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Environment monitoring system using low cost sensors

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ABSTRACT

Environment monitoring system designed to measure environment parameters. Proposed system measures Temperature, Humidity, and Absolute Barometric Pressure. It also detects the presence of toxic Gas- Carbon Monoxide, and detect presence of smoke. Low-cost sensor interfaces with Raspberry pi, and connected to ThingSpesk IoT platform. IoT platforms make it easier to manage these devices. The proposed system provides a cost-effective solution to environment monitoring. Raspberry pi read sensor data and send this data to the ThingSpeask IoT platform. Result shows that system is able to detect smoke and Carbon Monoxide. It accurately measures Temperature, Humidity, and Pressure. Proposed system monitors real time data, and sends it on ThingSpeak IoT platform after every 2 seconds.

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I. INTRODUCTION

Environment monitoring plays a very important role. Proposed system helps us to determine the quality of our environment. As well as focus on collecting information about the surrounding environment.

Environment monitoring system deal with various factors which need to be measured, mainly we are focusing on temperature, humidity, and pressure. The proposed system detects the presence of air pollutant carbon monoxide and smoke. The recent development in technology proves to be very helpful to monitor the environment [1]. Collected data can also easily shared and further proceed using recent technology like IoT, LoRa[2].

With the help of IoT, different devices, and several sensors can be connected to the Internet and IoT platforms make it easier to manage these devices. Raspberry pi can easily be connected to ThingSpeak, an IoT platform. Rest API used to send data to ThingSpeak.

II. RELATED WORK

Hasan Salman [3] proposed a robotic system which monitors Environment parameter – Temperature, Humidity, air quality, and harmful gas concentration. This data is shared into the Thinkspeak IoT platform. The author uses Arduino and Raspberry pi and sensor which provides low-cost system however this system requires 15 seconds of time to send data on the IoT platform.

Mohannad Ibrahim [4] proposed a system which is based on raspberry pi and sensor to measure temperature, Humidity, light intensity and concentration of carbon Monoxide, they also used a seismic sensor to detect earthquakes. Given data is uploaded on IoT, to access it from anywhere.

Sriyanka [5] proposed a system which uses Arduino, Raspberry Pi 3, Zigbee and Adafruit IO along with IoT, measures concentrations of carbon monoxide, carbon dioxide, combustible gases, smoke, and air quality. Zigbee protocol is used for communication between Raspberry Pi3 and Arduino. Then the result is uploaded on the Adafruit IO IoT platform. This allows system operation without human involvement.

George Mois [1] talk about the importance of Environment monitoring. This paper also presents different methods to monitor the environment using advanced technology. They also mention the difference and similarities between them.

Rizky Pratama Hudhajanto [6] proposed Wireless Sensor Technology to measure Temperature, Humidity and Carbon dioxide. They used the IEEE 802.15.4 protocol for data collection and sending it to the server. It also talks about using social media so share environment data.

Munmun Ghosal [7] proposed a quadcopter for environment monitoring. It also provides the facility to identify a location where air pollution is significant. It monitors the Temperature, Humidity, light intensity, smoke, and CO2. They used Atmega328 based microcontroller. GPS is also connected to the quadcopter to identify the location.

III. SYSTEM ARCHITECTURE

The proposed system uses to monitor temperature, Humidity, Barometric Pressure also it is used detect Carbon Monoxide and smoke.

The environment monitoring system consists of 4 sensors. DHT 11 used to measure Temperature and Humidity, BMP280 measures Absolute barometric pressure and also we can measure temperature from it. MQ 7 used to detect Carbon Monoxide and MQ 135 is used to detect Smoke. A GUI is used to display sensor data in a real-time environment.

All 4 sensors are connected to Raspberry pi. I2C protocol used to communicate between BMP 280 sensor and raspberry pi. Raspberry pi collects information from the sensor and then it sends this data to the IoT Platform ThingSpeak.

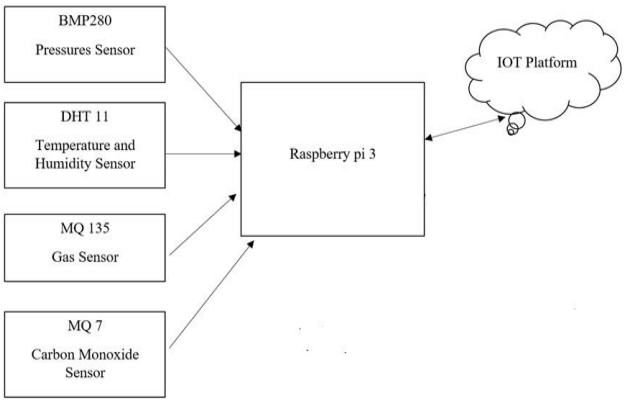

Fig. 1. Block diagram of proposed system

1) Temperature and Humidity sensor (DHT 11)

DHT11 sensor used to measure Temperature and Humidity. It uses Negative Temperature coefficient thermistor to measure temperature and to measure Humidity capacitive humidity sensing element is used.

2) Pressure sensor (BMP 280)

BMP 280 sensor measure barometric pressure, it is also able to measure temperature. It uses Piezo-resistive pressure sensing element and a mixed-signal ASIC.

3) Carbon Monoxide Sensor (MQ 7)

MQ 7 sensor used to detect the presence of Carbon Monoxide. Stannic oxide is use as a sensitive material for MQ7. In clean air, stannic oxide show lower conductivity, while as gas concentration increases conductivity also increased.

Fig. 2. Carbon monoxide sensor

4) Smoke sensor (MQ 135)

MQ 135 sensor used in air quality equipment. MQ 135 is used to detect various gases like Nitrogen Oxide, Ammonia, alcohol, Benzene, smoke, Carbon dioxide, etc. A variable potentiometer is provided to adjust the sensitivity of this sensor.

Fig. 3. Smoke sensor

Raspberry pi 3

Raspberry pi 3 uses Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC which operates on 1.4GHz clock frequency. It comes with connectivity - 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, hence it's easy to interface raspberry pi with IoT.

IV. HARDWARE DESIGN

All sensors are connected to raspberry pi 3 B+. Raspberry pi only supports digital signals. DHT 11 gives digital output. DHT 11 can be connected to any of the GPIO pin as it gives results in digital format. MQ 7 and MQ 135 sensors have two outputs, analog output, and digital output. Using digital output, we are detecting the presence of gases. This two sensor can be connected to any of the GPIO pin. A potentiometer is used to adjust sensitivity of this sensors.

Table 1. Raspberry Pi I2C pins

Raspberry Pi		
Pin	GPIO	Alternate function
27	GPIO0	EEPROM Data
28	GPIO1	EEPROM Clock
3	GPIO2	Data
5	GPIO3	Clock

BMP 280 senor works on I2C or SPI communication protocol. Raspberry pi support I2C, SPI, and Serial

communication protocol. Raspberry pi GPIO pins can be used with a variety of alternative functions, we are interested in I2C protocol. Table. 1 show's I2C pins of the raspberry pi.

BMP 280 sensor have 6 pins, not all of this pin useful to us. I2C require used of 4 pins only. Which are Vcc, Ground, SCL, and SDA.

Table 2. Connection between BMP 280 sensor and Raspberry pi.

BMP 280		Raspberry Pi	
Pin	Function	Pin	Function
1	Vcc	1	3.3V
2	Ground	6	Ground
3	SCL	5	SCL
4	SDA	3	SDA
5	CBS	NC	-
6	SDO	NC	-

CBS and SDO pins kept unconnected. Connection of Raspberry pi and the BMP 280 sensor is shown in Table 2.

Table 3. Sensor connection with Raspberry pi

Sensor	Sensor Pin	Connection to Raspberry pi	Comment
DHT 11	out	15	Temperature, Humidity
MQ 7	D0	31	Carbon Monoxide
MQ 135	D0	35	Smoke

DHT 11, MQ 7 and MQ 135 sensors pin to pin connection with the raspberry pi are shown in Table 3.

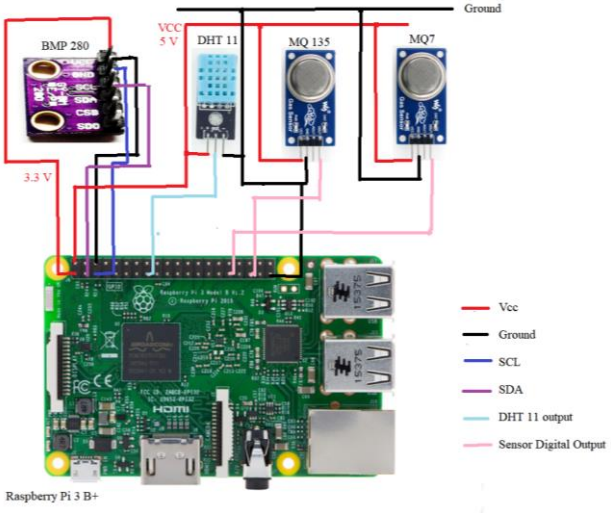

Fig. 4. Circuit diagram of proposed system

Raspberry pi provides 5 V and 3.3 V supply. Sensors like MQ 7, MQ 135, and DHT 11 require 5 V supply to their proper operation. They are connected to 5 V supply. BMP 280 work on low voltage to reduce power consumption. It operate on 3.3 V. Fig. 4 shows detail circuit diagram of proposed system. DHT 11, MQ 7, and MQ 135 are connected to GPIO, while BMP 280 connected to the I2C pins of Raspberry pi.

1) Programming

Python language is used to program Raspberry pi. The aim of this program is to obtain valid reading from all sensors, and this data to the IoT platform. In order to do that first we import essential library function which insured we get valid reading from sensor as well Raspberry pi send obtain reading to IoT platform. Fig. 7. Shows flow of program to obtain desired result.

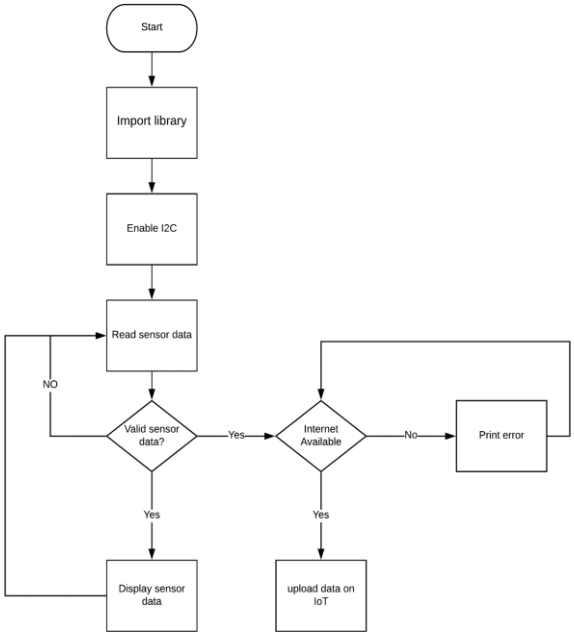

Fig. 5. Flow chart of proposed system

V. RESULT

Raspberry pi sends sensors data to ThingSpeak IoT platform. On ThingSpeak we can see this data graphically. Temperature, Humidity, and Pressure seen on ThingSpeak IoT platform.

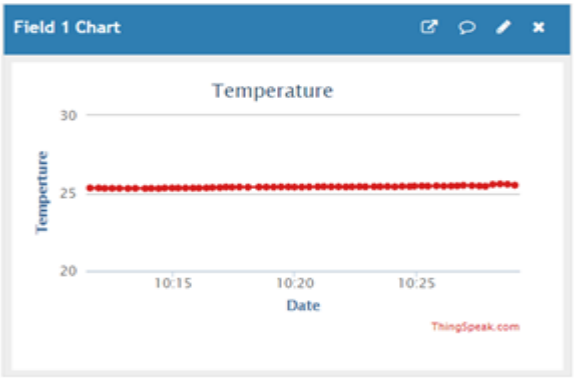

Fig. 6. Temperature Reading

DHT11 measure Temperature in degree Celsius (° C). Fig6. Shows Temperature reading from DHT 11 sensor on ThingSpeak platform. Proposed system measure Temperature from 0 °C to 50 °C.

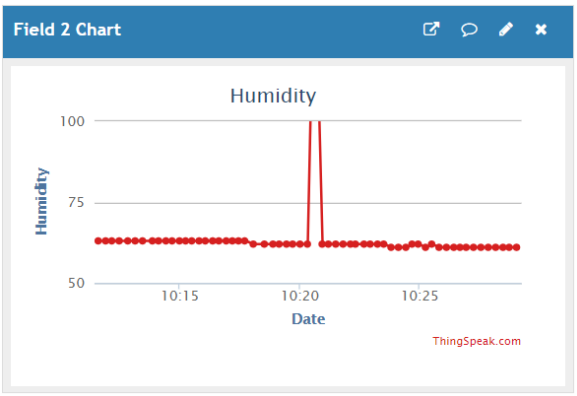

Fig. 7. Humidity Reading

DHT11 measure Relative Humidity in percentage (%). Fig7. Shows Humidity reading. Proposed system measure Relative Humidity from 20% to 90%.

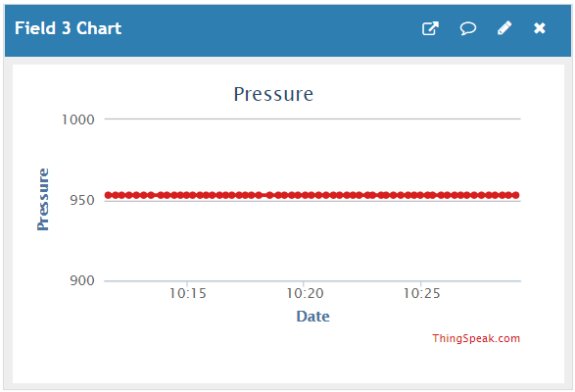

Fig. 8. Pressure Reading

Fig8. show Absolute barometric pressure measure in Hecto pascal (hPa). Proposed system measure pressure from 300 hPa to 1100 hPa.

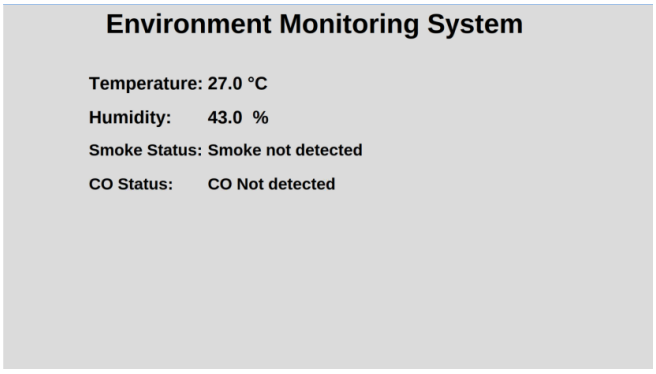

Fig. 9. GUI of Environment Monitoring system

Fig 9. Shows graphical user interface (GUI). It shows real time sensor data which update at every 5 seconds of interval. Raspberry pi display sensor data using GUI and when internet connection is available this data sends on IoT platform.

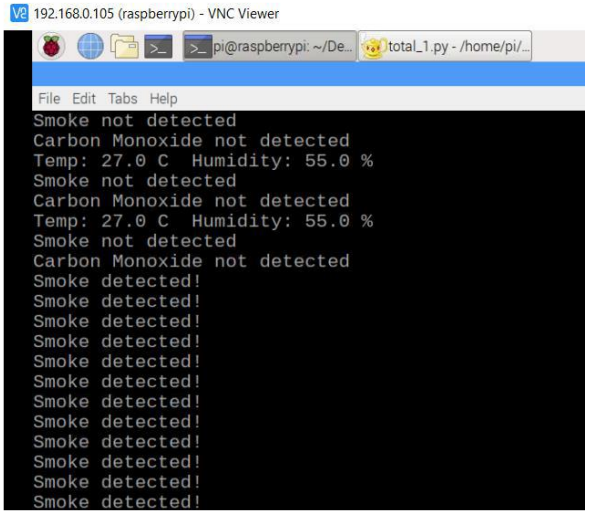

Fig. 10. Results of smoke detection on VNC viewer

Fig. 10. Shows result of Carbon Monoxide sensor (MQ 7) and result of Smoke sensor (MQ 135). When sensor comes to contact with smoke it alert us and display positive result as ‘smoke detected’. When sensor doesn’t sense Carbon monoxide and smoke, we can see results, ‘smoke not detected’ and ‘Carbon monoxide not detected’.

VI. Conclusion and Future Scope

The proposed system uses low-cost sensor and cost-effective, high-performance Cortex-A53 based Raspberry pi board. Obtain result shows that the proposed system measures Temperature, Humidity, and Pressure as well as it detects Carbon Monoxide and smoke in the surrounding environment. Proposed system sends real time data on IoT platform in every 2 seconds interval.

In future more number of gas sensors can be include in this system. We can collect data from different locations and it will help to carry out further analysis.

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