AUTOMATED AIR QUALITY MONITORING AND PURIFIER

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ABSTRACT

Internal air pollution negatively affects the health of the people worldwide. The majority of gases present in our environment are CO2, NH3, CO, SO2, methane, LPG, smoke etc. This situation is bad and to overcome the effects an automated air quality monitoring system is. This paper shows the working of a system using arduino uno board with eco friendly air purifier. It measures indoor Air Quality Index (AQI) and other harmful contents present in environment using various sensors and air is purified by using an electro chemical purifier. So the toxic content in the air is minimized to an appreciable level to maintain perfect air quality. The system can be monitored from anywhere as it is possible to access using a smart phone and all the data is uploaded using cloud computing. Mobile application is helps to gets the information of polluted air when it is detected.

Keywords: - *Air Quality Index, Volatile organic compounds, Cloud computing*

1. INTRODUCTION

Nowadays, air pollution is a very major problem, whether it is an urban or rural area [1]. Urban areas are mostly the victims of air pollution since most of the industries are situated in and around it [2]. The air pollution leads to severe lung diseases like breathing problems, severe coughing, asthma and emphysema [3]. Majority of the population spent their quality time in car cabins between two to three hours a day. Quality of air is not really a matter to the people in many places. The survey conducted shows the indoor air is more polluted than the outdoor air even in large industrial cities. Indoors and outdoors are not free from Volatile Organic Compounds (VOC) [5]. The harmful compounds will impair damage to the human organs and metabolic systems [4]. Proper visibility can be impaired due to air Pollution. As a solution we need an efficient air purification system.

Major harmful gases which are present in indoor are NH3, CO, SO2, methane, LPG, smoke etc. Table-1 shows the list of harmful poisonous gases in atmosphere.

Table-1: List of harmful gases in the atmosphere with their causes

SL.NO	LIST OF GASES	ALLOWED PERMISSIBLE IN AIR(ppm)	CAUSES FOR THE PRODUCTION OF GASES	SENSOR USED TO BE SENSE THE GAS
1	CO	Above 70ppm	Incomplete combustion of carbon containing components	MQ-7 Sensor
2	SO2	Above 400ppm	Burning of coal and oils	MQ-135 Sensor
3	NH3	Above 700ppm	Haber process	MQ-135 Sensor
4	Methane	Above 50000ppm	Hydrogenating Co2 by Sebatier process	MQ-2 Sensor
5	LPG	Above 2000ppm	Extraction during Natural gas process	MQ-2 Sensor
6	Smoke	Above 100ppm	Smoking and Combustion	MQ-135 Sensor
7	Co2	Above 1000ppm	Combustion or burning of hydrocarbon fuels	Ndir sensor

Air Quality Index is measured according to the contents of the matter and gases in the air over a particular period of time. According to the National Air Quality Index (AQI), the standard used in India, there are 6 categories of the air have been created .The table 2 shows the categories based on air quality.

Table 2:-Categories based on air quality and its health impacts

AQI	Associated Health Impacts
Good (0-50)	Minimal Impacts.
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101-200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged inhaling, and problems to people with heart disease.
Very Poor (301-400)	May cause respiratory illness to the people on prolonged inhaling. Effect may be more severe in people who are living with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during normal walk also.

An automatic air purification system can be developed using arduino microcontroller board. To measure the Air Quality Index various sensors are used. The arduino board connects with remote server platform using Wi-Fi module. A mobile application is used to display the Air Quality Index (AQI) value measured by sensors and will turn on air purifier if the air quality reaches the given threshold value. The sensor MQ-135 is used to measure the

overall ammonia quality, MQ-2 is used to detect LPG, smoke [7]. The sensor MQ-7 is used to detect the quality of CO concentration in the surroundings. The pollution level of the environment can be measured from anywhere, as the system is android application operated [3]. The purifier can be turn on or off from anywhere using smart phones. The system continuously monitors the air quality inside the room and if any harmful gases are detected, suddenly turns on purification system and the system will be working until the normal conditions.

The overall history of polluting contents can be viewed on smart phone, the system uses cloud computing for storing purpose. The aim of proposed system is to develop automated air quality monitoring and purifier. This system not only help people be well aware of environmental parameters whenever necessary, but also provide extended interfaces for other devices.

2. BLOCK DIAGRAM

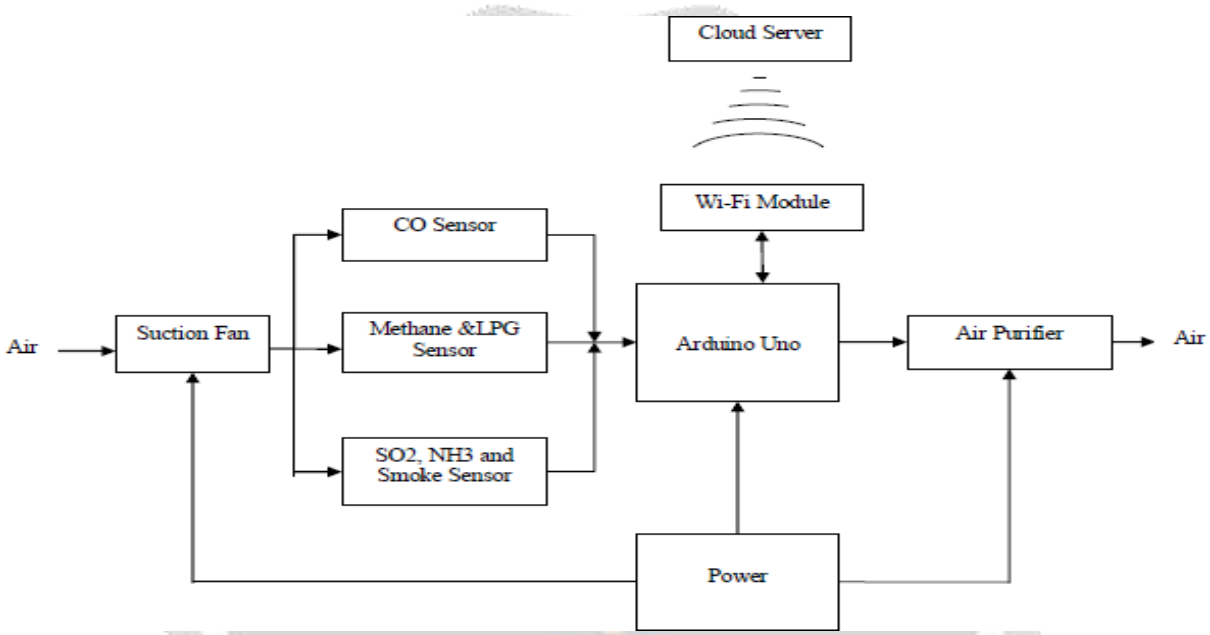

Fig 1-: block diagram of the system developed

2.1 SUCTION FAN

Suction fan is used to suck the air present in the atmosphere. It will suck the air very faster in order to reach in the sensors. This works with the help of external power unit [7].

2.2 SENSING UNIT

It includes mainly three sensors, and this will sense the dangerous gases amounts from the intake air, and it will updates the values to the processing unit in every 3 seconds.CO sensor (MQ-7)will sense the amount of CO gas in the air, and it will be transfer the value to the processing unit. Methane and LPG Sensor (MQ-2) sense the amount of methane gas and LPG gas in the air, and it will transfer the value to the processing unit.SO2, NH3 and smoke sensor (MQ-135) will sense the amount of sulphur dioxide, ammonia gas, and smoke and will transfer the value to the processing unit [7].

2.3 PROCESSING UNIT

It processes the information about the gases present in the atmosphere and updates it to the cloud server. It includes an arduino uno processor board and Wi-Fi module to transfer the information, Also it will receives the command from cloud server [8]. It is a microcontroller board based on Atmega 328.

2.4 AIR PURIFIER UNIT

Air purifier unit will purify the polluted air by the chemical reaction only after getting the purify command from the processing unit. This is an eco-friendly automated purifier system which gets automatically on when the air is polluted. Once the fresh air level is maintained the purifier system which get automatically switched off. Here we use the modification of the process discussed in [2].Through this process we can purify .5 billion Ls of air can be purified by a single liter of water.

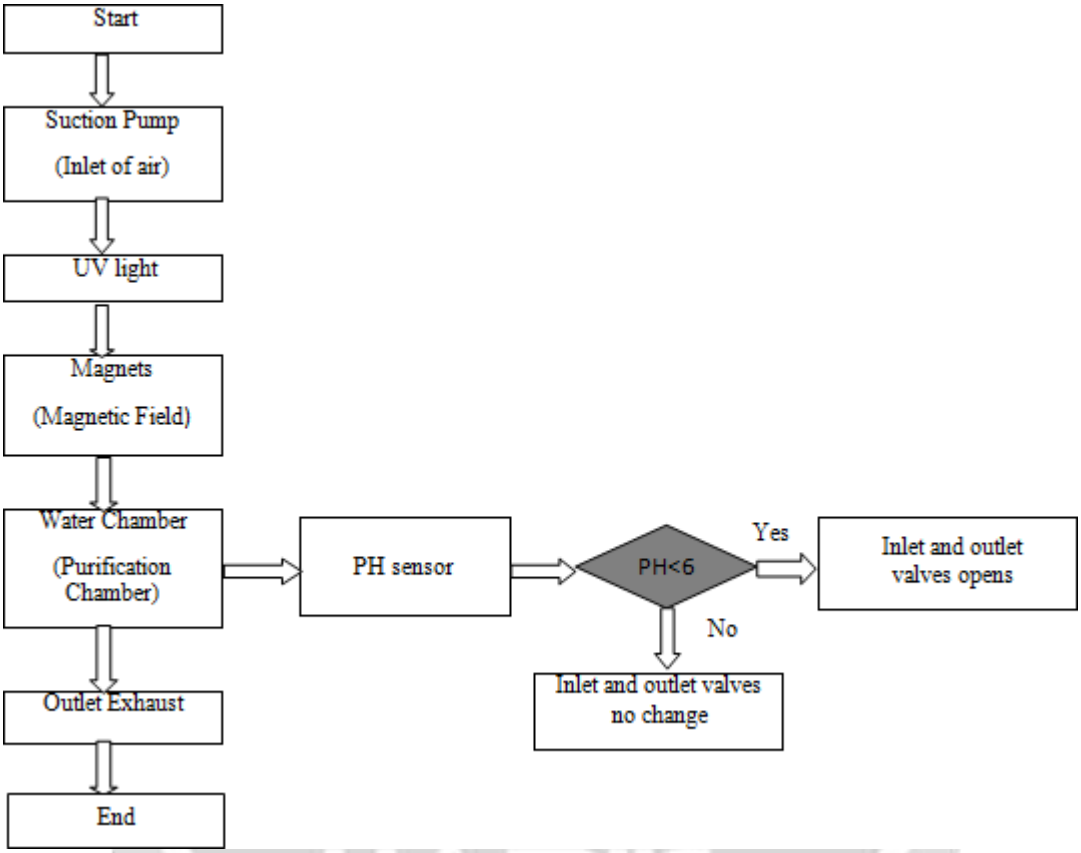

Fig 2:-Process flow of air purifier system

The suction pump sucks the polluted air to be purified. This air is exposed to the UV region and the gases like SO2 and CO which cannot get dissolve in distilled water will be changed into SO3 and CO2 in the presence of UV rays. These SO3 and CO2 which are dissolvable in distilled water is passed to the purification chamber through small pores. The magnetic region is for removing the NOx gases which is attractive to magnet. Distilled water is pumped with the help of valves to the purification chamber. There is a provision to change the distilled water when it is no more used for purification, the water in the chamber is pumped out and good distilled water will pump in by the help of programmable board which is placed inside the chamber. These gases after passing UV region and magnetic region comes to the purification chamber and get dissolved in the distilled water and gives the purified air to outlet exhaust [7].

2.5 POWER UNIT

The power unit provides the required power for the Arduino Uno board, Suction fan and air purifier unit. In this air purifier system requires about 350 watt of power for its efficient working.

2.6 WIFI MODULE

Using Wi-Fi module, the information about the contents of above discussed gases will transfer to the cloud server using Wi-Fi module [6]. Instead of Arduino Uno board, it is possible to build this system using Node-MCU board which is having inbuilt Wi-Fi module.

2.7 CLOUD SERVER

It will provide the storage for the sensing information of the gases. We can see the information and can give the purify command to the processing unit from the cloud server. Data is published in the form of a JSON object through an MQTT broker.

3. WORK FLOW OF THE SYSTEM

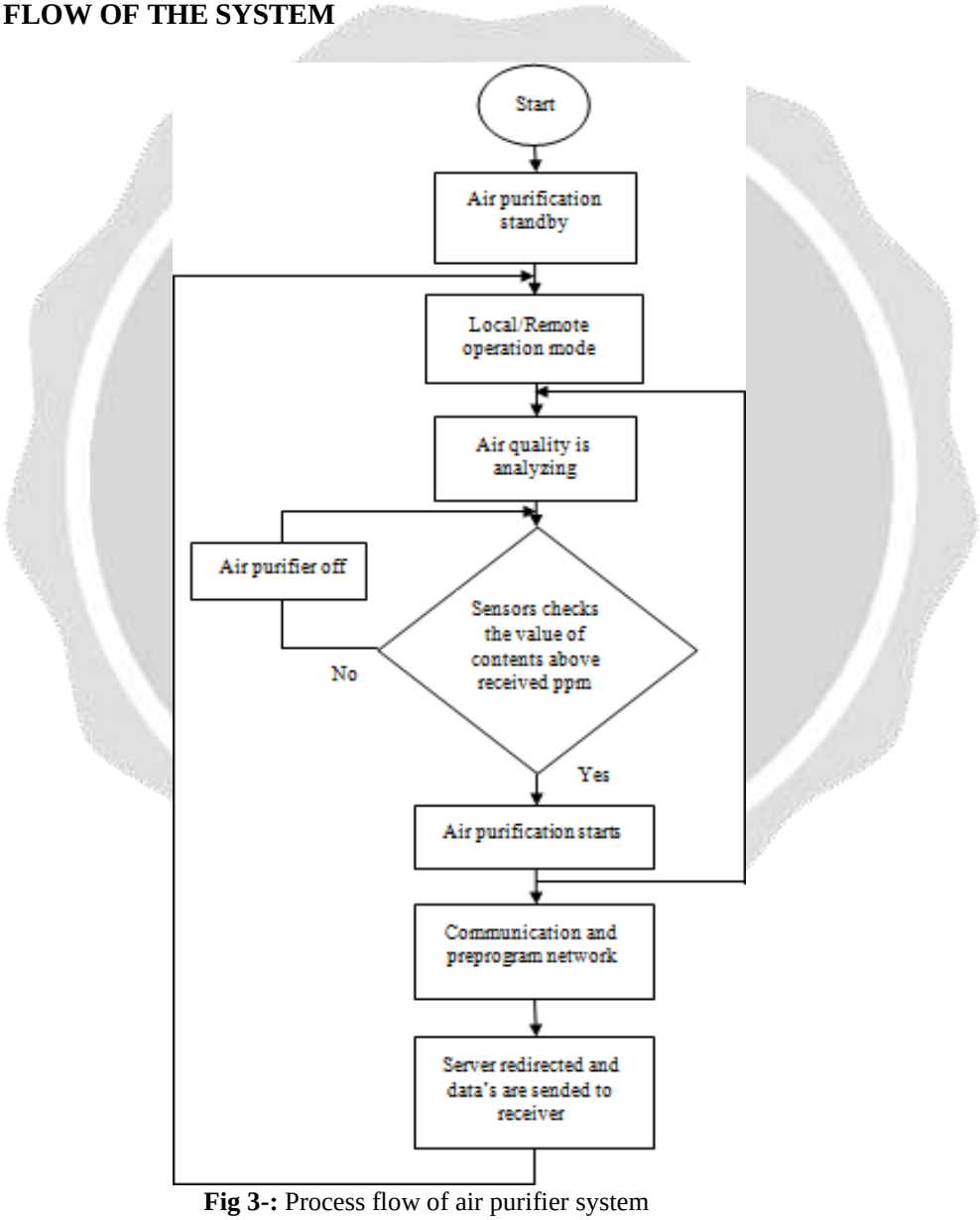

Fig 3-: Process flow of air purifier system

The system flow chart is as shown above. When the device is getting started the air is passed into the device through the suction fan and analyzed by using the sensors. This sensor checks the value of the contents above the received ppm. Here we use three types of sensors, MQ-2, MQ-7, and MQ-135[7].Each sensors will sense toxic gases from the atmosphere and when the value of any gas is above the received ppm the air purification starts. If the value is below it goes to the analyzing stage again to check the air contents. When the purification is started then the purified gases again goes to the initial stage to checks the air quality again. This process occurs continuously and the sensor repeats the process every 3 second,

4. EXPERIMENTAL READINGS AND CONCLUSIONS

The Air Quality Index measures the quality of air. It shows the amount and types of gases dissolved in the air the Air Quality Index is composed of 8 pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb).Out of these the major concentrations in polluted air such as SO2, CO and NH3 are measured using our system and Air Quality Index is analyzed from the table 3.

Table 3:-List of AQI category, pollutants and health breakpoints

AQI Category(Range)	CO(8hr)	SO_2(24hr)	NH_3(24hr)
Good(0-50)	0-1.0	0-40	0-200
Satisfactory(51-100)	1.1-2.0	41-80	201-400
Moderately polluted(101-200)	2.1-10	81-380	401-800
Poor(201-300)	10-17	381-800	801-1200
Very poor(301-400)	17-34	801-1600	1200-1800
Severe (401-500)	34+	1600+	1800+

When we analyzed the observations over time with the pollutants added in the air we got the concentrations of SO2, CO and NH3 above acceptable levels. Once the air purifier started working and the readings are measured all the harmful contents are reduced to appreciable levels. The readings are analyzed continuously and the average values are listed in table 4.

Table 4:- Observations

Concentration of gases	SO2(24 hr)	CO(8 hr)	NH3(24 hr)
Before Air Purifier ON	480	6	600
After Air Purifier ON	64	1.4	340

From the results obtained it is clear that initially air is moderately polluted with AQI value nearly 200.When the air purifier is turned on for 3 hours, again observations are taken and the air quality is highly improved. This is a very efficient system which effectively works in indoor environment.

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