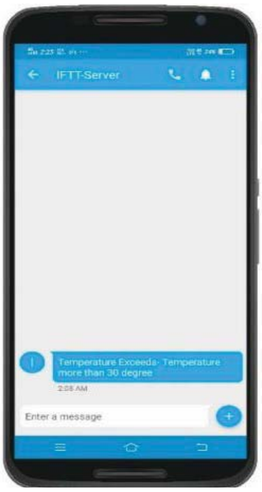

Fig. 6. Smartphone Application

NodeMCU has been used in the system that is programmed to detect the humidity and temperature every seconds. The code is run in the Arduino IDE and the reading data is sent to the serial monitor and ThingSpeak. The values in the serial monitor of Arduino IDE is shown in Fig. 7.

Fig. 7. Serial monitor

IV. Result and Discussion

The temperature and humidity data have been displayed on two separate graphs (Fig. 8 and Fig. 9) through the ThingSpeak interface. Y-axis represents the humidity and temperature data, and X-axis illustrates the time. ThingSpeak delineates the sensed data according to the accurate date and time. Sensed data is stored in the server.

Fig. 8. ThingSpeak Temperature Graph

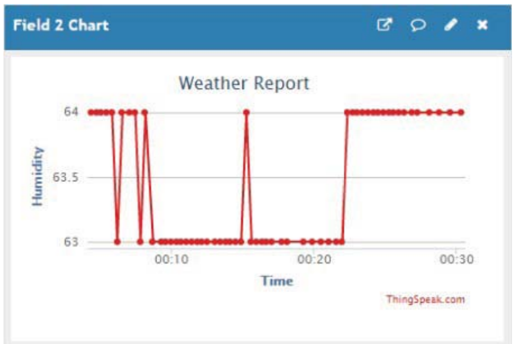

Fig. 9. ThingSpeak Humidity Graph

The temperature and humidity data, collected through ThingSpeak dialog boxes, have been shown in Fig. 10. The data in the dialog boxes is in numeric data type.

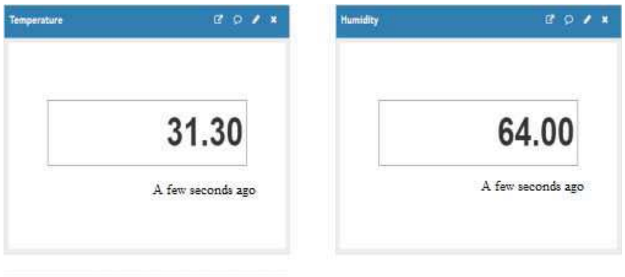

Fig. 10. ThingSpeak Dialog Box

Data were collected randomly in a day for a certain period of time from two different locations. The temperature and humidity data were monitored for five minutes intervals within an hour, and then the mean value were computed to plot the graph. Temperature and humidity graphs at location 1 and 2 have been shown in Fig. 11 and Fig. 12 respectively. Fig. 11 shows higher temperature and humidity than those in Fig. 12.

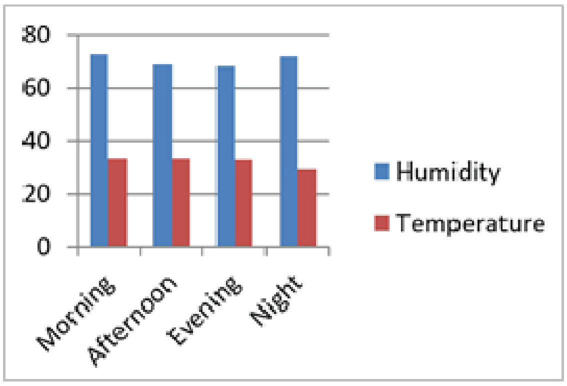

Fig. 11. Humidity and temperature reading at location 1

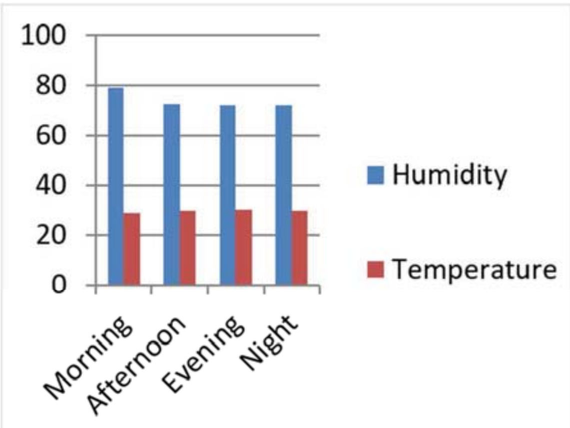

Fig. 12. Humidity and temperature reading at location 2

Due to the direct sunlight at location 1, the temperature was higher than that at location 2. Due to the covered area at location 2, sunlight could not arrive directly and the temperature is lower. The graph indicates the alterations in the readings from morning to night. Both at location 1 and location 2, the temperature is maximum from the afternoon to the evening which is above 30 degree Celsius, but the temperature is minimum in the morning and night. It can be concluded that the sensor records the temperature and humidity percentage from the atmosphere and the functionalities of the system run well and produce readings correspondingly.

Threshold value for the temperature was set to test the system. Whenever the system crosses the threshold value, it sent an alert notification to the smartphone.

V. CONCLUSION

Application of IoT in agro-farming converts the traditional farming into smart farming. IoT allows a system to monitor the weather at real-time that enables a farmer to monitor the farm from anywhere at any time. The proposed system sends alert message to user smartphone and signals to buzzer that enables the farmer to monitor the poultry farm remotely.

A system architecture has been proposed and implemented, and a smartphone application has been developed as a prototype. In the prototype, DHT11 sensor was connected to the NodeMCU that transmitted the sensed data to the server. NodeMCU was programmed to detect the humidity and temperature. The code was run in the Arduino IDE and the reading data was sent to the serial monitor and ThingSpeak that visualized the data. The implemented prototype successfully collected real–time temperature and humidity data, transmitted to the server through the gateway. For testing purpose, data from two different locations was collected at different time of the day, and the system successfully identified, compared and alerts whenever the threshold value was superseded. Moreover, different threshold values were set, and the system correctly sent alert notifications to the smartphone depending on the threshold values.

Since all the functionalities are not yet implemented, the system sends notification comparing the threshold value only. It is our high priority to implement all the essential functionalities soon to develop a real system.

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