Internet of Things (IOT) Based Home Automated Weather Monitoring System

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***Abstract*—Nowadays, temperature changes often drastically affect our modern lifestyle. For instance, climate and weather changes strongly control what fruits and vegetables can grow. Another important aspect of weather that has a huge effect on our lives is extreme weather events, such as hurricanes, droughts, fires (forest fires), floods, heat waves, or cold snaps, and winter storms. Since the world is changing so fast so should weather stations. We people would always want to be able to control and monitor the temperature of our surroundings remotely. In this paper, we present a weather station that is very helpful for smart home challenges. This weather station is based on IoT (internet of things). It is equipped with environmental sensors used to capture distributed meteorological measurements at any particular place and report them in real time on cloud. The sensors constantly sense weather parameters and keep on transmitting them to the online web server over a Wi-Fi connection. The weather parameters are uploaded on the cloud and then provide the live reporting of weather informatics. Also, the system allows user to set alerts for particular instances, the system provides alerts to user if the weather parameters cross those values. The temperature could also be regulated to its predestined value that was set by the user. This is possible through the DC fan installed in the house that would turn on if the actual temperature would be greater than the desired temperature. This could be accessed by any remote device anywhere in the world.**

***Keywords*—IOT, weather station, sensors, temperature, humidity, Thinger.io**

INTRODUCTION

Background of the study

The internet of things (IoT) is viewed as the innovation and financial wave in the worldwide data industry after the internet. Being the network of all physical devices (items embedded with electronics, software, sensors) which enables them to connect and exchange data. It accomplishes the objective of keen recognizing, finding, following, observing, and overseeing things. [1]

Using the internet to its full potential, the IoT idea consequently goes for making the internet much more immersive and unavoidable. Associations with a wide assortment of gadgets (home apparatuses, reconnaissance cameras, checking sensors, actuators, showcases, vehicles, etc.), the IoT will encourage the advancement of various application that make utilization of the possibly gigantic sum and assortment of information created by such questions give new administrations to subjects, organizations, and open organizations [2].

Now, coming into the main topic, we all know environmental issues like climate change and Earth's temperature are moving up every year. Environmental monitoring procedures is a basic assignment for both researches and specialists. From past decades, environmental data has gotten an extremely quick advancement and wide application in checking environmental processes. Environmental informatics include particular natural issues identified with the uses of software engineering and frameworks building methods, administration information framework, and ecological data framework, which were intended to gather, process, and trade information since the 1980s. Automatic data acquisition has been quickly expanded by an assortment of advancements, for example, remote detecting, land data framework, worldwide situating framework, etc. From the 2000s, the multiplication of programmed information securing innovations, for example, radio recurrence recognizable proof and sensor advances, were acquainted with choice emotionally supportive networks and coordinated ecological data systems and furthermore conveyed new essentialness to environmental monitoring [3].

The fast advancement and wide utilization of natural informatics has huge enhanced environmental monitoring and viability. In the most recent decade, the internet of things (IoT), an idea depicting how the internet reaches out into people groups' regular daily existences through a remote system of particularly identifiable objects [4].

Problem statement

There is a need of a weather station to identify the temperature and humidity of the environment as well as to control it. The problem of the study also comprises the following:

- What IoT platform to use;
- Functionality of the sensors; and
- Flexibility of the system.

Objectives of the study

To develop an IoT based weather monitoring system that is able send instructions and as well as receive sensor data. Specifically, this study aims, to: be able to interface with the Thinger.io platform; test the functionality of the sensors that were used; and design a system for weather data acquisition, analysis, and control.

Scope and limitations

Using the internet for weather monitoring raises new issues and there are remaining implementation limitations. Internet communications are scalable and can be used to connect to everything in a weather monitoring network, from a single sensor to a display, to a complete global data network. This not only applies to data connectivity, but also to network management and maintenance of systems.

Significance of the study

By connecting this weather station to the internet, the IoT can be made much more extensive in predicting and knowing the weather data in a particular place. The mobile application and Thinger.io database can be used to store and share the weather data which are key ways to associate the weather station with the internet of things. IoT applications gather more data compared to traditional batch processing. Having capabilities for streaming data continually is key to reliably feeding real-time business processes and extracting timely insights.

REVIEW OF RELATED LITERATURE

Shifeng Fang (2014) states that in today's world, many pollution monitoring systems are designed by considering different environmental parameters. Existing system model is presented using Zigbee [3] based wireless sensor networks to monitor physical and environmental conditions with thousands of applications in different fields. Sensor nodes directly communicate with moving nodes deployed on the object of interest which avoided the use of complex routing algorithm but local computations are very minimal.

L. Atzori (2010) states that mobile phones or smart phones that are enabled with sensors are used for impact on social media including how mobile technology has to be used for environmental protecting, sensing, and influencing just-in-time information to make movements and actions environmentally friendly. Mobile phone sensors were deployed and used in urban areas for monitoring and categorized into two major classes—participatory sensing, where user is directly involved and opportunistic sensing, where user is not involved, but its limitation includes power and static information processing or mobility restrictions [4].

P. Bellavista (2013) also states that wireless sensor network (WSN) consists of many inexpensive wireless sensors, which are capable of collecting, storing, and processing environmental information and communicating with neighbouring nodes. In the past, sensors are connected by wire lines.

The access method of the WSN gateway node is convenient because data can be received from a WSN via the gateway at any time and any place. The gateway acts as the network coordinator in charge of node authentication, message buffering where you can collect, process, analyse, and present measurement data. Wireless sensor network management model consists of end device, router, gateway node, and management monitoring center. End device is responsible for collecting wireless sensor network data and sending them to parent node, then data are sent to the gateway node from the parent node directly or by router. After receiving data from the wireless sensor network, gateway node extracts data after analysing and packaging them into ethernet format data, sends them to the server. A server is an instance of a computer program that accepts and responds to requests made by another program known as client. Less formally, any device that runs server software could be considered a server as well. Servers are used to manage network resources. The services or information in the servers are provided through the internet that are connected through LAN and made available for users via smart phones, web browsers, or other web browser devices to make the system more intelligent, adaptable, and efficient [5].

METHODOLOGY

The research method in this paper is design/experiment. The reason for this is the uncertainty of how well the hardware and software will work independently and more importantly, together. A series of tests was conducted to prove the accuracy and reliability of the sensors.

Conceptual frameworks

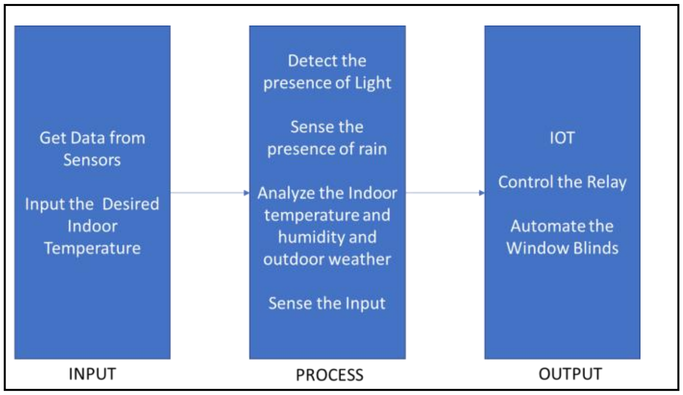

Figure 1. IPO chart

Figure 1 is the IPO chart which shows what would be the input, process, and output of the system.

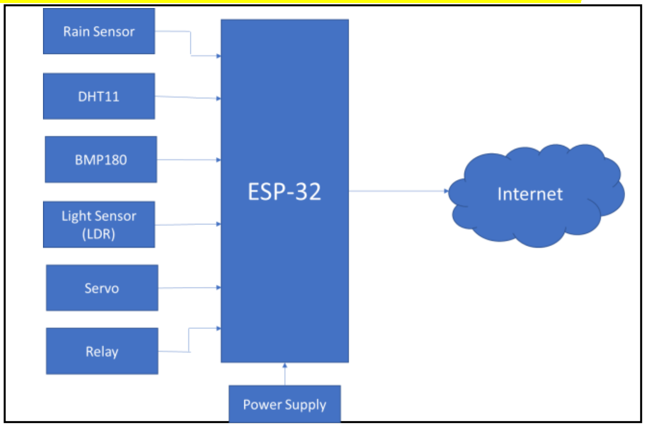

Figure 2. Functional block diagram

The block diagram of the system shows the following sensors and devices connected to the microcontroller board that transmits data across the internet to be received by the user.

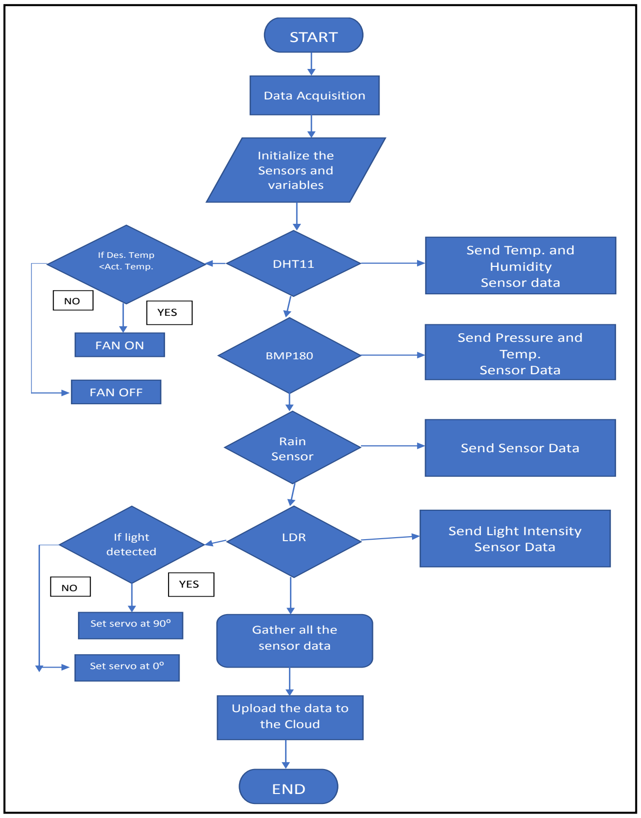

Figure 3. Flow chart

At the start of the flowchart, the sensors were first initialized. Then, the DHT11, BMP180, rain sensor, and light dependent resistor (LDR) transmit all its data to the cloud. A part of the flowchart includes that if the DHT11 sensor detects that the actual temperature is greater than the desired temperature, it would switch ON the fan. Finally, if the LDR senses light, the servos would rotate to 90 degrees which would open a window blind.

System requirements

Communication standards

IEEE 802.11n is the newest of the wireless standards listed in the Network+ objectives is 802.11n. The goal of the 802.11n standard is to significantly increase throughput in both the 2.4GHz and 5GHz frequency range. The baseline goal of the standard was to reach speeds of 100Mbps, but given the right conditions, it is estimated that the 802.11n speeds might reach a staggering 600Mbps. In practical operation, 802.11n speeds will be much slower.

IOT platform

The Thinger.io platform senses and acts over devices in real-time. Its technology minimizes data bandwidth, processing power, code size, and increases server scalability.

Hardware used

ESP-32

ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed with TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility, and reliability in a wide variety of applications and different power profiles.

DHT11

DHT11 digital temperature and humidity sensor is a composite sensor that contains a calibrated digital signal output of temperature and humidity. Application of a dedicated digital modules collection technology and temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement device connected with a high-performance 8-bit microcontroller.

BMP180

This is a breakout board for the Bosch BMP180 high-precision, low-power digital barometer. The BMP180 offers a pressure measuring range of 300 to 1100hPa with an accuracy down to 0.02hPa in advanced resolution mode. It is based on piezo-resistive technology for high accuracy, ruggedness, and long-term stability. These come factory-calibrated, with the calibration coefficients already stored in ROM.

Rain sensor

The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features a rain board and the control board that is separate for more convenience, power indicator LED, and an adjustable sensitivity though a potentiometer.

Servo

Servos are devices that are commonly used in robotics and have many applications. They are used to move object parts from one angle to another and most servos can only move within a limited range.

Light dependent resistor (LDR)

An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. A light dependent resistor (LDR) is a light-controlled variable resistor. The resistance decreases with increasing incident light intensity; in other words, it exhibits photoconductivity.

DATA AND SIMULATION RESULTS

Table 1. Test of the functionality of the sensors

Test	Expected Output	Actual Output	Remarks	
Light Sensor #1	Input Light			
1	Servo turn	Servo turn	Successful	
2	Servo turn	Servo turn	Successful	
3	Servo turn	Servo turn	Successful	
Light Sensor #2	Input Light			
1	Servo turn	Servo turn	Successful	
2	Servo turn	Servo turn	Successful	
3	Servo turn	Servo turn	Successful	
DHT11 Temp. Sensor	Heat Applied			
1	Turn on Relay	Turn on Relay	Successful	15 out of 15 or 100%
2	Turn on Relay	Turn on Relay	Successful	
3	Turn on Relay	Turn on Relay	Successful	
BMP180 Sensor				
1	Data Received	Data Received	Successful	
2	Data Received	Data Received	Successful	
3	Data Received	Data Received	Successful	
Rain Sensor	Water Applied			
1	Detected Liquid	Detected Liquid	Successful	
2	Detected Liquid	Detected Liquid	Successful	
3	Detected Liquid	Detected Liquid	Successful	
Legend :	Sucessful - Expected Output is equal to the Actual Output			
	Unsucessful - Expected Output is not equal to the Actual Output			

Based on the results, the sensors' data were 100 percent accurate during testing. The expected output was at par with the actual output.

Figure 5. The prototype

The DHT11 temperature sensor was mounted inside the miniature house to measure the inside temperature and humidity. So, if the desired temperature is less than the actual temperature, the relay would automatically turn on which would also turn on the DC fan which would be able to cool the house.

As a medium to control the window blinds, an LDR was used to detect the presence of light. Although the window blinds were controlled by some servos. So, if light is detected, it would automatically turn the servo to 90 degrees which would open the window blinds, then bring it back to 0 degree when the presence of light has disappeared.

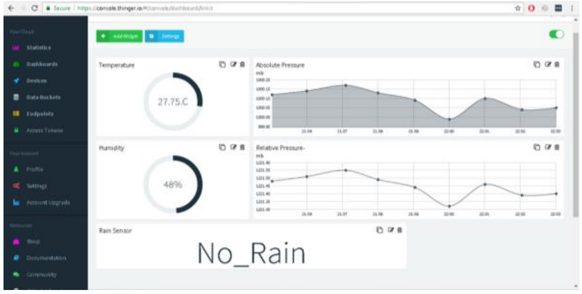

Figure 6. Thinger.io dashboard

The data from the sensor is sent to the cloud using a Wi-Fi connection. With a goal of this information to be assessed at the IoT website called Thinger.io. Since the sensor's data are transferred to the cloud, it means that anywhere in the world, as long as there is internet connection, this data can be received and seen.

To use the IoT protocol in the Thinger.io website, an account must be created. With this free account, only two devices can be connected simultaneously. The ESP-32 board was configured to this website; this was possible through the credentials given by the website which then needs to be integrated into the main code for this device to identify what account it should connect to. After registration, a channel was created for the device. A channel is made for taking all the information you want to display, update, send, or receive. It is used for interaction between ESP-32 and the channel. While creating the channel, specify or check the number of fields for data you want to visualize or post to the server. Thinger.io website provides API write key and API read key for each of its own purpose. To send or update information regarding the device on live feed, the API write key will be used and specified in the code while making requests to the website. When the ESP-32 is connected to the Wi-Fi, sensors that are connected to the board are able to send data to a particular dashboard that is configured (Figure 6). After thorough testing, it was found that it takes approximately one to two seconds for data from the sensors be received based on the speed of internet connection.

CONCLUSION

The Thinger.io IoT platform was used to be able to receive and send data. The data from the sensors were accurately transmitted to the Thinger.io dashboard to be viewed in a series of graphs and plots.

The functionality of the sensors was also tested through a series of tests and it was concluded that the expected output was exactly the same with the actual output.

The IoT-based communication provided to be a very flexible way to receive and send information at long distance at the expense of the internet.

RECOMMENDATIONS

Future researchers may include statistical analysis to show the stability of the system using the data gathered.

ACKNOWLEDGEMENTS

The proponents of this study would like to express gratitude for without the help and guidance of the Almighty God, this research will not be a success. To the College of Engineering and Computer Studies (COECS) who provided the curriculum for students to do such research, to Lyceum of the Philippines – Laguna (LPU-L) who allowed this research to be possible, and to their families who supported them, the researchers would like to extend gratefulness for this success.

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