Portable Weather Station with Web Based Data Visualization and Analytics

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***Abstract* - This being the decade of IoT, it is an upcoming trend to normalize digital transformation in almost every aspect of life. IoT is one of the biggest technology trends that organizations are not only investing in 2020 but even looking to understand in-depth as part of their R&D.**
The circuitry was developed using a Wemos D1 Mini board. The device's case was 3D printed to match the dimensions of the circuit on the board. The device's size and weight were the most important factors that were taken into consideration during the whole process and the components were chosen respectively.
This report contains the specifics and the working of the project with a demo video demonstrating the device's capabilities.

I. INTRODUCTION

This project is an implementation of a popular requirement that has been implemented in every mobile device nowadays. The need for proper weather information and predictions has been absolutely necessary in today's world. The result of this project is a portable device that one can carry along, specialized only for this purpose, and provides extremely accurate predictions and information about the climate.

II. PROBLEM STATEMENT

To make a compact and reliable weather monitoring package for a user to know about his/her location's weather conditions or check the precise conditions at his/her home when the user is away.
To provide personalized periodic notifications to the user's primary device about the conditions of a particular day and suggest short notes for the user to handle the day.
To provide the user with a dashboard which contains a comprehensive view of the weather and climate of the day, so the user can plan his errands accordingly.

III. LITERATURE SURVEY

An existing work related our project is a novel weather station which was designed using Micro Electro Mechanical Systems (MEMS), a technology that has been in significant use for the past two decades. Based on MEMS technology, multi-sensor chip integrated temperature, relative humidity and pressure is developed and manufactured. In the field of weather monitoring and forecast, it was observed that a micro system has an exceptional advantage compared to traditional weather monitoring stations. However, the integration processes of the sensors are a tad complicated and the performance strength of micro mechanical systems are relatively low.
A similarly made work is an update station which monitors additional parameters like monoxide density, windspeed, direction and pressure. This system is largely based on the Arduino for processing and sending data. For stability, this system uses a traditional ethernet wired connection at the cost of being less portable. The system comprises two main units' sensors: the outdoor units, to which the outdoor weather sensors are connected, and the indoor unit which is made up of two Arduino Uno boards mounted with an Ethernet shield. Its primary purpose is to write the weather data read by the outdoor unit to the SD card and send it to the online server for remote monitoring and data visualization.

IV. METHODOLOGY

1. PROPOSED SYSTEM

The idea behind our project is to create a portable weather station which uses Wemos D1 Mini and gets weather data from OpenWeatherMap API and this data could be visualized and analyzed using InitialState dashboard. The data will also be displayed on the I2C/IIC display which is connected to the Wemos D1 Mini. We will also be sending rich notifications to the mobile phones by using IFTTT. All the hardware components and softwares used are connected with each other using Node-Red. The

data that is being sent to InitialState through Node-Red. The data is also sent to mobile phones which is connected with Node-Red.
The temperature readings are categorized in Node-Red into different intervals. If the temperature recorded is in between 15-19 then the notification message sent to the mobile is “It is too cold outside, don’t forget to wear a sweater.”. Similarly, such messages are sent for other temperature reading also.
Raw weather data that consists of important climate parameters are obtained by the Wemos D1 Mini board through the API linkage provided by the Weather Station library by ThingPulse (Arduino IDE). The Weather Dashboard created though the InitialState platform then obtains the same information from a related API which (WeatherStack API). Certain parameters are then injected into Node- RED which in turn pushes values as information to IFTTT that interfaces the mobile devices to Node-RED for pushing notifications to the user’s phone.

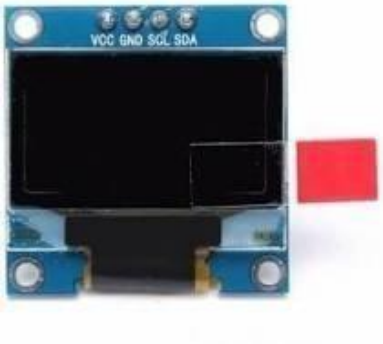
2. COMPONENTS USED

A. Hardware Components

1. Wemos D1 Mini

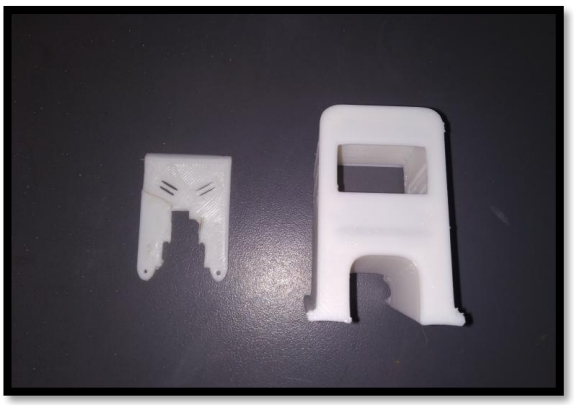
- Wemos D1 mini is like a "little Arduino with Wi-Fi" for a great price. It's based around the ESP8266, has one analogue port and 11 digital ports. It's programmed via micro-USB (or remote flash via Wi-Fi).
- You can use it with the Arduino IDE, micro python or NodeMCU. It runs from 5V or 3.3V. Logic levels are 3.3V for all ports.
- If you use the Arduino IDE, there are a lot of example sketches already provided. This makes it relatively easy to be able to do what you want with the board.
- I used these to read temperatures in various locations and send the data to a Raspberry Pi web server via Wi-Fi.
- They work well with TMP36, DS18B20, RasPiO InsPiRing RGB LEDs, PIR motion sensors, BME280 barometric pressure/temperature/humidity sensors.

2. I2C/IIC Display Module (1.3 Inch)



- This 0.96-inch OLED display is based on a popular SSD 1306 display controller.
- It works on both I2C (TWI). The display is small in size and very crisp. It has resolution of 128 x 64 pixels.
- It is ideal for projects where you want do display graphics, bitmaps and fonts of various sizes. Since it is based on popular display controller libraries are available for Raspberry Pi, Arduino, AVR, PIC and ARM microcontrollers.
- NOTE: This board/chip uses I2C 7-bit address 0x3C.

3. 3D Printed Case



- A 3D printer essentially works by extruding molten plastic through a tiny nozzle that it moves around precisely under computer control.
- It prints one layer, waits for it to dry, and then prints the next layer on top. The plastic from which models are printed is obviously hugely important.
- 3D printable models may be created with a computer-aided design (CAD) package, via a 3D scanner, or by a plain digital camera and photogrammetry software.
- 3D printed models created with CAD result in relatively fewer errors than other methods. Errors in 3D printable models can be identified and corrected before printing.
- The manual modelling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting.
- 3D scanning is a process of collecting digital data on the shape and appearance of a real object, creating a digital model based on it.

B. Software Components

1. Arduino IDE

The Arduino Integrated Development Environment is a cross-platform application that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

2. Node-Red

Node-RED is a flow-based development tool for visual programming developed originally by IBM for wiring together hardware devices, APIs and online services as part of the Internet of Things.

It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

3. IFTTT

If This Then That is a web-based service that allows users to create chains of conditional statements triggered by changes that occur within other web services such as Gmail, Facebook, Telegram, Instagram, or Pinterest. The service is offered in freeware, subscription, and enterprise versions.

You can build applets on IFTTT.com or in the iOS and Android mobile apps. There are generic channels for things like stocks, weather, date, time, and taking or making SMS messages and phone calls. There's even some "button widgets" to create smartphone home-screen-activated instant applets.

4. Initial State

- Data analytics and visualizations for the Internet of Things
- Real-time dashboards, waveforms, charts and maps automatically built from your data
- We can see what is happening in real-time, but also analyse what happened yesterday, last week, last month, last year...
- Transform your data instantly with mathematical expressions
- Embed your dashboard and visualizations into your website or project
- Stream data from any device capable of making an HTTPS request
- Get notifications based on a geofence or a data reading that is outside the acceptable range.

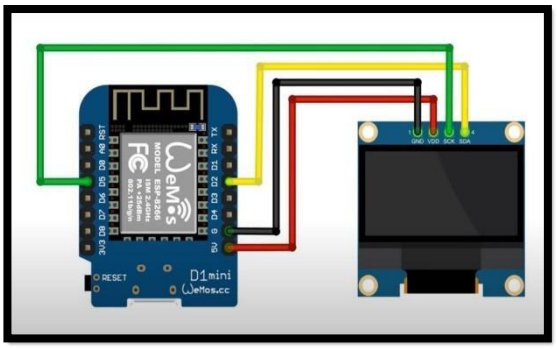
5. OpenWeather One Call API

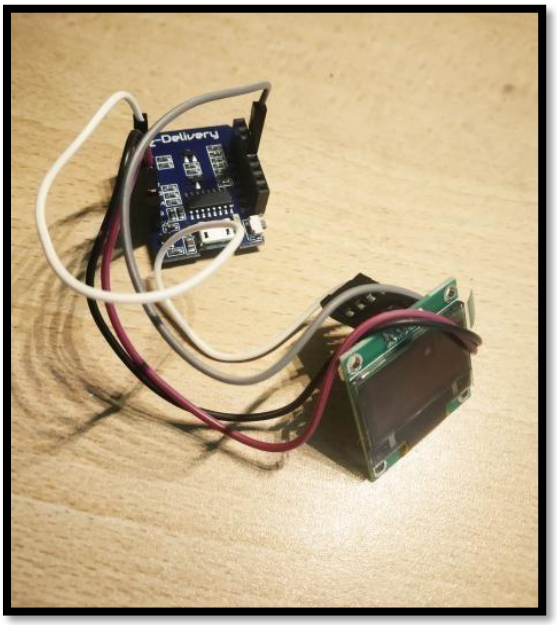
- We can access current weather data for any location including over 200,000 cities
- We can collect and process weather data from different sources such as global and local weather models, satellites, radars and vast network of weather stations
- JSON, XML, and HTML formats

6. ThingPulse

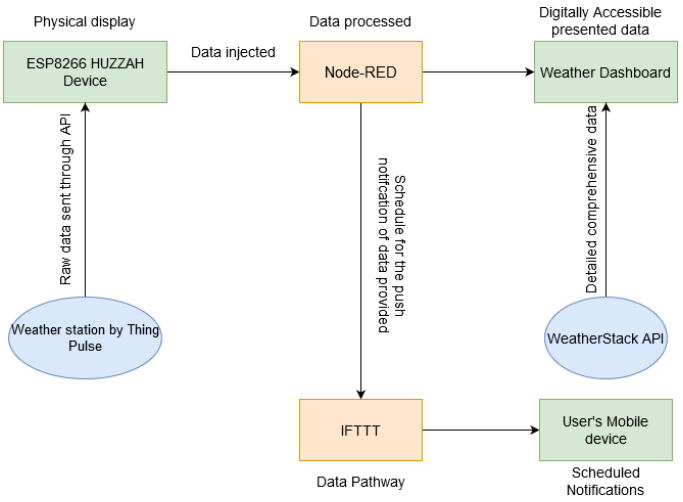
This platform is used by Arduino libraries to get weather data which can be used by hardware components like NodeMCU, Adafruit HUZZAH, Wemos D1 Mini, etc.

3. CIRCUIT DIAGRAM

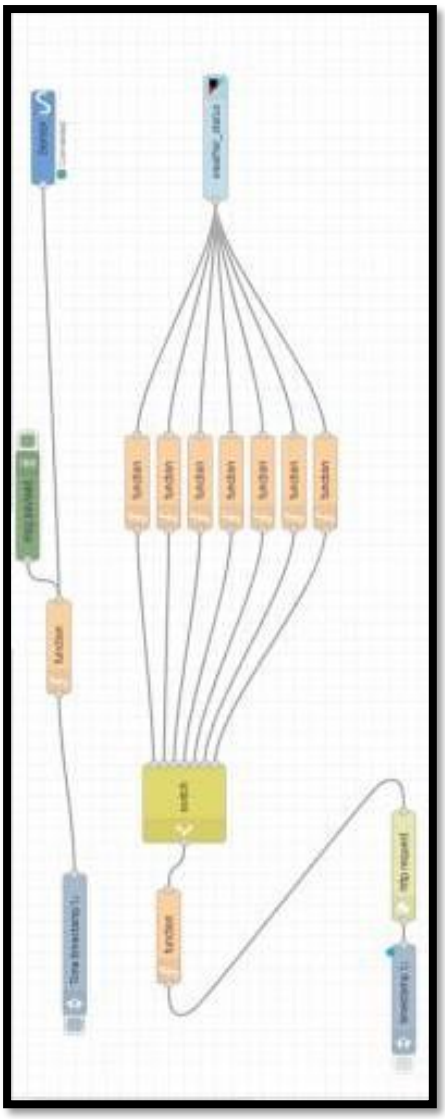




V. WORKING MECHANISM



The above figure shows a flowchart describing the working mechanism of our project.



The above figure shows how Node-Red connects all the components in our project.

The above figure shows how Node-Red classifies the temperature values obtained in order to send rich notifications to the user.

VI. REULTS OBTAINED

The device developed shows current climatic information.

The weather dashboard which was made using InitialState

Result obtained after clicking the notification. The notification redirects the user to InitialState website on their phone.

VII. FEATURES COVERED FROM IoT POINT OF VIEW

The entire project depends on cloud features like data pipeline through cloud. Data procurement is done through the respective weather data APIs. This ensures the swift transfer of data through to the respective nodes in the entire system. Moreover, it also reduces the storage necessities of the handheld devices, thus enabling ergonomic optimization. This entire cloud architecture eliminated the presence of physical data storage facilities.

The InitialState platform allows and easy to use interface for data visualization solutions. It has customizable tiles that require minimal coding. The platform also has a very dynamic data procurement backend service that reduces latency and delay in the entire process. This is really necessary for real-time visualizations and thus makes the weather dashboard more reliable and precise.

The transfer of weather data from the cloud structures to the mobile devices are securely protected in two ways. One the IFTTT applet is two protected through passwords in both the mobile device and the transmitting account. The applet is also protected through an unique ID. The Node-RED is also interfaced with InitialState through two IDs(one being the bucket key and access key). The node-red interfacing to IFTTT is also authorized through a key. All these keys are randomly generated and this level of authorization is extremely crucial to protect the data that is being transferred through these pipelines. It ensures that only the subscribers and publishers have access to the data and also that they don't have access to the data they are not entitled to.

VIII. DEMO VIDEO LINK

https://drive.google.com/file/d/1yJzUt50zIPNoivajGgm4qKZQM9FjM9VO/view?usp=sharing

IX. FUTURE SCOPE

This device has great scope of implementation in coming times. This type of devices can be used in different sectors like military and industries to eliminate the presence of huge (bulky and expensive) weather monitoring systems. But this can only be done with drastically improving the accuracy and precision of these devices. This is where cloud comes into the scene and provides clear cut solutions to latency and precision problems. With the current rate at the cloud technology is improving, this technology is not far away from implementation and integration into these sectors.

X. REFERENCES

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