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# Iot Based Weather Monitoring System Using Arduino Uno

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**Abstract:** *The paper introduces an innovative system that utilizes the Internet of Things (IoT) to provide an enhanced approach for reporting weather conditions at a specific location and making this information accessible globally. The IoT technology serves as the underlying mechanism for connecting various devices, such as electronic gadgets, sensors, and automotive electronic equipment, to the internet and establishing a network that encompasses a wide range of interconnected objects. In this system, sensors are employed to monitor and regulate environmental factors such as temperature, relative humidity, and pressure levels.*

## 1. INTRODUCTION

We present an innovative Internet-based smart weather reporting system that enables direct access to weather data without relying on traditional weather forecasting agencies. Our system incorporates temperature, humidity, and rain monitoring through sensors to provide real-time weather statistics. By leveraging technologies such as the Internet of Things (IoT) and cloud computing, our system collects and analyzes various weather parameters from different locations, facilitating weather forecasting and analysis. The IoT concept connects devices to the internet and other interconnected devices, allowing seamless transfer of information from IoT devices to the cloud and, subsequently, to end users. Weather monitoring, a practical implementation of IoT, involves capturing and recording weather parameters for alerts, notifications, appliance adjustments, and long-term analysis. Additionally, our system aims to identify and visually represent parameter trends using graphical displays. The devices employed in this system collect, organize, and present weather information. With the potential to capture, process, and transmit weather parameters, IoT has the capacity to revolutionize environmental monitoring and control. Cloud computing refers to the availability of computer system resources, such as data storage and computing power, without requiring active management by the user. In our system, captured data is transmitted to the cloud, enabling further display and processing. The system utilizes various components, including an Arduino UNO board, which serves as a microcontroller board with digital pins and USB connections to support the microcontroller. The DHT11 sensor is employed to detect temperature and humidity, while the Wi-Fi module converts the collected data from the sensors and sends it to a web server. This setup allows for the monitoring of weather conditions at any location from remote locations worldwide. The system continuously transmits data to the microcontroller, which processes and transmits it to the online web server via a Wi-Fi connection. The data is live-updated and can be viewed on the online server system. Additionally, the system enables users to set alerts for specific conditions. The presented system follows an IoT-based weather monitoring and reporting approach, allowing for the collection, processing, analysis, and presentation of measured data on a web server. The wireless sensor network management model includes end devices, routers, a gateway node, and a management monitoring center. The end devices collect data from the wireless sensor network and send it to the parent node, which, in turn, transmits the data to the gateway node directly or through a router. The gateway node analyzes and packages the received data into Ethernet format before sending it to the server. In simpler terms, any device running server software can be considered a server.

## 2. LITERATURE SURVEY

This paper discusses the challenges associated with weather prediction systems, particularly in the context of extreme weather events that can have detrimental effects on lives and property. The accuracy of weather data is identified as a critical challenge that needs to be addressed in order to enhance weather prediction skills and improve resilience against adverse weather conditions. The author highlights the specific case of Uganda and other developing countries, where limited weather observations and high costs of developing automatic weather stations contribute to the scarcity of timely and accurate weather data. The lack of funding available to national meteorological services further exacerbates the problem. To address these challenges, the author proposes the implementation of an Automatic Weather Monitoring Station based on a wireless sensor network. The proposed system aims to develop three generations of Automatic Weather Station (AWS) prototypes. The research focuses on evaluating the first-generation AWS prototype in order to improve and refine the second-generation AWS based on specific needs and advancements. The author suggests enhancements for non-functional requirements such as power consumption, data accuracy, reliability, and data transmission to ensure the effectiveness of the Automatic Weather Station. The focus of the proposed work is to develop a robust and affordable Automatic Weather Station (AWS) to improve weather forecasting in developing countries like Uganda. By reducing costs, it becomes more feasible for these countries to acquire AWS in sufficient quantities. The author introduces an IoT-based weather monitoring system, where environmental parameters are collected using sensors. Different sensors are used to measure parameters such as humidity, temperature, pressure, rain value, and light intensity (measured using an LDR sensor). The system also calculates the dew point value based on temperature readings. The temperature sensor is utilized to measure values in specific areas, rooms, or locations. The light intensity, captured by the LDR sensor, is incorporated into the monitoring system. The author incorporates an SMS alert system that triggers notifications when the sensing parameters, including temperature, humidity, pressure, light intensity, and rain value, exceed certain predefined thresholds. Additionally, email and tweet alerts are implemented. The system employs a Node MCU ESP8266 microcontroller and various sensors. In another paper, the author presents a low-cost live weather monitoring system that utilizes an OLED display. The IoT technology is highlighted as a revolutionary system that enables real-time weather condition measurement. The monitoring of weather conditions proves beneficial for various stakeholders, including farmers, industries, daily workers, and schools. By developing this live weather monitoring system, the author aims to simplify the challenges faced by farmers and industries. The system utilizes an OLED display to present weather conditions. The proposed model incorporates an ESP8266-EX microcontroller as its foundation. In this paper, the We Mos D1 board, running on Arduino, is utilized to retrieve data from the cloud. The We Mos D1 board is a Wi-Fi module based on the ESP8266EX microcontroller with 4MB of flash memory. It is compatible with Node MCU and Arduino IDE. The author employs only two devices, namely the We Mos D1 board and an OLED display, to measure weather conditions. Once connected, the system stores the data on the cloud, specifically using the Thing Speak website to display weather-related data. The data is shown on both the OLED display and the Thing Speak cloud. The primary objective of the author is to provide live weather information on the OLED display. In another paper [4], the author proposes a system for monitoring and predicting weather conditions, enabling individuals to plan their daily lives effectively. This system proves beneficial in various fields, including agriculture and industry. To achieve weather monitoring and prediction, the author presents a two-stage weather management system. The system combines data from sensors, bus mobility, and deep learning technology to enable real-time weather reporting in stations and buses. The forecasting of weather is achieved through a friction model in this research. The author incorporates sensing measurements from vehicles, specifically buses, to leverage local information processing. In Stage-I, the weather condition is sensed, and multilayer perception and long-term memory models are trained and validated using temperature, humidity, and air pressure data from a test environment. In Stage-II, the training is applied to learn the time series of weather information. The author compares the predicted weather data with actual data obtained from the environment Protection Administrator and the central Bauer of Taichung observation system to assess the accuracy of the predictions. The proposed system demonstrates reliable performance in weather monitoring and also provides a one-day weather forecast using the trained model. The author emphasizes that the system enables real-time weather monitoring and prediction using bus information management. The system consists of four basic components: information management, interactive bus stops, machine learning predictive model, and a weather information platform. Dynamic charts are used to display the information. In another research paper [5], an IoT-based weather monitoring system is implemented. The author highlights the use of IoT technology to monitor weather conditions and provide information on climate changes. The project aims to raise awareness among people regarding climate condition changes. The system offers accurate and efficient output, and the swarm algorithm is used to further enhance accuracy. Hardware and software components are used to facilitate the implementation of the project. Different sensors are employed to collect climate information, which is then stored in the cloud. The website www.thingspeak.com is commonly used for cloud storage in Internet of Things projects. The weather data is extracted from the cloud and uploaded to an Android mobile application using an API key. A rain sensor, which detects raindrops, is utilized to measure rainfall by analyzing the voltage variations on the sensor strips.

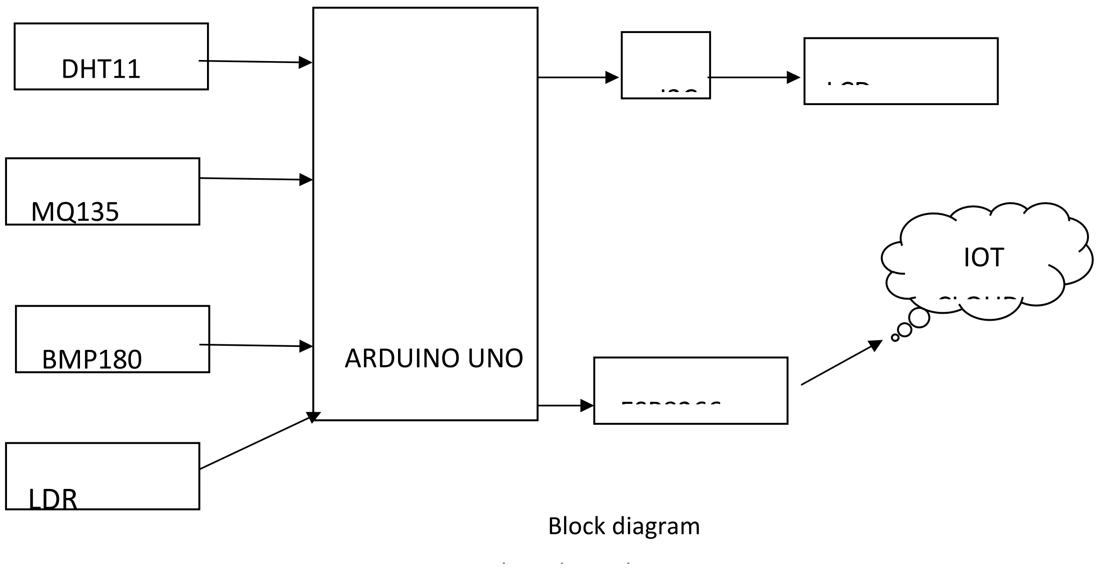


**FIGURE 1.** Block diagram

Our objective is to create a weather monitoring system by employing the components depicted above. The central component of this project is an Arduino board, which serves as the main control unit. Surrounding the Arduino board, we have digital and analog sensors that gather data regarding the local weather and environment conditions. To enable connectivity with the internet, we utilize a generic ESP8266 module, which interfaces the circuit setup with the internet via the 2.4 GHz Wi-Fi band. The ESP8266 module is responsible for transmitting the sensor data to a cloud server. This allows for real-time updates of the data and also ensures that the information is stored for future analysis. In order to provide local observation of the real-time data, we have incorporated a 16 x 2 LCD display. This display showcases the sensor data, providing a convenient means for monitoring the current conditions.

**1. Circuit Diagram:**

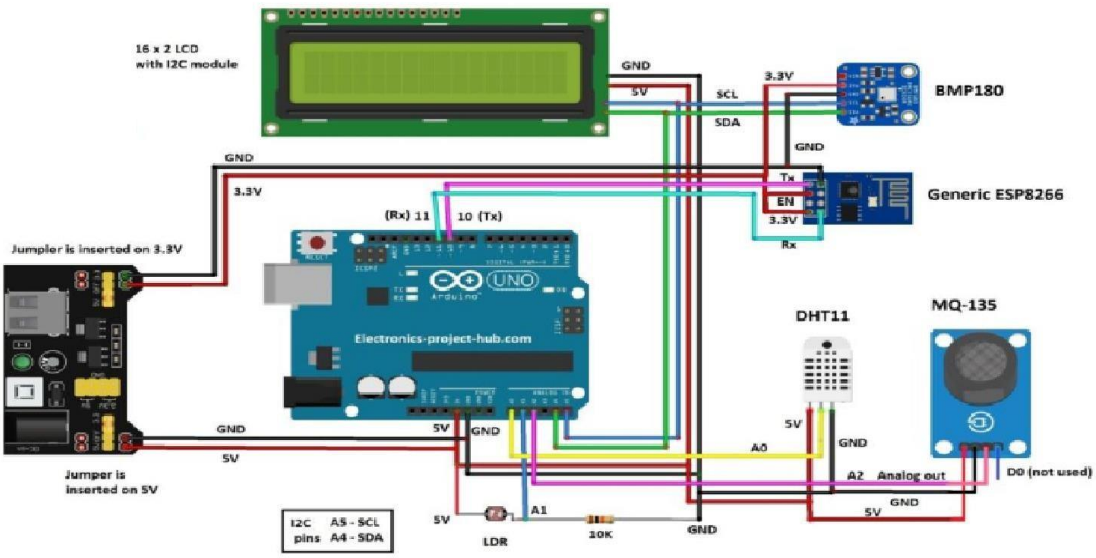


**FIGURE 2.** Circuit diagram of proposed method

The working principle of this project involves the interconnected functionality of the components and their outputs, as illustrated in Figure 1. The initial step is to supply the required power of +5v to initialize all the components. The project incorporates two temperature sensors, namely lm35 and dht11. The purpose of using two sensors is to ensure accurate temperature readings by taking the average of the two values. Based on the temperature reading, the system determines whether to introduce hot air or cool air to maintain the preset temperature threshold. If the temperature is too low for the specific area, hot air is blown to moderate the temperature. On the other hand, if the temperature is too high, cold air is blown to bring it down to the required level. This process allows for temperature manipulation. Additionally, there is an LDR (Light Dependent Resistor) that operates based on light intensity. When the sunlight is either excessively bright or insufficient for the plant's requirements, a servo motor is activated to open or close the door of the glass box. This action is determined by the readings of the LDR, ensuring that the natural light incident on the area is recorded and adjusted accordingly. The variability of natural light intensity is significant, particularly in agricultural applications where plants rely on light for growth. Some plants may not thrive well in low light conditions, while areas with consistently high light intensity throughout the year are suitable for setting up solar power stations. By considering light intensity in conjunction with other parameters like temperature and humidity, it becomes possible to make weather predictions without relying on satellite data. The collected data is transmitted in a serial manner to a computer. To establish communication between the computer and the Arduino device, the communication port (com port) is utilized. The recorded data is stored in a text file format. This text file can be easily imported into an Excel file using the functionality of a macro, enabling further analysis and visualization of the data. Once the data is imported into Excel, it undergoes sorting and formatting processes. This ensures that the data is organized in a structured manner for further analysis. Subsequently, charts are generated using the imported data. These charts serve as visual representations of the data, illustrating the weather patterns observed over the recorded period of time. By examining these visual patterns, it becomes possible to discern the weather behavior of the specific region, which is the main objective of this project. The DHT11 sensor is responsible for providing current temperature and humidity readings. This sensor produces analog output, which is connected to the analog input pin (A0) of the Arduino micro-controller. The DHT11 sensor comprises three pins. In addition to temperature and humidity, other derived values from the DHT11 sensor include the dew point and heat index, among others. These values provide further insights into the weather conditions of the monitored area. The dew point refers to the temperature at which the moisture present in the atmosphere condenses and forms water droplets. It signifies the point at which the air becomes saturated with water vapor, leading to the formation of dew or fog. The heat index, on the other hand, is a measure of the perceived temperature that the human body experiences from the surrounding environment. It takes into account both the actual air temperature and the relative humidity. In areas with high humidity, even if the temperature may not be extremely high, the body may still feel warm due to the increased moisture content in the air. Humidity, in general, refers to the amount of moisture or water vapor present in the air. High humidity levels can cause discomfort as it affects the body's ability to cool down through sweating or perspiration. Indeed, through a weather monitoring system, we can gather data on humidity and temperature, and utilize this information to generate graphical representations within the system. These graphical charts can be uploaded to websites, enabling access to the data from anywhere. The collected data can also be utilized for pattern analysis, where weather parameters are recorded over an extended period of time. This accumulated data serves as the basis for weather prediction analysis. The primary objective of this project is to develop a system that can sense and monitor the key components that contribute to weather patterns, ultimately enabling accurate weather forecasting with minimal human error. However, it is important to note that despite efforts to minimize errors, there may still be significant errors within any specific guidance or model run. Weather prediction remains a complex task with inherent uncertainties, and while individual systems may have small average errors, larger errors can still occur in certain instances.

## 3. RESULT

During the development process, all the modules were designed and the components were assembled successfully. Each module underwent testing, and the sensor readings were retrieved accurately in a stable environment. The retrieved data was stored in files for further analysis. Automation was implemented to import the files into Excel using macros, facilitating automatic data cleansing and formatting for improved presentation. Graphical charts were plotted using the imported data, providing a comprehensive and analytical view of the weather patterns based on the sensor readings. This successful testing phase demonstrates the functionality of the system. However, it is important to note that the study was conducted in a controlled environment. To further validate the system and its performance, additional experiments need to be carried out in environments that closely resemble real-world weather conditions. The table below presents the results obtained thus far, which serve as a foundation for future experiments and improvements. [Please provide the table or specific information you would like to include in the table for me to assist further.

**TABLE 1.** Real Time Experiment Result

Real Time Experimental Result

| Date | Temperature | Humidity | Pressure |
|---|---|---|---|
| June - 12 | 29.1 | 95% | 999 mbar |
| June - 12 | 29.4 | 95% | 100 mbar |
| June - 12 | 29.5 | 95% | 1003 mbar |
| June - 12 | 29.6 | 95% | 999 mbar |
| June - 12 | 29.7 | 95% | 998 mbar |
| June - 12 | 29.8 | 95% | 997 mbar |
| June - 12 | 29.9 | 95% | 999 mbar |

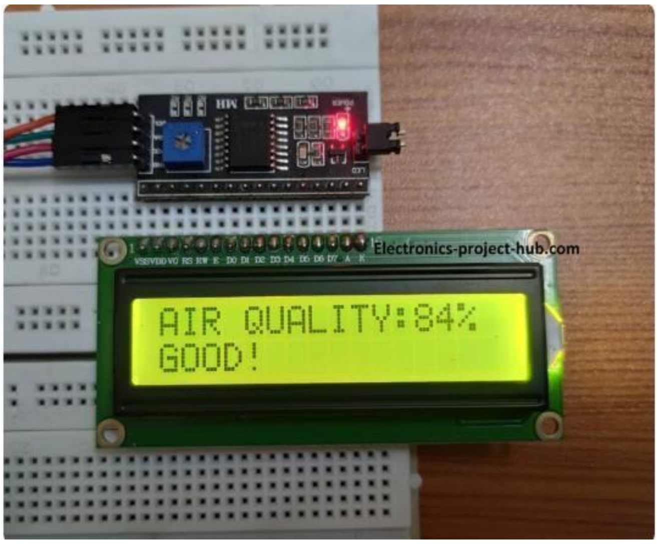


**FIGURE 3.** MQ-135 Sensor

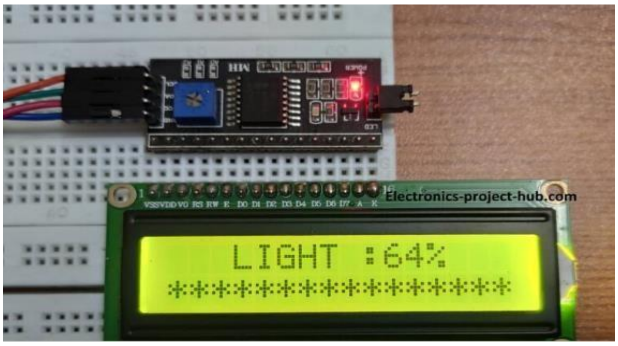


**FIGURE 4.** LDR

## 4. CONCLUSION

By deploying a weather station in the environment for monitoring purposes, we enable self-protection and create a smart environment. The implementation involves the use of sensor devices placed in the environment to collect data and perform analysis. This approach brings the environment into real life by actively monitoring its conditions. The collected data and analysis results are made accessible to users through Wi-Fi connectivity. This allows users to stay informed about the environmental conditions in real time. Additionally, the data from the sensors is sent to the cloud, where it can be stored for future analysis and easily shared with other users. This promotes collaboration and knowledge sharing. The presented model in this paper offers an efficient and low-cost embedded system for monitoring the environment in a smart way. It serves as a foundation for continuous monitoring and provides a means to protect public health from pollution. This model can be expanded to monitor developing cities and industrial zones, enabling effective pollution monitoring and ensuring the well-being of the public.

***Future Scope:*** Absolutely, expanding the system by incorporating additional sensors to monitor other environmental parameters would enhance its capabilities. Sensors such as CO2, pressure, and oxygen sensors can provide valuable data for a more comprehensive understanding of the environment. By integrating satellite connectivity into the system, it becomes possible to establish a global reach, enabling the monitoring of environmental conditions on a larger scale. This can be particularly beneficial in aircraft, navigation, and military applications, where real-time data and analysis are crucial for decision-making and safety. Moreover, the system can find application in hospitals or medical institutes for conducting research and studies on the "Effect of Weather on Health and Diseases." By **analysing** the relationship between weather patterns and health outcomes, the system can provide valuable insights and precautionary alerts, improving the overall well-being and health management of individuals. Expanding the system's sensor capabilities and leveraging satellite connectivity opens up a wide range of opportunities for various industries and sectors, allowing for better monitoring, analysis, and decision-making based on real-time environmental data.

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