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An Intelligent IoT Sensor Based Weather Monitoring System

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Abstract— In Present, monitoring systems play a key role in daily lives. Recently, due to the rapid development in technology, estimating the environmental weather conditions is a challenging task. In traditional systems, measuring the environmental parameters such as temperature, humidity and pressure are quite complex. To address this issue, propose an intelligent smart systems framework for environmental weather conditions. The proposed system uses an IoT-Sensor base architecture using Raspberry Pi and sends this measured data to the cloud server. Finally, the data is read from the web server using the HTTP protocol. The measured data is displayed on the website to monitor the weather conditions. This system is more intelligent compared to state-of-the-art systems. The experimental work shows that the proposed framework fulfils the requirement of both automated and real-time monitoring of weather conditions.

Indexed Terms— Raspberry Pi, IoT sensor, Webserver, HTTP protocol, Environmental parameters.

I. INTRODUCTION

Recently, one common buzzword in scientific literature is the Internet of Things (IoT) due to rapid development in smart technologies. Many IoT devices are designed to control, manage, and monitor human actions. As aware, AMAZON Alex is one of the IoT devices used to control various devices in the home and many more. All these inventions make human life easier compared to earlier. When the data is stored in the cloud, it is easier to analyze the things and useful for many authorities like governments, NGOs, scientists and so on. Humans have long sought to understand their environment.

This led to the invention of many devices to measure various parameters. To measure temperature, atmospheric pressure, and solar radiation, humans have created thermometers, barometers, and pyrometers, respectively. However, those traditional tools must be applied to the local environment. The weather monitoring system plays a key role in agriculture, plant cultivation and the health sector. Monitoring the weather allows data analytics and weather prediction to provide valuable weather information [1]. Current methods for meteorological monitoring and forecasting are characterized by their structure and data processing perspectives when considering system functions and processing techniques. As a result of IoT, humans can measure all environmental parameters remotely.

Depending on the system framework, weather monitoring systems can be static or mobile. Based on data produced by stationary weather stations, the cooling and warming of the grids can be estimated using a specific simulation tool that uses numerical simulations [2,3]. The amount of weather stations scattered around the city determines the accuracy of the approximated calculations for every grid. The National Meteorological Sensor Grid system is meant to observe weather data contemporaneous throughout spread regions in a city, with weather stations installed in schools. This work implemented a framework for weather monitoring systems using the Internet of Things (IoT) -sensor-based architecture. There are several architectures, frameworks and models designed by various organizations, academic and business sectors. However, there is no single standard reference architecture for IoT to encompass various technologies. In our system, Raspberry Pi plays a major role. This device can process the acquired data from the sensors and store it in a cloud server. One more application is the user can monitor and analyze the parameters using web applications. The major contribution of this paper is as follows:

- Design the simple IoT architecture for the weather monitoring system.
- Upload the data to the cloud and analyzed the data for feature predictions.

- Proposed a simple hardware model for estimation of weather parameters with state-of-the-art models.

The rest of the paper is structured as follows: Related works are described in Section 2. Materials and methods are presented in detail in Section 3. Then, Section 4 describes the implementation of the IoT model and testbed in various places. The experimental results are discussed in Section 5 and finally, Section 6 concludes this paper.

II. BACKGROUND AND RELATED WORK

A state-of-the-art review is outlined in this section with a major contribution to IoT-based weather monitoring systems. All these applications are developed by IoT with rapid technological development. Recently [4-5] implemented an IoT system for environmental monitoring to measure various parameters like temperature, humidity, and pressure. Monitoring systems require an application interface, which might be a web page, software, or mobile application for seeing and manipulating the received information [6]. The authors of [7] proposed a heterogeneous Internet of Things sensor node system for sensing acoustic, rain, wind, light, temperature, and pH levels in cornfields for smart agricultural applications. The technique attempted to harvest productive maize in large-scale fields by employing a drone that collects data and transfers it to a gateway.

The authors in [8] presented the system for monitoring Weather based on IoT. Later [9] designed a new system based on the internet of things technology by using the Raspberry Pi card. The system aimed to evaluate air quality by measuring its parameters, such as temperature, monoxide and dioxide carbon, and air pressure and humidity. This designed system is the more accurate author does not attempt to analyze the measured data. One more in [11] proposed an optimization based IoT framework for greenhouse climate control with efficient energy consumption. Another author [12] implemented a multi-mode IoT architecture to measure the environmental condition PIC microcontroller and Raspberry Pi under the master and slave control approach. This system used the measured data for farmers and the contribution of the authors was much appreciated. In [13] used a relative sensor (Pt100 and HC101) and an Arduino Uno to monitor distant temperature and humidity in the atmosphere (AtMega2560) and sent the sensed data to a web server.

From the above discussion, all the IoT frameworks have differed in architecture, hardware, and application point of view. Some of them are contributed to agriculture, some are for specific geographic regions and so on. However, all the IoT models perform the same task but vary in complexity levels. Most of the researchers used Arduino-based designs and the sensor used in this work are not stable. Hence, we conduct a suitable experiment and formulated the intelligent IoT sensor-based model for a weather monitoring system that supports all conditions. Moreover, this design is well suited for predicting the weather conditions based on historical data that was stored in a cloud server with help of machine learning and artificial intelligence.

III. MATERIALS AND METHODS

This section presents the architecture of the proposed IoT framework, which aims to monitor weather conditions. Fig (1) represents the conceptual bird-eye view of the proposed architecture.

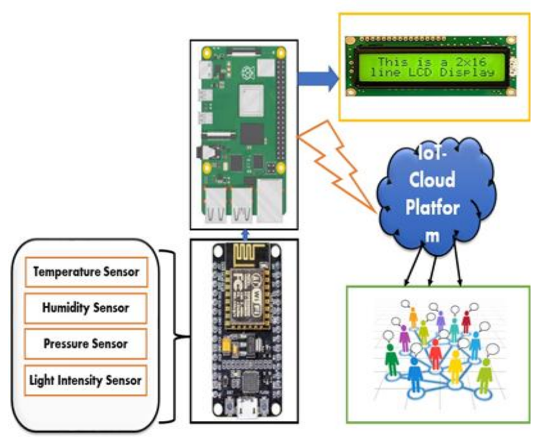

Fig1: Overview of IoT Sensor-based framework for Weather Monitoring System

The framework is comprised of three modules. First, is the Sensor Module, consisting of a temperature sensor, humidity sensor, pressure sensor and light intensity sensor. This sensor detects respective parameters and sends them to ESP8266. The Second module, with ESP8266, receives parameters from sensor nodes and sends them to the processing phase. Then, another module consists of Raspberry Pi, which sends the data to a cloud platform to store the measured data. Hence, this Raspberry Pi acts as a gateway between the cloud platform and sensors. The last module is the user interface provided to the user like farmers to know the status of the weather condition from the web application or mobile application. It was placed in the open air to collect all the relevant meteorological factors. To avoid malfunction owing to the risk of encountering water, sensors and microcontrollers were shielded by transparent housing.

3.1 Storing Weather data in Google Cloud

This phase is the most challenging task to store the data in the cloud platform. In literature, researchers used different cloud platforms to store the sensed data. In this work, select the cloud platform i.e., Google Cloud [14] which is the most well-known platform for all designers. In this, a table was created using SQL and stored the data sensed by the sensor via a cloud platform. The system was programmed to save the data to the cloud SQL table every 5 minutes. Compared to other cloud platforms, Google Cloud SQL was easy to set up, easy to run and with inbuilt security features. The system can manage all weather parameter data for the whole year, perhaps, and integrate data from sensors over the Internet. Aside from saving data into Google Cloud SQL storage, RPi3 Model B users can also save data into the local SQL storage via phpMyAdmin. It is shown in Fig2 that the data saved in local SQL storage can only be accessed by administrators with usernames and passwords instead of users.

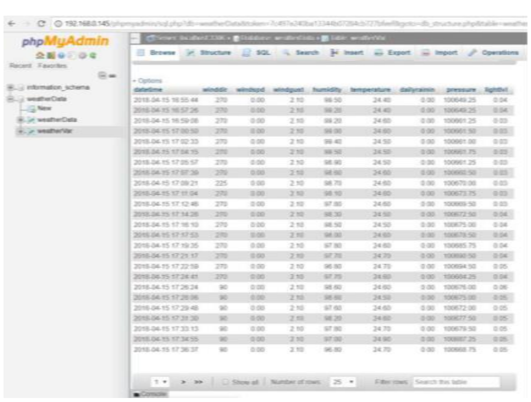

Fig2: Sample SQL table using PhpMyAdmin

3.2 Displaying Weather data

Once the data is stored in the Google cloud, then these data should be presented using various methods like a graph, bar chart and so on. For this, Google Data Studio [15] is the best option for displaying the sensed data from a sensor to the web platform. The main advantage of Google Data Studio over other platforms, it supports monitoring, logging, and analyzing the data which can be accessed by the administrator via a web page. Users may access data by filtering it by dates. Furthermore, users may export the data in a variety of forms, including CSV and Excel Sheets, for personal use. The data gathered was also analyzed further.

The complete workflow will be described using the below Fig 3.

IV. EXPERIMENTAL SETUP AND DISCUSSION

After integrating all the setup, which was discussed in Section 3, then all the parameters such as temperature, humidity and pressure are stored in cloud platform. This section highlights practical measurements and results of proposed system. The proposed system was deployed and tested in various places like farmland and city and rural areas.

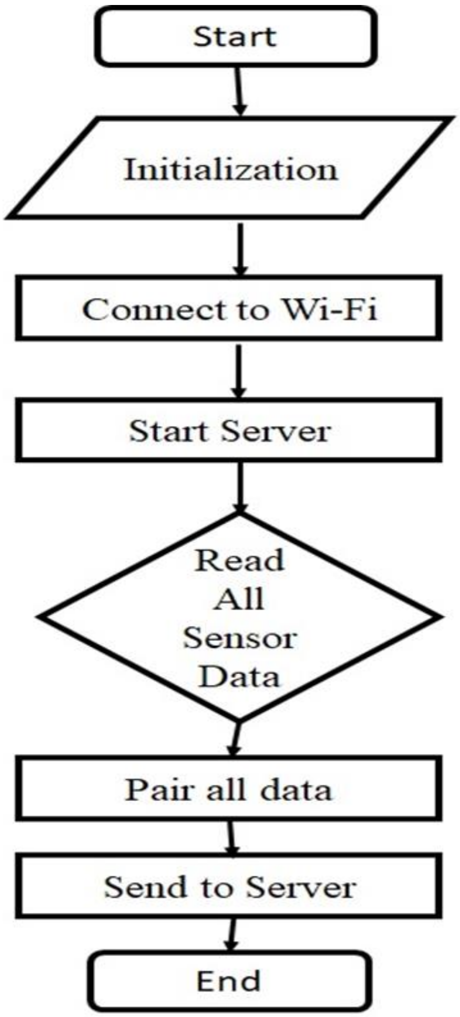

Fig3: Methodology for Proposed weather monitoring system

Here, the Fig 4 gives the data of temperature measurements taken from webserver. This shows that, at different time stamps, measured temperature is plotted. From this, the temperature is starts reducing from morning 8:52AM to 08:52PM. In the same direction, Fig 5 gives the data visualization between humidity and timestamps which was stored in webserver. Fig6 gives the atmosphere pressure in environment and give some information and plotted the same. All these data are very useful to analyze the weather conditions in specific time.

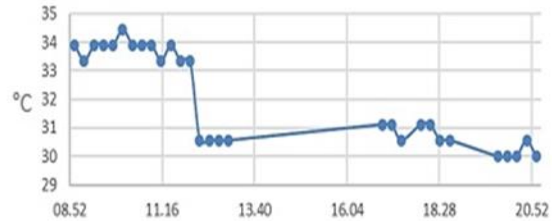

Fig4: Temperature measurement from Google Cloud SQL table

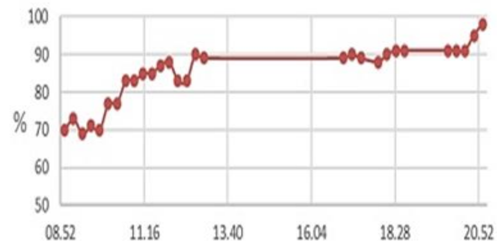

Fig5: Humidity measurement from Google Cloud SQL table

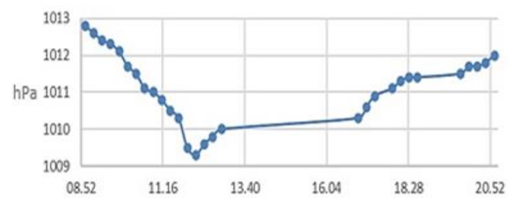

Fig6: Pressure measurement from Google Cloud SQL table

This approach may also be used to detect pollution in new and modern metropolitan areas. This approach provides an effective and low-effort reaction for continuous observation to preserve the general well-being against pollution.

V. CONCLUSION

The conclusion of the research from this article shows that the framework for IoT sensor-based weather monitoring system. This framework is simple compared to state-of-the-art IoT models and successfully deployed in any place to measure the weather condition parameters. The results obtained by the cloud platform are accurate and tested with traditional systems. The detailed experimental evaluation done by ESP8266 and Raspberry Pi4, later analyzed the data stored in webserver. The proposed system is flexible in all types of environments such as agriculture, urban and rural areas. In future, the proposed system is already had Raspberry Pi, so, using Machine learning models to predict the weather conditions based on historical data stored in webserver.

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