

Project Based Learning (PBL-3)(CSP 391) LAB

Weather Monitoring Station

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# Project Title

Weather Station

# Team / Group Formation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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**ABSTRACT**

This project aims at developing an accurate weather station using the Arduino platform that measures local temperature, humidity, air quality index (AQI),UV ray index and atmospheric pressure. The integration of the ESP8266 Wi-Fi module provides internet connectivity, data transmission, and remote monitoring. The weather service interacts with the OpenWeatherMap API to capture real-time weather data for most of the states in India, which it then projects.

This project served two purposes: it is a useful tool for personal and community use, and it acts as an educational platform covering hardware and software skills such as sensor integration, microcontroller design, API communication and what etc. Collected data is crucial for well-informed agricultural decision making, urban planning, and disaster management Important Impact Usefulness is also emphasized.

**INTRODUCTION**

Access to reliable information is crucial and invaluable for sectors such as agriculture, disaster management, transportation, and daily life activities at a time when climate change and environmental management have become increasingly important. This project provides a complete weather station using the Arduino platform. The main function of this weather station is to measure temperature, humidity, air quality index (AQI), atmospheric pressure, and UV ray module. The DHT22 sensors measure temperature and humidity, and the MQ135 is an air quality sensor. With the use of these sensors, the weather service can provide accurate, real-time environmental information.

The project integrated the ESP8266 Wi-Fi module to enable Internet connectivity to allow data transmission and remote monitoring. The weather service can access and display the current weather data from the various states across India by connecting with the OpenWeatherMap API, providing a complete view of environmental conditions throughout locally and nationally.

The hardware-software combination of the weather station project integrates sensor incorporation, microcontroller design, and networking to provide an experience with a complete learning tool in monitoring environmental conditions. Critical to informed decision making regarding agriculture, urban planning, and environmental protection is the gathering and presentation of information, thereby emphasizing the value of work on and potential impact.Technology to be used:

**TECHNOLOGY USED:**

**Hardware Technology**

**1. Microcontroller applications:**

* Arduino Uno: The primary microcontroller board where all the sensor data gets collected, processed, and then transferred to the Wi-Fi module.

**2. Sensors:**

* DHT11: It is a digital temperature sensor. It increases the accuracy and reliability and is used in environmental monitoring.
* MQ135: Gas Sensor to monitor the air quality index. It measures the presence of a series of gases, including ammonia, nitrogen oxides, alcohol, benzene, smoke, and carbon dioxide along with total oxygen.
* Ultraviolet Ray Module: Ultraviolet, ultraviolet rays are kinds of electromagnetic radiations originating from the sun and artificially generated surfaces, like tanning beds. They occur between visible light and X-rays, having a range between 100 to 400 nanometers. The types of UV rays include
* BMP180: BMP180 is a digital barometric pressure sensor. This sensor has been used in many applications to measure atmospheric pressure and altitude. This is an accurate sensor capable of reading pressure from 300 to 1100 hPa with an accuracy of ±0.02 hPa, thus making it applicable for weather monitoring, altitude, and other applications where pressure information is required along with temperature measurement.

**3. Wi-Fi Module:**

* ESP8266: This is a module that gives WiFi connectivity between the Arduino Uno and the Internet so that the Arduino Uno can send locally stored data to the server to receive real weather from external APIs.

**4.Actuator:**

* LCD/OLED Display: This is for local display of temperature, humidity, and AQI data. It enhances user interaction because of direct access to environmental conditions.

**5. Empowerment:**

* 5V Power adapter or battery pack: It powers the Arduino Uno and connected sensors excellently with stable and reliable operation.

**6. Features:**

* A breadboard and jumper wires for linking sensors, Wi-Fi modules, and the Arduino Uno during the developing and testing stages.
* Resistors and Capacitors: Used as required for voltage regulation and signal conditioning, mainly to ensure the proper voltage levels for the ESP8266.

**Software Technology**

**1.Arduino IDE:**

* Objective: write, integrating and sending code to Arduino Uno.
* Features: User interface to write and test code: Arduino microcontrollers.

**2. Programming Language:**

* C/C++: This is the primary programming language used with the Arduino Uno. It calls libraries and APIs to read sensor information, Wi-Fi linkages, and HTTP requests.

**3. Libraries:**

* DHT Library: It shall offer an interface with DHT22 sensor to read temperature and humidity data.

Example: include <DHT.h>

* Wi-Fi by the ESP8266WiFi library: Communication in between Arduino modules with ESP8266.

Example: #include <ESP8266WiFi.h>

• ArduinoJson library- json text in the response of APIs.

Example: #include <ArduinoJson.h>

**4.Development Tools:**

# Serial Monitor: This is an IDE tool that is particularly useful in debugging and monitoring the output of Arduino, such as sensor reading and API response.

# Online IDEs-Optional: for cloud-based coding and project management if needed.

# 5. Data visualization (optional):.

# Software application To display the data, which is being captured by this weather station, in the form of a graph or perhaps some dashboard.

# Web Dashboard: Web-based interface (if applied) to use real-time and historical view via HTML, CSS, and JavaScript.

# Problem Statement

# More on environmental awareness and the actual need for precise weather information, many communities are still lagging far behind in having accessible reliable real-time weather information, Sky existing condition data and monitoring systems are not only costly but perhaps do not give localized, complete information. This project addresses all of these issues.

# 1. Unsound monitors of the local environment:

# There is a lack of adequate weather monitoring systems in many areas, especially rural or inaccessible ones. Cost-effective solutions that can provide accurate and real-time information about the local environment, including temperature, humidity, and air quality, are required.

# 2. Regional climate data not available in sufficient quantity:

# While some sites may provide regional weather data, they are not generally localized to the specific needs of the local environment and are not usually integrated with local sensors. A system is required that monitors the local environment and provides a more holistic view of the local climate by integrating with external factors.

# 3. Integrates real-time data:

# Existing solutions miss actual local information and complete local information. This will, therefore, bridge this gap - by combining the sensor data on real time updates from an external API to create the completeness of the view of environmental conditions.

# 4. Cost and complexity of existing solutions

# Traditional weather stations and environmental monitoring systems are cost-prohibitive and technically complicated to install. A low-cost, simple system that makes installation and usage simple is needed for climate systems.

# 5. Inadequate power supply:

# If the power supply does not provide sufficient current or voltage, Arduino is the associated component, then the sensor are not working properly.

# Literature Survey

This paper is focused on the importance and possibility of developing a condition management system for AWS based on WSN and details the potential AWS problems so our CM consists of data receiver, data analyzer, problem classification and reporting module. According to the data, the researcher identifies the attributes and then the classifier defines the attributes. Reports reporters build via SMS or email, and then these are installed for less frequent. And condition monitoring, when applied achieves the set goal of addressing equipment-related issues with reduced instances of downtime. We have client worked and planned the rest of the installations in May 31, 2018. Besides evaluating the proposed condition management tool, testing was conducted as a few of these AWS, more particularly large loads where many of them are likely to fail. [1].

Hence, the proposed model was successfully built with improved post-test results. The remote station with solar cells received the sensor data and transmission was successful. The base receiving station received the data and showed data one by one because on LCD, there were only 160 blocks. Other variables such as wind direction and wind speed can be measured. If the unit can access solar conditions via some kind of battery storage to be used as a cloudy day, more flexibility can be built. In return, the added features on the part of the company would push up the price of the unit. Since more intelligence is put in the system, it would be able to forecast weather with site specific ground data collected.[2]

This paper presents the design and definition of the proposed loT based weather monitoring experimental setup for our organization for weather parameter monitoring. Embedded sensor networks have been proven to be a reliable solution for sensing in our system. Sensors through information technology are connected to the system to measure or calculate aspects of a particular area such as temperature, humidity, air quality etc. Another, applications and functions including Twitter updates are facilitated for the users to use. Regarding our main concern, it helps to set the right conditions for the centers of our organization that correspond to certain climate characteristics. But it will be our improvement in the future work of this project to try to modify it for the process, to be faster, shorter and suitable for the specific task. Furthermore, in case changes are drastic, we could even warn the users through alert messages or e-mail. [I I] This is the reason why the weather station application uses intuitive beauty graphs to represent properties of the atmosphere in a composite yet easy to understand way.[3]

Results from this study are weather obtained from the city weather station data and indoor weather got by sensors DHT22, BH1750, BMP180. These two data are compared. Weather of indoor in is equal to weather data obtained from weather stations. Conditions necessary to use each actuator for their respective Actuators used are bulbs, fans, heaters, coolers, and spray pumps. Each of the other six representatives can make his or her choice for any situation. However, this means that in case there is future research prospect in using urban climate data from stations to determine the indoor climate, the study still needs to be adapted accordingly the test reality matches.[4]

This paper presents the design of an automated weather monitoring system which offers several ways to access the data from a DIY IoT-based AWS: a www site, an m-site mobile application and ThingSpeak cloud. The exhibited data includes text values of current and historical weather parameters as well as dials, graphs and charts. This data is comprised of temperature, relative humidity, air pressure, wind speed and direction, rain fall, soil moisture, dew point and etc. From the following options below, the users are left to decide which one to use in order to continuously track the changes of weatherparameters. An executable Shell script was introduced to act as a middle man between AWS and different platforms which was displaying the data. Furthermore, the pros and cons of the system as well as factors and potential ideas for further improvements are proposed. All of its components are free which makes it fit for low budget and amateur projects only. It is possible to state that high reliability of the system can be provided by its use during more than two and a half years without revealing of essential problems and shortcomings.[5]

Daily, monthly, seasonal and annual mean atmospheric air temperatures at an equatorial station are shown using directly measured data collected from the Campbell Weather Station from July 2014 – February 2014 each, soil temperature, soil moisture and evapotranspiration Since the study, improvements in the values ​​were also being considered more A surprising finding is that soil moisture levels are completely independent of air temperature because some conditions may there is a non-air temperature moderation relationship between the two indices The maximum air temperature for several months reflects LT 16, averaging 33.3°C in March and 25.5°C in August. Because these results will enable meteorologists as well as agricultural scientists to investigate and predict the along axis weather; Because effects in shown here for weather event by atmospheric weather event will prove the physical impact due to the atmospheric weather on the agricultural production according to the production time theory.[6]

DHT11 sensor, BME280 sensor, and raindrop sensors have collected the figures of humidity, temperature pressure, and rain level respectively Parameter of upcoming weather has been predicted and has been compared in Random forest,ANN,Linear Regression and Support Vector Machine whose graph of mean square error has been drawn to identify the best fit approach for weather forecasting. But, there is a significant limitation in which more data has to be collected, and more factors have to be linked with the weather forecast to achieve more accurate results. Thus, in accordance with the technique used, the model having the highest R square value and lowest mean value of square is considered to be the best possible fit for the model. Based on the findings in this study, we argue that Random Forest is the most appropriate classification algorithm.[7]

There is an increasing amount of statistical data available to meteorologists from sources various in both spatial extent and scientific origin. This therefore requires tools that can be used to quantitatively analyze such data. The output of the visual theme would be compact, especially based on big data sets that visual inspection delivers. To end with, this work was providing geovisual tools for integration and the visualization of georeferenced data originated from Basque Country meteorological instruments: a weather radar system and a meteorological station network with nearly one hundred multisensor stations; raw data generation of radar as pseudo-volume images, also at interactive frame rates. For example, meteorites. A user easily sees on the hey map where meteors are in the sky and where the rain images should be at that moment, but in reality, it appears as the radar data with types of real rain available and being detected by weather stations is a really good tool for the visual inspection of the process.[8]

It has therefore been possible for this work to show how the APRS based network could be used or implemented as a weather station network protocol. A temperature, humidity, barometric pressure sensor is included in the first prototype development of the invention to show micro weather system. With reference to the latter, weather station information can be mapped with APRS-IS network without any problem and is freely available to users through several APRS web-server. Energy has to be saved so that weather station has to be set at any place as the need of energy cannot be altered. But for other purposes for example in a, weather station then other sensor such as precipitation sensor wind speed and direction sensors among others are required.[9]

Weather forecasts have a significant impact or are vital in nearly all aspects of life especially in Agriculture for East Africa as discussed below. However, according to the survey results, we observe that there is a very weak infrastructure of the weather stations in Uganda. We have done a recommendation on densification, though proposing a low-cost setup for a potential benefit to the East African National Meteorological services towards efficient weather information management.[10]

Without the automatic weather station equipment, a portable weather station has to do something. The device has an accurate sensor for measuring atmospheric conditions such as air temperature, humidity, and pressure. The device has an accuracy of more than 95 percent. Real-time monitoring with advanced protocols such as the IoT protocol of MQTT can also be used for real-time weather monitoring. This smartphone screen device accepts data sent to the LCD-MQTT server with a successful message using the MQTT dash application, which will be sent to MQTT dash. The device also stores two seconds of data each on the SD card per day.[11]

In this context, for the purposes of this work "OBS" and "RMAPS" databases are used to predict hourly weather conditions at a meteorological station The first time on original data is an additional variable and processing using One-Hot Encoding used this 10-station weather forecast during data preparation. Another improvement in the weather forecasting algorithm is a new model, which is the combination of 1D-CNN and Bi-LSTM in a single framework. Based on the evaluation of the proposed method, it can be concluded that the 1D-. The proposed CNN and Bi are compared with FNN, 1D-CNN, LSTM, and Bi-LSTM model -LSTM hybrid model gives improved results for atmosphere situational forecastingcontext with multistation weather forecasting.[12]

A weather station that measures weather data wirelessly and transmits the information over a global network, so that the data between the local stations and mainframe computers is shared much more efficiently One major advantage would be wireless control since remote recording is required for the monitoring of the sky condition. It is a TCP/IP controlled extension of the laboratory. The station can be merged with the LabVIEW programs to synchronize its operations as well. The station thus offers remote research capabilities besides establishing a virtual laboratory with regard to the research undertaken and depth of knowledge gathered. It recharges itself well before the operation, allowing the collected data to be stored in multiple formats for the analysis later.[13]

The first application of the IoT was presented by measurement of wind and climate with a basis of station weather systems and consumption of energy in several functions within this system. Sensor data is beating environmental and weather conditions in a tested indoor version of the system, being an inexpensive solution: wireless sensors with low power consumption, and the SoC also includes a Wi-Fi module. These will be useful for further research, and are more easily shared with other users. This model can be expanded to pollution control in other urban areas. Thanks to the current model calibration, it provides the greatest and most sensitive analysis for daily care, thus providing the highest level of protection for general welfare from contamination.[14]

We proposed a model that combines historical local delay data with IoT data feeding the LSTM network for air temperature forecasting in New York City. The durability model, historical average, ARIMA, and FNN are considered as comparison models. It is found that the LSTM network discovered two: 1) LSTM (GeoTab), the model is only IoT analysis and 2) LSTM (GeoTab+WU), IoT reading and recording of different meteorological stations vary This fact emerged in the analysis where we found that the historical climate inclusion model in the proposed framework improves and gives better results than other models for time series prediction, estimation, and deep learning. It utilized the historical data of the in situ observations of the air temperature. So at the same time when this air temperature was predicted, for very historical parameters that could not be covered by any IoT model, this LSTM model could identify them.[15]

* **Here’s is the table summarizing the features of the each paper**

|  |  |  |
| --- | --- | --- |
| **Author Name** | **Technology Used** | **Key Features** |
| Cunningham | WSN-based AWS, data receiver, SMS/email notifications | Condition monitoring framework for AWS, components include data receiver, data analyzer, problem classifier, reporting module, minimizes downtime |
| Ghosh | Solar cell, sensor transmission system, LCD display | Solar-powered remote weather station, measures wind direction and speed, potential for sun-tracking, data transmission |
| Tandan N | IoT, embedded sensor networks, ICT | Monitors temperature, humidity, and air quality; integration with user-friendly Twitter updates; instant alerts through SMS/email |
| Suryana A | DHT22, BH1750, BMP180 sensors, actuators | Compares room weather with outdoor station data, uses actuators (fans, heaters, etc.) for maintaining conditions |
| Stoyanov S | DIY IoT-based AWS, ThingSpeak, Shell script | Displays weather data on multiple platforms (web/mobile), data visualization tools, low-cost system suitable for amateur projects |
| Adebesin B | Campbell weather station | Analysis of diurnal, seasonal, and annual temperature changes, insights into agricultural implications |
| Vidhya Sakar | DHT11, BME280, raindrop sensors, ML algorithms (Random Forest, ANN, SVM) | Predicts weather parameters, compares ML models, identifies Random Forest as best fit |
| Moreno A | Visual Analytics, geovisual tool, 3D modeling | Integrates weather data from radar and stations for visual analysis, 3D meteorological mapping |
| Neonet Y | APRS-based network, sensors (temperature, humidity, pressure) | Demonstrates APRS protocol for weather data transmission, energy-saving approach |
| Cunningham | IoT-based weather system | Recommends low-cost setups for weather monitoring, benefits for East African meteorological services |
| IC2IE | MQTT protocol, SD card storage | Portable device with high accuracy for temperature, humidity, and pressure; real-time monitoring and data storage |
| Fu Q | LSTM, 1D-CNN, One-Hot Encoding, OBS and RMAPS datasets | Advanced weather forecasting using a hybrid ML model for multi-station predictions |
| [13] | LabVIEW, TCP/IP, wireless connectivity, solar panel | IoT weather station with data acquisition, long-range communication, virtual lab environment |
| Mabrouki | IoT, wireless sensors, low-energy SoC | Low power consumption monitoring system, indoor and urban application, environmental contamination observation |
| Yu M | LSTM network, historical data, IoT observations, ARIMA, FNN | Forecasts air temperature using IoT and historical data, high spatial resolution, effective model comparison |

# Here's a table comparing the limitations of the case study to the project "Weather Station":

|  |  |  |
| --- | --- | --- |
| Case Study | Limitation | Weather Station |
| [1] | Limited scope in integrating actuators for all environmental parameters, no focus on power efficiency or cost. | Integration of multiple sensors and actuators for comprehensive monitoring and control, focus on energy efficiency. |
| [3] | Limited Wi-Fi coverage area, potential inaccuracy due to environmental interference, reliance on Google Sheets for data storage. | Enhanced data accuracy with advanced sensors, robust data storage solutions, wider coverage area with improved connectivity options. |
| [4] | Limited to short-term alerts, no focus on long-term data analysis, basic sensors may lack high accuracy. | Comprehensive data analysis and long-term storage, high-accuracy sensors for precise measurements. |
| [5] | High initial setup cost for AWS, limited focus on real-time data processing, potential issues with sensor calibration. | Low-cost setup with efficient real-time data processing, regular calibration checks for sensor accuracy. |
| [6] | Potential security issues with SMS and email alerts, dependence on stable internet connection, limited data storage options. | Secure data transmission methods, offline data access, robust and scalable data storage. |
| [7] | Limited display size for data visualization, dependency on specific microcontroller, potential data loss without internet. | Larger and more flexible data visualization options, adaptable microcontroller choices, reliable data storage even without internet. |
| [8] | High computational resources needed for deep learning, dependency on bus mobility data, potential for prediction inaccuracies. | Efficient data processing with optimized algorithms, independent from external data sources, high prediction accuracy. |
| [11] | High initial cost for prototype development, limited focus on real-time monitoring, potential data transmission reliability issues. | Cost-effective with a focus on real-time monitoring, reliable data transmission with redundancy measures. |
| [14] | Complex setup with dense circuitry, reliance on LABVIEW, potential for high maintenance costs, need for specialized programming knowledge. | Simplified setup with modular components, user-friendly software interface, low maintenance costs, easy programming. |
| [15] | Limited by Wi-Fi coverage area, potential for data transmission delays, complexity in integrating multiple sensors, potential inaccuracies with wind speed and direction measurement. | Wide coverage with improved connectivity, low-latency data transmission, seamless sensor integration, precise wind measurements. |

# This table provides a comparison of the limitations between the generic case study and the specific project focused on Weather Station.

# Project Description

Detailed Working of the Comprehensive Weather Monitoring and Control System

1. Sensor Data Collection

Temperature Sensor (DHT11):

* Function: Measures ambient temperature.
* Process: The sensor uses a thermistor to measure the temperature. It converts the temperature into a digital signal that can be read by the microcontroller.

Humidity Sensor (DHT11):

* Function: Measures ambient humidity levels.
* Process: The sensor uses a capacitive humidity sensor to measure the moisture in the air. It converts this into a digital signal for the microcontroller.

Air Quality Sensor (MQ-135):

* Function: Measures air quality by detecting harmful gases and pollutants.
* Process: The sensor measures the concentration of gases such as ammonia, nitrogen oxides, alcohol, benzene, smoke, and carbon dioxide. It outputs an analog signal corresponding to the air quality level.

**These sensors are connected to the ESP8266 microcontroller, which continuously collects data from them through its input pins.**

2. Data Processing

Microcontroller :

* Initialization: On startup, the Microcontroller initializes all connected sensors.
* Data Collection: It continuously reads data from the temperature, humidity, and air quality sensors.
* Data Processing: The microcontroller processes the raw data to ensure it is in a usable format. It checks the sensor readings against predefined thresholds stored in its memory.

3. Connectivity and Data Transmission

Wi-Fi Module (Integrated with Microcontroller):

* Function: Provides internet connectivity for data transmission.
* Process: The microcontroller uses the Wi-Fi module to send data to a cloud storage service (e.g., AWS IoT) and a local database (e.g., MySQL). This enables remote access to real-time and historical data.

4. User Interface

OLED Display:

* Function: Provides a local, real-time display of environmental readings.
* Process: The microcontroller sends the processed sensor data to the OLED display, allowing users to see current temperature, humidity, and air quality levels.

5. Power Supply

Main Power Source:

* Function: Provides power to the entire system.
* Process: The system is connected to a main power source. An optional solar power setup can be integrated to make the system more sustainable and reliable in remote areas.



Oled Display

Dht 11

Arduino UNO

BMP180

Air quality sensor

Wi-Fi Module

UV Ray Module

Fig-1. **Block Diagram of weather Statation**

# Project Modules: Design/Algorithm

# 1.DHT11:

# The DHT11 is a basic, low-cost digital sensor used for measuring temperature and humidity. It’s popular in DIY projects and various electronics due to its simplicity and reasonable accuracy for basic applications.

# Key Features

# Temperature Range: 0°C to 50°C with an accuracy of ±2°C.

# Humidity Range: 20% to 90% with an accuracy of ±5%.

# Operating Voltage: 3V to 5.5V, making it compatible with most microcontrollers.

# Digital Output: Provides data through a single wire, using a proprietary protocol.

# Sampling Rate: 1 Hz, meaning it can provide data once per second.

# 

# 

# Fig.2.DHT11 Sensor

# 2.MQ135 air quality sensor

# The MQ135 is a popular air quality gas sensor module that can detect various harmful gases, including ammonia (NH3), nitrogen oxides (NOx), alcohol, benzene, smoke, and carbon dioxide (CO2). It is commonly used in air quality monitoring systems and pollution detection devices. The sensor works by detecting changes in the conductivity of its sensing material, which changes with the concentration of gas in the air.

# Key Features

# Detection Range: 10 to 1000 ppm for NH3, NOx, alcohol, benzene, smoke, and CO2

# Operating Voltage: 5V DC

# Power Consumption: 150mA

# Preheat Time: Over 24 hours

# Sensitivity: High sensitivity to various gases

# Response Time: Less than 10 seconds

# Recovery Time: Less than 30 seconds

# 

# Fig.3.Air Quality Sensor

# 3.TFT Display

# A 5-inch TFT (Thin-Film Transistor) LCD screen is a type of display technology commonly used in various electronic devices, including smartphones, tablets, and embedded systems. TFT screens are known for their bright display, high resolution, and ability to render rich colors. They are particularly suitable for projects that require graphical user interfaces (GUIs), such as displaying data in a weather station.

# Key Features

# Screen Size: 5 inches (diagonal)

# Resolution: Typically 800x480 pixels (can vary by model)

# Interface: SPI, Parallel, or HDMI (depending on the model)

# Color Depth: 16-bit or 24-bit color, capable of displaying 65K or 16.7M colors

# Touchscreen Capability: Available in both resistive and capacitive versions

# Backlight: LED backlight for bright and clear display

# Operating Voltage: 3.3V or 5V, depending on the model

# Power Consumption: Low power consumption, suitable for battery-powered projects

# Viewing Angle: Wide viewing angles, often 160° or more

# Controller: Integrated TFT controller, such as ILI9486 or SSD1963 (varies by model)

# Applications

# 

# Fig.4.TFT Display

# 4.UV Ray Module:

# A UV ray module or UV sensor module is an electronic component used to detect ultraviolet (UV) radiation levels in the environment. These modules are often employed in projects that require monitoring UV exposure for applications related to health, safety, or environmental conditions.

# Key Features

# UV Index Measurement: Provides output related to the UV index to indicate the strength of UV radiation.

# Analog or Digital Output: Available in both analog (voltage-based) and digital (data-based) formats for flexible integration.

# Wide Detection Range: Capable of detecting UVA and UVB radiation.

# Low Power Consumption: Suitable for battery-powered and portable devices.

# Easy Integration: Compatible with microcontrollers like Arduino and ESP8266 via analog input or I2C communication.

# Real-Time Monitoring: Supports continuous monitoring for responsive data logging and safety applications.

# Compact Design: Small and lightweight for easy incorporation into various projects.

# 

# Fig.5.UV ray Module

# 5.Arduino Uno

# The Arduino Uno is one of the most popular microcontrollers in the Arduino family. It is widely used for electronics projects and prototyping due to its simplicity, ease of use, and extensive community support. The Uno is based on the ATmega328P microcontroller and provides numerous digital and analog input/output (I/O) pins, making it suitable for various applications.

# Key Features

# Microcontroller: ATmega328P

# Operating Voltage: 5V

# Input Voltage (recommended): 7-12V

# Input Voltage (limit): 6-20V

# Digital I/O Pins: 14 (of which 6 provide PWM output)

# Analog Input Pins: 6

# DC Current per I/O Pin: 20 mA

# DC Current for 3.3V Pin: 50 mA

# Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader

# SRAM: 2 KB (ATmega328P)

# EEPROM: 1 KB (ATmega328P)

# Clock Speed: 16 MHz

# LED\_BUILTIN: Pin 13

# 

# 

# 

# Fig.6.Arduino UNO

# 6.BMP180 :

# The BMP180 is a digital barometric pressure sensor that is widely used for measuring atmospheric pressure and altitude. It is a highly accurate sensor capable of reading pressure from 300 to 1100 hPa (hectopascals) with an accuracy of ±0.02 hPa, making it suitable for weather monitoring, altitude measurement, and other applications requiring pressure data. Additionally, it can provide temperature measurements.

# Key Features

# Pressure Measurement: Measures atmospheric pressure from 300 to 1100 hPa with high accuracy.

# Temperature Measurement: Integrated temperature sensor with a range of 0°C to 65°C.

# High Accuracy: Pressure accuracy of ±0.02 hPa, suitable for applications like altimeters and weather monitoring.

# Low Power Consumption: Operates efficiently with minimal energy, making it suitable for battery-operated projects.

# Compact Size: Small form factor ideal for embedded systems and portable devices.

# Interfaces: Supports I2C and SPI communication for easy integration with microcontrollers like Arduino and ESP8266.

# Altitude Calculation: Can be used to calculate altitude based on pressure readings.

# 

# Fig.7.BMP180 Sensor

# 7.9V Adapter

# A 9V adapter is an external power supply unit that converts AC (Alternating Current) from a wall outlet to 9V DC (Direct Current) power, which is commonly required by many electronic devices and microcontroller projects, such as those using Arduino boards, Raspberry Pi, and various sensors and modules.

# Key Features

# Input Voltage: Typically 100-240V AC (depending on region)

# Output Voltage: 9V DC

# Connector Type: Usually comes with a standard barrel jack connector, micro-USB, or USB Type-C, depending on the device it is intended to power.

# Regulation: Provides a stable 9V output, often with built-in over-voltage, over-current, and short-circuit protection.

# 

# Fig.8.Adaptor

**Implementation Methodology**

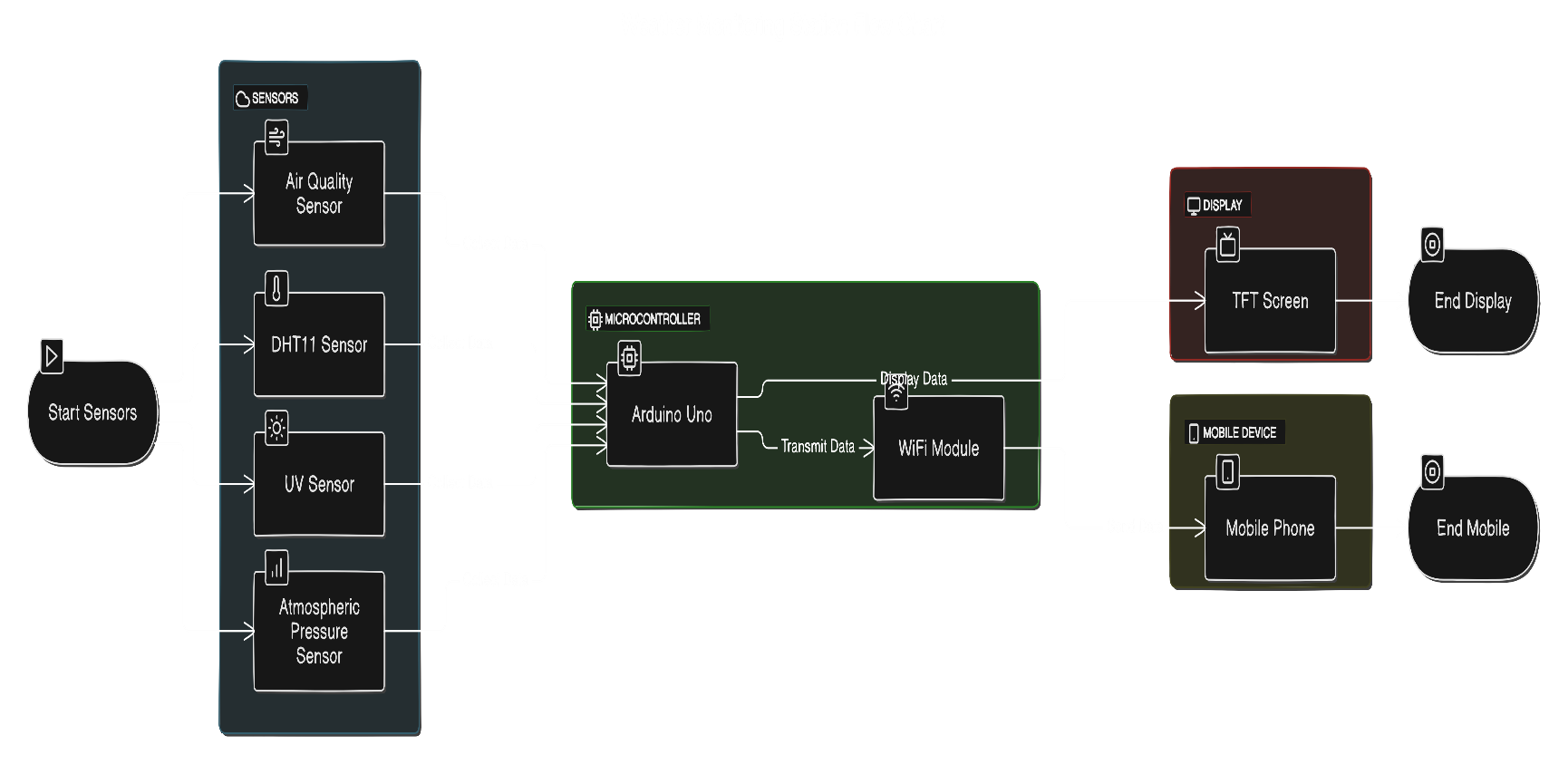
Some modules and sensors are connected to the Arduino Uno microcontroller that monitor and report the environmental conditions for the final session of the weather station project. The accessories used include DHT11 sensor, BMP180 sensor, MQ135 fresh air gas sensor, UV beam module, OLED display, and ESP8266 Wi-Fi module Arth communicate as follows:

Connect DHT11 sensor to the digital 11 pin of Arduino Uno, MQ135 sensor to A5 analog pin of Arduino, UV ray module to A5 analog pin, and BMP180 to SDK and SCL pin of Arduino uno a. Learn data from the environment and transmit it to the microcontroller.

The TFT screen is connected to the parallel interface I2C which exists on the Arduino has three analog pins and seven digital pins and a reset pin. This display actually offers real-time information that indicates temperature, humidity, and even the air quality.

The ESP8266 Wi-Fi module has been integrated with the Arduino Uno for wireless data transfer. The TX and RX pins of the module were connected via a voltage divider to the RX and TX pins of the Arduino because the ESP8266 module takes 3.3 V logic, while the Arduino Uno has 5V logic, thus protecting a module from damage.

The Arduino Uno and peripherals take their power from a 9V adapter. The assemblies ensure that all parts are well connected; therefore, it ensures that the power to ground connections are well maintained to stabilize and prevent electrical issues. It then enables the weather station to accurately monitor the environmental conditions and send data wirelessly for remote transmission and analysis.

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# Fig.9.Flow Chart of the Weather Monitoring Station

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# Fig.10. DFD of Weather Monitoring Station

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# Fig.11. E-R Diagram Of Weather Monitoring Station

# Advantages of this Project

# 1. Real-time Data Management:

# It generates continuous, real-time, and ongoing information regarding temperature, humidity, and air quality, hence permitting timely decision-making based on current environmental conditions.

# 2. Low cost:

# This product uses low-cost and commonly found materials, which makes this a very inexpensive option in many small personal, educational, or climate research needs.

# 3. Flexibility:

# The functionality is very easily customisable or extendible for extra sensors or other features like data logging, wireless communication, or remote monitoring.

# 4. Learning Outcome:

# It is a hands-on course in electronics, programming, and environmental science that will be suitable for the student or enthusiast.

# 5. Compact and portable design:

# The use of Arduino Uno with small sensors ensures that the system is compact and portable enough for most applications within limited systems in the environment.

# 6. Energy efficiency:

# The system can be designed to function on low voltages, so this can be used for a long period even in remote areas where there are relatively few power sources.

# 7. User-Friendly Interface:

# The 3.5 inches dimension gives a readable display screen allowing for an intelligible interface with users to observe what is in the environment.

# 8. Flexibility:

# Further units can be spread further, which spreads work to another environment or over several larger geographical areas.

# 9. Environmental Awareness:

# Raises awareness of what may be useful in terms of conditions in the environment to garden, farm, or just understand the climate in any area.

# 10. Do-it-yourself Community Support:

# Because it is based on an open-source base such as Arduino, there are many community resources and support available to research, debug, improve.

# 

# Future Scope and further enhancement of the Project

# 1. IoT integration:

# Internet of Things (IoT) integration will enable the station to gain instant access to real-time data in a web or mobile application for remote monitoring

# 2. Advanced sensors:

# • Using extra sensors to get many environmental parameters, for instance, UV index, moisture levels in the soil, wind speed and direction and even some gas concentrations (even the CO2 level.)

# 3. Wireless Communication:

# • Integrate Wi-Fi, GSM, and LoRa modules to transfer data to the cloud for further processing, analysis, or simulation.

# 4. AI and Machine Learning:

# • Apply machine learning algorithms on the data set to predict future patterns of either weather or just unusual changes in the environment.

# 5. Development Implementation:

# • More advanced User Interface on the TFT screen, graphical representation of data; alerts and reports on extreme climatic conditions.

# 6. Weather Forecast:

# Use the algorithm to predict short-term Climate Change by increasing the range of forecasting by local incorporation of weather data.

**OUTCOMES**

**Real-time environmental monitoring:**

The weather service shall collect accurate, real-time information on temperature, humidity, and AQI. This data can be displayed on an OLED or TFT screen for ease of reading.

**2. Practical exercise: Sensors and Microcontrollers:**

•This will provide practical experience in creating the project, and therefore you get a hands-on feeling for working with sensors integrated in the system and their work with the microcontroller used, such as the Arduino Uno. In doing this, you develop your deeper understanding of the nature of such processes and how they interlink.

**3. Data Logging and Analysis:**

• Longer data recording period In case the program is an environmental study, data may be recorded over a long time to allow interpretation of trends and climate patterns. This would especially help in studies regarding climate change or local environmental change.

**4. General knowledge on circuit design:**

• Assemble and solder components. This will give you a sense of the design of circuits, circuit design, and associated challenges of designing reliable, efficient electronic systems.

**5. Communication Systems:**

• KNOW the various communication protocols (I2C, SPI, One-Wire) used to connect sensors to the Arduino. In embedded systems, knowledge about these protocols is essential when communicating between multiple devices.

**6. Application of Planning Skills:**

• Programming the Arduino for collecting and displaying data from sensors will enhance your skill in C/C++ programming, especially with embedded systems.

**7. Weather Services End:**

• Upon completion, this project will provide a fully functional weather station that can be used for personal or community purposes or as part of a larger weather station exhibition.

**8. Ground for further development:**

• This is an important step toward the advanced services. Wireless communications (Wi-Fi or Bluetooth) will access remote servers and use machine learning algorithms for the integration forecast of weather.

# 9. Environmental Awareness:

# • Continuously monitor environmental conditions. Increasing awareness of local climate and air quality will be greatly brought forward, and this is worthy to contribute to the best possible environmental management and decisions.

# 10. Instructional Resources:

# • The project can be utilized as an educational device to demonstrate principles of sensor integration, data gathering, and environmental monitoring to students or any interested parties in the electronics and the environment science.

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