Weather Station Using Raspberry Pi

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***Abstract*: Weather is the everyday climate that is hard to predict and impacts human activities and is important in many different sectors. However, it is expensive and huge, bringing pain to current meteorological stations on the market. The aim is to develop a weather station that provides real-time warnings for climate monitoring, interfaces with a cloud platform and analyses weather. This project has been completed with a Weather Station to record weather conditions by means of SparkFun Weather Shield, Arduino Uno R3 and Weather Meter. Data from the sensors are then recorded using Raspberry Pi 3 Model B in Google Cloud SQL, where they are gateway and the analysis of meteorological data is done. The website and mobile application are designed to illustrate real-time weather conditions for managing and users using Google Data Studio and Android Studio. In this Article various environmental components may be monitored in real time utilising IoT at minimum costs. For this reason, we use the ARM-based Raspberry Pi board. The Raspberry Pi OS is selected for the Linux kernel. Python, as the Idle is understood, is a programming language. A wide range of digital and analogue sensors, such DHT11, BMP180, LDR and a distinctive scale, are used with ULN2803 for measuring the environment parameter. The Raspberry Pi server, which is saved to CSV and text files, reads these input sensor data. Customers may obtain this information from anywhere in the globe on stuffpeak.com in real time. To connect the server to the client, use the HTTP protocol.**

Keywords: Embedded system, Raspberry Pi, Wi-Fi, temperature, humidity, wetness of soil, precipitation, light, and server.

I. INTRODUCTION

For centuries, climatic and weather changes were noticed. To assess changes in the environment, observing the meteorological parameters is necessary. The impact of climate on human existence that led to the creation of whole scientific disciplines of climatic and weather monitoring has always been extremely important. At the beginning, basic and imprecise equipment were employed that were unable to read and store measured parameters easily. Today, numerous automated observatories and weather prediction systems worldwide continually gather environmental parameters for certain or other uses that illustrate how important weather is every day. In addition to governmental and non-governmental entities, the predicted weather data may also be used in areas such as agriculture, transport, construction, etc. Weather forecasting systems can be utilised for training reasons in addition to scientific and business uses [1]. The goal of this project is therefore to build an online weather system that allows users to monitor a location's weather in real-time with only a few buttons. In addition, people are notified or reminded in real time. Weather forecasts are being made that enables users in the present weather to prepare themselves for their plans.

Google's cloud platform is selected because it is quick to set up, convenient to operate and features integrated with safety. It is used for analysing data and developing applications for mobile weather monitoring. Google Cloud is ideal for the use of various features on this platform to get the required outcomes in a project. The system includes a raspberry-pi3 to process the sensor and peripheral activities [2]. In assessing the needs of the application, the system's wireless communication standards were established that the weather should be continually monitored and updated. We need to make the weather of a certain area internationally informative in our application.

The parameters measured are kept in a cloud and may be downloaded over a communication link from a remote place. If the information is saved in a cloud, recorded data must be transferred physically to the computer for additional processing at a later time. The system has all sensor devices that function as a client for sending the data to the web server. Additional use of the Wi-Fi router, which is managed by the raspberry-pi3, was made for connection between sensor network and Internet. A wireless Internet connection source is required for a Wi-Fi module. Once the Wi-Fi module is set up as a client with an Internet source, it delivers sensor information the user receives like a mobile app. The Internet of Things is the requirement for linking all sensors to the Internet (IoT). It is extremely important to monitor the weather in any industry during specific dangers. Figure 1 shows the weather station using raspberry Pi.

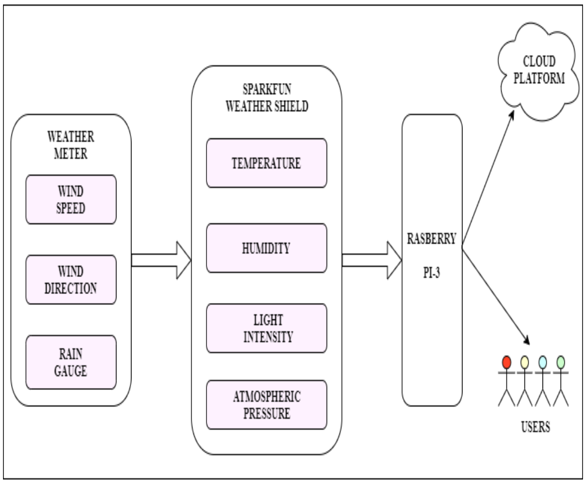


Fig. 1. Weather Station using Raspberry Pi

The main objective paper's main purpose is to build an IoT system to design a meteorology monitoring system to enable weather parameters in any sector to be monitored [3, 4]. The sensor data are gathered via the hyperbaric pipeline, the sensor data are sent into the cloud by using the connection space. It connects physical items, buildings, vehicles and other components like sensors and actuators to one other. The network connection to integrated electricity, software, sensors and actuators enables these objects to acquire information and to share information. By utilising IoT items, that detected or remotely controlled via existing networks. It allows the physical world to be connected to computer-based technologies [4]. IoT increases efficiency, precision, economic advantages, and decreased workforce. IoT frameworks are used to assist interface "things." Supports more sophisticated architectures such as distributed computing, too.

II. LITERATURE SURVEY

Already an automated weather station in distant regions in Sri Lanka has been awarded and deployed, but until now there has been little focus on using these types of equipment to decrease the cost effectively. Automated weather stations have been established at universities to receive hard copies of weather information by using the interface meteorological parameter sensing to microcomputer / commercially available data loggers via communication devices or through parallel and serial ports (Lanre Joseph & Umoru Sam, 2012; Ramesh, 2016; Robotics, 2010). An automated meteorological station with integrated data logging and USB transmission facilities was recently created by Colombo University.

The study of wireless technology was done initially in order to build a network of wireless sensors. In this study, wireless technology is chosen for its economic and technological characteristics. The main objective is to find a range of communications while selecting the communication technique. Wi-Fi is deemed to be 802.11 b/g. The data can be transmitted anywhere in the globe via their IP address when we offer the Internet source. Microcontrollers might be employed in the future investigation. Implementation of the system is part of the underlying objective of producing a low-energy solution [5]. In addition to the remaining sensors, the raspberry must also consume little power. We have picked the low-energy raspberry-pi3, with built-in Wi-Fi and just 3.3v work.

The following research focused on the web page's data logger mechanisms. The data from the sensors are often gathered in the form of integer values that reflect the ambient value. The website which immediately displays data from sensors does not make the users easier to feel. It should be presented in a graphical image for simple user understanding. The information housed on the website is costlier and must be rented out for it. We selected a certain amount of free data hosting websites that provide our sensor data a cloud space to make the system universal and less costly.

During the earlier days the data from sensors to remote regions were collected and transmitted to the ZIGBEE communication module to the database station, although there is no chance of overcoming that problem if we want to monitor sensor data from anything, we send those sensor data to the web server in our proposed system, and they have access from anywhere [6]. Raspberry Pi and Arduino wireless sensor network design for applications like environmental monitoring Wireless sensor network technology has developed into a feasible solution for many creative applications over a decade of active research and development. We discuss a wireless network sensor system we have created using Arduino and Raspberry Pi, open-source hardware. The system is cheap and highly scaled, both in terms of sensor types and the number of sensor nodes, making it suitable for a wide range of environmental monitoring applications. This article provides details about the overall system architecture and development of the hardware and software components. There are also sample deployment and measurement data to show the utility of the system. An open-source hardware platform named Raspberry pi, is a network wireless sensor system. The system is cost-effective and highly scalable in both kind of sensor and number of sensor nodes, making it suitable for a wide range of environmental monitoring applications. In order to establish WSN, the XBee module will be used to examine the ZigBee Protocol.

Paper title Environmental Monitoring Application for IoT and Raspberry PI. The paper discusses the Internet of Stuff and the Wireless Sensor System (IOT), builds a hardware platform, raspberry pi (2B model), ZigBee and sensors utilising the WSN [7]. It is cheap, low-power consumption, highly scalable in a sensor type and the number of sensor nodes. The sensor node is a mix of sensor, control, and XBee module, making it suitable for a range of environmental monitoring applications. The IoT is an emerging essential technology for future businesses.

Arko Djad et al. have proposed the system of monitoring environmental quality using the IoT sensor network. This system uses serial interfaces such as Modbus and I2C for connecting sensors into Net Client. Then TCP/IP delivers Fog net data gathered. Data from all the environmental sensors work as inputs in the Arduino ATMega2560 board. This board requires Wi-Fi to be connected to the Wi-Fi router. For online monitoring reasons, these results can be sent to the web server [8]. For as long as they are connected to the Internet, electronic gadgets such as laptops or phones are available. The sensors used are the ambient sensor DHT11, the sound-sensor and the sensor of ambient light.

Tamilarasi B. et al. have introduced the WSN platform functional design system which can be used for sustainable environmental monitoring inside the IoT application [9]. Nikhil Ugale et al. suggested the IoT-based environment monitoring system for homes. Several sensors for collecting data, including light, temperature, levels and moisture, are employed in order to monitor environmental conditions and detect failures. A PIC microcontroller is used to run and monitor all connected sensors [10].

The technology is an advanced way to monitor weather conditions in a particular zone and provide the information offered by Kondamudi Siva Sai Ram anywhere in the world. On the web of things, technology is employed (IoT). The sensor may be gathered using a microcontroller that is sent via the Wi-Fi module ESP8266 over the TCP/IP protocol pile [11,12].

III. PROBLEM STATEMENT

Weather and climate are the most prevalent aspects for house and environment planning; therefore, they play a vital role in our daily lives. Furthermore, the phenomenal growth of weather conditions can now be monitored via the internet. The data acquired at numerous locations can be shared and analysed by connecting all of the items, sensors, and devices over the Internet. With modern technology helping humanity and bringing convenience to society, it is now time for weather broadcasting to be integrated into mobile phones rather than relying just on television or radio for information [13, 14]. There are still people racing to appointments in the rain without an umbrella despite the fact that we have a mobile weather checking system. Laundry is still getting wet, while houseplants are withering due to the hot and dry weather conditions. Laundry continues to be soaked and home-planted plants are withering due to the hot and dry weather.

IV. HARDWARE COMPONENTS USED

A. Raspberry Pi

There are four USB ports and a 10/100 Base T Ethernet connector on the Raspberry Pi, making it a versatile device shown in figure 2. To connect the sensors to the MCP3008 Analog to Digital Converter chip on the Raspberry Pi board, a forty-pin GPIO header has been added. The device receives power from a 5V Micro USB power connector [15]. There is an HDMI port for connecting the Raspberry Pi to the monitor, as well as USB connectors for connecting the keyboard and mouse. If we are running the Linux-based Raspbian Jessie botting software, we need to place the Micro SD card in a bottom-mounted Micro SD card reader slot.

Fig.2. Raspberry Pi

B. Breadboard

It is a plastic rectangle with numerous little holes depicted in figure 3. For example, this circuit with a battery, switch, resistor, and LED may be easily prototyped (created and tested as an early version) with these holes (light-emitting diode) [16].

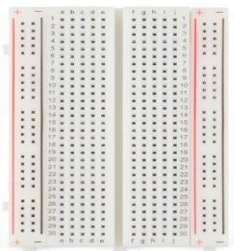


Fig. 3. Breadboard

C. Anemometer

There is an anemometer on almost every weather station to detect patterns and fluctuations in the wind's behaviour. We need anemometers to predict weather predictions and notifications since wind currents are constantly changing [17]. Anemometers are used to measure wind speed and pressure using a variety of technologies as depicted in figure 4.

Fig. 4. Anemometer

D. Wind Vane

At the top of the wind vane, there is a revolving ornament that indicates the direction. One little globe is located at the top and one larger one is located towards the bottom [18]. On the rod between the two globes is a direction marker that shows north, south, east, and west. The wind van is shown in figure 5.

Fig. 5. Wind Van

E. Rain Gauge

A rain gauge is a meteorological instrument that measures the amount of rain that falls per unit area in a certain amount of time as shown in figure 6 [19, 20]. A collection container is put in an open location to serve as the instrument. Precipitation is stated in millimetres and is measured by the height of precipitated water accumulated in the container over time.

Fig. 6. Rain Gauge

V. WORKING PROCEDURE

The Raspberry PI platform was identified to be the best available device after analysing the existing open-source platforms in terms of specification, price, and development tools. The Raspberry PI is the project's basic basis platform in this project. In order to produce a low-cost prototype for the environment parameters monitoring system, the parameters are monitored using inexpensive sensor components [21, 22]. The measured parameters must be sent to the device and subsequently to the server, where they will be stored and used for statistical purposes on a regular basis. The hardware for a weather station is made with a Raspberry Pi Weather Shield and a sensor-connected metre. Between the sensors and the database server, a Raspberry Pi 3 Model B served as a gateway. It was set up in the open to collect all of the required weather data. The flowchart of the proposed system is shown in Figure 7.

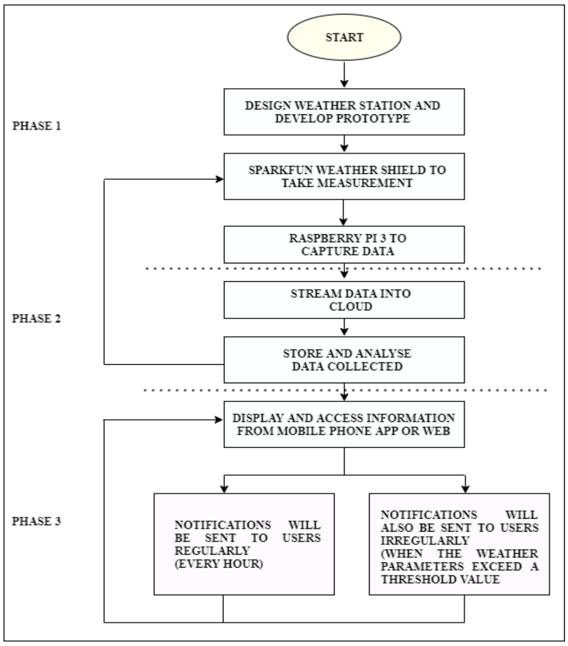


Fig. 7. Flowchart of proposed system

Because of the Internet of Things, Home automation, wireless sensor networks, and control systems are all examples of old technology that are more efficient and smarter. IoT applications include medical applications, such as monitoring a patient's health and transmitting information wirelessly [23]. Wearable instrumentation, such as smart wristbands and navigation pills, is mostly reliant on IoT. To update health information or control the gadget using a smartphone, all of these ways require an internet interface. Figure 8 represents the work-flow of the proposed system.

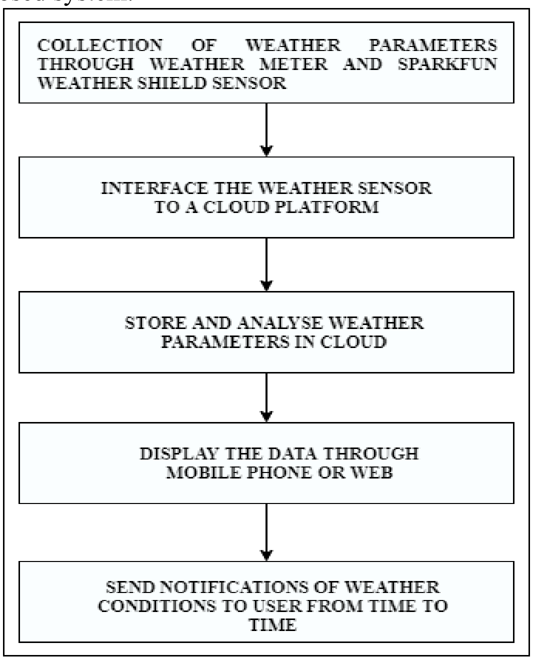


Fig. 8. Work-flow of the proposed system

By connecting this weather station to the internet, the IoT may be extended to anticipate and know meteorological data in a given place. With a mobile app and a database, a weather station may be connected to the internet of things so that it can store and exchange weather information [24, 25]. Comparatively, IoT applications capture more data than traditional batch processing methods. To ensure real-time business operations and timely insights, continuous data streaming capabilities are required.

VI. RESULTS AND DISCUSSION

Forecasting the climate in a place based on meteorological factors is an essential element. Because of this, the estimated results from this technique may be used to predict the weather for an amount of time in a certain location. With the addition of small components and an increase in the scaling factor, you can make this mini weather system considerably more compact and dependable. In this model, we used a Raspberry Pi3, which allows us to send an immediate warning message when the parameters change suddenly. It's easy to add sensors to monitor various weather conditions, as the possibilities are endless. Raspberry Pi is used in Agricultural areas where it can benefit from the sensors that measure soil moisture, PH and other factors. Therefore, it would be beneficial for farmers to consider agricultural output. On the system side of things, Raspberry Pi may be utilised as a web server and as a data gathering board. As well as pressure and altitude sensors, the light intensity sensor and rainfall level sensors are utilised to obtain data on weather and humidity conditions. Data is subsequently sent to the client through HTTP protocol, where it is received. You may access the web on the board using an Ethernet connection or a USB adaptor. As a result, the prototype will only work if the sensors are working correctly and accurately. Wi-Fi is required to send data from the Raspberry Pi to the server. Figure 9 depicts the database output for the proposed system. Figure 10 & 11 shows the output of the proposed system.

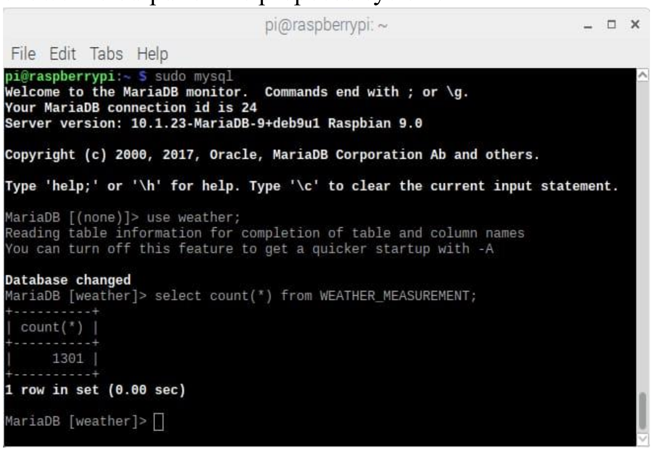


Fig. 9. Database output of proposed system

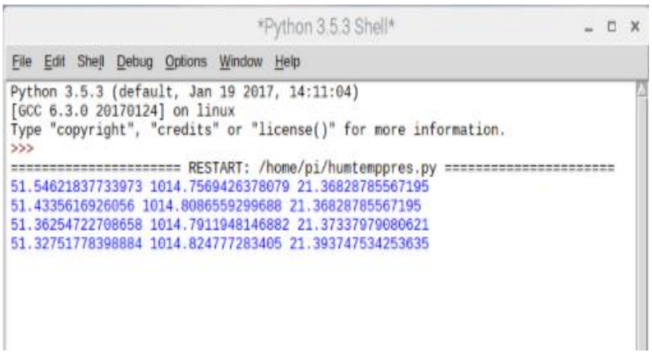
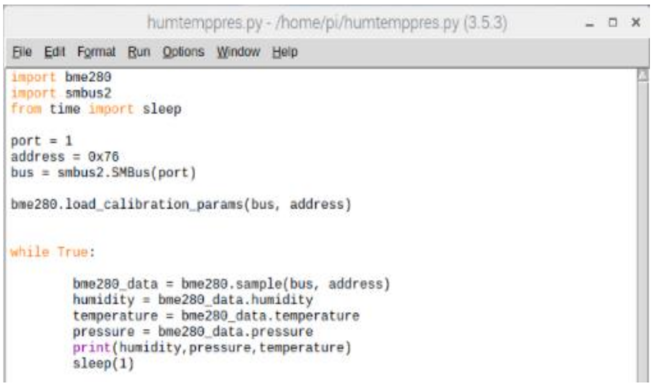


Fig. 10. Humidity, Pressure & Temperature Readings



humtemppres.py - /home/pi/humtemppres.py (3.5.3)

File Edit Format Run Options Window Help

```
import bme280
import smbus2
from time import sleep

port = 1
address = 0x76
bus = smbus2.SMBus(port)

bme280.load_calibration_params(bus, address)


while True:

        bme280_data = bme280.sample(bus, address)
        humidity = bme280_data.humidity
        temperature = bme280_data.temperature
        pressure = bme280_data.pressure
        print(humidity,pressure,temperature)
        sleep(1)
```

Fig. 11. Output of the proposed system

VII. CONCLUSION

One approach for the weather forecasting system through Wi-Fi network is presented in this research. The major goal was to employ low-cost components to create the most accurate weather monitoring system for agricultural fields. A prototype had been created by combining sensors for air temperature, air humidity, light, soil moisture, and rain detection with Raspberry PI. In order to make the information available to everyone, the sensors broadcast data to a central server. This IoT-based system monitors environmental parameters in real time. Using this method, you may keep an eye on the weather conditions such as the temperature, humidity, pressure, altitude, light intensity, and rainfall. Anywhere in the globe may access the data. With the help of this system, the client may continually monitor several environmental factors without having to communicate with a server. In fact, the Raspberry Pi itself functions as a server in this case. Using the Raspberry PI, this weather monitoring system offers low cost, compact size and low power consumption as well as quick data transfer, good performance, and remote monitoring capabilities Compared to traditional base stations (gateways), this technology is less expensive, uses less power, and is easier to use.

The system's greatest advantage is its ease of upkeep. This project involves the integration of a wireless sensor network's gateway node into a credit card-sized computer called the Raspberry Pi, which can be readily configured to function without a display or keyboard. Many environmental monitoring and data collecting applications can benefit from such a system. Data from a higher number of remote locations with precise and quick measurement will be available in the future, as will the addition of new sensors to the current planned sensor. Data visualisation and data processing may be implemented via web interfaces. By using small components and raising the scaling factor, this mini weather station may be made considerably more compact and dependable. And it's really affordable, so we can get more precise readings at a lower price point than ever before.

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