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Air Pollution Monitoring System Using WSN

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ABSTRACT: In this paper air pollution monitoring system is proposed. This system can be used for monitoring pollutants in the air of particular area. The proposed system is consisting of two parts. 1. First part will focus on the monitoring of air pollutants concentration with the help wireless sensor networks (WSN) 2. Second part will deal with interfacing of WSN with Internet. Monitoring part of the system will be discussed here. Air pollution monitoring system consists of various sensors that are used to detect the concentration of pollutants in the air i.e. MQ-4 for Methane, MQ-7 for Carbon Monoxide (CO), MQ-135 for Carbon Dioxide (CO₂) and DS18B20 for Temperature measurement. The detected concentration of pollutants will be displayed on LCD screen on the system. This collected information will be directly sent to the internet from system.

KEYWORDS: Raspberry Pi, WSN etc.

I. INTRODUCTION

Air pollution not only brings serious damage to human health but also causes negative effects to natural environments. The air pollution occurs due to contamination of air with Carbon monoxide (CO), Carbon dioxide (CO₂), Nitrogen dioxide (NO₂), Sulfur dioxide (SO₂) and many other harmful pollutants. It has hazardous effects on human health. Carbon monoxide reduces oxygen carrying capacity of the body's organs and tissues which may lead to cardiovascular disease. Carbon monoxide causes visual impairment, reduced manual dexterity, reduced work capacity, poor learning ability. So it becomes more and more important to monitor and control air pollution. It will become easy to control it by monitoring the concentration air pollutant parameters in air. Using laboratory analysis, empirical analysis conventional air automatic monitoring system has high precision, but large bulk, high cost make it impossible for large-scale installation.

To monitor air quality, wireless sensor networks (WSNs) might be a great tool, because they can automatically collect air quality data. It will also help us to keep a working staff away from danger and a high security can be achieved and it will also help the Government authorities to monitor the air pollution.

The proposed system will focus on the monitoring of air pollutants concentration with the help of combination of Internet of things with wireless sensor networks. This information will be displayed on the webpage via internet in real time.

II. PROBLEM FORMULATION

Using laboratory analysis, conventional air automatic monitoring system has relatively complex equipment technology, large bulk, unstable operation and high cost. This system can only be installed in key monitoring locations of some key enterprises, thus system data is unavailable to predict the overall pollution situation.

The proposed system will not only detect the concentration of pollutants in the air but also gives the information about quality of air. This information will be stored on a webpage with the help of internet.

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III. AIR POLLUTION MONITORING USING WSN

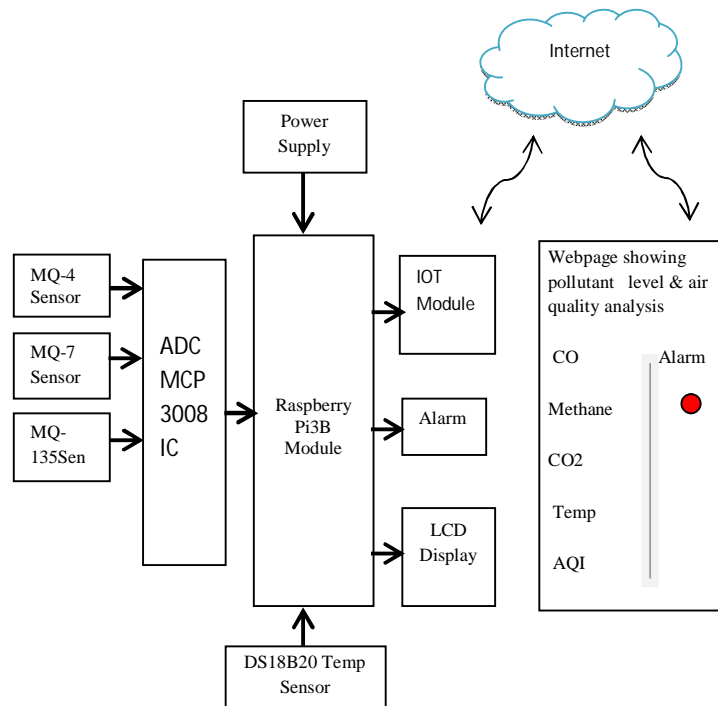


Fig 1: Block diagram of air pollution monitoring using WSN

The block diagram of proposed system is shown in fig 6. It consists of Raspberry pi module in the center of system. The various sensors for detection of pollutants and other parameters are connected with raspberry pi through ADC interface IC MCP3008. Here Methane (MQ-4), CO (MQ-7) and CO₂ (MQ-135) sensors will detect respective gas concentration and Temperature(DS182B0) of the air of particular area. The concentration of particular parameter will be sensed by sensor and that values will collected by raspberry pi module via ADC IC. Some analysis will be done on these values to find the air quality of that area. The information will also be displayed on the LCD display at system side. This information in analysis form will be send to the internet cloud using IOT module. This information is uploaded on the website from cloud. In case of emergency and high pollution condition the alarm can be generated at site by giving alarm command from the webpage itself.

The proposed system mainly consists of

1. Raspberry pi
2. ADC MCP3008 IC
3. Various sensors (MQ-4, MQ-7, MQ-135, DSB18B20)
4. LCD display
5. IOT module
6. Alarm
7. Webpage

Out of above parts working of first four parts has been done and discussed in this paper.

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1. RASPBERRY PI

The Raspberry Pi is a low cost, **credit-card sized computer** that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. The operating system used for raspberry pi is Raspbian.

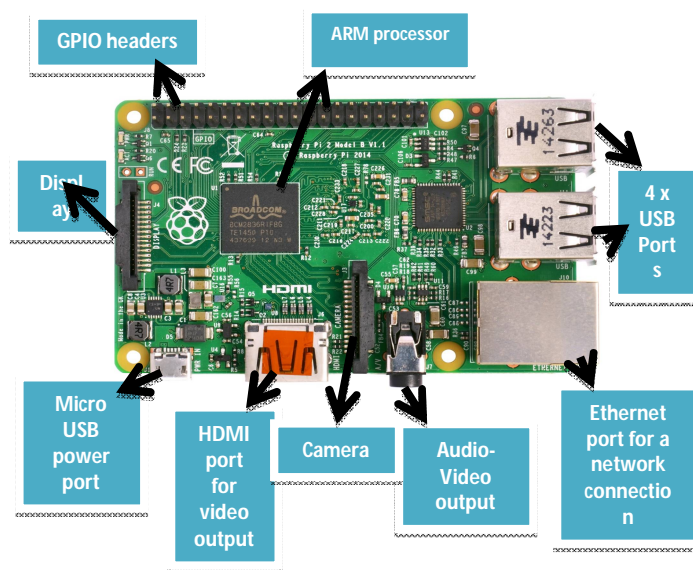


Fig 2: Raspberry Pi 3B Module

Features of Raspberry pi

- A 1.2GHz 64-bit quad-core ARMv8 CPU
- 802.11n Wireless LAN
- Bluetooth 4.1
- Bluetooth Low Energy (BLE)
- 1GB RAM
- 4 USB ports
- 40 GPIO pins
- Full HDMI port
- Ethernet port
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot (now push-pull rather than push-push)
- Video Core IV 3D graphics core

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2. ADC MCP 3008 IC

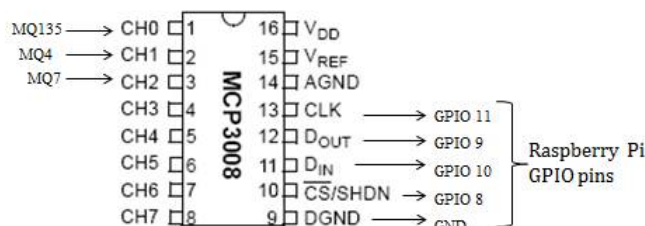


Fig 3: Interfacing of ADC MCP 3008 IC

The MCP3008 is a low cost 8-channel 10-bit analog to digital converter. MCP3008 is offered in 16-pin PDIP and SOIC packages. The MCP3008 is programmable to provide four pseudo-differential input pairs or eight single-ended inputs. The MCP3008 IC operates over a broad voltage range (2.7V - 5.5V).

3. VARIOUS SENSORS

a. MQ-4 sensor for methane

Sensitive material of MQ-4 gas sensor is SnO₂, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. MQ-4 gas sensor has high sensitivity to Methane, also to Propane and Butane. The sensor could be used to detect different combustible gas, especially Methane. The operating voltage is 5.0V±0.1V. It is with low cost and suitable for different application. Detecting range is 300ppm-10000ppm Methane.

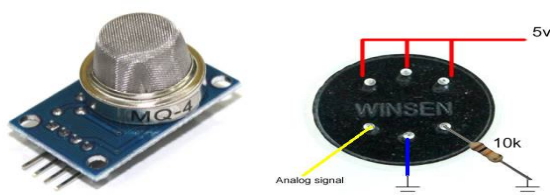


Fig 4: MQ-4 sensor

b. MQ-7 sensor for CO

Sensor composed by micro AL₂O₃ ceramic tube, Tin Dioxide (SnO₂) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components, the enveloped MQ-7 have 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current. The operating voltage is 5V±0.1. Detecting range is 20ppm-2000ppm carbon monoxide.

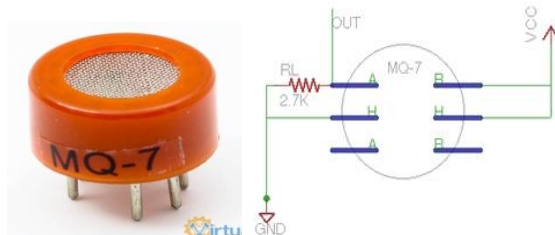


Fig 5: MQ-7 sensor

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c. MQ-135 sensor for CO₂

Sensor composed by micro AL₂O₃ ceramic tube, Tin Dioxide (SnO₂) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The enveloped MQ-135 have 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current. Resistance value of MQ-135 is difference to various kinds and various concentration gases. The operating voltage is 5.0V±0.1V. The detecting range is 100ppm NH₃ or 50ppm Alcohol concentration in air and use value of Load resistance that (RL) about 20 KΩ(10KΩ to 47 KΩ).

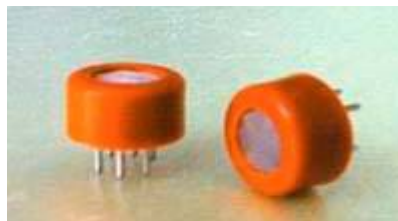


Fig 6: MQ-135 sensor

d. Temperature Sensor DS18B20

The DS18B20 Digital Thermometer provides 9 to 12-bit centigrade temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of -55°C to +125°C and is accurate to ±0.5°C, over the range of -10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line (“parasite power”), eliminating the need for an external power supply.

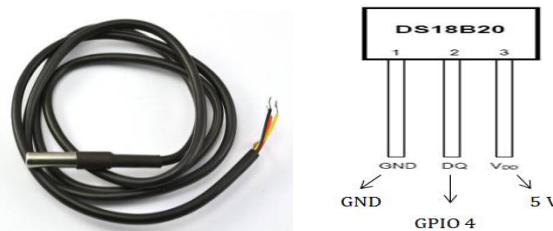


Fig 7: DS18B20 sensor

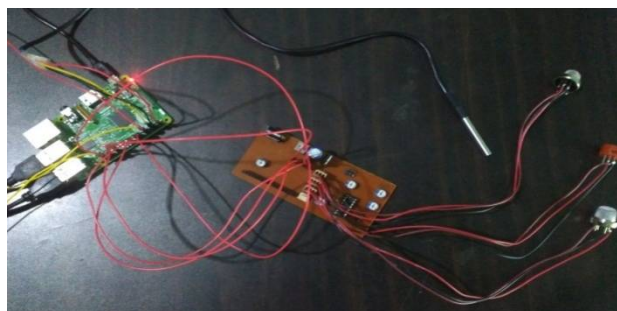
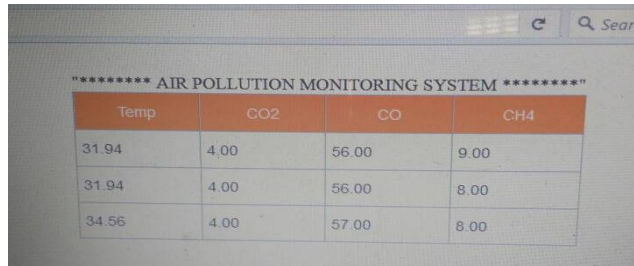


Fig 8: Interfacing of Sensors with Raspberry Pi

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***** AIR POLLUTION MONITORING SYSTEM *****			
Temp	CO2	CO	CH4
31.94	4.00	56.00	9.00
31.94	4.00	56.00	8.00
34.56	4.00	57.00	8.00

Fig 9: Readings of Various Sensors

1. LCD DISPLAY

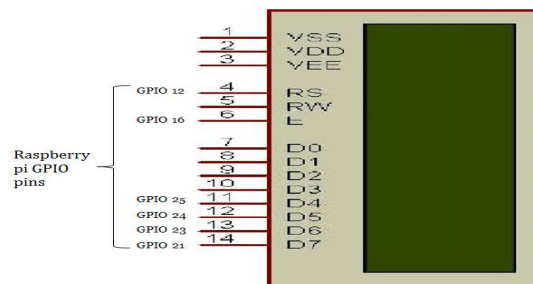


Fig 10: LCD interfacing with raspberry pi

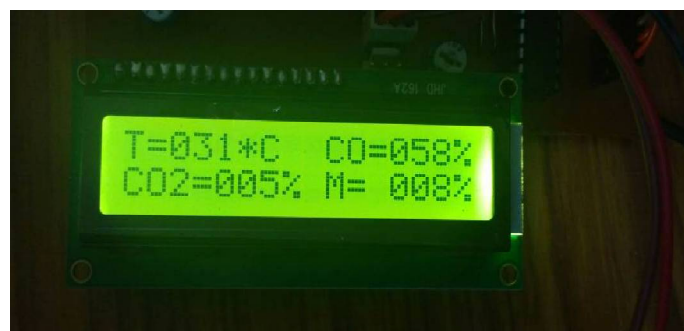


Fig 11: LCD output

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IV. CONCLUSION

Though previous air pollution monitoring systems discussed in [11] are based on different platforms are cost effective in some cases, they are time consuming. Some of them have used microcontroller ([1], [3], [4], [6], [7], [8]) for monitoring purpose. For analysis purpose they have used Artificial Neural Networks [2] which needs mass data and algorithms like ID3 [3] makes system complex. Since the information is sent to PC and then it is uploaded on web the system is quite time consuming and not real time.

The air pollution monitoring system measures pollutant concentration in the air. Here sensors MQ-4, MQ-7, MQ-135 are used to detect Methane (CH₄), Carbon monoxide (CO) and Carbon Dioxide (CO₂) respectively. Also DS18B20 used to measure Temperature. Since we are using raspberry pi, the size of this system will be reduced as compared to previous systems. The time required for complete process will be less as we uploading the information on internet directly from system. As we are doing analysis of air quality the prediction related to the environment can be done.

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