
Design and Development of Web based server for Monitoring Industrial Air Pollutants

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ABSTRACT

For last few years, challenges in monitoring and control of distant environmental parameters accurately have emerged as a new field of research. The concept of Internet of Things (IoT) is also emerging very fast where everything around us comes with an internet connectivity for monitoring. Air pollution monitoring is though old but very useful concept in day to day life. Air pollution monitoring starts from the traditional way to the most sophisticated computer have been used to monitor the air quality. Monitoring the industrial air pollutants and displaying the parameters data on the webpage is a key part of this proposed system. In our proposed system, we design an industrial air pollutants monitoring system, capable of monitoring the environmental parameters like temperature, carbon monoxide, nitrogen dioxide and the particulates matter. These environmental parameters are responsible for the air pollution. So, we focus on design of a low cost system that is capable of remotely monitoring the environmental parameters like temperature and different air pollutants at the remote industrial area.

KEYWORDS

Raspberry Pi, CO, NO₂, Temperature, PM_{2.5}, PM₁₀.

1. INTRODUCTION

Environmental monitoring system is a framework that is equipped for measuring a few ecological parameters like temperature, CO, NO₂, PM_{2.5} & PM₁₀. These parameters are essential in numerous applications like in industry, parks, in recreation areas and climate gauging. We focus on design of a low cost system that is capable of remotely monitoring the environmental parameters like temperature and different air pollutants at the remote industrial area.

Here a solution for monitoring the air pollution levels in industrial environment or particular area of interest using wireless embedded computing system is proposed. The solution includes the technology Internet of Things (IoT) which is outcome of merged field of computer science and electronics. Here the sensing devices are connected to the embedded computing system to monitor the fluctuations of parameters like temperature and air pollution levels from their normal levels. This system uses wireless sensor networks for sensing the environmental parameters in the area under supervision. The sensor array is connected with the microcontroller unit and further interfaced with the web server. Sensor nodes have been designed to measure the temperature and different air pollutants. The central monitoring of air pollutants is based on the Raspberry Pi board.

2. MOTIVATION

One of the greatest problems that the world is facing today is the environmental pollution. It consists of soil, water and air pollution. The first and foremost environmental pollution is air pollution which causes global warming and climate changes. It also adversely affects on human health. In contrast to the developed countries, civic action pressure groups and public demand for environmental improvement are not strong. The widely publicized environmental deterioration of the industrialized nations has however had its impact on developing countries.

3. OBJECTIVES

- i. To design a system that performs the online monitoring of the industrial air pollutants.
- ii. To collect data from array of sensors and to send the measured data to the microcontroller unit.
- iii. To monitor the various environmental parameters like temperature, CO, NO₂, PM_{2.5} and PM₁₀.
- iv. To collect data on real time basis without any human intervention.
- v. To display the different measured parameters on the screen and send the associated information on the particular industry's web site.

4. LITERATURE SURVEY

Nihal Kularatna and B.H.Sudantha [1] presented environmental air pollution monitoring system in 2008. The system is based on the IEEE 1451 standard. In this paper STIM smart transducer interface module was developed which consists of microcontroller and group of various sensors like CO₂, CO, NO₂, O₃. This also used Personal computer PC for graphical representation. STIM connected to the PC via transducer independent interface which uses IEEE 1451 standard.

Y.J.Jung and Y.K.Lee [2] developed air pollution monitoring system using geosensor network in 2008. Geosensor network is used to detect the condition of remote place. In this context, model and concept of flexible sampling interval change was introduced to increase the battery lifetime. Context model designed which determines the polluted areas and accordingly alarm message and safety guidelines send to the people in that area.

In the year of 2010 A.R.Al-Ali, Imran Zualkernan and FadiAloul [4] introduced Mobile GPRS sensors for pollution monitoring. This included Data acquisition unit, GPRS modem, and GPS module and pollution server. In this DAQ unit, GPRS and GPS were connected to the microcontroller via RS-232 interface and finally gathered data were sent to the pollution server.

Jen-Hao Liu et al. [6] introduced micro scale air quality monitoring system for urban areas in 2012. This system monitors the concentration of carbon monoxide caused by heavy vehicles emission. Sensor nodes were deployed in highly populated areas. System was integrated with the GSM for data transmission. Gateway collects the data from all sensor nodes and sends to control center by the GSM network.

Anuj Kumar et al. [7] in 2013 conducted a review on environmental monitoring system. The review discussed different techniques and various hardware used in the environment monitoring systems. It also considered the parameters like low cost, low power consumption, reliability and signal to noise ratio and RF interference.

Abdullah Kadri et al. [8] in 2013 presented real time air pollution monitoring based on machine to machine communication. The system was implemented with various monitoring stations which consists of different gaseous and meteorological sensors. Each monitoring station communicates with the backend server through M2M communication which uses GPRS network.

As in the earlier systems above mentioned used data aggregation algorithm, GSM for Data transmission and the concept of geosensor network was used. As the system complexity and implementation cost is high for the above systems mentioned. So, here the more sophisticated and flexible system has been proposed. Here by using the raspberry pi unit and wi-fi interface, the web page is designed for monitoring the air pollutants which gives us the reduced implementation cost and ease of accessibility.

5. PROPOSED SYSTEM

The proposed system consists of various sensors: Temperature sensor, CO sensor, NO₂ sensor, PM_{2.5} and PM₁₀ sensor. All above sensors which are connected to Raspberry-pi via 8-channel 12-bit ADC (MCP3208) with SPI serial interface unit is as shown in the fig1. These sensors can appear in any combination attached to a wi-fi device, with an LCD for the local visualization of the measured values. A portable industrial air pollutants online monitoring system to be designed with the help of embedded systems. The designed system will be light weight, portable, low cost and operated with low power consumption. The type of sensors involved in the process and the corresponding type of installation depend on the kind of collected data and on

their geo localization (i.e., urban areas, where powering and communications are relatively simple,). The aim is to monitor the different industrial air pollutants like CO, NO₂, PM_{2.5}, PM₁₀, etc. and continuously display the level of all air pollutants on the display. Finally all collected data will be continuously transmitted, through the internet communication infrastructure, to industry web site or environmental department for further analysis in treatment of industrial process.

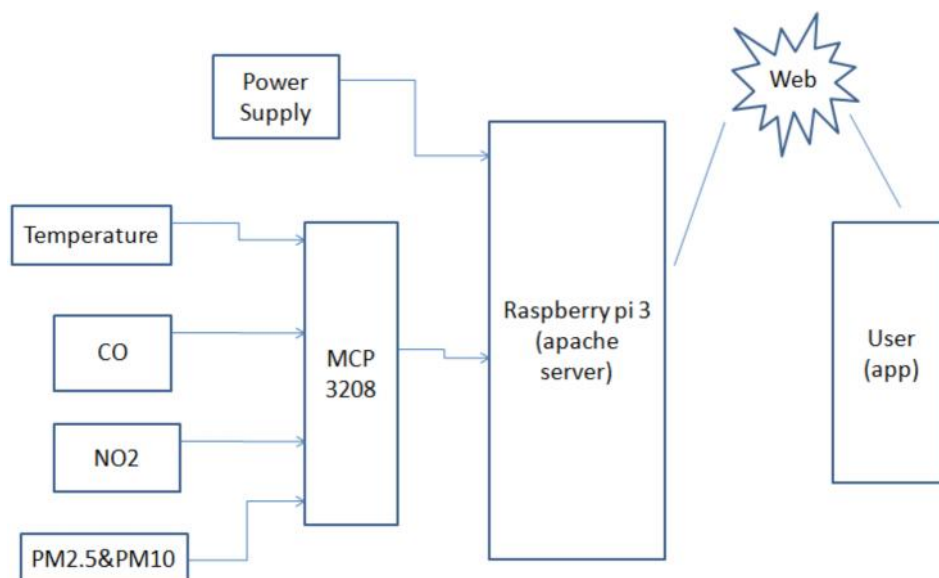


Fig1: Block diagram of the proposed system

Here all the necessary analog data from the different sensors are fetched and digitized with the help of MCP3208. Then the further processing and control action of the sensors is done by the microcontroller unit raspberry pi. At the backend all the initial values of the used sensors are stored in the database. At the user end, the sensors readings are displayed on the user designed webpage named as “Air Quality Monitoring” which can be monitored wirelessly within the network area.

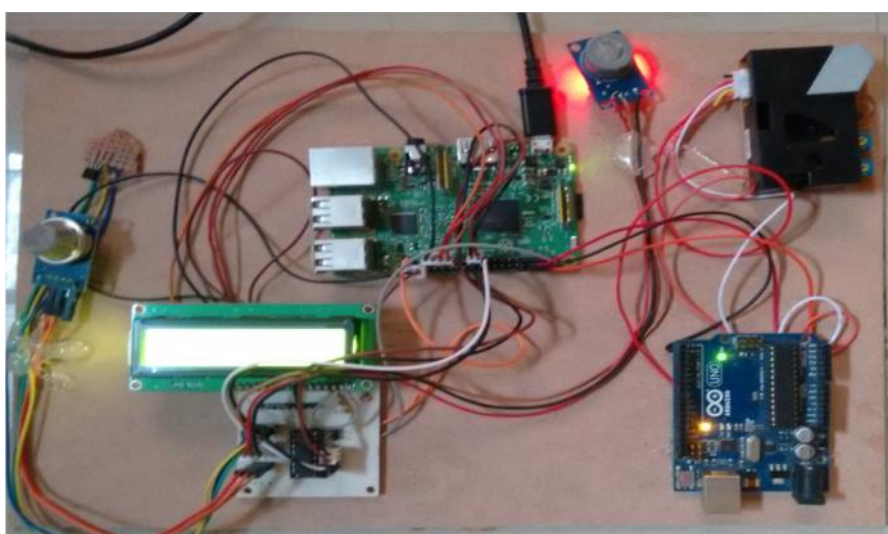


Fig2: Hardware setup

The above fig 2 shows the hardware setup for the sensor communication and web page development setup. Figure shows all the hardware including Raspberry-pi and sensors like temperature sensor, CO sensor, NO₂ sensor and PM sensor are connected to the Raspberry pi.

Advantages of the system:

- Online monitoring systems provide continuous measurement of data for long periods of time, at the monitoring site of interest, without skilled staff being required to perform the analysis.
- In case of sudden disturbance in the system, compared to conventional methods the online analyzers provide timely information for taking immediate corrective/preventive steps.

6. RESULTS

The fig3 below shows the air pollutants parameter on the LCD screen in the remote area. The following observations were made as a result of experiments on the basis of industrial air pollutants.

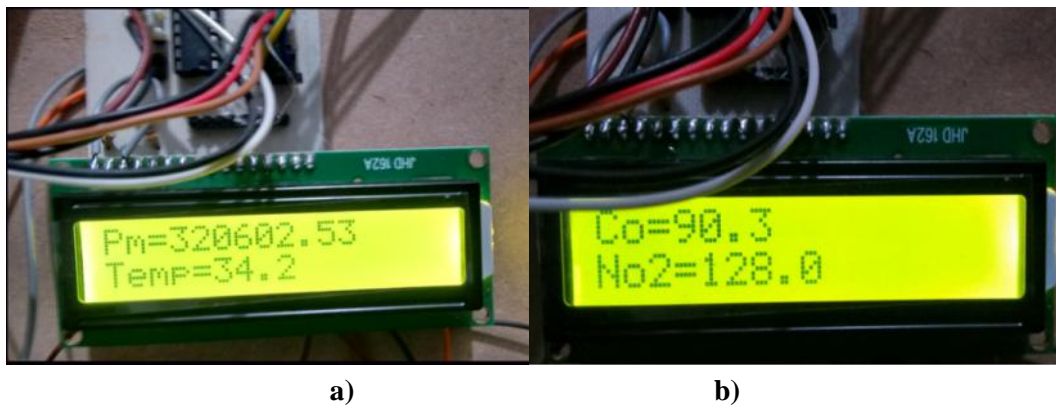


Fig3: Air pollutants reading on the field

The above 2 figures shows the result of experiment which are shown on the LCD display for the monitoring of air pollutants on the field. The figure a) shows the readings of two parameters i.e. PM and temperature. The PM value shown is 320602.53 and temperature value is 34.2. These values change according to the air quality changes. The figure b) shows the readings of two parameters i.e. CO and NO₂. The CO value shown is 90.3 and NO₂ value is 128. These values change according to the industrial air pollution index. All above parameters shown on the screen changes accordingly with the changes in the environmental air quality.



Fig4: Webpage of air pollutants monitoring

The fig4 shows the air pollutants data on the web page server of the industry. We have designed a web page and this web page is connected to experimental module. With the help of wi-fi, we send the data shown on the screen to the particular industry web server. From the web page we can monitor the different continuously varying air pollutants at the remote location.

7. CONCLUSION

Averting environmental pollution is one of the tedious tasks since the humans are responsible for this hazardous nature which poses threat to whole world. And we are responsible to eradicate pollution problems. Virtually all emissions vary from time to time. It is an excellent concept that will show a new dimension. Although the general and specific objective is very similar, the technological solutions employed are very different.

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