Using IoT for Smart Weather Station

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Abstract **–** Weather and climate forecasting plays an important part in our lives as they can protect and enhance our daily activities from various walks of life. Real-time data on weather information which are accurate and detailed can provide immense help to farmers for making better decisions on their crops and ways of pests' control. The construction industries are also affected by extreme weather conditions as there can be damage and depreciation of equipment. Weather forecast helps us in choosing the type of clothes to wear and in planning activities ahead based on the predictions. This paper proposed real-time weather station based on IoT which utilizes low-costs IoT-device Raspberry Pi and sensors. Two sensors are used to collect data from the environment. The real-time data on the weather condition are integrated and visualized in an IoT platform. This platform helps users in organizing and presenting the digital data collected from the real-world into a simplified visual form directly onto mobile phones or computers.

Keywords : *Internet of Things (IoT), Weather Station, Raspberry Pi, Sensor, IoT platform.*

I. INTRODUCTION

As weather and climate change can affect us in various ways such as our health, water, cultivation of crops, construction industries, etc., it becomes an important issue to develop a smart weather station facility for providing the weather forecasts to take necessary actions based on the weather and climate data. Environmental issues which arise with the advancements in different industries have also necessitated the need for efficient monitoring system. The internet of things (IoT) technology has attained increasing recognition in recent years owing to the powerful yet cost-effective nature of its implementation. IoT is believed to impact our daily life as it enabled interconnection of computers and many devices with the help of the IPv6 network. All objects surrounding us such as clothes, refrigerators, etc are able to gather information or data with the help of the IoT sensor devices. Hence, automated actions can be taken on the massive data collected for performing specific operations to suit our needs. This paper proposes weather station which is automated for collecting and recording the various fluctuating parameters of the environment such as temperature, humidity and atmospheric pressure without human involvement. IoT enables not only human to human, but also human to things and things to things communications [1]. Furthermore, the ability of the micro-computer and the sensors to get access to the global internet provides accurate, fast and flexible weather monitoring system for the users.

II. RELATED WORKS

The authors in [2] presented WSN utilized for monitoring a greenhouse. They made use of a Raspberry Pi with temperature sensor and soil moisture sensor for gathering information about the environment. The sensors are calibrated for getting accurate data. Authors in [3] designed and implemented WSN to monitor the environment using LoRa protocol. Sensors such as smoke, alcohol, methane, carbon-monoxide, temperature and light sensors were used for collecting different data on the environment. These data collected are then sent to the gateway which can send them to the cloud.

The authors in [4] proposed environment monitoring system which is low-cost and reliable. The system was built with microcontrollers and arduino boards. It consisted of sensors such as DHT22, DSM501A, BMP180, MQ135 and MQ9 for detecting environment parameters. The data collected by these sensors can be viewed by users from anywhere in the world through the IBM IoT platform.

The authors in [5] presented WSN-based system for monitoring water quality as pollution in water can lead to many diseases. Their system consisted of sensors for sensing pH value, turbidity level, CO_2 concentration, water temperature and distance of the water level. It also employed two RF modules XBee for longer distance transmission of data between computer and the SoC FPGA board.

Another system for monitoring water quality is presented in [6] which can detect pH, temperature and dissolved oxygen values of water. The sensors used for collecting these parameters are connected to arduino board with zigbee module. Comparison between the proposed brokerless architecture and the MQTT architecture was carried out.

The authors in [7] developed weather station able to provide data to users with the help of arduino board. As IoT technology has seen its applications in many fields, environment monitoring even in health-care industry can be implemented by using IoT devices [8]. IoT can also be applied for monitoring pollutions in the environment [9] and for analyzing the data gathered from the environment [10] to warn humans of the harmful pollutants.

III. METHODOLOGY

The system is built with a microcomputer Raspberry Pi 3, temperature sensor DHT11 and air pressure sensor BMP280. The microcomputer [11] is chosen as it is low-cost, having many interfaces through the 40 GPIO pins and high processing power. It is considered as the third generation among its predecessors. DHT11 [12] is used due to its low-cost yet accurate nature, and can measure humidity as well as temperature of the surroundings, by using thermistor and humidity sensor. BMP280 sensor [13] from Bosch is used as it can measure both barometric pressure and temperature with high accuracy. An IoT platform, uBeac [14] is used for integrating the data collected by the sensors and visualizing them in a meaningful way.

Both sensors DHT11 and BMP280 as given in fig. 1, collect the surrounding temperature and humidity as well as the air pressure. The data are collected by the IoT device Raspberry Pi through the GPIO pins available. After which they are transmitted to an IoT platform uBeac, which provides cloud-based services to the many IoT devices. This platform allows the user in visualizing the data in an organized way for easy analysis of data to make sense of the weather conditions quickly. The platform also supports many sensors to be integrated for various applications and allows several weather monitoring systems to be monitored in a single dashboard.

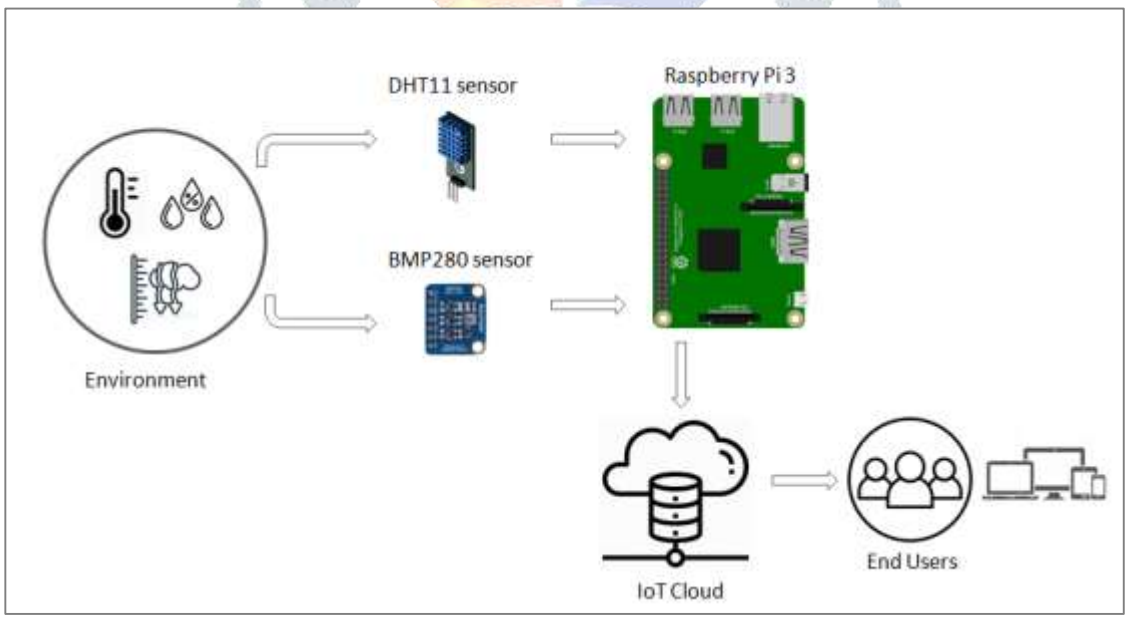

Fig 1. System Architecture

IV. FLOWCHART

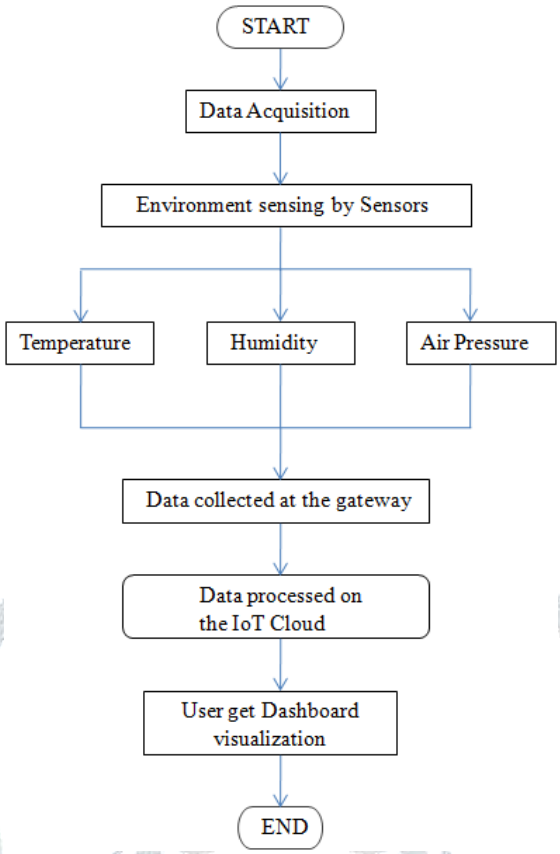

Fig 2. Flowchart of the System

V. RESULTS AND DISCUSSION

The experiment setup of the Raspberry Pi and the sensors is built as given in fig. 1. The data collected by the sensors are sent to the Raspberry Pi using Python script running on the IoT device. The script also exports the data collected from sensors as JSON data as shown in fig 3. As IoT platform is an important component for any IoT system to make sense of the large volume of data from the sensors, a simple, cost-effective but secure IoT platform uBeac is chosen. uBeac can process different types of data such as CSV, JSON, etc from the supported gateways as shown in fig 4.

```
import json
import threading
import http.client
from BMP280_sensor import BMP280
from DHT11_sensor import read_dht11_dat
from _util import get_sensor

# Configuration setup
UBEAC_URL = 'hub.ubeac.io'
GATEWAY_URL = 'INSERT UBEAC GATEWAY URL HERE'
DEVICE_FRIENDLY_NAME = 'Smart Weather Station'
SENT_INTERVAL = 1
# Sent data interval in second
```

Fig 3. Python script for Main Program

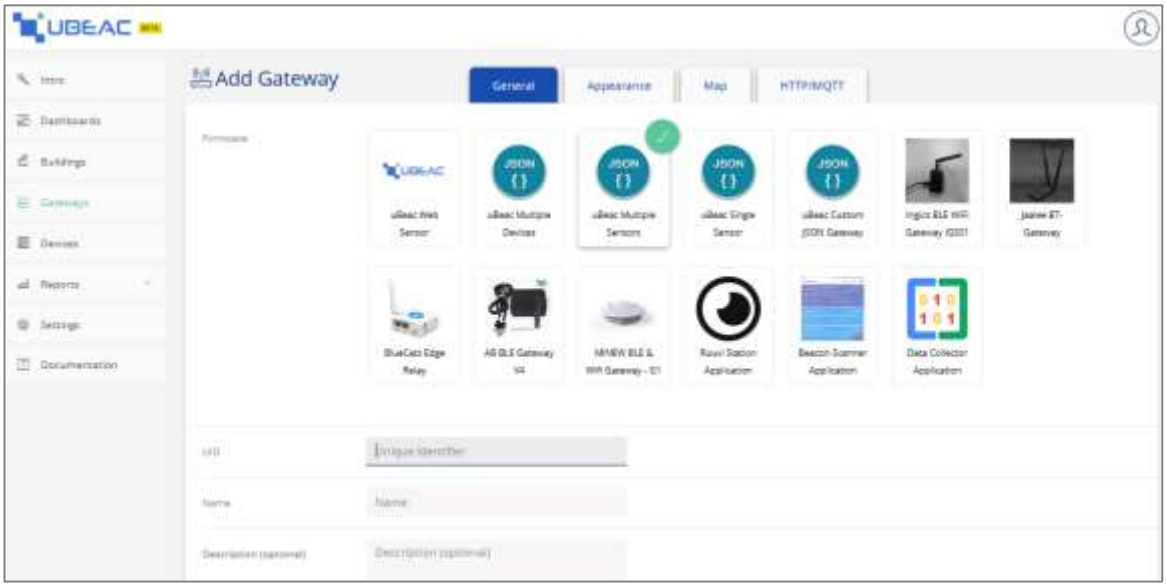

Fig 4. uBeac Platform for Selecting Gateways

Data are transmitted from the Raspberry Pi to the cloud using HTTP or MQTT protocols, which ensure security and reliability in communication. For data visualization, an user-friendly dashboard is used to show the real-time data in a clear cut manner that helps the user to understand trends and patterns of weather and climate condition as depicted in fig 5.

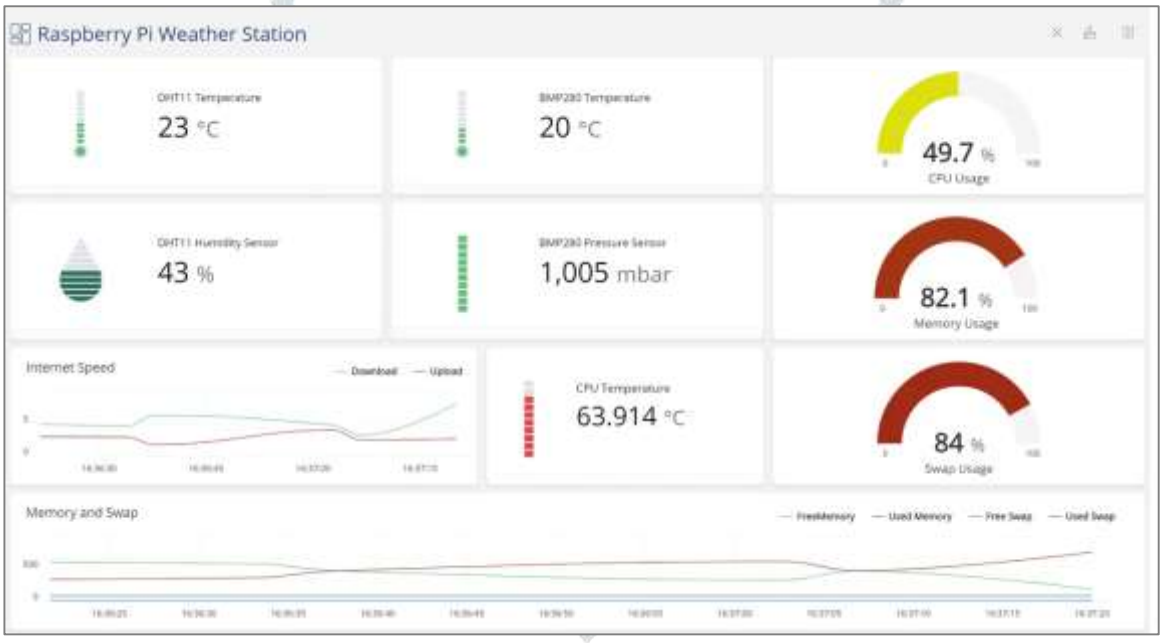

Fig 5. Dashboard display of the Weather Station

VI. CONCLUSION

The weather station presented in this paper is implemented with gateway Raspberry Pi and sensors with the help of a reliable and flexible IoT platform. The sensors are used to collect information about the temperature, humidity and air pressure values of the environment. The system can be used to realize the goal of weather forecasting system for providing important information to users which can reduce loss incurred due to adverse weather conditions and thereby improve public health and protection. Consequently, it provides a smart, low-cost and efficient way of monitoring the environment parameters through powerful dashboard which helps in visualizing the real-time data. As the environment data is stored on the cloud, it can be used for real-time analysis in order to identify patterns and trends. The system can be extended to take action based on certain real-time data and for implementing smart manufacturing and agriculture systems.

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