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Raspberry Pi based IOT Weather Station

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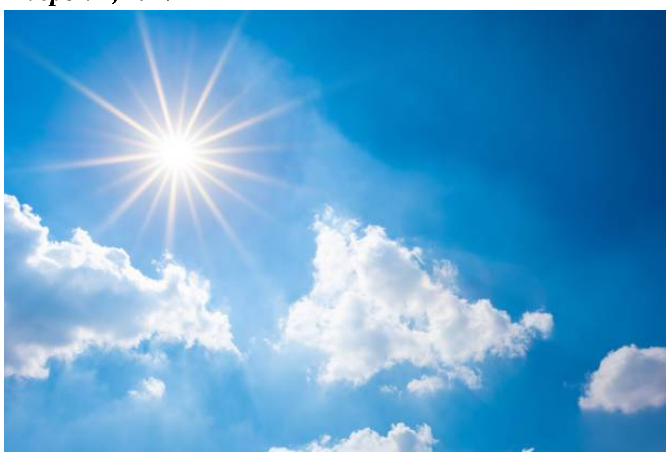
Abstract: This paper presents a real-time system for monitoring and updating weather conditions online. The system tracks three key parameters: temperature, humidity, and rainfall. These values are displayed on an LCD screen and stored in a database. When the area is dry, the rainfall reading shows zero. If raindrops are detected, the rainfall value updates accordingly. As the temperature changes, it also reflects on the display. Users can check the weather status of a specific area from anywhere. We use an ARM-based Raspberry Pi 3 board, running the Raspbian operating system with a Linux kernel. The programming is done in Python, which is supported by the IDLE environment. This system provides users with a clear understanding of local weather conditions, making it a valuable tool for monitoring the climate in a specific area.
Keywords: Raspberry Pi 3, Sensors, Raspbian, IoT.



I. INTRODUCTION

Weather is influenced by many factors and, in turn, affects both living and non-living things. Weather stations use various instruments to study environmental parameters. The data gathered is valuable not only for government and non-government organizations but also for fields like agriculture, transportation, and construction. Additionally, weather forecasting systems can serve educational purposes. However, for this data to be useful, it must be transmitted quickly and accurately to users. Effective data transmission is crucial, and there are several ways to achieve this, such as Wi-Fi, GSM/GPRS, satellite links, and wired connections. Reliable and precise weather forecasting is essential for all applications, ensuring that users can easily access all measured parameters. The quality of sensors and the location of weather stations can greatly impact the accuracy of weather data. Typically, users have limited options based on what manufacturers provide. If even a slight change in monitoring or processing occurs, commercial devices may become unsuitable. Some applications require more flexible and customizable solutions, while commercial devices can often be too expensive. To address these challenges, we designed a low-cost, portable, real-time weather station using a Raspberry Pi 3. Our system measures key environmental parameters like temperature, humidity, and rainfall. We utilize various modules—like GSM, Zigbee, and Ethernet—along with an ADC and microcontroller to enhance our monitoring capabilities. The Raspberry Pi 3 is well-suited for managing these operations. Programs are written in Python using the IDLE text editor, and the output data can be viewed on IoTgecko.com. This paper discusses our weather forecasting prototype, which uses affordable components to measure air temperature, humidity, rainfall, and soil moisture. This prototype can be particularly useful in agriculture, allowing for efficient weather monitoring and data analysis. The Internet of Things (IoT) connects physical devices—such as sensors and actuators—enabling them to collect and exchange data over networks. IoT enhances efficiency and accuracy while reducing the need for manual labor. It facilitates interaction between devices and supports complex structures like distributed computing and applications. Today, many IoT frameworks focus on real-time data logging solutions, making weather monitoring even more accessible and efficient

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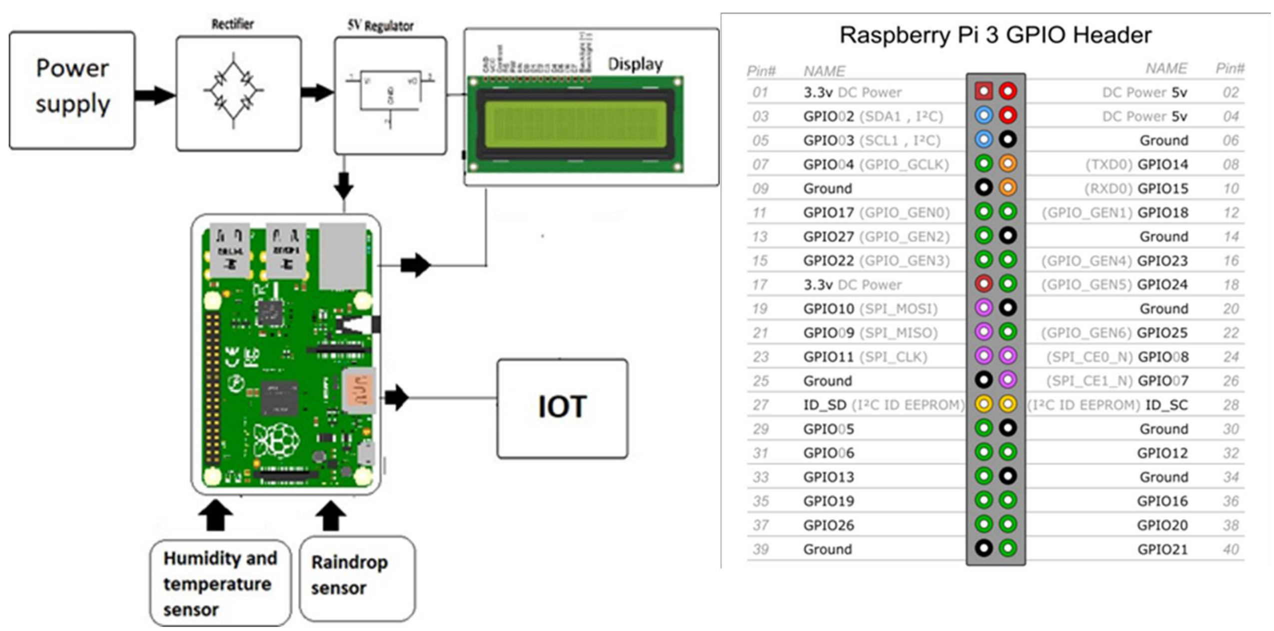
II. MATERIAL USED

1) Raspberry Pi 3
2) Temperature Sensor
3) Humidity Sensor
4) Rain Drop Sensor
5) LCD Display
6) Cables and Connectors
7) IC Sockets
8) Software : Python
9) OS : Linux

III. PROPOSED SYSTEM

The proposed system is a Raspberry Pi-based weather station designed to monitor and report various environmental parameters in real-time. The system aims to provide accurate data for temperature, humidity, atmospheric pressure, light intensity, rainfall, and soil moisture, making it a valuable tool for both personal use and agricultural applications.

A. Visualisation



B. Detailed Working Of Block Diagram

This IoT-based weather monitoring system is built using the versatile Raspberry Pi board, which helps reduce the need for additional hardware like external microcontrollers and ADCs. The system features a Temperature and Humidity Sensor (DHT11) and a Rain Water Level Sensor designed with a marked scale and ULN2803. All sensors connect directly to the GPIO header of the Raspberry Pi.

For real-time data monitoring, the system utilizes an Ethernet network. It tracks three key parameters: temperature, humidity, and rainfall. These readings are displayed on an LCD screen and updated on IoT Gecko, providing users with a clear view of local weather conditions.

The setup includes a raindrop sensor, a temperature sensor, an LCD, and a buzzer. Once powered on, the system connects to the internet via Wi-Fi. It continuously monitors the three parameters, displaying zero rainfall when the area is dry. If raindrops are detected, the rainfall measurement updates accordingly, and temperature changes are reflected in real-time.

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Users can access the weather status of a specific area from anywhere, making this system a practical tool for local weather monitoring.

C. Raspberry PI 3 (Model B)

The Raspberry Pi 3 is an affordable, credit-card-sized computer that easily connects to a monitor or TV and works with a standard keyboard and mouse. It's a great tool for anyone interested in exploring computing and learning to program in languages like Scratch and Python.

Released in February 2016, the Raspberry Pi 3 is the third generation of the Raspberry Pi series, succeeding the Raspberry Pi 2 Model B. It features several upgrades:

1.2GHz 64-bit quad-core ARMv8 CPU: Delivers better performance for various tasks.

802.11n Wireless LAN: Allows for easy wireless internet access.

Bluetooth 4.1: Connects to Bluetooth devices for added functionality.

Bluetooth Low Energy (BLE): Supports energy-efficient connections with other devices.

The Raspberry Pi 3 maintains the same size and shape as its predecessors (Raspberry Pi 2 and Pi 1 Model B+), ensuring full compatibility with existing accessories. This makes it a versatile option for a wide range of projects, from simple computing to advanced IoT applications.

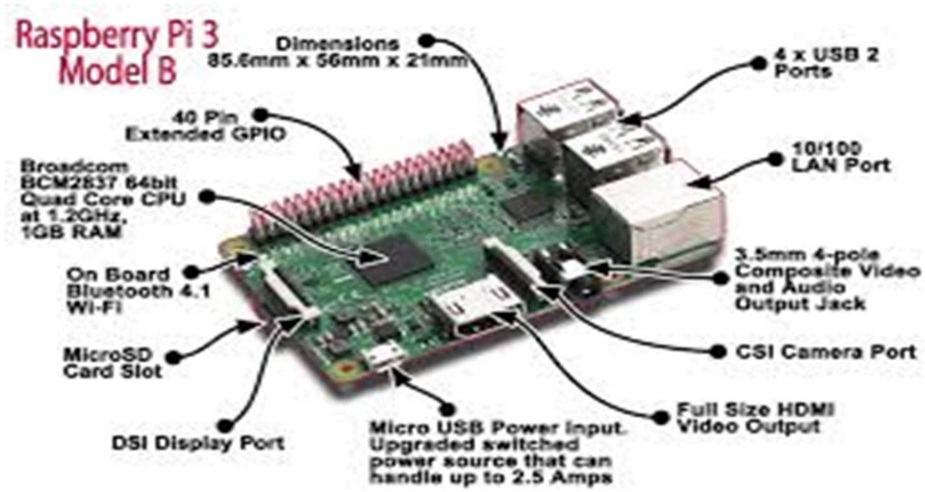

Fig. 2 Raspberry Pi 3 Module Description

D. Raspberry PI 3 Technical Specifications

SoC: Broadcom BCM2837 64-bit ARMv8 quad-core Cortex A53 processor at 1.2GHz, paired with a dual-core VideoCore IV GPU running at 400 MHz. Supports OpenGL ES 2.0, hardware-accelerated OpenVG, and can decode 1080p30 H.264 video. Offers up to 1Gpixel/s, 1.5Gtexel/s, or 24GFLOPs with advanced texture filtering and DMA support.

System Memory: 1GB LPDDR2 RAM.

Storage: Micro SD card slot for storage expansion.

Video & Audio Output: HDMI 1.4 port, along with a 4-pole stereo audio and composite video port.

1) Connectivity

10/100M Ethernet port

Wi-Fi 802.11 b/g/n (up to 150Mbps)

Bluetooth 4.1 Low Energy (BCM43438 module)

2) USB Ports

4 USB 2.0 host ports (with improved power management for higher power peripherals)

1 micro USB port for power supply.

3) Expansion Options

40-pin GPIO header

MIPI DSI for connecting a Raspberry Pi touch screen

MIPI CSI for connecting a Raspberry Pi camera.

Power Supply: 5V power supply via micro USB, with a maximum current of 2.4A.

Dimensions: 85 x 56 x 17 mm.

The Raspberry Pi 3 is a compact and powerful platform ideal for various computing projects and applications

E. Temperature and Humidity Sensor

The DHT11 sensor is a compact 4-pin device that operates on a power supply of 3.5 to 5.5V. It measures temperature from 0 to 50 °C with an accuracy of ±2°C and relative humidity from 20 to 95% with an accuracy of ±5%.

This sensor outputs fully calibrated digital data for both temperature and humidity. It uses a unique 1-wire protocol, which means it cannot communicate directly with other peripherals. Instead, the protocol needs to be integrated into the firmware of a microcontroller, requiring precise timing to ensure accurate communication.

The DHT11 is a reliable choice for basic temperature and humidity monitoring in various applications.

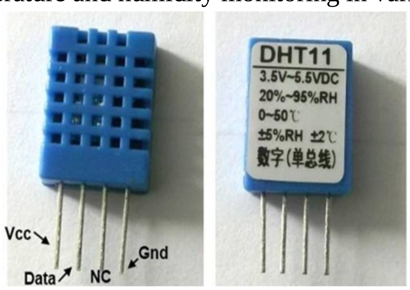

Fig3 Temperature and Humidity Sensor

F. Rain Sensor Module

The rain sensor module is a simple and effective tool for detecting rain. It functions as a switch that activates when raindrops fall on its sensing board, and it can also measure rainfall intensity.

The module consists of two parts: a rain board for sensing and a separate control board for convenience. It includes a power indicator LED and features adjustable sensitivity through a potentiometer, allowing users to customize its response to varying levels of rainfall. This makes it a versatile choice for weather monitoring projects

Fig 4 Rain Sensor

G. Specifications: Pin Configuration

04 double sided material. □ Area: 5cm x 4cm nickel plate on side, □ Anti conductivity, with long use time; □ Comparator output signal clean waveform is good, driving ability, over 15mA; □ Potentiometer adjust the sensitivity; □ Working voltage 5V; □ Output format: Digital switching output (0 and 1) and tage output AO; □ With bolt holes for easy installation; □ Small board PCB size: 3.2cm x 1.4cm; □ Uses a

H. Pin Configuration Internet of Things Components

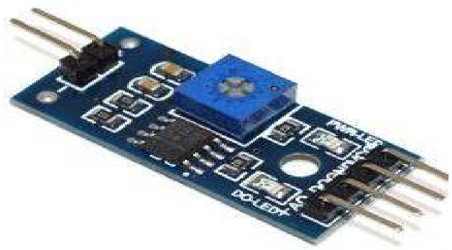

FIG 5 PIN DESCRIPTION

I. Internet of Things Components

The key components that make the Internet of Things (IoT) possible include:
Hardware: Physical devices that can respond to commands and gather data.
Software: Tools for collecting, storing, processing, and managing data.
Communication Infrastructure: Essential protocols and technologies that allow devices to exchange information.

1) Raspbian

Raspbian is a free, open-source operating system based on the Linux kernel. It is installed on an SD card and is specifically designed for Raspberry Pi.

2) Python

Python is a versatile, high-level programming language that is free to use. It is known for its simplicity, making it great for beginners. Python runs smoothly on the Linux kernel and uses IDLE (Integrated Development and Learning Environment) as its primary text editor for coding.
These components work together to create a connected and interactive environment in IoT applications

J. Advantages of The Proposed System

1) Decreased field damaging conditions
2) Improved safety and security
3) High quality receiving data
4) Less power consumption
5) High speed data rate

K. Applications

6) Industry Monitoring
7) Home Automation
8) Medical Industry
9) Agriculture

IV. CONCLUSIONS

This IoT-based system provides real-time monitoring of environmental parameters such as temperature, humidity, pressure, altitude, light intensity, and rainwater level. Users can access this data from anywhere in the world, with the Raspberry Pi serving as the server, eliminating the need for additional servers. The system operates efficiently on the Raspbian operating system and is designed to be low-cost, compact, energy-efficient, and capable of fast data transfer.
For future improvements, we can use upgraded Raspberry Pi models and add more sensors to enhance monitoring capabilities. Solar panels and wind turbines could also be integrated for remote power supply.
Future enhancements might include:

1) *Weather Prediction:* Using collected data to forecast local climate conditions over time.
2) *Compact Design:* Utilizing smaller components for a more reliable and space-efficient weather station.
3) *Alerts:* Sending immediate notifications or emails to users' mobile phones when significant changes occur.
4) *Expanded Monitoring:* Adding more sensors to track additional weather parameters.
5) *Advanced Technology:* Implementing future hardware advancements for better performance.
6) *Agricultural Use:* Including soil moisture and pH sensors to support farmers in managing crop yields.
7) *Mobile App:* Developing an app for Android and other platforms, allowing users to check data anytime, anywhere.

With these improvements, the mini weather station can become even more efficient and user-friendly, making it accessible foreveryone

V. FUTURE SCOPE

The project has significant potential for enhancement in several key areas, making it even more beneficial for users, particularly in agricultural contexts.

One promising improvement involves integrating a soil moisture sensor. This addition would allow the system to accurately measure the moisture levels in the soil, helping farmers determine when their crops genuinely need water. By using this data, farmers can avoid overwatering, which not only conserves water but also reduces the need for unnecessary fertilizers. This targeted approach can lead to healthier crops and lower environmental impact.

Additionally, incorporating a water meter could provide insights into the amount of water used for irrigation. This feature would enable farmers to track their water consumption more effectively, offering a clearer understanding of their water usage and facilitating better management practices. By analyzing this data, farmers can estimate their water costs, helping them make informed decisions that can ultimately lead to reduced expenses and increased profitability.

Together, these enhancements would not only optimize resource usage but also help in minimizing overall agricultural investment. By utilizing precise data, farmers can make smarter choices about when and how much to water their crops, leading to improved yield and cost savings.

Moreover, as technology continues to evolve, the system could be further developed to incorporate additional features such as weather forecasting capabilities, which would provide even more valuable insights into environmental conditions. This could empower farmers to plan their activities around predicted weather patterns, enhancing their efficiency and productivity.

In summary, the future scope of this project is vast. By adding soil moisture sensors and water meters, we can create a comprehensive system that supports sustainable farming practices, reduces costs, and ultimately contributes to more efficient agricultural management. These enhancements will not only benefit farmers but also promote responsible resource usage, making agriculture more sustainable for the future.

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