Internet of Things (IOT) based Weather Monitoring System

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Abstract- This research presents an innovative approach to weather monitoring through the Internet of Things (IoT), enabling real-time observation of environmental conditions from virtually anywhere. The proposed system integrates various sensors to track temperature, humidity, and carbon monoxide (CO) levels and transmits the data to an online interface for visualization. Leveraging the capabilities of IoT, this setup allows continuous environmental monitoring via the internet, offering users access to dynamic graphical reports. With compact hardware and internet connectivity, the system essentially functions as a portable, personalized weather station.

Keywords- Internet of Things (IoT), Embedded Systems, Arduino, ESP8266, Smart Environment.

I. INTRODUCTION

With the advent of the Internet of Things (IoT), the world we live in is witnessing a key moment of change in both the manner in which data is transferred, exchanged and circulated, and in the way in which we are automating our functions. IoT is built upon the known ground of traditional internet technologies and wires up a variety of physical devices to digital networks, enabling devices to automatically communicate and intelligently handle data. Such an interconnected capability brings forth sophisticated capability such as remote sensing, real time tracking, autonomous control, and system optimization.

The development of smart environment is a cornerstone of the IoT implementation, as physical objects should be viewed as possessing sensors, microcontrollers, and communication modules. These are these are autonomous environments that constantly monitor environmental parameters such as temperature, humidity, and gas concentrations, and respond to changes by executing pre defined responses. For example, an automated alert would be triggered by any variation in a given CO level or variation in temperature, thereby improving the environmental awareness and safety.

Technological progress has increasingly been directed towards improving controlling and monitoring mechanisms to better adjust to human and environmental needs. When air quality indicators such as noise, radiation, or CO are above threshold levels, smart technologies are pivotal to mitigating risk. We are developing these systems based on a synergistic integration of sensors, processors, and software tools into self regulating frameworks for continuous monitoring and real time intervention.

The two main values in using smart systems in preservation of ecological resources and human safety are the ability of those systems to detect and react to anomalies. In addition, the proximity between embedded devices and computational engines connecting to cloud based analytics broadens the area of applications from industrial pollution tracking to urban environmental planning. Broadly speaking, there are two categories of monitoring infrastructures: event triggered, because of their data acquisition and response strategies; and process based.

This paper presents the design and development of a reliable environmental monitoring system that remotely collects and analyzes temperature, humidity and CO concentration levels through a cloud based platform. With wireless modules, sensor generated data is sent to the cloud for real time visualization and trend analysis. An embedded system architecture that permits remote data access with wireless operation and energy efficient operation is implemented.

This IoT based model enables long term environmental monitoring by integrating multiple sensing devices, cloud computing and wireless communication. A scalable design makes it easy to deploy in residential, industrial, and other various contexts, and an important tool for environmental data collection, analysis, and development of urban policy.

II. SYSTEM ARCHITECTURE

The environmental data monitoring setup proposed in this work employs the ESP8266 microcontroller as the central component for handling sensor input, data processing, and wireless communication. This embedded system is designed for uninterrupted environmental tracking, allowing for real-time data access through remote interfaces.
The configuration consists of a Wi-Fi interface module, a combined temperature and humidity sensor (DHT11), and a gas sensor (MQ-6) for detecting carbon monoxide levels. Inputs from the sensors are processed by the microcontroller and transmitted to an online platform, where they are stored and visualized for user interpretation.

A. BLOCK DIAGRAM:

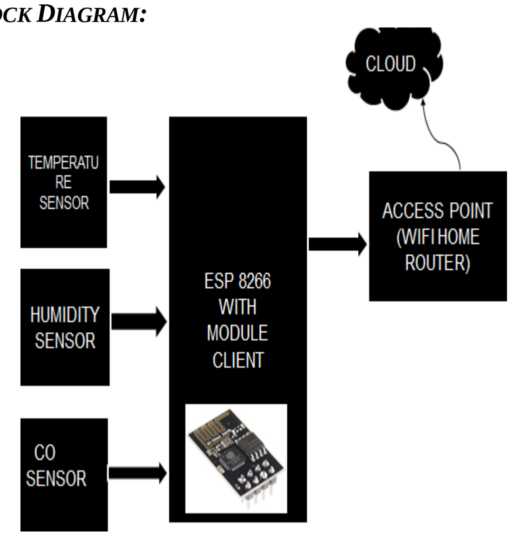

Fig. 1 Block Diagram of the Project

B. WI-FI MODULE:

Fig. 2 ESP8266

The ESP8266 modules are selected for their energy efficient design and robust communication features for forming the communication backbone of the system. An integrated TCP/IP protocol suite and UART communication with the microcontroller are included in this module. It is programmed using AT commands, and able to perform in client and server modes required for different networking forms. The module establishes a secure and consistent connection so that the data could be sent in a non interruptive manner.

C. SENSORS:

In the design, two primary sensors are used: What we used in order to capture ambient temperature and humidity were the DHT11 and for CO gas concentration for MQ-6.

Analog traces which are generated based on environmental inputs originate from these sensors. However, these values are read by the ESP8266 and converted to digital form by its internal ADC (Analog-to-Digital Converter) to be ready for wireless transmission.

D. TEMPERATURE SENSOR AND HUMIDITY SENSOR:

The DHT11 is a low-cost, compact digital sensor suitable for applications requiring basic weather data.

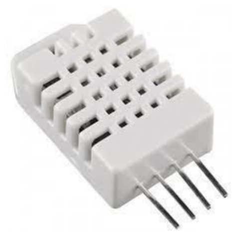

Fig. 3 Temperature and Humidity Sensor DHT 11

Working in voltage range of 3.3V to 6V and has acceptable precision. Temperature response is ±0.5°C and relative humidity is ±2%. It refreshes quickly, on the order of 1 refresh per second, so it works well for circumstances where you need near real time updates.

E. CARBON MONOXIDE:

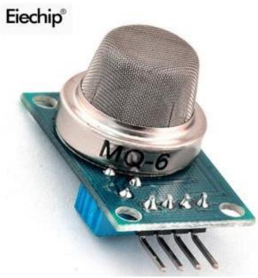

Fig. 4 Carbon Monoxide (CO) sensor MQ 6

Gas detector MQ-6 sensor is to detect carbon monoxide level in the environment. It can detect CO concentration between 20 ppm to 2000 ppm. With varying gas concentration, the analog voltage signals output by the sensor change. The internal heating element of the circuit is powered by a 5V supply, as well as a load resistor for interfacing with the microcontroller's ADC.. For precise data representation, the following conversions are used:

- 1 ppm = 1.145 mg/m^3
- 1 mg/m^3 = 0.873 ppm

F. THING SPEAK:

The system is integrated with ThingSpeak, a cloud based service designed for IoT applications, to store and visualize sensor readings. This data is then transmitted to ThingSpeak using HTTP requests.

ThingSpeak provides realtime data plotting, historical data log, and MATLAB analytics with custom data processing. This integration allows users to take sensor information and perform an interactive visual interpretation of that information without the need of proprietary software.

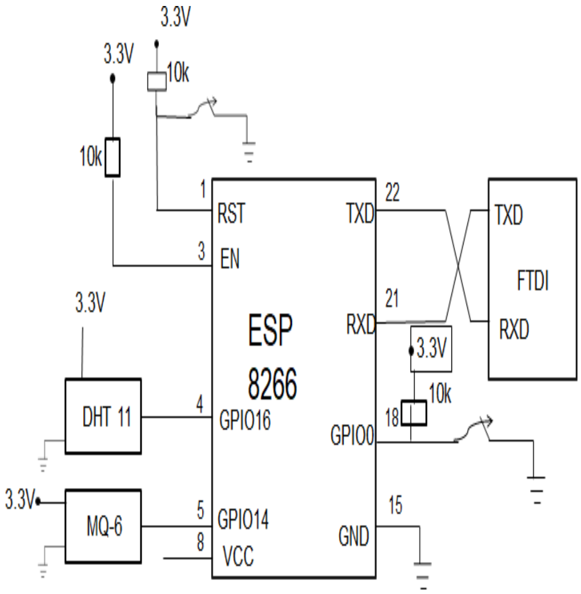

Fig. 5 Circuit Diagram of the system

III. SIMULATION RESULTS

For measuring system performance a prototype was implemented and installed within a controlled environment. The sensors were read at a predefined interval. Once an internet connection was established environmental data from ESP8266 was uploaded to the online server. On the dashboard of the server, live temperature, humidity, and carbon monoxide content recorded at the deployment site were displayed.

In addition, the information was synchronized to a Google Sheet through ThingSpeak's built-in APIs. How this was implemented was one that enabled historical trends to be monitored, and what resulted over time due to that historical trend was displayed to users. Visual graphs were created to graphically depict these models.

- Progression of temperature over time
- Humidity changes at varying intervals
- Overall trend of carbon monoxide composition (smoke) within the whole observed space.

All the above-mentioned processes were modeled and confirmed that the system functioned satisfactorily and reacted rapidly to fluctuations of environmental factors.

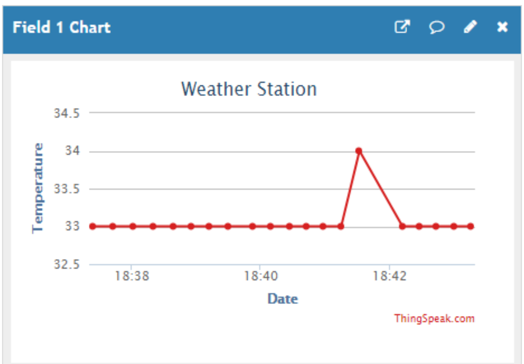

Fig.6(a) Simulation of Temperature v/s Time

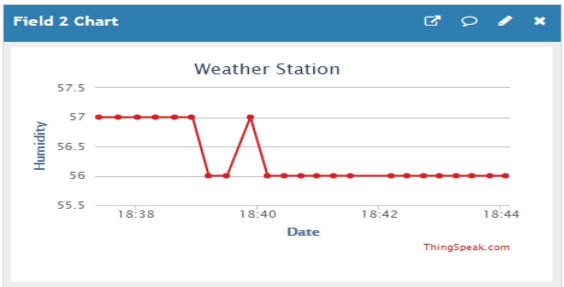

Fig. 6(b) Simulation of Humidity v/s Time

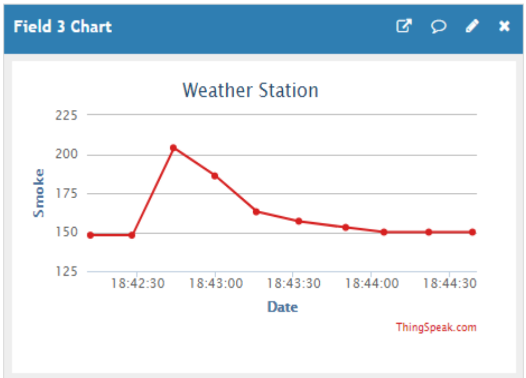

Fig. 6(c) Simulation of Smoke content v/s Time

IV. CONCLUSION

The research outlines a cost-effective and flexible IoT-based solution for environmental monitoring. The system architecture supports continuous data acquisition and remote access, providing real-time insight into surrounding atmospheric conditions. With low hardware requirements and efficient software integration, the setup is practical for deployment in both urban and rural settings.

Testing demonstrated the system’s ability to gather, process, and transmit critical air quality parameters such as temperature, humidity, and CO concentration. Sensor data is stored in the cloud and displayed through an interactive web interface, making it accessible from any location. This work lays the foundation for scalable monitoring systems that can be tailored for broader environmental, industrial, and agricultural applications.

V. FUTURE SCOPE

This will help improve platform's reliability and scope. the following improvements are proposed:

- Automated Alerts: Audio visual alarms are integrated to signal when hazardous air quality event occurs (e.g. elevated CO level).
- Mobile Connectivity: Let a user know when the environment changes for the worse with SMS or mobile push notifications.
- Sensor Expansion: Broaden the support to include also other pollutants such as PM2.5, NOx and O_3.
- environmental coverage.
- Off-Grid Operation: To allow for autonomous, design a version that is powered by solar panels or rechargeable batteries an operation in areas where running water is unavailable, remote or rural areas.

VI. REFERENCES

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