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Design and Implementation of an Internet of Things-based Environmental Monitoring System

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Abstract: Plants can survive in a wide range of temperature and humidity conditions. This work aims to construct a real-time system to monitor and warn the administrator of problems. The system consists of an Arduino microcontroller, a DHT11 temperature and humidity sensor, and an Ethernet shield. It constantly checks and controls the values of environmental parameters to make sure that plants grow as well as they can. The sensors measured temperature and humidity independently. If data exceeds a specific limit, the Ethernet connection is used to send it to Thingspeak instead of the Wi-Fi network. Also, a new technology called IFTTT was used, which is a web service that helps send alarm emails to the administrator.

Keywords: IoT, smart systems, plant environmental monitoring, Thingspeak

1. Introduction

Agriculture sector is growing globally side by side with the world's population growth. To keep up with rising food demand, agriculture needs to find ways to improve production and quality without relying on manual monitoring. Climate change and population growth are both worries in agriculture. Farmers and government officials can market and store crops better when they know they will have a good harvest. [4]. A real-time system means that the systems are subjected to real time, which means that it has to respond within a certain amount of time or meet a certain deadline. For instance, a flight control system, real-time monitors, and so on. [1]. An embedded system is a piece of computer hardware that has a microprocessor and is programmed to do a specific job. Arduino is an open-source microcontroller platform. An Arduino is both a physical circuit board and a computer program called an IDE (Integrated Development Environment) that enables you to write and upload computer code to the board[2]. Sensors in microcontrollers collect information. A calibrated digital signal comes from the DHT11 Temperature and Humidity Sensor. Using a digital-signal-acquisition method and keeping an eye on temperature and humidity makes the system very reliable and stable over the long term. Power can be between 3.5V and 5.5V. [3]. There are many ways to connect to the internet. In this research, an Ethernet shield was used. It is a computer part that is often used with Arduino technologies. With an Ethernet cable and a local access network, these parts let a device connect to the Internet (LAN). You can use them to send and receive information over the Internet. The most important part of these devices is a port where an Ethernet cable can be plugged in. The Ethernet jack and a few circuits are connected to a small board. The Ethernet shield can talk to the device it is connected to through these circuits. Most Ethernet shields come with a built-in feature that lets them reset when the device's power cycle is done. Some also have a slot for an SD card or a micro-SD card[4]. Due to climate change, learning methods to monitor the environment is crucial. Recent innovations, like IoT and cloud computing, make it easier to send and manage a huge amount of data about the environment. The growth of the Internet of Things (IoT) has led to the creation of new technologies that can better meet its needs.

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ThingSpeak gives you an instant picture of the data your devices send to it. By being able to run code in ThingSpeak, The most important part of ThingSpeak is the ThingSpeak channel. You can look at the data as it comes in and process it online. ThingSpeak is often used to create prototypes and proofs of concept for Internet of Things systems that need analytics. ThingSpeak lets sensors, devices, and websites broadcast data to the cloud in a private or public way. Once data is in a ThingSpeak channel, you can analyze and visualize it, calculate new data, and talk to social media, web services, and other devices[5, 6, 7]. This research used a new method called IFTTT, which is an automation tool that lets you easily script actions that connect a wide range of devices and services. "If This, Then That" is the abbreviation for "If This, Then That," which is a programming rule that explains in a nutshell how the service works. The part that says "if this, then that" is called the "trigger," and "then this" is the "action." It is a web service that can deal with microcontrollers through many different channels. IFTTT can be used to make a lot of different decisions, so it is software that makes something happen[8]. The reason is Temperature, humidity, light, and carbon dioxide levels are the most important factors in how well and how much plants grow. By keeping an eye on these environmental factors all the time, a grower can learn more about how each affects growth and how to make sure plants grow as much as possible. Controlling the weather and keeping an eye on the plants is an important part of agriculture. The things we're showing are similar to the idea of precision agriculture, which has become popular in recent years in both commercial and research farming. The purpose of this paper is to monitor the environment's temperature and humidity and send the findings to the IoT cloud so that they can be saved in a channel and an email sent when the readings exceed a specified threshold. This paper's outline is made up of five parts: two about related work; three about proposed systems; four about results and discussions; and five about conclusions and ideas for future work.

2. Related work

(Hassan et al., 2020). This paper provides an IoT-based system for analyzing environmental change using sensors, microcontrollers, and the IoT. The recommended module monitors interior and exterior temperatures, humidity, and dangerous gases. The data can be accessed from anywhere on the globe via an internet connection. In the proposed work, a web application provides users with critical information. The user can additionally configure sensor data notifications. The proposed system is low-cost, accurate, and user-friendly. cloud-based, with monitoring and data visualization modules. The system was examined in stages. After testing all functionalities, it is accurate and trustworthy [10].

(Ashifuddin, Mondal and Rehena, 2018). This research proposes an IoT-based smart farming strategy to deal with adverse conditions. Smart farming offers precise crop control, data collection, and automated farming. This study presents a soil humidity and temperature monitoring system for agriculture. After sensory input, it acts automatically. The ThingSpeak cloud stores soil temperature and moisture for examination.[11].

(Mois, Folea, and Sanislav, 2017). The current study introduces three IoT-based wireless sensors for environmental and ambient monitoring: one using UDP-based Wi-Fi, one using Wi-Fi and HTTP, and one using Bluetooth Smart. All of the exhibited systems may capture data remotely and display it on any Internet-connected device, allowing for the monitoring of huge areas. These systems' development details, contrasts, and commonalities are presented. Three developed systems were tested to see if they could be used to implement monitoring applications. They were found to be good candidates for IoT-based solutions[12].

(Pathak *et al.*, 2019). In the proposed system, a cuckoo search algorithm provides water for farming in every condition. Temperature, turbidity, pH, and moisture are measured using an IoT platform with sensors and wireless connectivity.

ThingSpeak displays sensor data in the cloud on this IoT platform. The ThingSpeak data is used in the Cuckoo Search Algorithm to pick appropriate crops for the soil [13].

Table 1 outlines the main differences between the above works and the proposed system:

Table 1:- Summarize the main differences between the works mentioned above and the proposed system.

Systems	New Technique	Modelling
Currently used system	New technique	Traditional modelling
Proposed system	Using new technology to achieve the overall goal of using IoT It's called IFTTT.	object-oriented modelling

3. The Proposed System

The proposed system would be used to monitor the environmental health of farmers of any kind, allowing them to measure the aspects that affect crop cultivation. In addition to temperature and humidity sensors, the system employs

microcontrollers designed by the company Arduino. The Internet of Things (IoT) methodology underpins the system. Figure 1 shows the system's block diagram, which shows the processing units as well as the input and output units. Sensors represent the input.

- CD , LD, and Ethernet represent the output.
- The Microcontroller represents the processing and the heart of the system to manipulate the data.

ARDUINO 1.8.15, an open-source Arduino software, is needed. Code is written and sent to the board with it. The software works with Windows, Mac OS X, and Linux. The environment uses open-source Processing and Java.

In Figure 1, the temperature and humidity values are sent via Ethernet shield to the cloud and saved in the Thingspeak platform channels.

The IFTTT service is used to send an email to the administrator if the temperature is higher than a certain point, such as 38 Celsius.

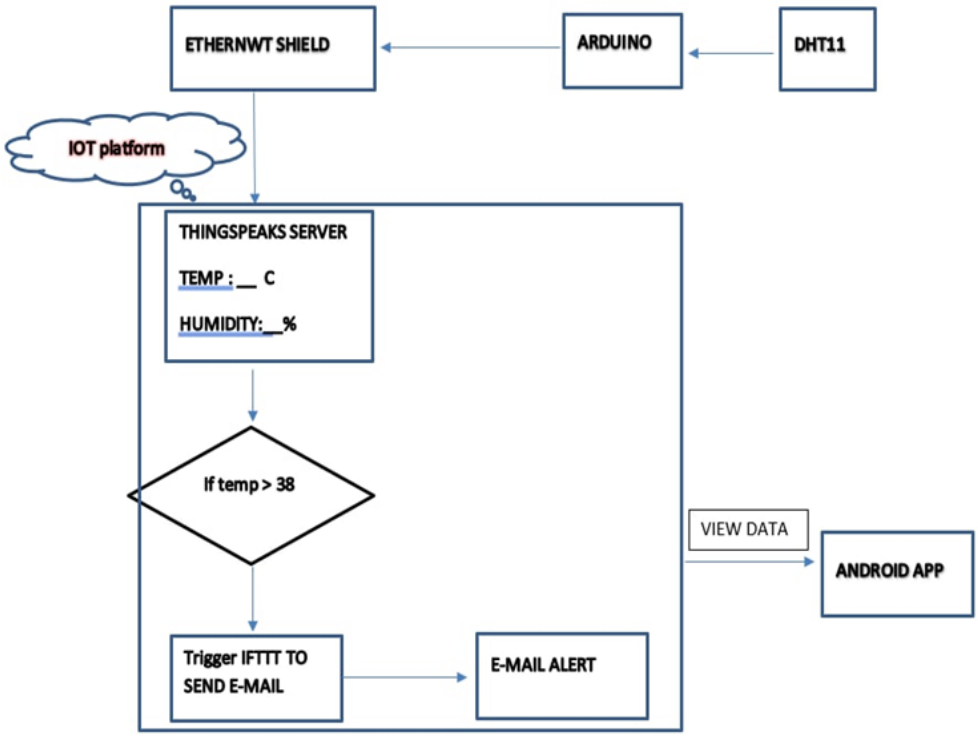

Figure 1: General Diagram System

Figure 2 shows that the values are also shown on the lCD.

Figure 2: Display the values of Temperature& Humidity

Figure 3 shows how the simulation model of the system based on the microcontroller is implemented in Proteus software. A Proteus is basically a piece of software that is used to simulate designing and drawing circuits [14].

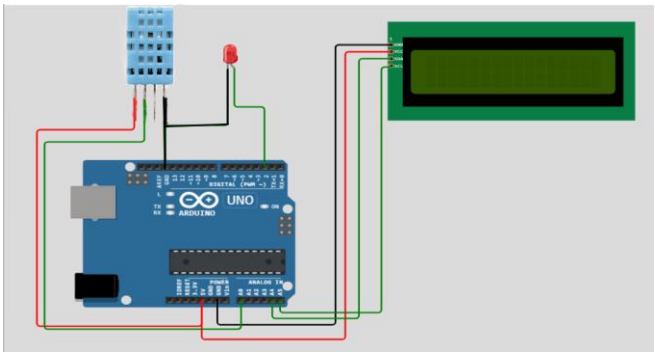

Figure 3: Simulation Circuit of system

4. Results and discussions

The system was tested in a number of agricultural ecological areas, and the results were good and correct. ThingSpeak is used to create proofs of concept for Internet of Things systems that need analytics. Figure 4 shows that it is used to store the analysis data in either a private or a public channel.

This information can communicate with social media, web services, and other devices.

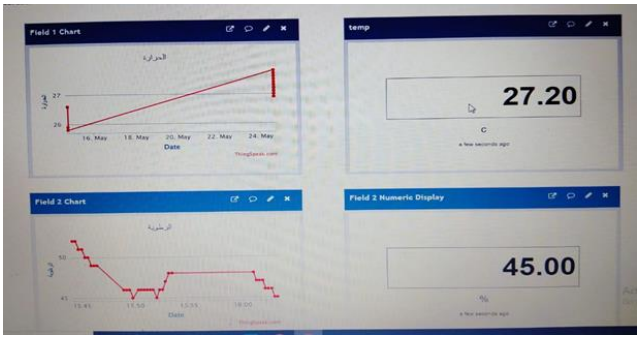

Figure 4: Thing Speak channels

ThingSpeack works with the IFTTT web service to send an alarm email to the admin when there's a problem, as shown in figure 5.

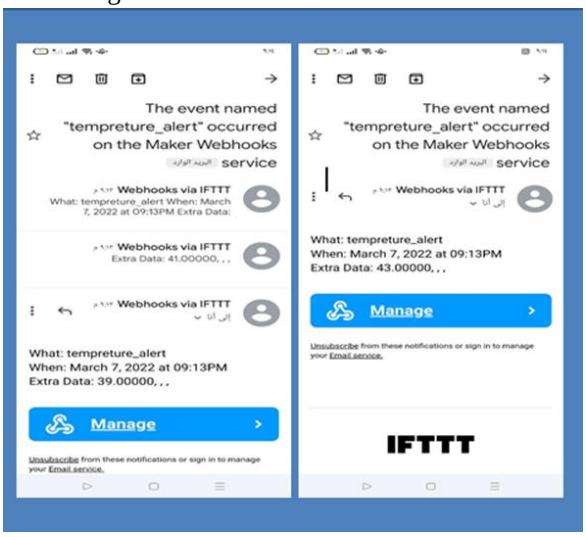

Figure 5: Alarm Email system

5. Conclusions

In order to automate the monitoring and control of the plants effectively, brand-new and ground-breaking solutions are required. This paper was produced to monitor the environmental parameters of plants using Arduino in order to avoid human errors and ensure that this data is known with perfect precision. The system used Ethernet because it offers reliable TCP communication and has a decent amount of throughput. Since the system receives a lot of temperature and humidity data every 5 seconds, storing large amounts of data is no problem. These values are cloud-stored. The device alerts the user if the observed temperature is too high for plant growth. Any internet-connected user can access the information.

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