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IoT based Indoor Air Quality Monitoring system using Raspberry Pi4

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Abstract: **Poor quality is a major concern in urbanized areas. With more than 85% of people exposed to high levels of a particular matter. According to the World Health Organization, people are more cautious to look up the quality of air, their health by focusing on the spaces where they spend most of their time at home, school etc., and in their car. In this concept, a system with low power and data consumption is introduced. In this article, the air quality using a Raspberry Pi4 with Grove - Air Quality Sensor v1.3, CCS811 CO2 Air Quality Sensor, DHT 11 Temperature and Humidity Sensor were discussed. The communication between the sensor and Raspberry Pi4 will be through a serial port communication protocol and the code is implemented on the Python interface. Air pollution is a global environmental health problem many people's are dying every year due to some of the visible and invisible parameters like small particles, gases and so on. Most of the parameters of the environment to be monitored such as volume of CO, CO2, Temp, Humidity, Gas Leakage, Smoke, temperature sensor, and etc. These parameters information can received by Rasp Pi4, Arduino Uno and process the information and transmitted to clouds where they are being continuously monitored and information will be stored in the cloud database.**

Keywords - Raspberry Pi4; IEEE 802.11 ac wireless; Air quality; CO; Arduino Uno; CCS811 CO2 Air Quality Sensor; DHT 11 Temperature and HumiditySensors; Grove - Air QualitySensor v1.3.

1. INTRODUCTION

Pollutions can be divided as 1° and 2°. Primary pollutants are those that are directly released by vehicles such as Carbon Monoxide, Carbon dioxide, etc., released from vehicle exhausts. Secondary pollutant form when primary pollutants emitted directly from a burning process react in the Environment [1]. Ozone, acid rains is an example of secondary pollutants. Various air pollutants like nitrogen dioxide, sulfur dioxide and carbon monoxide etc and the importance of air pollution according to the World Health Organization (WHO) in 99% of world population 9 out of 10 people in the world leaving their own places by the guidelines of central pollution control board. The cloud-based network is to monitor the quality of air, and the framework is proposed for data acquisition and transmission.

Fig. 1.Hazarderous Air pollutants

The remote sensing background is to prepare some mitigation strategies. The value of humidity and temperature-related information is transmitted over the IEEE 802.11ac wireless module also that everyone in the range of host can check it over their systems, laptops, Smartphones. This information of parameters is relevant to every person. Hazardous parameter as shown in fig.1 like CO is monitoring is an extra precaution. By using Raspberry Pi4, IEEE 802.11ac wireless is sent text message to base station parameters information whenever its volume exceeds a particular safe limit [2]. Air pollution is combined with different types of hard particles, hazardous gases in the air [3]. The public cannot agree on whether the air is good or bad.

II. SYSTEM ENHANCEMENT PROCESS

Previous existing systems can monitor using low sensitivity, and require laboratory analysis. The proposed system advances the Real-time Air Quality monitoring systems using ThingSpeak Cloud [4]. Here, the system is implementation using GUI design along with Qt5.

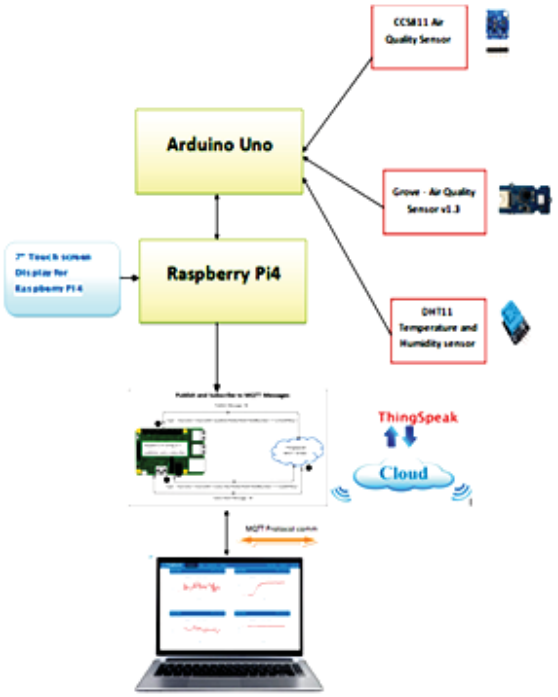

Fig.2 Block diagram of IoT-based Air Quality system using Raspberry Pi4.

To prevail over the troubles of existing systems, here, the IoT-based Air Quality monitoring systems is proposed [5]. Fig.2 consists of a block diagram of IoT-based Air Quality system using Raspberry Pi4 kit as using Arduino Uno, CCS811 CO2 Air Quality Sensor, DHT 11 Temperature and Humidity Sensor, Grove - Air Quality Sensor v1.3, Raspberry Pi4, Wi-Fi module and Arduino IDE [6].

III. WORK DESCRIPTION OF INTERFACING SENSORS WITH ARDUINO UNO & RASPBERRY PI4

Step 1:

After completion of circuit connection with DHT 11, CCS811, Grove Air Quality sensors, library files of interfacing sensors must be installed in it. Raspberry pi4 installed with the Raspbian operating system. The Raspberry Pi4 can scamper a more range of systems,

as well as the official Raspbian OS. Choose the SD card to write your own image.

Step 2:

Below table.1 contains an IoT-based Air Quality system using Raspberry Pi4 kit pin connection.

Table.1: Circuit pin connection of IoT-based Air Quality system using Raspberry Pi4 kit

Raspberry Pi4	Touch Screen Display
Vcc	Vcc
Gnd	Gnd

Arduino Uno	DHT11
Vcc	Vcc
Gnd	Gnd
D3 pin	Data

Arduino Uno	Groove Air Quality Sensor V1.3
Vcc	Vin(3.3V-5V)
Gnd	Gnd
A4	SDA(I2C DATA)
A5	SCL(I2C CLOCK)

Arduino Uno	Adafruit CCS611 Air Quality Sensor Module
3.3V	3.3V
Gnd	Gnd
A4	SDA(I2C DATA)
A5	SCL(I2C CLOCK)
NC	3.3V
GND	WAKE
NC	RST
NC	INT

Step 3:

Setup Qt Creator for Raspberry Pi4 cross-compilation. Qt is a cross-platform framework that can be used to create applications in C. Qt environment will allow you to develop Raspberry Pi4 applications that do not use specialties of the Raspberry Pi4 hardware to directly compile on a PC and test it there. With just one click and the right settings, you can then copy the software that you developed and tested on a PC to the Raspberry Pi4 and run it there. Writing Python applications around Qt means you have access to Qt Creator, which features a designer mode to generate code for the layout of the application.

Step 4:

PHP programming language: Easier development of graphical user interfaces using PHP [7]. Then execute python scripts using the exec() function in your PHP script. PHP is an open-source and scripting language for web development. The MySQL is an RDBMS that uses Structured Query Language (SQL).

Step 5:

Python to PHP Communication: first Connect to PHP Services using Python. The QT5 is installed in Raspberry pi4 for developing application software and GUI. After the completion of all these processes, the connection establishment between Raspberry pi4 with Arduino Uno.

Step 6:

Fig.3 contains Interfacing sensors with Arduino Uno and Raspberry Pi4 and set up all the sensors libraries in Arduino IDE form manage library function. Code implementation related sensors are developed in the Arduino IDE environment. The Air Quality parameters are monitored in the serial port 11500 baud rate. Wifi connection is enabled in Raspberry pi4. Sensors reading information will display on Raspberry pi4 GUI display when the connect button is pressed.

Step 7:

An account is created for cloud database using ThingSpeak. It is used to store information related to air quality parameters. Raspberry Pi4 CPU temperature information is sent to ThingSpeak, and aids to monitor this information from wherever on the

planet using the internet. After the implementation of Code, API can continuously monitor 7 environmental parameters in the ThingSpeak cloud.

Then obtain the information of 7 parameters of the air quality system. i.e.

1. CO values in between 1 – 1000ppm
2. NO2 values in between 0.05 – 10ppm
3. H2 values in between 1 – 1000ppm
4. NH3 values in between 1 – 500ppm
5. CO2 values in between 0 to 10000 ppm
6. Temperature
7. Humidity

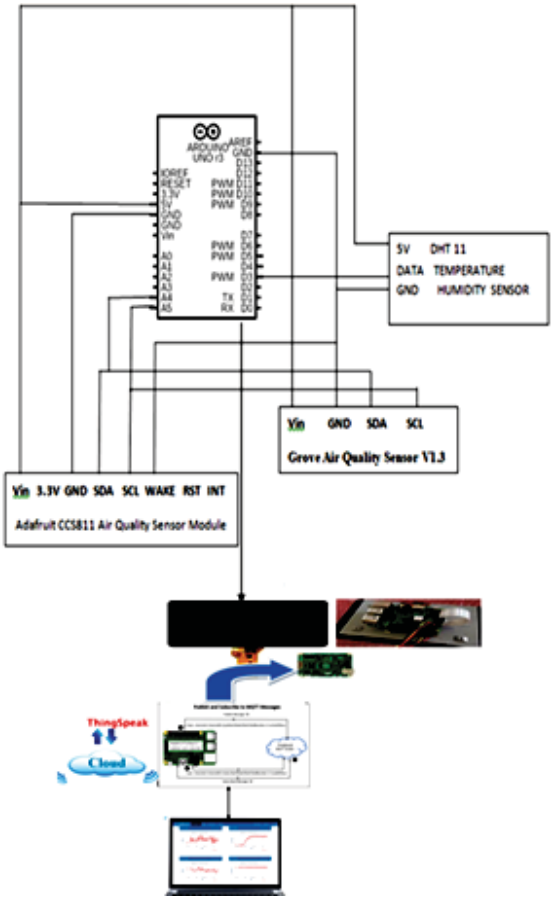

Fig.3 Circuit diagram of Interfacing sensors with Arduino Uno and Raspberry Pi4

IV. INTERFACING SENSORS IN AIR QUALITY SYSTEM

4.1. Raspberry Pi with an Arduino interface

Raspberry Pi with an Arduino Uno boards can communicate with one another using USB for serial communication with I2C[8].

4.2. CCS811 interface

CCS811 module interfaces with Arduino Uno as shown in fig.3. The Air quality parameter readings are obtained from the CCS811sensor and communicate using the I2C Bus. Connect sensor board's 3.3V pin to Arduino 3.3V pin and Gnd to Gnd pin of Arduino, SDA to A4 and SCL to A5 pin of Arduino Uno board. After installation of the CCS811 module VOCs detected. The CO2 concentration is continuous can monitor in clouds [9,10].

4.3. DHT11 interface

As shown in fig.3 consists DHT11 uses 5V and the middle pin is connected with the Arduino Uno D3 pin[11,12]. It is used to transmit Temperature and Humidity information to Arduino Uno and also monitor in a cloud database.

4.4. Multichannel Gas Sensor interface

Initially, connect the Grove - Multichannel Gas Sensor interface with Arduino Uno as shown in fig.3. Connect sensor module 5V pin to Arduino 5V pin and Gnd to Gnd pin of Arduino, SDA to A4 and SCL to A5 pin of Arduino Uno board. After the installation process is completed in Arduino IDE serial monitor will show results of CO, NO2, H2, NH3 air quality parameter information [13]. Through IoT, the data are monitored in a cloud database.

V. RESULTS AND DISCUSSIONS

IoT technology is implemented for continuous monitoring of designed sensors information to monitor the air eminence of both in different types of

situations. The information is collected from different sensors of each node, and saved it in local database using the ThingSpeak cloud database. As shown in fig 4, the local DB connection is maintained by retrieving, remote monitoring, and trend analysis.

Fig.4: Different field graphs Consists of real-time Air quality Parameters monitoring in Clouds

As shown above, all fig.4 indicates

Field 1. It consists of Real-time CO2 Monitoring in Clouds

Field 2. It consists of Real-time Temperature Monitoring in Clouds

Field 3. It consists of Real-time Humidity Monitoring in Clouds

Field 4. It consists of Real-time NH3 Monitoring in Clouds

Field 5. It consists of Real-time CO Monitoring in Clouds

Field 6. It consists of Real-time NO2 Monitoring in Clouds

Field 7. It consists of Real-time H2 Monitoring in Clouds

Thing Speak based Cloud services are generally used for storing information in the online monitoring cloud database for organization analytics technological services. This cloud service is measured as the data is stored in the database MySQL. The data is continuously updated to the related channels and was analyzed in Real Time System (RTS) using ThingSpeak. The complete running application on Raspberry Pi4 automatically initiated after the booting process is completed [14, 15]. Maintain the different java scripts are through to run and check the network connectivity, error connections can also be re-establishing the network connection.

VI. CONCLUSION

In this study, Air Quality Monitoring System is integrated between Connectionless sensor networks and Internet of Things based on the ThingSpeak cloud and the aim is to have completed remote monitoring in the air quality of the indoor environment [16]. Here, the MQTT lightweight protocol is implemented for IoT-based system connection. And also providing the authorization to a particular system for receiving, and sending of information, and also the number of web nodes involved. The future development work is on building a module for calculating the Air Quality Index (AQI) with the information aggregate from various sensor web nodes hence increases the number of web node deployments to have a large coverage areas.

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