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A Study on Real Time Air Quality Monitoring using LABVIEW

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***Abstract**: Pollution is the major issue worldwide in which Air pollution, considered the major concern which is the most dangerous and severe pollution among all the others i.e., water pollution, noise pollution, thermal pollution etc. Air pollutants are responsible for various health problems such as asthma, heart attacks, lung cancer etc. Monitoring these pollutants is very important because it then add to the air in the shape of air pollution which directly effects the human health. This will able the environmental planners to design and develop some new policies and develop public awareness. This works aims to deploy the efficient power usage, low cost, small size compact system, high accuracy. (RAQMS) Real-time Air Quality Monitoring System is a combination of hardware which includes Gas sensors (CO, NO_2, SO_2, Smoke) Temperature and Humidity sensors and a microcontroller ESP-32, Server, and android application. It is used for the interfacing with the equipment's where Real-time Index (RQI) are measured and transferred it to the centralized system through IOT (Internet of Things) where it is monitored on Lab View (software) Real-time platform. The measured data will be in real time and according to the standard values, based upon the parameters considered as standard which will give the indication about the environment condition either polluted or safe. The goal is to make pollution level estimation, share data and interfaces to design the air quality models, support research and also make this work as less costly as we can so that the people belong to any background and society, can use it.*

Keywords: Pollution, Air Pollution, Gases, Sensors, Real-time monitoring, Air Quality Index, Pollution Parameter, Lab View software, Mobile Application (Blynk).

1. Introduction

Air pollution is when the quantity of harmful gases or particles in air increases. Whether it's a developed or a developing country, air pollutions is the significant issue of each country. Health issues have been developing at quicker rate explicitly in the urban areas where there is release of a lot of gaseous pollutants because of industrialization and increase in the count of vehicles. Pollutants include nitrogen dioxide, carbon monoxide, sulfur dioxide, ozone, PM2.5 and PM10 particles, humidity. Air pollutants mainly come from the wood burning, industries wastes and smoke coming out from the vehicles. Detrimental effects of pollution include the allergic reactions like inconvenience of the throat, irritation in the eyes and nose, and some other significant issues such as asthma, bronchitis, pneumonia, heart issues including heart attacks, asthma, and lungs issues. Air is the valuable and essential thing for every single living thing. Researching on this major issue is the framework's primary reason and it was to gauge the nature of air for every individual and other living thing which exists on earth. It's something imperative that our living things should know is that how much at the protected end we are currently, and how the climate and environment has changed because of air contamination. The most essential element for life is "Air". Its quality describes the purity of oxygen. If the qaulity of air is Poor, it can badly affect the life of human, animals and plants. The main cause of poor air quality is air pollution. Air is being polluted by the elements emitted to it which requires the monitoring of its quality and pollution level can be estimated in this way. The working of this project based on monitoring the quality of air in realtime by implementing respective sensors and data is visualized on dislay of personal computer as well as on mobile app. It is cost effective system which monitors air quality in real time by using efficiet transducers.

Some preceding works has been introduced in past such as the low-cost air quality system discussed in 2008 because both the sensor and system were quietly expensive at that time [1]. Air pollution can be detected using a mobile GPRS system [2]. One wireless sensor-network based system was introduced in metropolitan cities to determine air quality [3]. Dynamic pollution monitoring systems were also used before [4]. The Smart Environmental Monitoring System was introduced in 2015 which was deployed on vehicles. It mainly traced the emission rate of toxic gasses that are responsible for pollution of air [5]. To enhance safety and health, air pollution monitoring system for industrial zone had been introduced to determine toxic gasses and their concentration [6].

Kumar and Jasuja (2017) presented an IoT based system to monitor Air Quality by implementing Raspberry Pi. This paper presented a realtime impartial system for monitoring air quality with several parameters like carbon monoxide, PM-2.5, CO_2 gas, CO, temperature, air pressure and humidity. Due to IOT, its been easy to manage the data which comes from different static sensors and also cloud calculating provided an innovative technique for well management. The data is compiled and transmitted via Raspberry pi, a minicomputer based on low-power and low-cost ARM. The model was tested in Delhi (India) and the results were compared with the data which was provided by the LECA (Local Environment Control Authority) and presented in tabular form. The values of the measured parameters were displayed in the IBM Bluemix cloud. [7]

Sumanth Reddy Enigella and Hamid Shahnasser (2018) proposed a model to Monitor the Quality of Air in Real-time. In this article, an air quality monitoring system based on real time crowd sensing is introduced. The presented system uses low cost and power efficient devices to get an air quality index from atmosphere. The data collected by gas sensors, was raw sensor data which was

further transmitted to cloud via Android Application. Data was stored in the cloud then processing take place. The data is viewed on the map in real time using an open-source geo-spatial data visualization such as Leaflet by implementing R programming [8].

Gupta, Bhardwaj, Agrawal, Tikkiwal and Kumar (2019) presented an Air Pollution Monitoring System based on IoT for Smart Cities. This article proposed the development of IoT based system and realtime data is fetched through the devices and analysed to measure the effect on city residents. The devices are capable of measuring Temperature, Carbon Monoxide, Smoke, Humidity, LPG and other dangerous particulate matters like PM 10 and PM 2.5 levels in atmosphere. The collected data is available worldwide via an Android Application [9].

Ramik Rawal (2019) proposed the system for air quality monitoring. This paper presented the measurement of the Air Quality using MQ135 sensor and MQ7 sensor for Carbon Monoxide CO. This work focused on Internet of Things by using Thing speak platform. This is an easiest platform because Thing speak set its dashboard to public so that everyone can get information about air quality of that area where the system is installed. The MQ-135 sensor is used to measure the quality of air. As CO gas is also one of the toxic and mainly responsible of Air pollution. Hence it is measured by using MQ7 sensor. In this system, Arduino platform is used to communicate the data simply and quickly [10].

Cynthia, Saroja, Sultana and Senthil (2019) presented an Air Pollution Monitoring System in real-time based on IoT. This article focused on monitoring pollution levels of numerous pollutants. Geographical area is categorized as residential, traffic and industrial zones. This paper proposed an IoT system that can be deployed to any location and the measured values can be stored in a cloud database. The Data Acquisition unit (DAQ) consisting of hardware and sensors, was essential to get Air Quality Index (AQI). SO2 was not measured as key pollutant. Temperature measurement is essential to determine the Air Quality Index value because it often depends on weather and temperature [11].

Kusuma, Anjasmara, Suhendra, Yunianto and Nugraha (2020) proposed Coastal Weather and Air Quality Monitoring based on IoT by using GSM Technology. It mainly focused on deploying Arduino based platform for monitoring of wind speed, humidity, temperature smoke. In this work, programming software was open source that can be used and modify by anyone. Arduino-Uno and cheap sensors both were used to have low-cost system. The system was capable of sending data to Thing speak as IoT-platform. This platform provides real time data gathering, processing and visualization. The system is low cost which is capable of monitoring air quality and weather that can be installed in any geographical area. This data is monitored both locally and remotely as results displayed in graphs. Results are useful to monitor air quality and weather at desired location [12].

Zhand and Simon (2020) proposed Localized and real time Air Quality Monitoring with Prediction by Mobile as well as Fixed IOT Sensing Network. This research focused on modelling the air quality in specified region by implementing fixed as well as moving IoT sensors. These sensors were deployed on automobiles traversing in that region. This method provided the analysis of a full spectrum in which varying air quality can be visualized in nearby regions. IOT sensor instrument design was consisted on temperature and humidity sensor, micro dust sensor, CO_2 sensor, Raspberry pi 3B+ and Arduino Mega as microcontroller. To power the system, a battery of 7000 m Ah was used. The machine learning algorithm was capable of providing heat map of the prediction and showed experiment area on google map. The measured data can be displayed on android app as well [13].

B. Jayasree, T. Subash, V. Priyadharsan and N. Priya (2021) presented Implementation and Measurement of IOT Based Air Quality Monitoring System for indoor. The proposed system consisted of a cheap and efficient air quality sensor with ESP32 controller by implementing new generation embedded system architecture.

Through this system we can easily know about the air quality. [14] Four significant gas sensors which are answerable for the air contamination mostly, is being utilized in the framework to know the best consequence of the condition of the air. CO, NO_2, SO_2. Air pollutions is also caused by humidity. All these are utilized in our designed system. This system also includes Smoke and Temperature sensor in order to monitor the temperature of surrounding. A server, and an android application have been utilized to know the insights at any place because now days now days nearly everybody has an android working gadget and feel at ease to access through web which will sum up its worth. [14] The prosed system implemented Blynk IOT platform which provides real-time monitoring of indoor air quality parameters on mobile app. This work also had open-source technology and mobility as remotely monitor the air quality. The data displayed on mobile app as well as on LCD attached with Arduino. An Arduino-UNO board with a Wi Fi module, was included for storing data in the cloud [15]. The flow of the proposed system is shown in Fig.1.

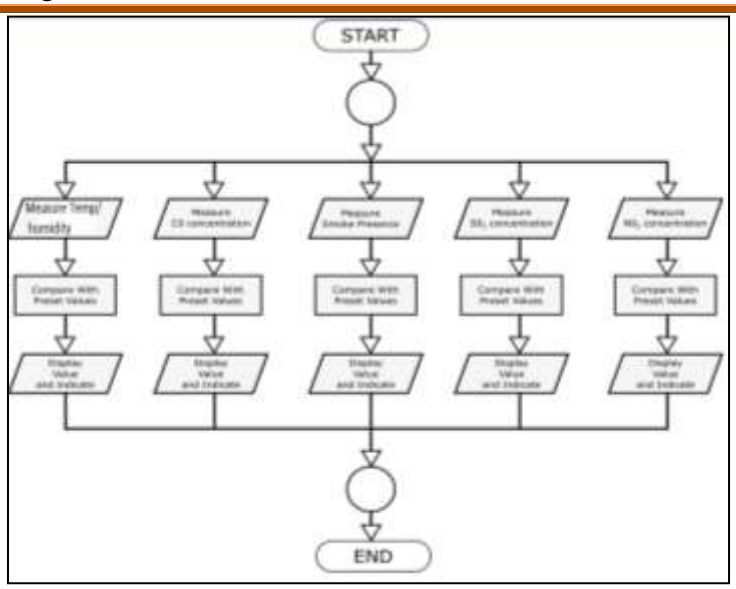

Figure 1. Flow Chart Diagram

A. System Description

In this system four sensor are used for the measurement of air quality monitoring and controlling. Main purpose of this work is to reveal the system that operates and allows the monitoring in real time of air pollutants such as Humidity, CO, NO_2, SO_2, Smoke and Temperature by using LabVIEW software. These quantities are detected, measured, and then change over into Digital Signals utilizing ESP-32 microcontroller. These are then forwarded to the computer were indicated in LabVIEW software which is interfaced with micro controller. At the same time, it is also displayed in an android app named as Blynk. The essential thought behind is to monitor the air quality in real time using LabVIEW. Sensors interface through ESP-32 device to the computer as shown in Fig.2.

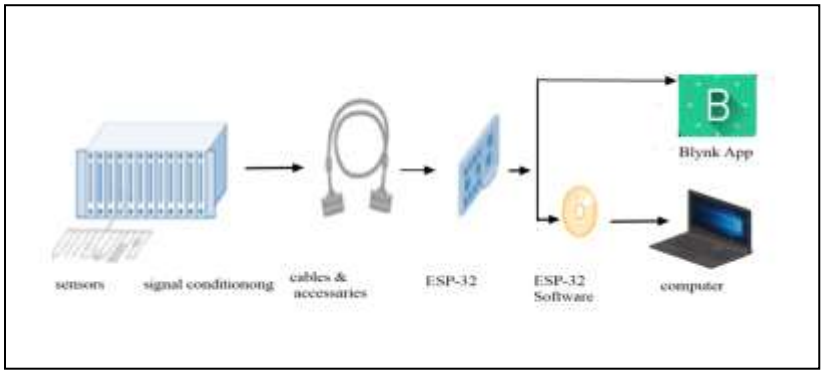

Figure 2. Interfacing of sensors with ESp-32, computer, and android app

2. Materials & Methods

A. Hardware Description

The proposed system consists of hardware and software. The hardware part is basically a device that takes the data from the environment. Air is taken as an environment and an input node. The device is built with various sensors installed which they take data by sensing from the air as an input node. These sensors will take the data in analog form from the environment which will later on converted into digital form with the help of microcontroller, ESP-32 and then sent to the computer where specific software is installed where it is monitored also at the same time through the server the data is sent which can be viewed on android app named Blynk. This device consists of the following components are listed below and also shown in Fig.3.

- Controller (ESP 32)
- Nitrogen dioxide sensor
- Temperature and humidity sensor DHT-11
- Carbon mono oxide sensor (MQ-7)
- Smoke Sensor (MQ-2)

- Sulphur dioxide Sensor (MQ 8)
- Power Supply
- Micro USB Cable

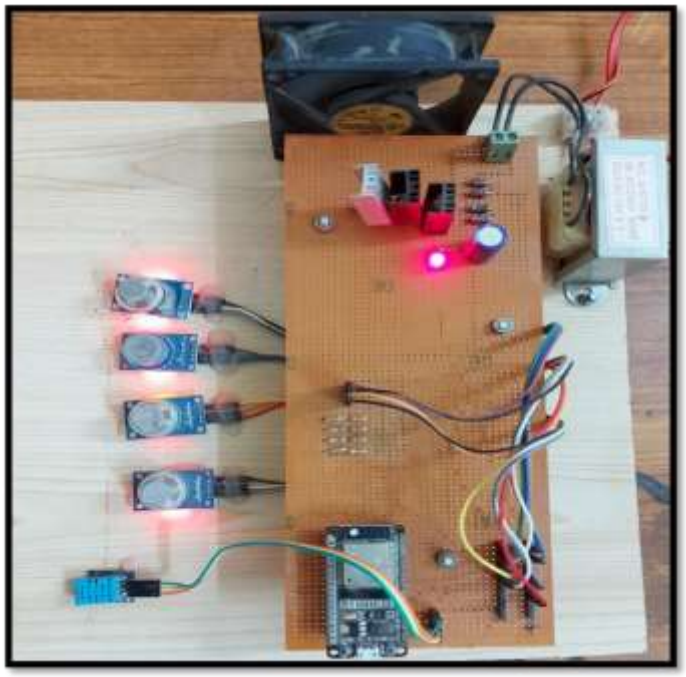

Figure 3. Hardware of the system

B. Software Description

The Software components which are used during this work to fill full our desired outputs are Lab View software and the ESP-32 coding. Lab VIEW stands for (Laboratory Virtual Instrument Engineering Work Bench) is basically a programming language software which is designed the organization named as (NI) National instruments which is basically used for the automation and data acquisition in the analysis laboratories and industries. Hardware should be interfaced and attached to make the software work. It works through different controllers such as ESP-32 in this work to monitor and in controlling the related instruments, take its measurements and in organizing of its results. The instruments basically convert the information into digital form also.

In lab view, basically, a program is built by employing an assortment of tools and objects denoted as front panel. After that, to control the objects of front panel a code has been added. The lab view contains a block diagram, which will contain that code. It contains libraries, through which analysis, presentation, data assortment, and storage can be done.

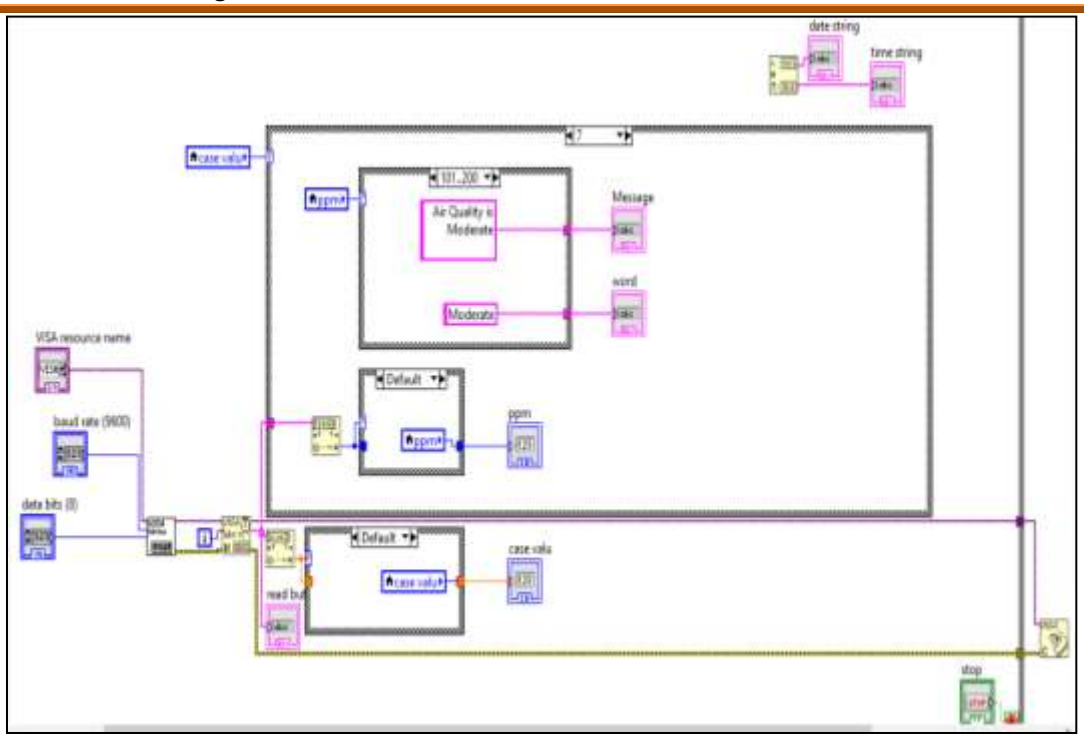

Figure 4. Block Diagram of Air Quality Index

The front panel as shown in fig.4. contain six gauges in which one with the vertical scale is a temperature gauge and horizontal scale is humidity gauge which will show indication in Degree Celsius between 0 to 50 **°C** and humidity between 0 to 100 RH %. The Gauge with the Scale 0 – 300 is used to indicate Carbon mono oxide concentration in ppm with the three LED indications which will show either the present concentration is under the acceptable limits which is green for normal, Yellow for moderate without health risks or exceeding the survival limits indicated Red LED as hazardous. The gauge with 0 – 200 scale reveals the concentration of NO_2 in ppb. As it is more dangerous gas and very little amount can have high health risks so calculated in ppb as per standard. The gauge contains scale from 0- 700 shows the concentration of SO_2 in ppb with the three LED indications as per defined conditions. The gauge with the scale 0- 600 shows particulate matter in a combination of smoke with the two LEDs indicate its presence and absence. After detection of all gases its AQI will be calculated and showed in numeric value also, according to condition, message will be displayed either it is good, moderate or hazardous for health.

3. Simulation Results

Before These days, real time monitoring is a monotonous thing in the industry so, decided to propose a multi parameter monitoring system based on Lab View. To measure those parameters, micro controller ESP-32 is used. To collect the real time data, specifically in industrial zone, is very difficult task. Main objective is to design a compact, low-cost system which collect the real time information specifically in the industrial area or at other places where it is needed. Main objective of this work is to design an actualize a compact system for the industries which will monitor the data in real time and inform about the results both through PC and android application. Pollution Levels estimation, publish pollution data to public, implementation of goals, provide information about air quality trends, share data and interfaces to design air quality models. So, this includes the worth towards the less assembling time, measuring of real time actual values, information register requests of industry at ease.

Case 1

In the first case, initially the sensors are placed at room condition where all the gases and particles appeared to be normal. The sensors will sense the presence of gases and after fetching it will appear on the screen. Under normal condition the temperature is 33 **°C** and humidity is 41 Rh as shown in fig.5. Also, if the CO concentration is between 0-35 ppm so normal green LED will turn 'ON' as an output indicating the condition normal. The green LED of normal condition for NO_2 will light up when its concentration is between 0- 53 ppb. For SO_2 the normal Led will turn 'ON' as output if the concentration is between 0- 300ppb. If the concentration is between 0- 300ppm so the condition of undetected particulate matter as smoke will be fulfilled until it exceeds 300ppm concentration.

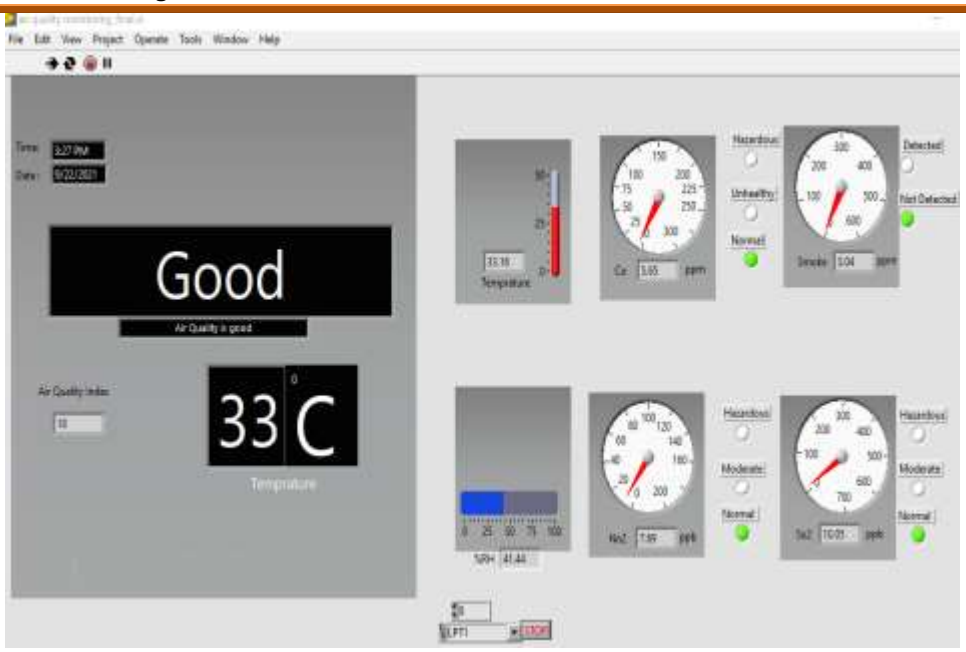

Figure 5. Normal condition for air real time air quality

Case 2

In the second case, when the concentration get exceeded from the normal limits and entered into moderate or unhealthy condition so yellow Led will get turn 'ON' as an output, indicates that condition is moderate and having health risks which is between 36- 50 ppm for CO, 54-62 ppb for NO_2, and 301- 500 ppb for SO_2. In the presence of concentration, above 300ppm detection Led will get turn ON.

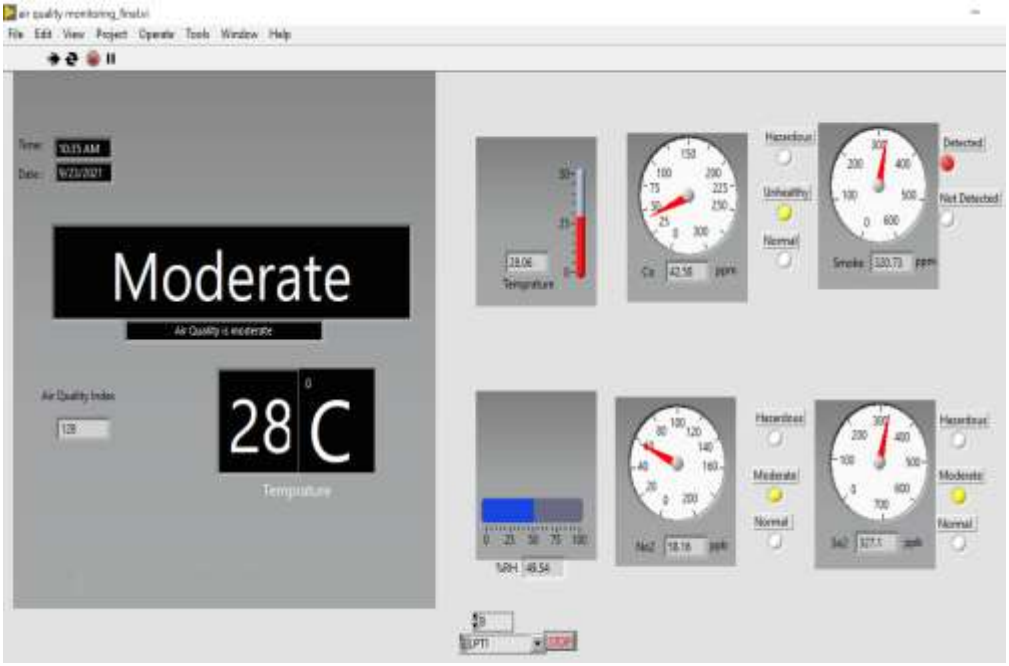

Figure 6. Unhealthy condition for air real time air quality

Case 3

In third case, the concentrations exceed from the moderate, will make the red Led 'ON', fulfilling condition "hazardous" extremely dangerous and appears to be deadly for health. The AQI will be calculated on the basis of these concentrations in combination and message will displayed on the screen.

Figure 7. Poor condition for air real time air quality

4. Conclusion

This work contains the modish, cheapest, and compact way to monitor the quality of air specifically the pollutant in the air is highlighted in this thesis. It is efficient method which can be implemented anywhere being cheapest. Engineering elements of various sensors and their functioning technique have been discussed. It also includes working, applications, their uses optimally, tackling information and correlation with standard base information are additionally highlighted here. The real-time air pollution monitoring system tried for observing the gas levels on various places of the country. It additionally sent the sensor parameters to the main server which is called the main station. The proposed work is based on effective and low-cost device and able us to monitor the air quality in real- time anytime, at any place. In place of cheap sensors if it is replacing with quality sensors, then its working will be more efficient than previous and can be reliably installed anywhere which can help in the sorting out the pollutant area where easily precautionary steps been taken to get safe from the damage that will be caused in future.

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