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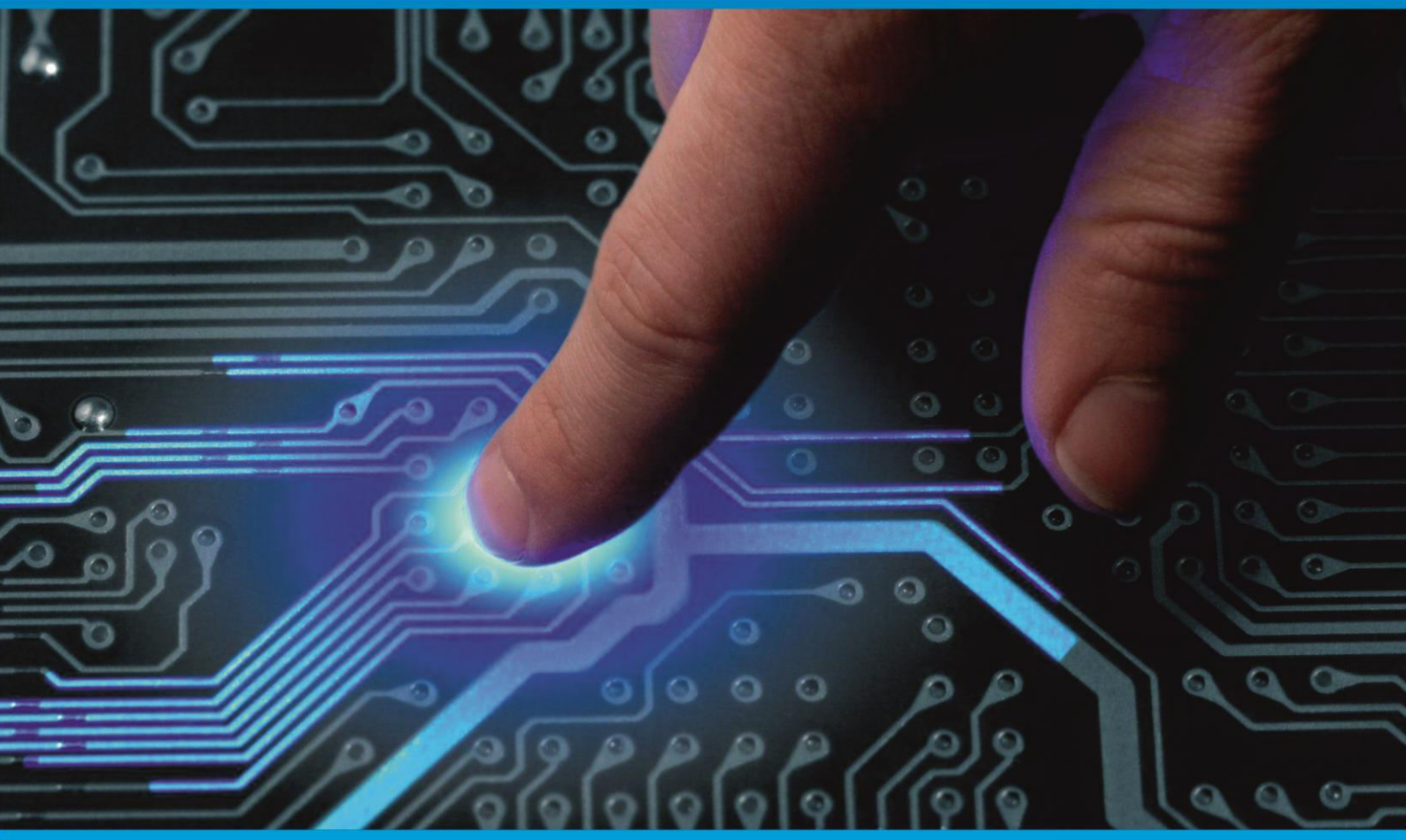

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Weather Data Accumulation using Arduino

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ABSTRACT: Weather data accumulation plays a very vital role in understanding the varying weather patterns. This changing weather condition affects the country and people financially. Determining weather is a difficult and challenging task. Weather forecasting is used for determining future weather conditions based on current and past weather data. This data is collected and after applying various machine learning techniques provided strategic information. The accumulation of data is done with the help of sensors. This paper describes various techniques to collect the weather data with the help of electronic systems, process the data, and send it to the centralized and secure data storage.

KEYWORDS: Weather monitoring, Electronic sensing, Centralized data storage, Wireless data transfer, Internet of Things, Correlated weather parameters, data cleaning.

I. INTRODUCTION

Data collection in any country is done by their Meteorological department and this data then can be used for various specialized purposes. To perform the analysis on that data, the data needs to be bought which may prove to be costly. [1] Also, there is a need for continuous data collection with the perseverance of past data. [6] Today, IoT has made the traditional objects not only smart but also has opened the doors for a wide range of applications. Now, further advancement has been made in this field with the introduction of IoE which makes the process more automated. So the need for continuous monitoring becomes minimal and in many cases even negligible.

This paper discusses the approach of IoT to build an electronic system for weather data collection. This system will be based on the Arduino platform and coded in embedded C using its Ide. Arduino is an open-source platform with real-time usage. Today, we have many sensors which help us to perceive the data of the environment and convert into numerical form and use it to perform various functions. The project discussed in this paper uses a Temperature and Humidity sensor namely DHT11, a Gas Sensor namely MQ7, and a Pressure sensor MPX10DP. All these sensors serve various purposes to complete the weather data collection.

a. Problem Formulation

Formulation of Problem plays an important role in determining the purpose, requirement, and usage of the project that is made.

So the problem statement of this project can be formulated as, Creation of the IoT based electronic system with the help of Arduino based microcontroller board for the collection of weather data in a given environment. This system uses different electronic sensors for data accumulation.

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II. LITERATURE SURVEY

a. Design of Weather Monitoring System and Smart Home Automation

Automated systems can be created by using the weather data as input to control the home devices. Weather data is collected through various sensors i.e. DHT-11 for temperature and humidity, LDR for light, BMP180 for atmospheric pressure, and LPG gas sensor. The automation achieved through weather sensing involved temperature, light, and water heater control. This system also helps to avoid hazardous situations that could occur due to leakage of gas. It opens the door of the windows as soon as the gas leakage is detected. The system also targets the usage through smartphones and a voice assistance approach for disabled people. [1]

b. Weather Monitoring System using IOT with Arduino Ethernet Shield

Sensors generate lots of data that it senses through the environment and storing that data requires lots of storage space. So using Cloud to store the data and then accessing and displaying the monitored parameter on the web page proves to be beneficial. Arduino Ethernet shield allows the Arduino Uno board to wirelessly share data through the internet. It also has an on-chip micro-SD card slot for storing the data. The sensing of Temperature and humidity is done with the help of the DH11 sensor and rainwater is detected with the help of the rain sensor. This system aims to reduce the manual data collection and introduce some automation in the process. [5]

c. Implementation of Weather Monitoring System

Weather monitoring proves to be an important step for weather forecasting. This study explains the already implemented weather station in Sri Lanka and suggests the extension with the implementation of a modular weather station with the support for wireless transmission and reception of data. It also explains various weather sensing modules and their usage. The system is implemented on the Arduino Uno microcontroller board and allows the sensing temperature and humidity through the DHT11 sensor. This work also suggests further extension by the introduction of the device controlling through a change in sensor reading. [3]

III. HARDWARE REQUIREMENTS

This section discusses the various components required to make this project.

Sr No.	Sensor Names	Description
1.	DHT11	Humidity & Temperature Sensor
2.	MQ-7	CO Gas Sensor
3.	MPX10DP	Pressure Sensor
4.	Arduino Uno Board	Micro-Controller Board
5.	ESP8266 NodeMCU	Wi-Fi Module

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1. DHT-11 - Humidity & Temperature Sensor

DHT11 is a low-cost temperature and humidity sensor that gives us a perusing of the encompassing temperature & humidity.

Specifications:

a. Operating Voltage: 3.5V to 5.5V
b. Operating current: 0.3mA (measuring) 60uA (standby)
c. Temperature Range: 0°C to 50°C
d. Humidity range: 20% to 80%

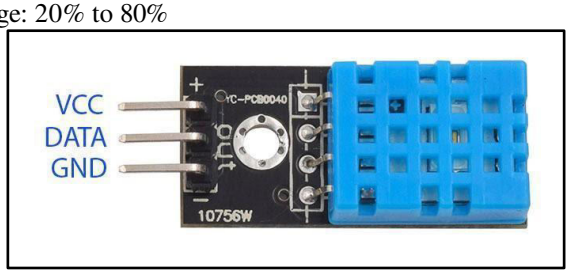

Fig 1: DHT11 Pinout

[9] This sensor serves as the collector of Temperature and Humidity data from its sensing environment. It has an inbuilt thermistor for sensing the temperature and a humidity sensor for sensing the humidity. The reading of humidity is relative humidity measured in percentage and temperature is in the format of degree Celsius.

2. MQ-7 CO Gas Sensor

The MQ7 sensor senses the Carbon Monoxide concentration in the air. The affectability for the sensor is high and has a high reaction time.

Specifications:

a. Operating Voltage: 1.5V to 5V
b. Operating current: 150 mA
c. Detection Range: 10ppm to 1000ppm

CO is a dull, dry, scentless, ignitable gas. It very well might be noxious which might be lethal to human wellbeing that has additionally been found in a few nations.

Fig 2: MQ-7 CO Gas sensor

It is equipped for identifying the measure of CO gas in the scope of 20 to 2000 ppm.

3. MPX10DP - Pressure Sensor

The MPX10DP is a Pressure Sensor for showing the natural changes in pressure. [4] It furnishes us with practically precise outcomes and the reaction time is likewise acceptable separated from the smallest deferral here and there.

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Specifications:

a. Operating Voltage: 3V to 6V
b. Operating current: 6mA
c. Detection range: 0KPa tp 10KPa
d. Pressure Type: Differential

Fig 3: MPX10DP Pressure Sensor

The yield given by the sensor is straightforwardly corresponding to the applied pressing factor.

IV. METHODOLOGY

This section will describe the methodology & approach taken for the weather data accumulation system.

A. Setup of Working Environment

We have performed our experiment on the micro-controller board named Arduino Uno. [3] It is based on the Atmega328P microchip having 14 Digital pins and 6 Analog pins. The operating voltage for this board is 5V.

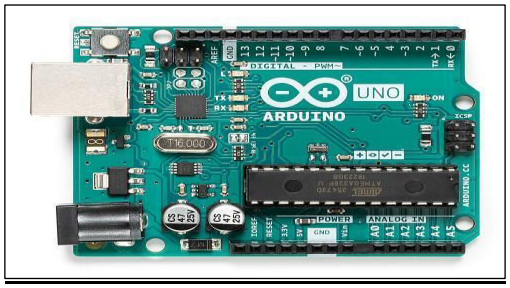

Fig 4: Arduino Uno board with Atmega328P Chipset

[2] Arduino provides an integrated environment for programming the microcontroller board. This IDE provides an abstraction from the programming of hardware with assembly-level programming. [5] Arduino IDE allows the programmer to compose the code in Embedded C with the support of easy-to-use libraries for the many hardware components.

B. Connecting to cloud

One of the important steps in the data accumulation process is the storage of data. This storage of data allows us to perform further steps of analysis. To connect the system to the cloud, we need a Wi-Fi module for the system. Arduino Uno doesn't come with the inbuiltWi-Fi module. So we included an ESP8266 incorporated microcontroller board named NodeMCU.

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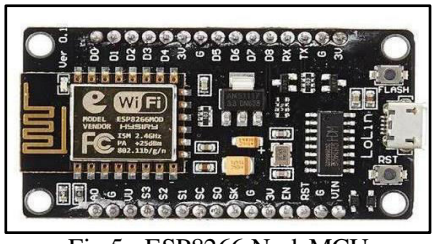

Fig 5: ESP8266 NodeMCU

It is planned particularly for IoT-based applications and it incorporates firmware that suddenly spikes in demand for ESP8266 Wi-Fi Soc from Espressif Frameworks.

C. Importance of Sensing the Environment

The sensors are responsible to percept their environment and gather the data for which it is built. MPX10DP is a temperature and humidity sensor that helps to gather real-time change in temperature and humidity data. [10] Both the Temperature and humidity are inter-connected and change in one affects the other. An increase in temperature decreases the humidity and as temperature decreases humidity level increases and reaches the dew point when its relative level is 100 percent. [11] At dew level, the air around us is saturated with water vapor i.e. more water is in the gaseous state in the environment. High humidity also introduces some concerns. So measuring the real-time value of temperature and humidity is important for studying the weather.

MQ-7 CO is a carbon monoxide sensor that collects the CO concentration in the environment. [7] Carbon Monoxide is a toxic gas which directly affects the human. High concentration in the environment can disrupt the transport of blood which leads to heart problems. Its presence also encourages greenhouse gases to stay in the environment. So Carbon monoxide doesn't directly affect the weather, but measuring its concentration can help to reduce various issue caused by its presence,

MPX10DP is a pressure sensor that measures the Atmospheric pressure in KPa. [8] Atmospheric pressure is affected directly by altitude. Pressure decreases as the altitude increases. Decreased air pressure affects the oxygen concentration in the environment. The movement of low atmospheric pressure in an environment makes the weather cloudy, windy and increases the chance of precipitation. So sensing the environment helps to a greater extent to understand the change in weather, effect on humans and the environment.

D. Project Workflow

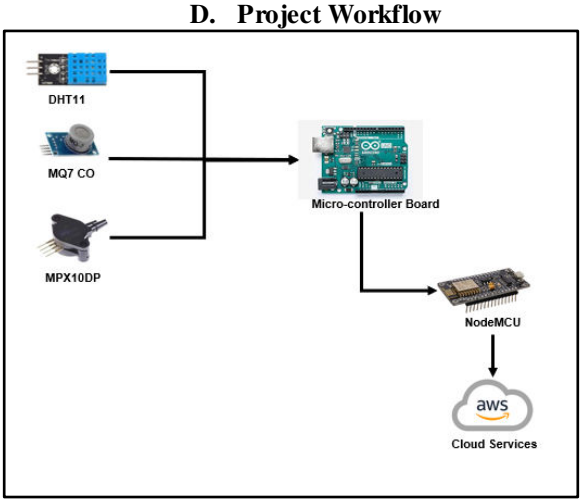

Fig 6: Workflow of the system

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Fig 6. Discusses the flow of data in the system among various components. The data about the environment is collected by the three sensors i.e. MPX10DP, MQ7 CO, DHT11. The collected data is about the temperature, humidity Carbon monoxide concentration, and Atmospheric pressure. This data is processed by the microcontroller board and is then forward to the cloud with the help of NodeMCU for storage. Storage of data is an important step in this process, as the data then can be fetched and after applying various analysis algorithms can generate conclusive reports.

E. Using Data for analysis

The data collected through the sensors and stored in the cloud can be used to analyze it and induce some conclusive reports. The data first needs to be cleaned. To make the data more comprehensive, we can introduce some gaps in the data collection stage as continuous data can use up all the storage. Cleaning of data makes sure that the data is properly formatted and there is no incomplete data as well as corrupted data. After the process is completed the data is fed into the Machine learning algorithm and is checked against various algorithms and the one with maximum accuracy is selected. Thus this helps to perform the task of forecasting the weather based on the previous data as well as the newly generated data. The graphical charts and diagram can also be generated which helps to generate interactive and easy to interpret reports.

V. CIRCUIT DIAGRAM

To visualize the working of an electronic project, creating a circuit diagram is an important step. It shows various circuit-level details

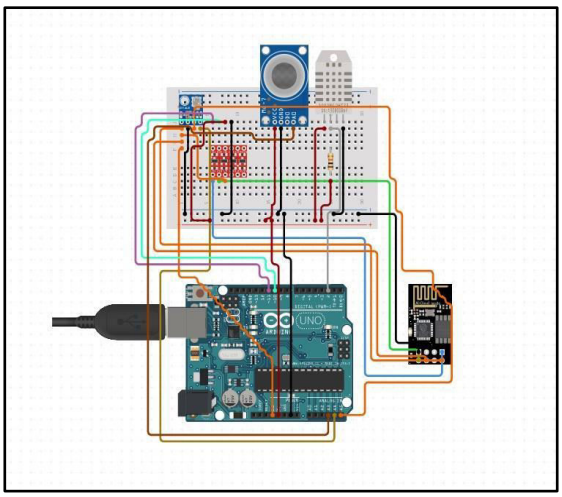

Fig 7: Circuit Diagram

a. The associations are easy to the interface where the sensors are associated with the Vcc, GND, and their separate simple or advanced information pins.
b. The undertaking can be executed for industries, family applications which empowers us to screen the climate.
c. The utilization of the Wi-Fi module is to empower an entire universe of plausibility when we send the information to some cloud administration like Amazon Web Administrations (AWS), Google Cloud, ThingSpeak, and so on.
d. The investigation of information should be possible to foresee future examples of climate or learn experiences that could help anybody and everybody during troublesome occasions.

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VI. SOME COMMON MISTAKES

- The sensor associations are practically clear as they, for the most part, have advanced or simple pins with a Vcc and GND association which is quite straightforward.
- Utilize long wires and associate each wire appropriately with the pins of sensors and microcontroller board by studying the datasheet and circuit diagram.
- Ensure none of the wires are taken out in a rush and every wire is associated with your right terminals.

VII. FUTURE SCOPE

- This system along with the integration of machine learning algorithms for forecasting can be used in agriculture for the farmers to have a standalone system specialized for their farms.
- More specialized and sensitive sensors which can collect the data of the slightest change in the environment can be used to make the system less prone to errors.
- To increase the interactivity of the users with this system, a user-friendly mobile or web-based application will be a prominent step in the success of this project.

VIII. CONCLUSION

Weather data collection and storage is an important step to achieve the final step of weather forecasting. Selecting sensors with proper specification helps to achieve accurate sensing and accurate sensing leads to more prominent reports. Cloud storage helps to provide a robust and efficient data storage platform. Electronic system with less human intervention is what is achieved through the imminent field of IoT. This helps to build the prediction model through the use of various algorithms whose input requirement is satisfied by this data collection electronic model.

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