International Journal of
Satellite Remote Sensing

Volume 2, Issue 2, 2024
July–December
DOI (Journal): 10.37591/IJSRS

https://journals.stmjournals.com/ijsrs

Review IJSRS

Smart Weather Monitoring Station

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Abstract

Climate change and the environment have been inattention lately. Therefore, it is essential to track the real-time weather conditions of one location from a different one. The Internet of Things (IoT) plays a crucial role in measuring these parameters by utilizing sensor networks that cover the surrounding environment. The Internet of Things is the next miracle of the Internet that will change the lifestyle of the people. It extends connectivity far beyond just phones and computers to include virtually any device with a chip and a data interface. The Internet of Things (IoT) collects data from electronic sensors and is designed to transmit this data to the cloud for storage and analysis across various applications. This paper demonstrates real-time monitoring of temperature, humidity, and air quality using IoT on the Thing Speak cloud, incorporating temperature and pressure sensors integrated with the cloud platform. Accordingly, we have added alert system via which the alert can be received by the signed person and major accidents can be avoided. As well the live data can be viewed via a web application designed specifically which will help to know particular data of the given location at a particular time.

Keywords: Cloud platform, data analysis, embedded system, internet of things, nodeMCU, thing speak platform, web application

INTRODUCTION

The Internet of Things (IoT) refers to a network of interconnected electronic devices, mechanical and digital computers, living organisms, animals, and people, each having a unique identifier (UID) and the ability to send data without the need for human-to-human or human-to-computer interaction [1]. Examples of IoT objects include a person with a heart rate monitor implant, an animal equipped with a biochip transponder, a vehicle with sensors that alert the driver about low tire pressure, or any other object—whether natural or man-made—that can be assigned an IP address and transmit data through a network. Since IoT connects more items and correlates more details, it creates new opportunities to change companies in any sector [2]. The Internet of Things (IoT) refers to the idea of embedding electronics, Internet networking, and other types of hardware (such as sensors). These devices can connect and engage with others over the Internet, as well as be tracked and managed remotely [3]. The Internet of Things (IoT) paradigm aims to makethe Internet more determined by allowing us to track and knowcrucial changes in our environment through devices that include sensing, processing, and transferring data to the cloud, which stores and analyses the data [4]. Furthermore, the IoT enables quickaccess and connectivity with a wide variety of items, such as surveillance cameras, home appliances, tracking sensors, and soon, allowing for the growth of appliÊtions that make use of thevast amounts of data generated by such objects to provide services. This method has a wide range of applications, including mobile healthcare, home control, environmental surveillance systems, traffic

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Received Date: December 01, 2024
Accepted Date: December 05, 2024
Published Date: December 15, 2024

Citation: Mohan M. Khambalkar, Anitta N. Bhatt, Ibrahim Koicha, Priya Tandel, Mohit Gidwani. Smart Weather Monitoring Station. International Journal of Satellite Remote Sensing. 2024; 2(2): 36–44p.

management, among many others.Environmental observation is a critical IoT framework that involves tracking the surrounding environment and storing datafor effective short-term actions such as remote systemmanagement and long-term data collection and measures. The implementation specifics and findings of an environmentalsurveillance framework are presented in this article. The deviceis made up of a NodeMCU ESP8266 Wi-Fi module that interfaces with a DHT11 humidity and temperature control sensor as well as a BMP 180 pressure monitoring system on theinput side, and the sensed data is transmitted over the Internet to a remote cloud storage free IoT API ThingSpeak on the output side. Along with wireless sensor networks (WSNs) and mobile Internet, the Internet of Things (IoT) offers a promisingapproach for remote surveillance and related operations. The Internet of Things (IoT) is the product of the integration of technology such as wireless networking, the Internet, and micro electromechanical systems. The project's findings demonstrate how to measure humidity and temperature levels in real time from every place on the planet, as well as how to analyse the data. This also demonstrates the air quality of that specific area [5–8].

THEORY

Proposed System with Hardware Description

Environmental conditions in every environment are tracked, and data is sent to the cloud, most specifically, the real-time environment can be transmitted. Any environmental abnormalities can be updated in the cloud, and the situation canbe accessed by anybody using the internet. The Internet, along with evolving technology like near-field communications, real-time localization, and embedded sensors, could help us better understand and respond to our surroundings. If the environment's health deteriorates, this mechanism allows for steps to be taken.

Block Diagram of IoT System is shown in Figure 1.

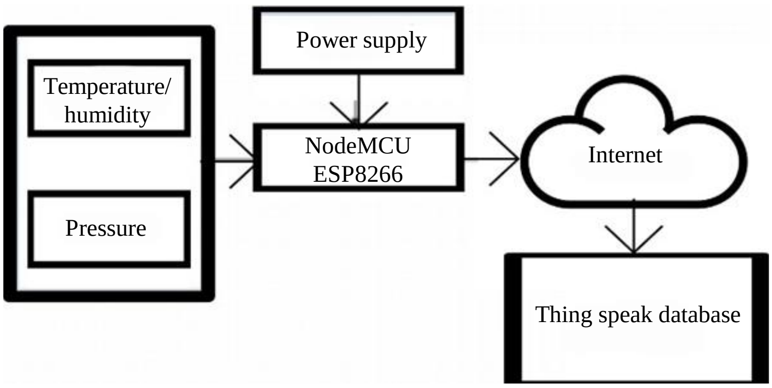

Figure 1. Block Diagram of IoT System.

The NodeMCU ESP8266 microcontroller with Wi-Fi module, temperature sensor, humidity sensor, gas sensor, and power supply source with buzzer and led indicator make up themajority of this device. Figure 1 depicts the system'sfunctionality, in which the DHT11 sends live temperature and humidity readings, as well as pressure readings, to the NodeMCU ESP8266 microcontroller with Wi-Fi module over the internet via the ThingSpeak cloud. The data collected by these sensors is deposited in the ThingSpeak database, where itis analysed and tracked [5].

NodeMCU

It is an open source Internet of Things platform that makes use of the ESP-12 hardware package and the ESP8266 Wi-Fi SoC. It is commonly used in various IoT applications and applies to firmware rather thanthe construction of kits that have access to these GPIOs of the ESP8266. It allows you to access the General Purpose Input/Output (GPIO) of the module. Its behavior can be controlled while it is operating and it can be either an input or an output pin. NodeMCU Pin Diagram is shown in Figure 2. NodeMCU is shown in Figure 2.

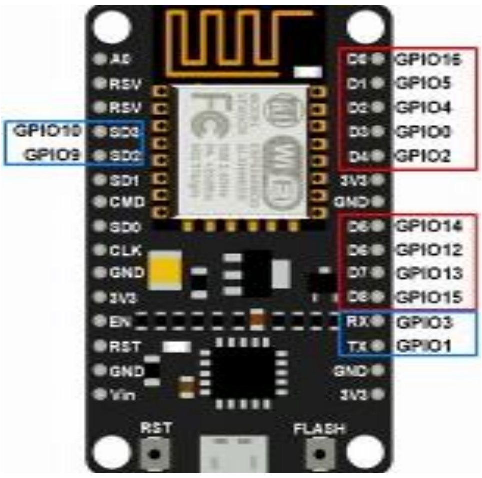

Figure 2. NodeMCU Pin Diagram.

Other SoC components, including flash memory, can be communicated with via some of the processor chip's GPIO lines. For GPIO purposes, there are about 11 GPIO pins left. Out of the 11 GPIO pins, the RX (receiver) and TX (transmitter) pins are typically set aside for communication with a host PC that is used to download compiled object code. This module is powered on, and a USB cable is used to move data from the host to the board [8, 11].


Figure 3. NodeMCU Diagram.

DHT11

It has three terminals: VCC, DATA, and GND, and its composite sensor chip gives readings for both humidity and temperature. It has a minimal footprint and is inexpensive. It also has a high level of accuracy, robust anti-interference capabilities, quick response, accurate calibration, and digital signal delivery. DHT11 Temperature Sensor is shown in Figure 4 [10].

Figure 4. DHT11 Temperature Sensor.

BMP180

It is a sensor from the BMP XXX array. All of them are designed to compute atmospheric pressure, sometimes referred to as barometric pressure. A high-precision sensor designed for commercial use is the BMP180. Barometric pressure is the weight of air applied to an object. BMP180 Pressure Sensor is shown in Figure 5.

Figure 5. BMP180 Pressure Sensor.

IMPLEMENTATION ON THE SOFTWARE SIDE

ThingSpeak Platform

Through sharing data, the Internet of Things infrastructureoffers a basic but efficient capability to interact with various types of devices and applications. Sending messages to clients connected to the network is the responsibility of IoT systems. ThingSpeak is an IoT network that collects and stores sensor data in the cloud while also developing IoT applications. Before acting, you can use the apps on the ThingSpeak IoT platform to examine and model data in MATLAB. The sensor data will be transmitted to ThingSpeak by the NodeMCU ESP8266 Wi-Fi module. This essay addresses the environmental variables like temperature, humidity, and pressure changes in a specific location utilizing the information gathered from the corresponding sensors and shown in ThingSpeak.

Cloud

It is regarded as the data's repository, and it can be accessed bycomputers with special privileges that specify the data's accessrights. In most cases, the user receives an API key, a password,and information about the computer for which it is registered. The data obtained from the devices could be accessed using these API keys and the password that the user has set up by using the user's Wi-Fi hotspot [9].

Devices

They serve as cameras, tracking and sending data to the cloud for a variety of purposes. The DHT11 composite sensor (for temperature and humidity) and the BMP180 pressure sensor were used in this paper. Block Diagram of Cloud Platform is shown in Figure 6. Dashboard of ThingSpeak Channel is shown in Figure 7.

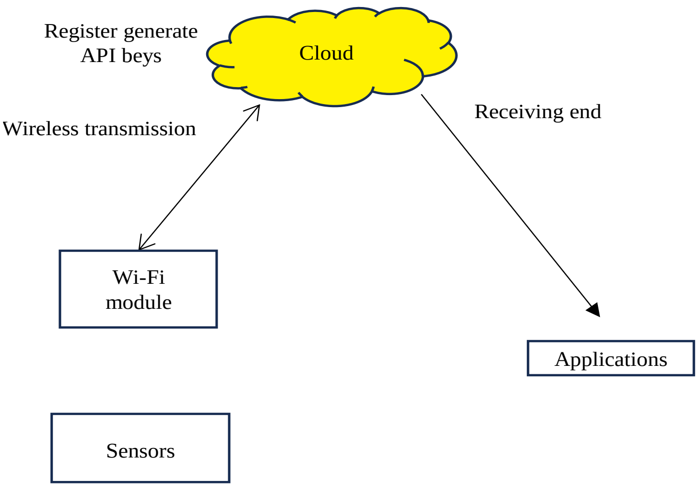

Figure 6. Block diagram of cloud platform.

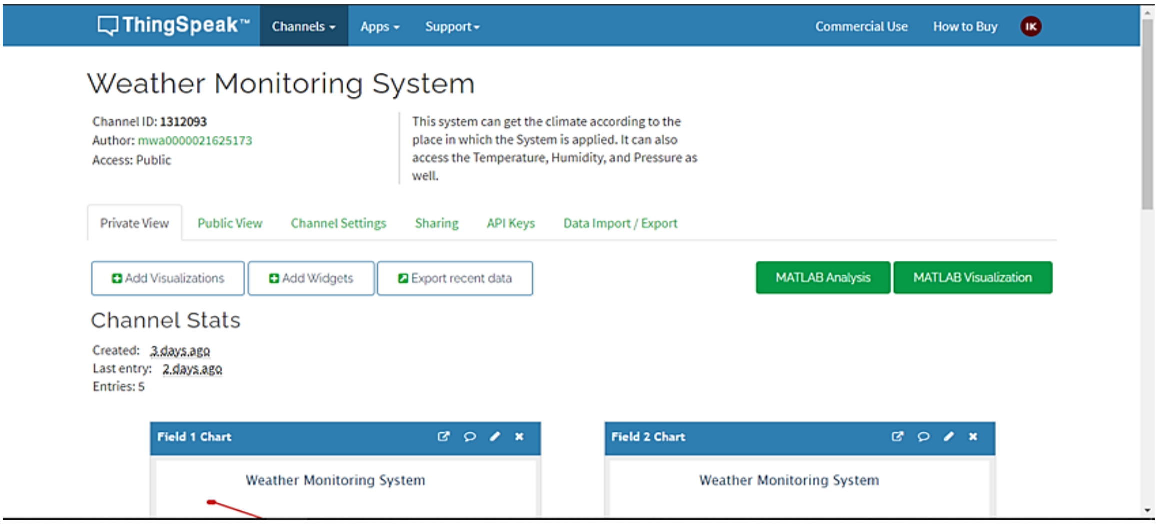

Figure 7. Dashboard of ThingSpeak Channel.

Arduino IDE

The Arduino IDE was used to programme the data collected from the sensors, which was then sent to the server. Since independently checking the hardware modules, they were combined aboard. To begin, the Wi-Fi module was configuredby sending commands. We wired the ESP8266 Wi-Fi module after initialization. Finally, we developed software that reads sensor data from the DHT11 and BMP180 and displays temperature, humidity, and pressure readings in real time. We use ThingSpeak's IoT analytics service to aggregate, visualise,and interpret live data after sensor data is submitted to the cloud.

The Wi-Fi module uses its allocated IP to transfer data to the cloud.

Webhooks Server

One way web apps can communicate with one another is using webhooks. If a certain occurrence happens, it helps you to send real-time data from one programme to another. In this casesituation, we've set some parameters for the readings we'll get from the sensors that Thingspeak Channel will add. If the temperature, pressure, or humidity limit exceeds the discussed threshold, the device will send warnings to the signed individual based on the data collected. Alerts may be sent to thesigned person by email, voice over internet protocol, or even text message. As soon as he receives the alert he can take the appropriate steps needed to control the process. Also while farming this process can be performed as we can know when the crops can be performed and efforts can be minimized so thatwe can obtain optimized outputs.

Figure 8. Dashboard of Webhooks Server.

Dashboard of ThingSpeak Channel is shown in Figure 8.

MATLAB

The key goal of the method we're proposing is to make Matlabvisual analytic connections easier. To accomplish this, we impose semantic objects that allow any entity to communicate with one another. The following subsections cover the system'slayout and user experience, as well as the theory of entity linking, which is the paper's main contribution, and implementation information. The graphs obtained from thesensors can be adjusted, solidified, and smoothed to meet the individual's needs. To make the data more visually appealing, we will develop a number of visualizations.

Google Firebase

The website provides information about the framework,including how to view the graphs and plotting of the embeddedThingSpeak web channel. This website was hosted and made available online using Google Firebase. Google's Firebase software allows developers to create smartphone and web apps. In 2011, it began as a separate company. The platform was acquired by Google in 2014, and it is currently their primary software development tool. Dashboard of Website Is shown in Figure 9.

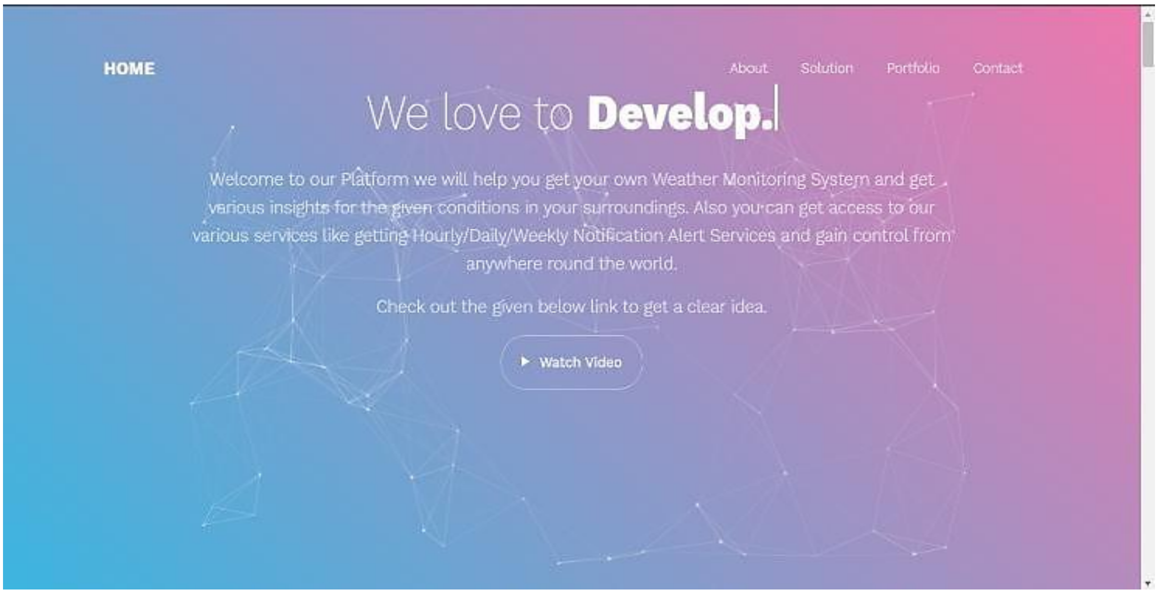

Figure 9. Dashboard of Website [7].

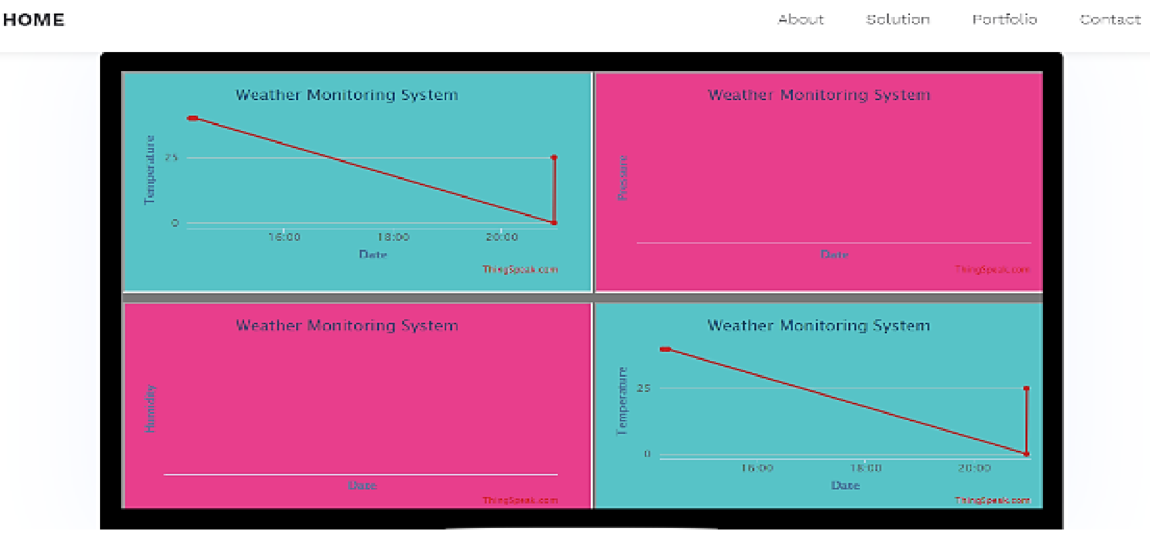

Figure 10. ThingSpeak Platform Plotting on the website [7].

Execution Side

The sensors are attached to the NodeMCU board, which is operated by a USB cable. These sensors provide data to the wifimodule, which is operated by a transformer. The USB cable provides both power and data transmission from the device. Wehave set the default value in software programming, and when the temperature reaches that value, an alarm is sent to the designated user, and that person is notified of the alert. ThingSpeak Platform Plotting on the is shown in Figure 10. Hardware Photo of our prototype is shown in Figure 11.

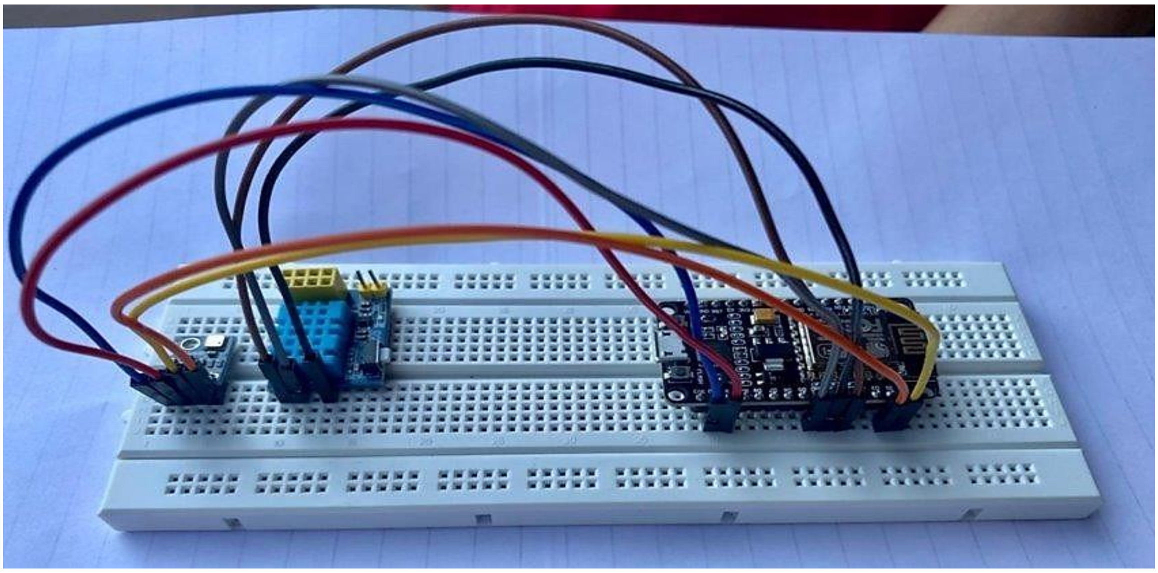

Figure 11. Hardware Photo of our prototype.

Simulation Results

Following the detection of data from various sensor instruments located in a specific region of interest. When a proper communication with the host computer is detected, the sensed data will be immediately transmitted to the web server. We would be able to track and manage the device using the web server tab. We can get the same results by entering the appropriate webpage of the respective server that is being monitored.

Monitoring system is placed. So, this model can be placed anywhere we want to measure the humidity, temperature as well as level of Pressure concentration in a given area.

Scope And Application

In the agricultural industry, weather forecasting is crucial. Additionally, it is beneficial in areas like jungles and volcanoes. A human being finds it very difficult to remain in such locations for an extended period of time. As a worldwide feature of this system, a few more sensors might be added and connected to the satellite. Additional sensors, such as CO2 and oxygen sensors, are being added to monitor various environmental conditions. This real-time technology has a wide range of applications in the military, aviation, and navigation. In order to improve precautionary alarms, it can also be used in hospitals or other medical facilities for research and studies on the "Effect of Weather on Health and Diseases."

Limitation

While deploying the sensors in the environment various factorshave to be taken care of. Maintenance becomes a big part considering if any of the system faces some issues maybe thenthere is a greater risk considering the amount of accuracy we get from the system. High Accurate sensors with good maintenance should be used in case of system with a greater use. Also, while determining the factors of weather at a particular place maybe, we need more factors like AQI, Amount of Oxygen in the atmosphere etc. as well so we can predict theoverall climate with a better precision. In the future scope of this project, we are wishing to add new sensor and more analytical techniques to get proper results. Also, if we can get the quality of soil in the given area we can use that data to analyse proper farming techniques for the given soil.

CONCLUSION

Self-protection (also known as a smart environment) is made possible by maintaining the embedded devices in the surroundings for monitoring. In order to accomplish this, sensor devices must be placed throughout the environment to gather and analyze data. We can bring the environment to life by placing sensor devices throughout it; that is, by allowing them to communicate with other objects over a network. The end user will then have access to the gathered data and analysis findings via Wi-Fi. In this research, many models of an intelligent approach to environmental monitoring and an economical embedded system are given. The functions of several modules were explored in the suggested architecture. Two factors were experimentally investigated in the Internet of Things (IoT)-based noise and air pollution monitoring system. Additionally, it uploaded the sensor's settings to Google Spreadsheets, a cloud computing platform. Future analysis will benefit from this data, which is also easily shared with other end users. This algorithm can be further developed to track pollution in industrial areas and emerging cities. This concept offers a cost-effective way to continuously monitor the environment in order to safeguard public health from pollution.

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