Scienxt Journal of Physics and Space Science
Volume-2 || Issue-1 || Jan-June || Year-2024 || pp. 10-19

IOT Research and use in weather monitoring systems

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Abstract:

The integration of diverse sensors, devices, and communication protocols is necessary for the study and implementation of Internet of Things (IoT) technology in weather monitoring systems. This permits the collection, transmission, and analysis of meteorological data. Data transfer rate, power consumption, range, and application-specific needs are just a few of the factors that can affect these systems' choice of internet protocol (IP). The use of IoT (Internet of Things) technology in weather monitoring systems has led to in notable progress in the gathering, processing, and distribution of data. The investigation and use of IoT in weather monitoring systems are discussed in this article.

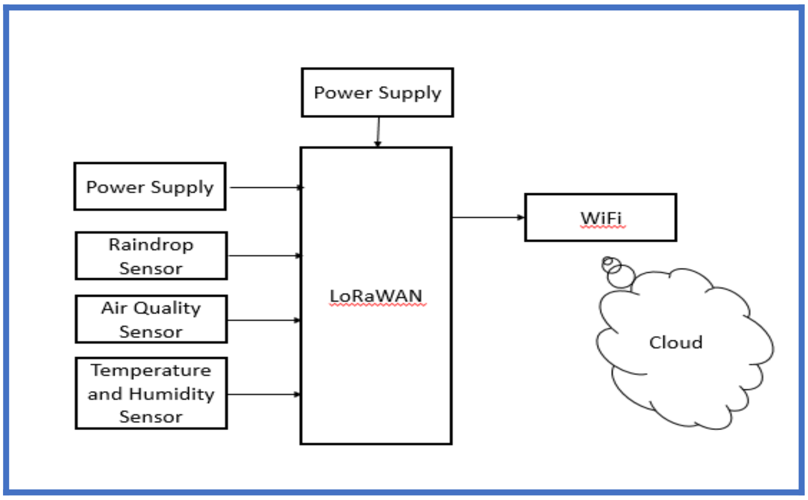
Keywords:

Sensor, Communication Protocol, MQTT, LoRaWAN, Arduino

1. Introduction:

Improved disaster preparedness, more accurate weather forecasts, and more efficient resource management in response to shifting weather conditions are all facilitated by the research and implementation of IoT in weather monitoring systems. The ongoing development of IoT technologies has increased the capabilities of weather monitoring systems, making them more dependable and adaptable to a variety of environmental challenges. To detect different meteorological characteristics, weather monitoring systems make use of an Internet of Things (IoT) sensor network. These sensors include ones that gauge sun radiation, precipitation, wind direction and speed, temperature, humidity, and atmospheric pressure. In order to record localized weather conditions, sensors are frequently dispersed throughout geographical regions. Using a variety of communication protocols, IoT-enabled weather sensors may communicate with central servers, cloud platforms, and one another. MQTT, CoAP, HTTP/HTTPS, LoRaWAN, and cellular networks are examples of common protocols. The flexible deployment of sensors in isolated or difficult-to-reach areas is made possible via wireless communication.

This technique reduces the amount of data that must be sent to centralized servers by processing data locally at the sensor level. Local processing lowers latency and improves



real-time capabilities, particularly in vital applications like severe weather monitoring. The Internet of Things frequently uses cloud platforms to handle and store weather data. Cloud computing makes it possible to have scalable storage, computational power, and accessibility. To improve forecasting and decision-making, machine learning algorithms, advanced analytics, and historical data analysis are carried out on the cloud. Internet of Things technology makes it possible to monitor meteorological conditions in real-time, giving analyst's access to the most recent data. As possible weather events develop, real-time analytics assist in spotting patterns, abnormalities, and possible threats. Web and mobile applications are among the user-friendly interfaces used to convey weather data.

Figure. 1: Weather Monitoring System using IoT

To provide more accurate forecasts, machine learning algorithms examine both historical and current meteorological data. By predicting both short- and long-term weather trends, predictive analytics enhances readiness and adaptability to changing circumstances. Critical weather events are communicated to users, authorities, or emergency services through the integration of automated alert systems into the Internet of Things weather monitoring platforms. There are several ways to send alerts, including push notifications, email, and SMS. Internet of Things (IoT)-based weather monitoring systems have the potential to integrate sustainable practices and energy-efficient designs. Using solar-powered sensors, energy-efficient parts, and low-power communication technologies all help to promote sustainability. Internet of Things (IoT) weather monitoring systems can be connected to emergency response platforms, environmental monitoring networks, and other smart city systems. Including agricultural, infrastructure management, and transportation systems improves a city's overall resilience. In a variety of difficult-to-reach locations, weather sensor administration and maintenance are made possible by remote monitoring capabilities. IoT technology makes it simpler to perform remote diagnostics, firmware updates, and troubleshooting.

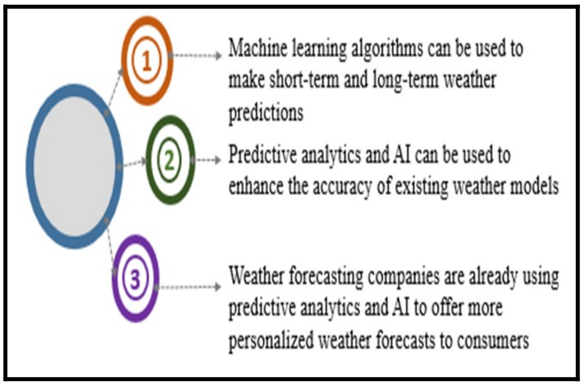


Figure. 1.2: Predictive Analytics and AI

2. Literature review:

We may gather data on temperature, humidity, and pollution using the meteorological system. We can also graphically alter the outcomes of any system by using both past and present data. After reading a lot of publications, I've found that there are currently considerably fewer that discuss having actuators to modify the lighting, humidity, and temperature levels in a small integrated system and monitoring the combination of these parameters. An actuator to be modified was not mentioned in a study report that included the monitoring of these three environmental parameters. The ultimate goal was to develop a system that could identify the primary constituents of the climate and forecast time without the need for human intervention. The majority of the weather forecasting techniques in use today are referred to as pattern recognition because they are predicated on observed event patterns. For instance, it's common to notice that the next day usually provided quite pleasant weather if the sunset was red and typical. More than and generations come together through this encounter to create the custom of the day. However not all of these forecasts are accurate, and several of them have since failed to hold up to thorough statistical analysis. Persistence is the simplest approach to time prediction, yet it relies on the state of affairs today to forecast tomorrow. In stationary states, like the tropical summer, this can be a useful method of weather prediction.

3. Communication protocol:

Network functionality depends heavily on communication protocols. Without them, computer networks would not be conceivable because of their extreme importance. The guidelines and formats for data transfer are clearly defined by these protocols. Syntax, error detection, semantics, synchronization, and authentication have been all handled by these protocols.

3.1. Message queuing telemetry transport, or MQTT:

Is an effective and lightweight protocol for device-to-device communication? Its low bandwidth consumption and adaptability to low-power, unstable network conditions make it a popular choice for Internet of Things applications. MQTT is frequently used to transfer meteorological data from sensors to a cloud platform or central server.

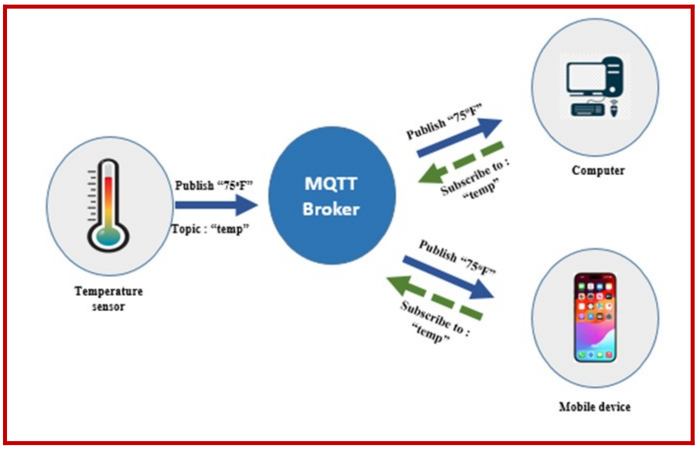


Figure. 1.3: MQTT (message queuing telemetry transport protocol) architecture

3.2 Constrained application protocol, or CoAP:

This protocol is appropriate for Internet of Things applications since it is made for networks and devices with limited resources. It is frequently employed in situations where effective communication and minimal power consumption are crucial. CoAP can be used to gather and send meteorological data from sensors to a cloud or central server

3.3 HTTP/HTTPS (Hypertext transfer protocol/secure):

Despite being a standard protocol for web communication, HTTP's overhead may make it less appropriate for IoT devices with limited resources. However, HTTPS (HTTP over TLS/SSL) may be used for transmitting weather data in some circumstances where greater data transfer rates are acceptable and security is a top concern.

3.4 LoRaWAN (Long range wide area network):

It is an LPWAN (Low-Power Wide-Area Protocol Network) that may be used for long-range communication. Weather monitoring stations in remote places are examples of IoT applications that frequently employ LoRaWAN.

3.5 Narrowband internet of things (NB-IoT):

This cellular communication standard is intended for lower-power, wider-area IoT applications. In situations where cellular connectivity is preferred, it can be used to send weather data.

3.6 Sigfox:

Sigfox is an unlicensed spectrum-based proprietary LPWAN technology. It can be used in some applications for weather monitoring and is appropriate for sending small amounts of data across vast distances. The precise needs of the weather monitoring system, which include variables like data volume, power consumption, communication range, and infrastructure availability, determine which internet protocol is best. In many instances, a weather monitoring system will employ a mix of protocols to maximize various communication facets.

4. Arduino uno:

Arduino is the company that created the Arduino Uno microcontroller board. It has been an open-source electronics platform primarily on the bsis of microcontroller Atmega328 AVR. 6-analog input pins, 14-I/O digital ports,and an interface of USB are features of the latest Arduino Uno model, which can be used to connect to external electronic circuits. PWM output is possible on 6 of the 14 I/O ports. It permits the designers to control along with the sense external electronic components of a real world. This board could be directly associated to a computer via a cable of USB and contains all the functionality required to operate the controller. The code has been transferred to the controller via the Arduino IDE software, which has been primarily used for programming Arduino. Programming languages such as C & C++ have been utilized in IDEs. The board could be powered by an AC to DC adapter or a battery to USB. The 8-bit AVR Atmel microprocessor in the Uno, the most recent official version of Arduino, has 32KB of RAM.

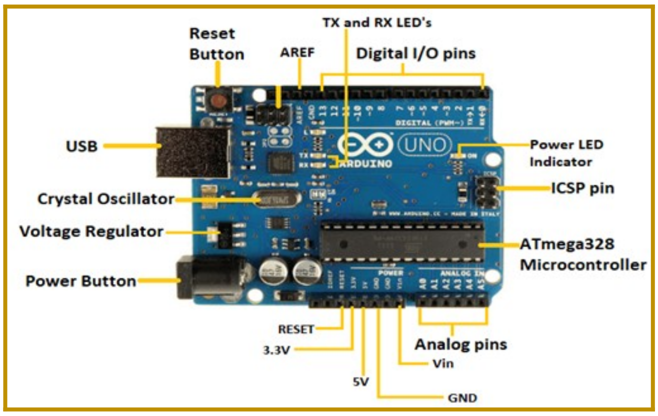


Figure. 1.4: Arduino UNO Board

5. Software requirements:

5.1. Arduino IDE:

An application for writing code for Arduino microcontroller boards is the Arduino IDE (Integrated Development Environment). This programmer facilitates the writing, assembling, and uploading of code to an Arduino board.

These are some of the Arduino IDE's most significant uses:

5.1.1. Code development:

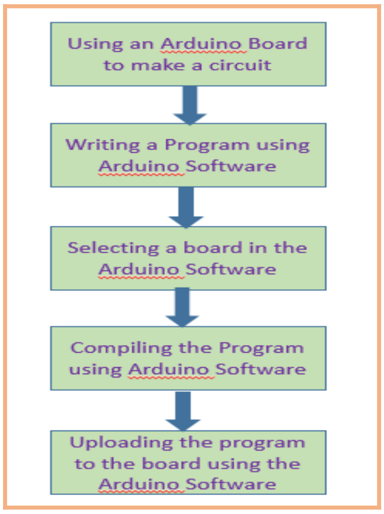
An easy-to-use code editor for writing, editing, and debugging Arduino programming language code is included with the Arduino IDE. Numerous built-in libraries for managing sensors, motors, and other Arduino board-connected devices are available in the IDE.

5.1.2. Hardware configuration:

The IDE allows you to adjust the board's parameters, including board type, serial port, and baud rate. By doing this, you can make sure the board is set up correctly for the current project.

5.1.3. Compilation:

The Arduino IDE compiles and verifies the code before uploading it to the Arduino board. This guarantees that there are no errors in the code and that it will work as intended. Upload: The compiled code can be uploaded to the Arduino board via the Arduino IDE. We call this "flashing the board." You can monitor and debug code in real-time by using the serial port that the IDE and the board can communicate via. An IOT platform that allows you to interface various devices and allow them to communicate real-time data was launched by the Arduino community. In addition, a straightforward interface will enable you to monitor and



manage data from any location.

Figure. 1.5: Steps to Involve Arduino board via the ArduinoIDE

6. Conclusion:

The project's primary aim is to compile the climatic parameters. The system integrated various sensors, including rain, CO2, pressure, temperature, and humidity. The outcomes aid in the collection of weather conditions, which improves our ability to forecast the weather. One benefit of this project is that it uses less power and is inexpensive. The project's scope is narrowly focused; it will be useful to monitor the climate and be installable anywhere. We can easily add new components to the system and make changes because it is inexpensive. The system keeps track of the local climate every day to assist users in choosing the best place to live and maintain good health. Agriculture and farmers worldwide will be greatly impacted by this. This technology will support persons in working appropriately by monitoring the state of a specific area. Imagine a farmer who wishes to plant a tree or crop that can only thrive under specific circumstances. With this device, he may thus view several parameters from any location, including temperature, humidity, and wind direction. This system will only require one installation by him; after that, it will operate on its own.

7. Future applications:

It is possible to obtain data about a specific location by integrating additional sensors, such as soil moisture, gas, and pressure measuring devices, with the current system.

- A moisture sensor allows us to monitor the presence of water in plants or fields, providing information that triggers an automatic pump turn-on or off.
- By adding a gas sensor that will provide information on the toxicity level of the gases existing in that specific location and our surroundings, we may utilize this system to monitor pollution. It is possible to use solar energy to power the device.

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