A Reference Book on

Emerging Trends in Science and Technology

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IoT Enabled Weather Monitoring System Using Raspberry Pi

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Abstract

Weather conditions have great impact on human daily life, making continuous monitoring of weather parameters is very essential for informed decision-making. This paper presents implementation of IoT based weather monitoring system using Raspberry pi aimed at data acquisition system and data analysis. The system integrates different sensors such as DHT11 for temperature, humidity measurement, LDR for light intensity measurement and rain sensor for rain detection. Sensor data is processed by the Raspberry Pi and transmitted to the ThingSpeak cloud platform, enabling remote access, visualization, and analysis. The proposed system offers potential applications in agriculture, disaster management, and environmental research.

Keywords: Raspberry Pi, IoT, ThingSpeak, DHT11, LDR

1. Introduction

Real-time data collection and monitoring of weather parameters play a critical role in various aspects of human life. Accurate weather monitoring and forecasting have significant applications in disaster management, agriculture, transportation, industrial operations, energy management, healthcare, and environmental protection. The integration of Internet of Things (IoT) technologies into environmental monitoring systems has gained significance in recent years. Suvinraj S et.al has been developed Arduino based weather monitoring system that measures temperature and humidity and sent to the smartphone via Bluetooth [1]. Hashmi et al. designed a weather monitoring system based on IoT technology, centred on the Arduino Uno. The setup features sensors for temperature, humidity, soil moisture, and rainfall, all connected to the Arduino to enable real-time data collection. In order to monitor weather parameters on mobile application through internet it requires external Wi-Fi module. Arduino Uno doesn't have Wi-Fi feature [2]. P.Susmitha et al. has been monitors gas and humidity using Arm microcontroller LPC1768.Data from sensors recorded in excel sheet and sent to mobile as a SMS by using GSM Module [3]. Poonam et.al monitors temperature and humidity parameters using Temperature sensor LM 35 and humidity sensor SY-HS220[4].

Various studies have explored the use of low-cost microcontrollers and single-board computers, such as the Raspberry Pi, in the development of weather monitoring systems. These systems aim to collect, transmit and analyze weather-related data in real time for a variety of applications.

This paper presents the design and implementation of an IoT-enabled Weather Monitoring System utilizing a Raspberry Pi as the core processing unit. The proposed system is equipped to measure essential atmospheric parameters including temperature, humidity, light intensity and rainfall through integrated sensors. Data acquisition, processing and transmission are managed by the Raspberry Pi, which interfaces with the cloud platform ThingSpeak.com via HTTP protocol to enable real-time data access and visualization. The system is developed using the Thonny Python IDE, ensuring seamless software integration and ease of deployment. By leveraging Internet of Things (IoT) technology, the system supports automated, continuous monitoring with remote accessibility, enhancing the reliability and timeliness of weather-related data. The paper details the architecture, components, and performance of the system, highlighting its potential to support environmental monitoring and remotely accessible weather information.

2. Experimental Details

Experimental details include Architecture model, system components and system flowchart.

2.1 Architecture model

Figure 1 provides a visual representation of the proposed system's architecture. It features a sensor node built using a single-board computer, specifically the Raspberry Pi 3B+. This sensor node is connected to the ThingSpeak cloud database and client devices for monitoring purposes. Clients can view and track real-time data by logging into the associated ThingSpeak channel.

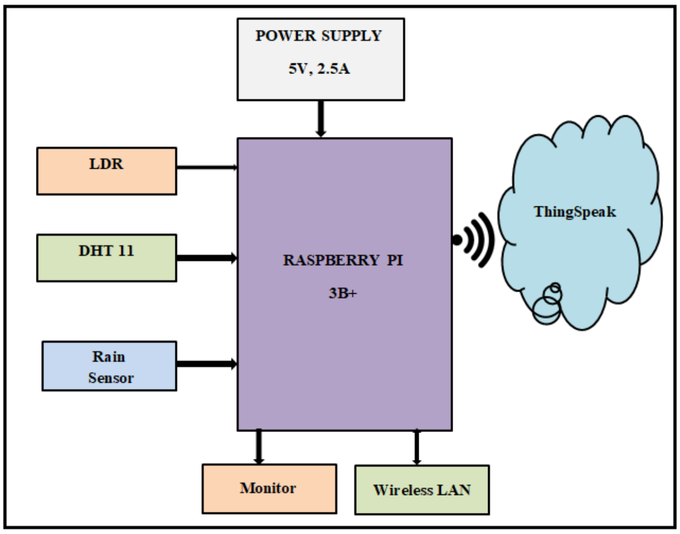

Fig. 1: Architecture Model

2.2. System Components

a) Processing Unit

The Raspberry Pi 3B+ is a compact, credit card-sized board powered by a Broadcom BCM2837B0 processor with ARM Cortex-A53 architecture, running a Linux OS. It requires a 5V/2.5A DC supply via micro-USB and offers four USB ports, Gigabit Ethernet (over USB 2.0), and HDMI for display. Wireless connectivity includes dual-band Wi-Fi (2.4GHz/5GHz), Bluetooth 4.2, and BLE. It features 1GB LPDDR2 SDRAM, a Micro SD slot for OS storage, and 40 GPIO pins for interfacing. Figure 2 displays Raspberry Pi 3B+ Module [5].

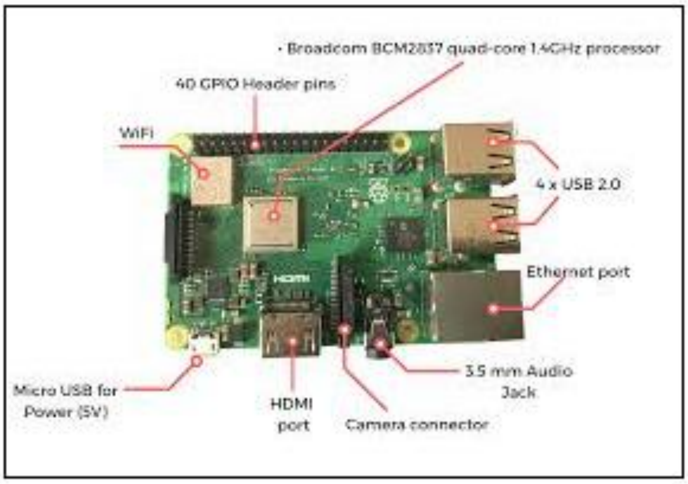

Fig. 2: Raspberry Pi 3B+ Module

b) DHT11

The DHT11 is a compact temperature and humidity sensor connected to the Raspberry Pi via GPIO pin 4. Figure 3 shows DHT11 Pin configuration. It delivers calibrated digital output, eliminating the need for an analog-to-digital converter (ADC). Encased in a 4-pin single-row package, it operates on a 3.5V to 5.5V power supply and uses a single-wire serial interface for communication. The sensor measures temperature in degrees Celsius (0°C to 50°C) with ±2°C accuracy and relative humidity (20% to 95%) with ±5% precision. With low power consumption and a signal range of up to 20 meters, it is well-suited for a variety of IoT applications [6].

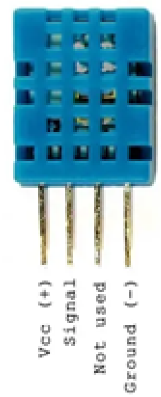

Fig.e 3: DHT11

c) Light Dependent Resistor (LDR)

The LDR module, connected to GPIO pin 16 of the Raspberry Pi, operates on the photo resistive principle. LDR pin configuration is displayed in Figure 4. The LDR (Light Dependent Resistor) exhibits lower resistance as light intensity increases and higher resistance in low-light conditions. It functions as a switch by modifying the GPIO input state from HIGH to LOW in response to changes in ambient light levels. When there is darkness the output of LDR is high when light intensity is fall on the LDR surface its output is low [7].

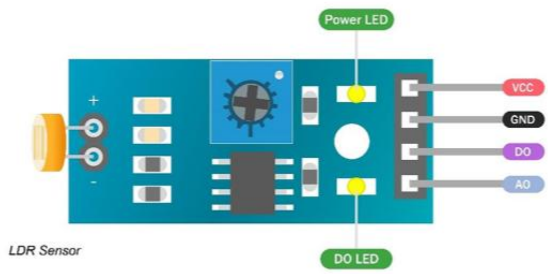

Fig. 4: LDR Module

d) Rain Sensor

The rain sensor, connected to GPIO pin 17 of the Raspberry Pi, detects rainfall based on electrical conductivity. Figure 5 a) and b) exhibit Rain sensor module. It features metal traces arranged in a grid; when rainwater bridges the traces, it creates a conductive path, allowing current to flow. The Raspberry Pi detects this voltage change to determine the presence of rain. When rainfall occurs, the sensor produces a low output voltage.

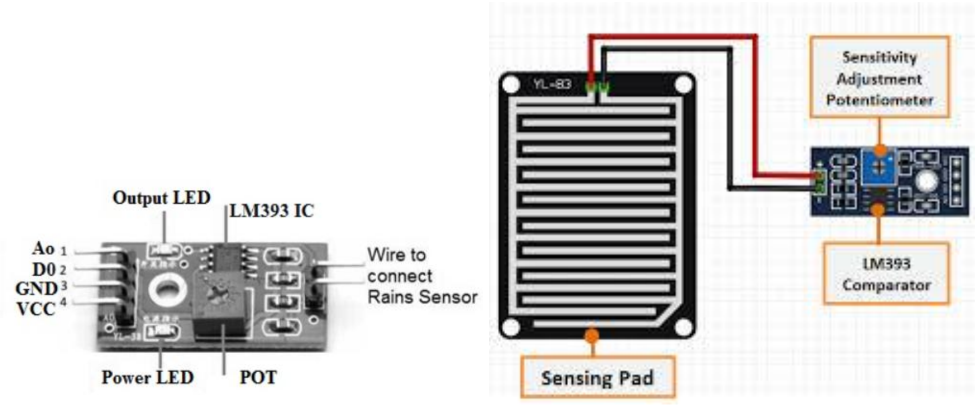

Fig. 5 a) Pin Configuration b) sensor view

e) Raspbian

Raspbian OS is a Linux-based operating system tailored for Raspberry Pi devices, optimized for seamless performance on their unique hardware architecture. Built on Debian, Raspbian offers a lightweight yet feature-rich desktop environment, making it well-suited for educational purposes, prototyping, and IoT projects. It comes pre-installed with various development tools, including the Python language and the Thonny IDE, providing an accessible platform for programming. Additionally, Raspbian supports a broad range of peripherals and libraries, allowing for easy integration with sensors and hardware modules.

2.3. System Flowchart

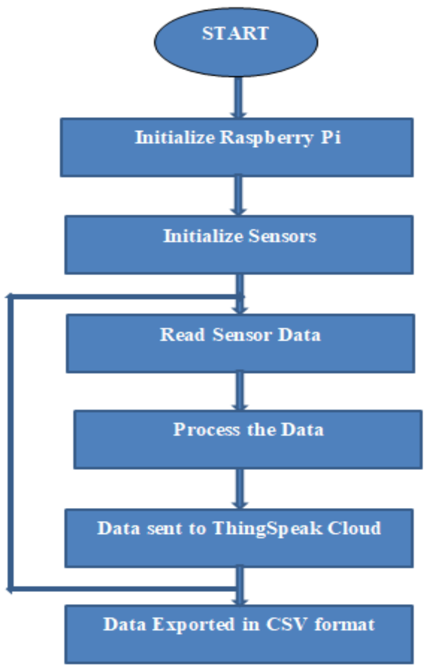

Fig. 6: Flow Chart

3. Results and Discussion

In the IoT-enabled weather monitoring system, the Raspberry Pi 3B+ functions as the data acquisition unit and transmits the collected data to the cloud. It gathers real-time information from temperature, humidity, light intensity, and rainwater sensors, which is then sent to the ThingSpeak platform using the HTTP protocol. The built-in Wi-Fi capability of the Raspberry Pi is utilized for wireless data transmission.

On ThingSpeak, a dedicated channel named Weather Monitoring is created to visualize the data. This channel includes four fields: Field 1 displays temperature in degrees Celsius, Field 2 shows humidity in percentage, Field 3 represents light intensity (ldr_state), and Field 4 indicates the presence of rainwater (reinstate). The collected data is presented in graphical format for easy monitoring and analysis, and can be accessed remotely from anywhere. Figure 7 displays picture of overall system implemented.

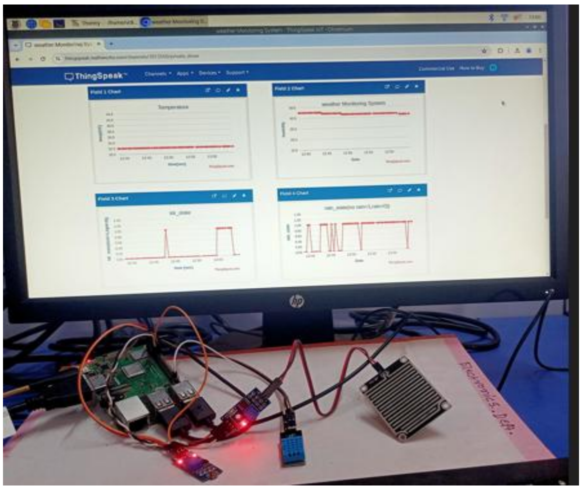

Fig. 7: Overall System Implemented

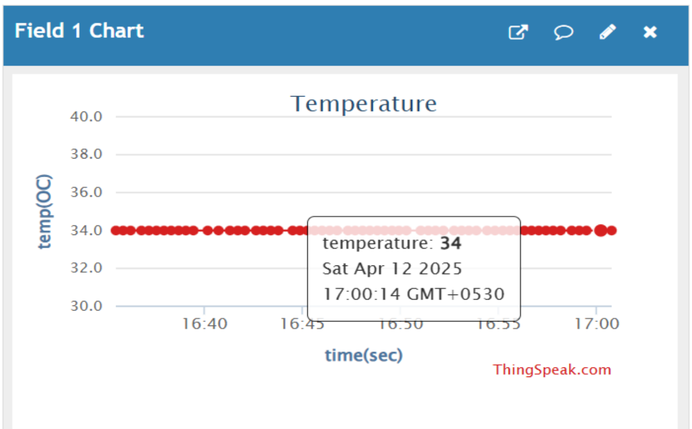

Fig. 8: Real time graph of Temperature in ^{0}C

The Figure 8 displays temperature readings over time using data collected from a sensor, with values consistently around 34°C. It shows real-time monitoring through ThingSpeak. The chart in Figure 9 illustrates variations in humidity (%) levels over time, gradually rising to 40%. It provides real time tracking of humidity levels through the ThingSpeak platform.

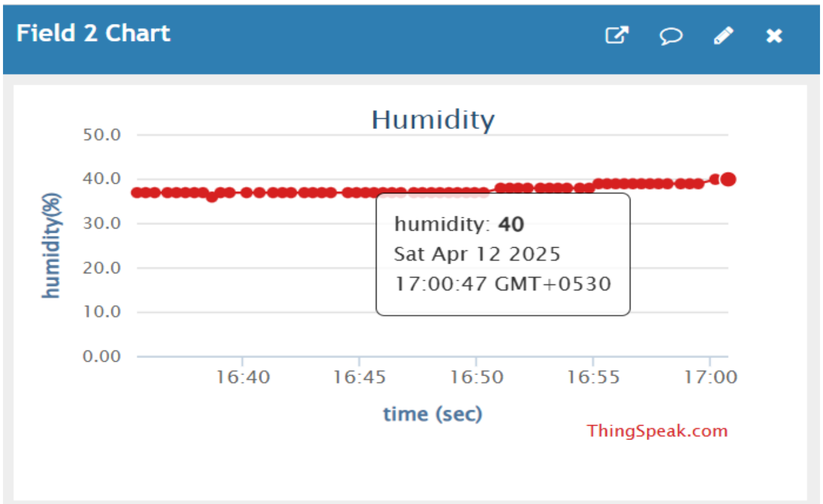

Fig. 9: Real time Humidity in (%)

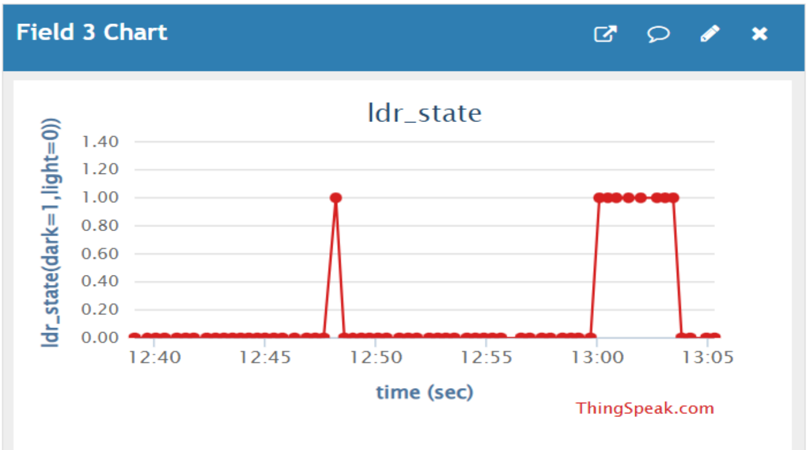

Fig.10: Light Intensity Detection Graph

The Figure 10 illustrate the LDR (Light Dependent Resistor) state across different time intervals, where '1' indicates darkness and '0' represents light, captured by the sensor and transmitted through ThingSpeak.

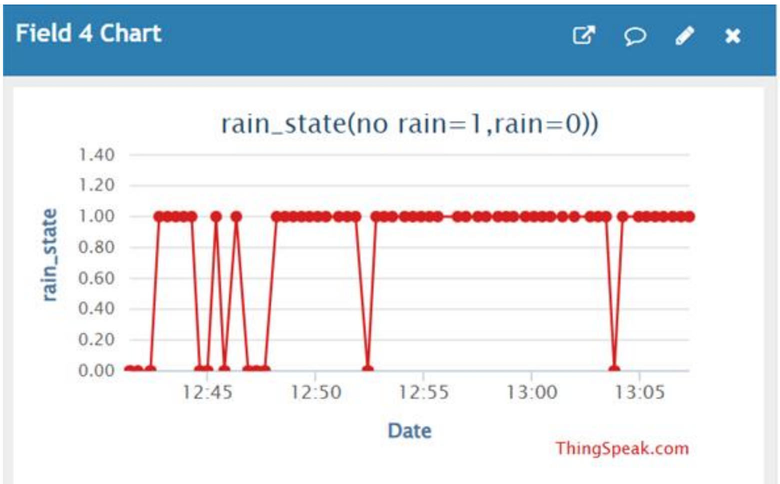

Fig. 11: Rainfall Detection Graph

The Figure 11 displays the rain state readings at various times, where '1' indicates no rain and '0' indicates rain detected, as monitored in real time via ThingSpeak.

4. Conclusions

The IoT-based weather monitoring system developed using a Raspberry Pi offers a cost-effective, efficient, and scalable solution for real-time environmental data collection and analysis. By integrating essential sensors such as DHT11, LDR, and a rain sensor, the system effectively captures key weather parameters including temperature, humidity, light intensity, and rainfall. The use of the ThingSpeak cloud platform enables remote monitoring, data visualization, and analysis, which is crucial for informed decision-making in fields such as agriculture, disaster management and environmental research. The implementation demonstrates the practical benefits of IoT technology to enhance the accuracy, reliability and accessibility of weather information. Future enhancements may include the integration of additional sensors node, predictive analytics and mobile applications to further broaden the system's applicability and user engagement.

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