IoT-Based Weather Station for Real-Time Environmental Monitoring

Sudhanshu Kumar Jha[1], Pratish Kumar[2], Suraj Bhan Dangi (Guide)[3], Mr Rajul Rai (Co-Guide)[4]
Sam Global University

***Abstract*—Weather monitoring plays a crucial role in agriculture, urban planning, and disaster management. This paper presents the design and implementation of a cost-effective, IoT-enabled weather station capable of real-time environmental monitoring using ATmega328 microcontroller and ESP8266 Wi-Fi module. It measures temperature, humidity, and air quality using sensors like DHT11 and MQ2. The collected data is displayed on an LCD and transmitted to the cloud for remote access via a web interface. This paper includes sample circuit diagrams, images, and code implementation. A literature review of seven related works is presented and compared in a tabular format. The proposed system offers a scalable and reliable solution for smart agriculture, industrial safety, and weather forecasting.**

1. INTRODUCTION

The increasing frequency of extreme weather events has highlighted the need for efficient and real-time weather monitoring systems. Traditional systems are costly and limited in remote accessibility. With the advancement of microcontrollers and the Internet of Things (IoT), compact, wireless, and low-power weather monitoring devices are now feasible. In this paper, we propose an IoT-based weather station that collects data from multiple sensors and uploads it to the cloud. The system uses ATmega328 microcontroller for sensor interfacing, and ESP8266 Wi-Fi module for network communication. It supports monitoring of temperature, humidity, air quality, and light intensity, providing live updates on a user-friendly web dashboard.

2. LITERATURE REVIEW

Numerous IoT-based weather monitoring systems have been proposed, each with varying architectures and sensor modules. Below is a review of seven relevant studies:

S. No.	Paper Title	Authors	Platform	Parameters Measured	Connectivity
1	A Low Cost Environment Monitoring System	Deshmukh & Shinde (2016)	Arduino + ZigBee	Temp, Humidity, CO2	ZigBee
2	Smart Farm Monitoring Using Arduino	Jindarat & Wuttidittachotti (2015)	Arduino	Soil moisture, Temp, Humidity	Wi-Fi
3	Weather Station Design Using Arduino	Savic & Radonjic (2015)	Arduino Uno	Temp, Humidity, Pressure	GSM
4	IoT for Environmental Monitoring in Homes	Ugale & Navale (2016)	Raspberry Pi	Temp, Humidity, CO2	Wi-Fi
5	Smart Sensor Interface for Environmental Monitoring	Tamilarasi & Saravanakumar (2016)	Arduino	Temp, Light, Rain	GSM
6	Ambient Environmental Quality Monitoring	Djajadi & Wijanarko (2016)	Arduino + NodeMCU	CO2, Dust, Temp	Wi-Fi
7	Wireless Weather Monitoring System	Keshav Kumar Singh	ATmega32	Temp, Humidity, Pressure	RF Communication

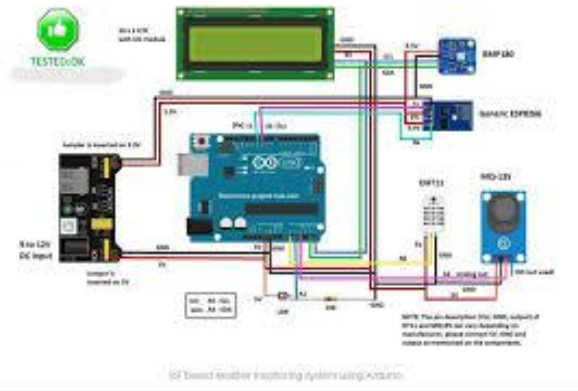
Summary: Most systems rely on Arduino or ATmega microcontrollers. Common communication protocols include Wi-Fi, GSM, and ZigBee. Our proposed system integrates digital sensors and cloud connectivity with ESP8266, offering a modern solution with cost-effective components.

3. METHODOLOGY

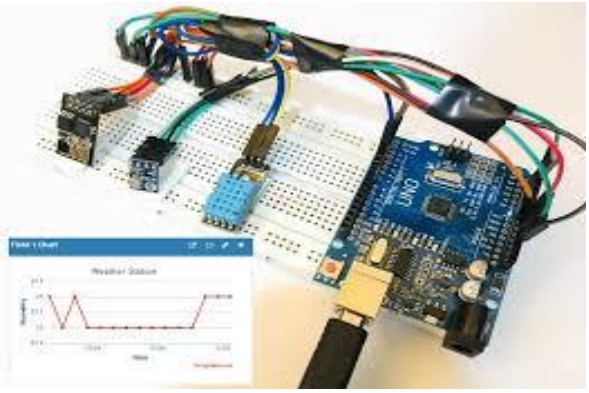
3.1 Hardware Components

- ATmega328 Microcontroller: Central controller for data acquisition
- DHT11: Temperature and humidity sensor
- MQ2: Gas sensor for air quality monitoring
- ESP8266: Wi-Fi module for internet connectivity
- 16x2 LCD: For local data display
- Power Supply: 5V regulated via 7805
- Other Components: Resistors, PCB, capacitors, potentiometer

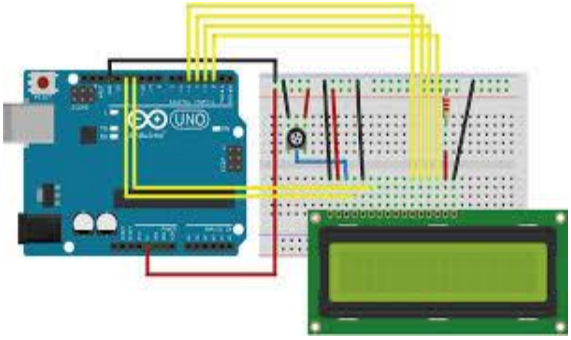
Circuit Diagram OF Whether OF IOT-Based Whether Station



Sample Pictures



Output Display on LCD



4. IMPLEMENTATION AND SAMPLE CODE

Arduino Code Snippet

cpp

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```
#include <DHT.h>
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>

#define DHTPIN 11
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
LiquidCrystal lcd(2,3,4,5,6,7);
SoftwareSerial esp(9,10);

void setup() {
  Serial.begin(9600);
  esp.begin(115200);
  dht.begin();
  lcd.begin(16,2);
  lcd.print("Weather Station");
  delay(2000);
}

void loop() {
  float h = dht.readHumidity();
  float t = dht.readTemperature();

  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Temp: ");
  lcd.print(t);
  lcd.print(" C");
  lcd.setCursor(0,1);
  lcd.print("Humidity: ");
  lcd.print(h);
  lcd.print("%");
```

```
 String data = "GET /update?api_key=YOUR_API_KEY&field1=" + String(t) + "&field2=" + String(h) + "\r\n\r\n";

esp.println("AT+CIPSTART=\"TCP\",\"api.thingspeak.com\",80");
 delay(2000);
 esp.println("AT+CIPSEND=" + String(data.length()));
 delay(2000);
 esp.print(data);
 delay(15000);
}
```

5. CONCLUSION AND FUTURE SCOPE

This IoT-based weather station provides an affordable, scalable, and real-time monitoring solution. It allows users to access environmental data remotely via the internet. In the future, the system can be extended to include rainfall, soil moisture, wind speed, and solar radiation parameters. It can also support alert systems via SMS or email and be used for agricultural automation and disaster management.

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