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Development of IoT Weather Monitoring System

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Abstract Internet connectivity of the Internet of Things (IoT) devices over the network have widely reduced the facility consumption, persistence, and connection to access data over the network. IoT is regarded as a trustworthy technology to support and advance the industrial sectors. In this article, the IoT is applied to design a weather monitoring system. It is forged by integrating a variety of sensors with a Raspberry Pi. In this paper, the implementation and data visualization will be gathered, evaluated, and analyzed. The Raspberry Pi will be the primary element to serve as a server to access information over the internet that can analyze and examine.

Keywords: Internet of Things, Raspberry Pi, Raindrop Module, Temperature Sensor, Humidity Sensor

1.0 INTRODUCTION

Weather and climate changes are among the salient factors that determine how society develops in geographical regions. In simple terms, the weather is the state of the atmosphere, describing whether it is hot or cold, dry or wet, clear skies or cloudy weather, etc. As for climate, it refers to the term averaging atmospheric conditions over a long period [1]
Data about the weather is critical in our daily lives. Natural disasters such as floods and drought can be avoided when taking precautionary measures with the collected data from rainfall and temperature or even climate changes [2]. It is also lively for people to plan their work so that it can be completed when it is due. For example, weather data is critical for project managers in the construction industry to prepare their schedules so that the project is completed on time. The weather data that was obtained over a long period can be used to forecast future trends in climate change and the data can also be used for analysis to identify climate change patterns. [3]-[7].

The weather monitoring system has become more public in nations around the world. A weather monitoring system is a device that can update weather data in a much quicker and more frequent way [8]-[12]. Therefore, it is of rising significance in the study of weather patterns.

2.0 METHODOLOGY

This section will discuss the areas related to the methodology used for the intended system [13]-[16]. The implementation of this system must consider all the hardware and software that will be discussed in this section.

2.1 BLOCK DIAGRAM

In this section, the information and process flow of the device will be explained briefly through the block diagram shown in Figure 1.

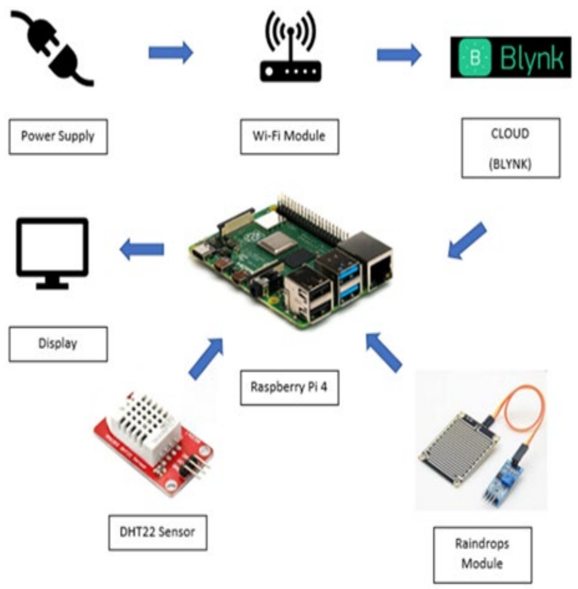

Figure 1: Block Diagram of IoT Weather Monitoring System

From Figure 1, the Raspberry Pi based IoT enabled weather monitoring system consists of a power supply, a Wi-Fi module, a Cloud Database (Blynk), Raspberry Pi, a Raindrops Module, a DHT22 Temperature, and Humidity Sensor, and LCD Display.

When the device is activated, it will automatically start searching for a Wi-Fi connection [17]. There are a few selections that can be chosen either connecting it to a public Wi-Fi, Hotspot or even using the ethernet. Once the device is connected, the cloud database (Blynk) will start pairing with the network that has been chosen. Blynk will also be connected to the Raspberry Pi and starts transmitting data from the Raspberry Pi to the Blynk database [18]. The raindrop module will collect data regarding rainy situations while the DHT22 sensor will collect the data for temperature and humidity. Both of these data will then be sent to the Raspberry Pi and Blynk which then will be displayed on the LCD or mobile devices by using a graphical user interface [19].

2.2 FLOWCHART

The flowchart of the IoT Weather Monitoring System is shown in Figure 2, it starts by turning on the device, and it will automatically search for a network connection. When the device has been connected to a network, Blynk will be needed to activate and start pairing with the same network connection. Afterward, Blynk will then connects with the Raspberry Pi and starts transmitting data from the Raspberry Pi to Blynk. The raindrop module and DHT22 temperature and humidity sensor will start collecting data on the weather conditions and will send it to the Raspberry Pi. It will then be displayed on mobile devices or any LCD that is chosen [20]. The device will keep sending notifications about the weather conditions from time to time. This process will keep going on until the user shuts down the device.

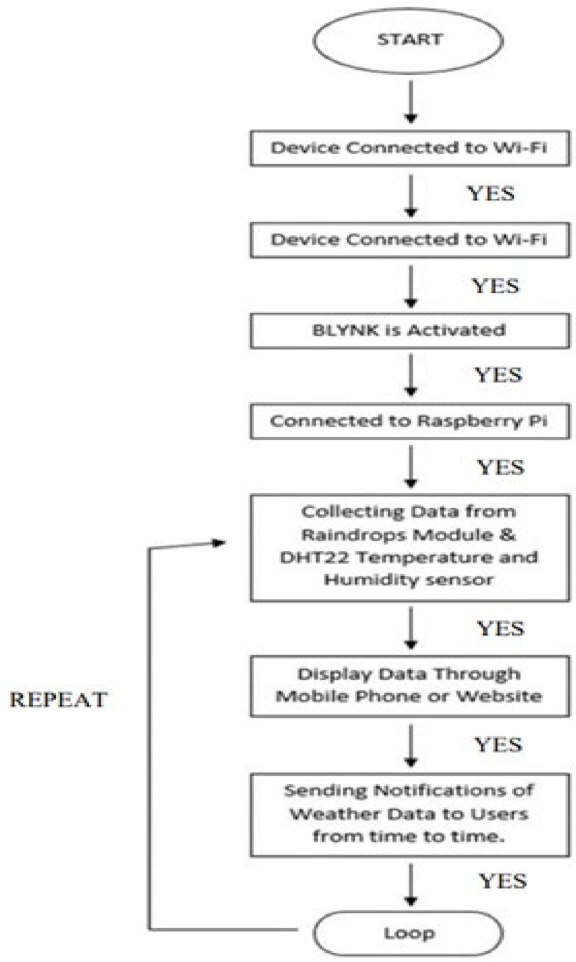

Figure 2: Flowchart of IoT Weather Monitoring System.

2.3 SOFTWARE USED

A. Python

As Figure 3 shows, Python with dynamic semantics is an interpreted, object-oriented, high-level programming language. Python is the world's fastest-growing programming language because it is a beginner-friendly language which means it is easy to use. People use Python for different variables of tasks, for example, big data analysis and visualization, artificial intelligence, machine learning, and automation. With fewer lines of code, Python can solve complex issues in less time [21]. Python is a multi-purpose language with a simple, and user-friendly syntax

Figure 3: Python

B. Blynk Database

As Figure 4 shows a Blynk Database. Blynk is a new framework that allows you to create interfaces easily from your iOS and Android device to monitor and track your hardware devices. After downloading the Blynk application, the user can customize a system panel and arrange buttons, sliders, graphs, and other widgets on the screen. The widgets allow the user to toggle pins on and off as well as display data from sensors.

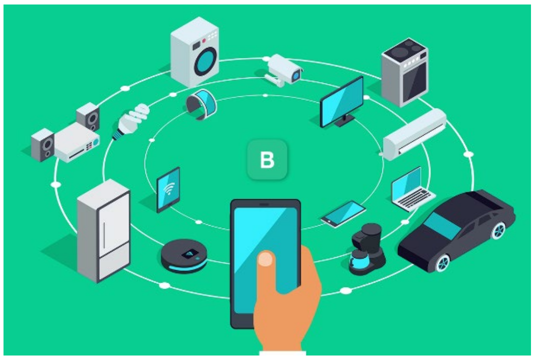

Figure 4: BLYNK Database

2.4 MATERIAL USED

A. Raspberry Pi

As Figure 5 shows, the Raspberry Pi board comprises a program memory (RAM), four full-size Universal Serial Bus (USB) ports, full-size Ethernet, memory up to 4GB, a quad-core processor, and also has built-in Wi-Fi and Bluetooth. The raspberry pi has general-purpose input/output pins (GPIOP) which can send and receive electrical signals that can control from the operating system wirelessly.

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Figure 5: Raspberry Pi

B. DHT22 Temperature & Humidity Sensor

As Figure 6 shows, The DHT22 is the costlier edition that has better specifications. The temperature measurement range is from -40 ° C to + 125 ° C with an accuracy of +-0.5 degrees, while the temperature range of DHT11 is from 0 ° C to 50 ° C with an accuracy of+-2 degrees. The DHT22 sensor also has a better humidity measurement range, from 0 to 100 percent with 2-5 percent precision, while the humidity of the DHT11 is better.

Figure 6: DHT22 Temperature, and Humidity Sensor

C. RAINDROP SENSOR

As Figure 7 shows, essentially, the Raindrop sensor is a board on which nickel in the form of lines is coated. It functions on the resistance principle. The Rain Sensor module allows moisture measurement through analog output pins and when the moisture threshold is exceeded, provides a digital output. The module is based on an op-amp for LM393. The electronics module and a printed circuit board are included, which "collects" the raindrops. As raindrops are collected on the circuit board, parallel resistance paths are generated that are calculated through the op-amp. The sensor is a resistive dipole that when wet displays less resistance and when dry, more resistance. It raises the resistance when there is no rainfall on board, it gets high voltage according to V= IR. It decreases the resistance when raindrop occurs since water is an electrical conductor.

Figure 7: Raindrop Sensor

2.5 INSTALLATION AND TESTING

The installation of the DHT22 sensor, Raindrop Sensor, Power Supply, and testing process of the system is illustrated in Figure 8, Figure 9, Figure 10, and Figure 11 respectively. Figure 11 shows that the device is up and running showing the indicator light up which means that the installation is a success. The Raspberry Pi Model B relates to the DHT22 temperature and humidity sensor which is then connected to the raindrop module. Subsequently, the device is connected to a power supply cable (black cable) and an output cable (white cable).

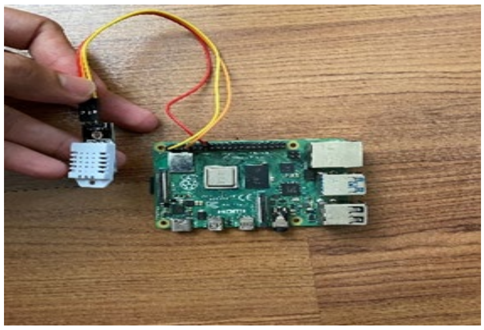

Figure 8: Installation of DHT22 Sensor

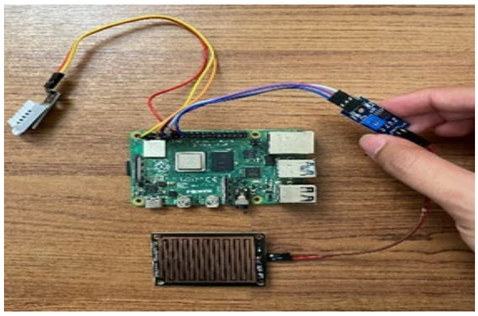

Figure 9: Installation of Raindrop Sensor

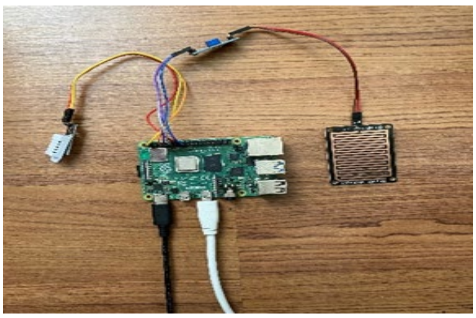

Figure10: Connection to Power Source & Output

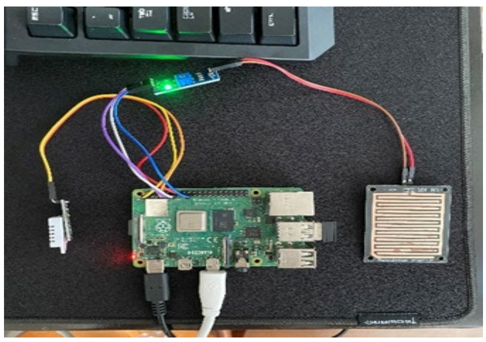

Figure 11: Overall Testing

3.0 RESULTS

In this section, the results of the developed system will be shown and explained. The systems are combined with hardware components and software applications. This section will discuss the effective performance of the device. The operation of the designed system consists of two main processes, which include hardware and software. The hardware device is relying on the internet connections and the power supply to operate appropriately. The software uses the internet as a bridge to connect the device and the mobile phone to display output.

3.1 TEMPERATURE & HUMIDITY TEST

The DHT22 temperature and humidity sensor when it is heated with a hair dryer are illustrated in Figure 12, and Figure 13 respectively. The temperature before is 33.10ºC and the humidity is 62.50%. After heating with a hairdryer as shown in Figure 14, the temperature rises to 44.10ºC, and the humidity decreases to 42.20%.

Figure 12: Reading before Applying Heat

Figure 13: Reading after Applying Heat

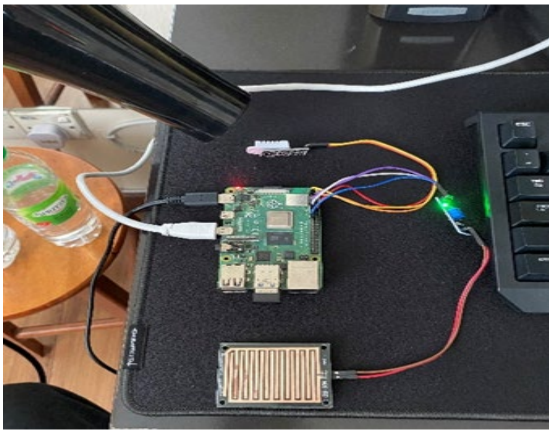
Figure 14: Applying Heat

3.2 RAINDROP TEST

The results of the device before and after a drop of water is detected on the raindrop module are illustrated in Figure 15 and Figure 16. To create rain, a few drops of water are poured on the raindrop sensor as shown in Figure 17. On the display, Raining State changes the reading from "not raining" to "raining".

Figure 15: Reading before Applying Water

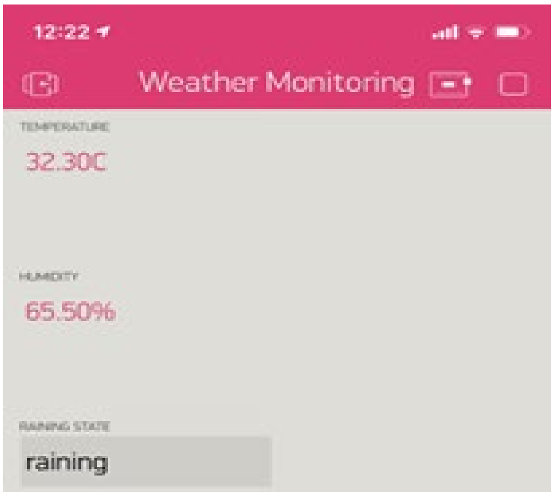

Figure 16: Reading after Applying Water

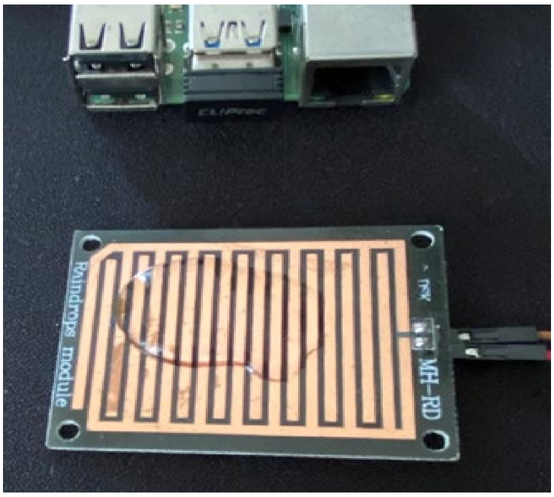

Figure 17: Applying Water

Table 1 shows the results of the raindrop module when it is tested with a drop of water. The display will show "raining" when there is a presence of water detected.

Table 1: Raindrop Module Test

Raindrop Module	Water Test	Result
	No	Not Raining
	Yes	Raining

Table 2 describes the humid state. From the results, it is clear that Temperature and Humidity are dependent on each other. They are inversely proportional to each other. When the temperature is high then the humidity level will be low and vice versa.

Table 2: DHT22 Sensor Test

DHT22	Heat Test	Result
Temperature and Humidity Sensor	No	31.10ºC, 62.50%
	Yes	44.10ºC, 42.20%

4.0 DISCUSSION

The operation of the developed system consists of two main processes, which include hardware and software. The hardware device is relying on the internet connections and the power supply to operate effectively. The software uses the internet as a bridge to connect the device and the mobile phone to display output. During the experiments, the device is working appropriately. All the data on current surroundings were measured accurately. The output display from this device is depending on the coding. Can have improvements to this device by changing the coding and installing add-on components to the device.

5.0 CONCLUSION

With the help of developed system devices, it can help each sector such as individuals, organizations, and the government to implement this device to take precautionary measures against harmful weather conditions. The device is working as expected by providing exact data on current weather conditions in the selected area. The main purpose of this system is to help individuals to determine the current weather conditions around the area. This will help users to be more prepared for upcoming weather conditions and avoid any inconvenience. This system also generates new ideas to make any improvements or create a new device that is even more advanced and engaging for users. Nowadays, internet connections are widely used and needed. This device will no longer be having problems regarding Wi-Fi connections and will provide convenience services in the weather conditions for all. This system is useful for individuals that monitor weather conditions from time to time or plan any outdoor activities.

6.0 RECOMMENDATION

As this device is using internet connections to send data information on current weather conditions to users, future recommendations could be to add on a GSM module or other devices that can send data information without the need for internet connections. This is due to certain areas or rural areas that have poor internet connection services. Apart from that, it could improve the range of the area so that the device could detect and collect weather data more efficiently and at a larger scale. Lastly, for future recommendations, it could improve by adding an anemometer to detect wind speed. This could prevent users from hurricane occurrences or other destructive weather conditions.

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