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SENSOR BASED AIR QUALITY CONTROL IN AIR CONDITIONER

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Abstract – *Air conditioners are turning out to be one of the most essential conditions for any ménage or assiduity to give comfort and better air quality. Air quality is a measure of how clean or weakened air can be which is bad for our health and health of the terrain. Air quality is measured according to the situations of different feasts present in the atmosphere. Detector grounded air quality regulator is used to measure the situations of colorful feasts using the MQ- 135 detector and allows us to maintain the air quality in the handed atmosphere. It helps us to not only maintain the air quality, it also enables us to remove the bank produced by burning incense sticks, cigarettes etc., The detector senses and monitors the quantum of feasts present in the room and sends the information to the Internet of effects(IOT) which controls the suckers present in the room. This sucker pumps out the old air from the room and pump in the fresh air from the outside terrain and also ensures to maintain the same temperature in the room. Then, IoT is used to give the information about the situations of feasts present in the room to the stoner via the android grounded operation which is developed with the help of MIT app innovator. The primary end of this system is to give and maintain a common standard of high inner air quality and a productive and comfortable place of work for all the people inside the room.*

Key Words: Air conditioner, Detector, Internet of things, Innovator etc,.

1. INTRODUCTION

Proper ventilation is the most essential requirement for any room and hence the ventilation system has to be designed properly. The Fig. 1.1 shows that the ventilation system is designed in such a way to prevent contaminants and aids in removing contaminants from the interior source. A ventilation system has several key components including contaminant source, an exhaust hood, air mover, ducts and Fittings, makeup air exhaust, air pollutants removal device, discharge stack and air re-circulation.

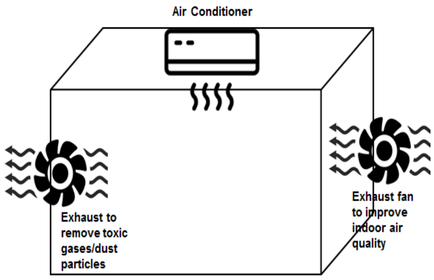


Fig 1.1 Ventilation system to improve air exchange

(IMAGE COURTESY: SCIENCEABC.COM)

There are three techniques for the control of indoor air pollutants dilution, extraction and source control. The following are additive control to reduce the indoor air pollutants:

- Elimination, removal substitution at the source
- Filtration and cleaning of contaminants
- Indoor ventilation
- Encapsulation or interfering with the material ability to give of air pollutants
- Isolation by space distance or time of use of potential contaminant
- Awareness to the building of occupant's operations under maintenance personnel

Indoor air quality is affected due to the factors since, the building fabric, furnishings and equipment, occupants and their activities produce pollution. In an inactive building, some of these air pollutants may have directly exhausted to the outdoors and remaining will be removed as the outdoor air enters the building and replaces the air inside. The installation of the air conditioning system with filtration unit enormously reduces the microbes, air pollutants and dust particles in the outside air. The adaptive ventilation system has to be designed for maintaining the indoor air quality enhancing better air exchange between indoor and outdoor. This project concentrates on the development of IoT based Smart Air Quality Monitoring System to remove the hazardous particles by continuous monitoring and improving the exchange of indoor-outdoor airflow.

1.2 PROBLEM DEFINITION

The major problems in any air conditioning system installed for indoor air regulation are better in providing the thermal comfort than maintaining indoor air quality. The air conditioned indoor due to improper maintenance and poor ventilation system causes serious health issues. This project aims to provide improve airflow rate enhancing ventilation during presence of toxic gases, hazardous smoke and dust particles. Developing a portable IoT based Air quality monitoring sensor devices along with smart phone application to alert user during hazardous exposure and air quality status in real time.

1.3 AIR POLLUTANTS AND SOURCES

Table 1.1: Air pollutants and their source

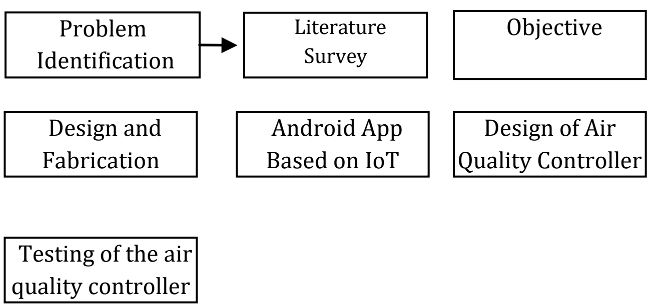
Location	Sources	Air pollutants
Offices, Government Buildings	HVAC systems, carpets, painting & Polishing, Household cleaners, aerosols insecticides, pesticides and personal care products.	Primary: PM, VOCs Additional: CO, NO_x, SO_2
Parking areas	Vehicular movements	Primary: PM, VOCs Additional: PAHs, SO_2
Public places such as restaurants, hotels, libraries, shopping malls, etc.	HVAC systems, carpets, paintings & polishing, insecticides, pesticides, smoking, construction activities	Primary: PM, VOCs, Nicotine Additional: CO, NOx, SO_2
Rural Households using biomass	Biomass burning for cooking, heating, waste burning, Kerosene burning for lighting	Primary: PM, CO, BC Additional: VOCs

1.4 AIR POLLUTANTS CONSIDERED FOR INCLUSION BY "WORLD HEALTH ORGANIZATION"

The following air pollutants are the considered to be hazardous and causing ill effects during continuous exposures.

- Benzene
- Carbon monoxide
- Formaldehyde
- Naphthalene
- Polycyclic aromatic hydrocarbons
- Benzo pyrene
- Radon
- Trichloroethylene
- Tetrachloroethylene
- Nitrogen dioxide
- Particulate matter

1.5 Methodology



2. LITERATURE SURVEY

[1] The health care providers are concerned with environmental exposures to play in the development of respiratory disease. The Environmental Protection Agency (EPA) regulates and sets standards for both outdoor and indoor air quality. According to the EPA, indoor levels of air pollutants may be up to 100 times higher than outdoor pollutant levels and there is a strong correlation between the health and air quality. It becomes important for the people spending most of their time under the roofs can be prone to a potential risk of indoor air pollution and their adverse effect causing illness leading to health issues.

[2] The indoor air has a special role as a health determinant and that the management of indoor air quality requires approaches different from those used for outside air. The WHO have concerns more about the existence of indoor sources, availability of toxic and hazardous gases, poor ventilation and air exchange between indoor to outdoor. The WHO also suggested control of emission through adapting source control and pollutant dispersion methods, proper selection of equipment and devices for indoor operations, application of low-emission materials, outdoor venting for required products and proper ventilation system.

[3] The researchers have modeled parameters such as people count and air infiltration rate are usually highly uncertain, yet they have significant impacts on the simulation accuracy. With the increasing availability and affordability of sensors and meters in buildings, a large amount of measured data has been collected including indoor environmental parameters, such as room air dry-bulb temperature, humidity ratio, and CO2 concentration levels. Fusing these sensor data with traditional energy modeling poses new opportunities to improve simulation accuracy. This study develops a set of physics-based inverse algorithms that can solve the highly uncertain and hard-to-measure building parameters such as zone-level people count and air infiltration rate.

[4] This paper it is proposed that a portable device is capable to check and measure the air quality and Particulate Matter Concentration in accordance with environmental parameters like surrounding temperature, humidity, atmospheric pressure and dew point. In the proposed system Thingspeak, an IoT based platform is used for real-time monitoring of all the data related to air quality. Thingspeak provides a digital dashboard on your Smartphone/PC that displays real-time air quality readings for the immediate surroundings. Due to the portability of the system, it can be installed anywhere required in the city, local market, or industry. The device has the capability to collect the PM1.0, PM2.5, PM10, Temperature, Humidity, barometric Pressure, Air Quality Index, Dew Point and Estimated Altitude. The collected data is uploaded to the cloud after a regular interval of 15 s, which can be viewed by using a Smartphone or PC from any part of the world. This recorded data can be analyzed by doing the comparison with the standardized parameters of PM2.5 (0–30 μg/m3), PM10 (0–50 μg/m3) and Air Quality Index (0-50PPM). If the Concentration of the PM is increasing and AQI is degrading at the alarming rate then the Government should take the appropriate action by viewing the concentration of the gases to reduce the air pollutants and enhance the air quality. In this way, the quality of air can also be understood by people living in that area.

[5] This research work proposes an IoT based indoor air quality monitoring system for tracking the ozone concentrations near a photocopy machine. The experimental system with a semiconductor sensor capable of monitoring ozone concentrations was installed near a high-volume photocopier. The IoT device has been programmed to collect and transmit data at an interval of five minutes over blue tooth connection to a gateway node that in turn communicates with the processing node via the Wi-Fi local area network. The sensor was calibrated using the standard calibration methods. As an additional capability, the proposed air pollution monitoring system can generate warnings when the pollution level exceeds a predetermined threshold value.

3. STUDY ON EXISTING SYSTEM AND PROPOSED NEW SYSTEM

3.1 EXISTING SYSTEM WORKING PRINCIPLE

The existing air conditioners have two units, first is the outdoor unit which consists of a condenser, compressor and a common motor. This outdoor unit pumps the air required for the indoor unit which does the circulation part. The indoor unit consists of flaps that provide the directional flow of air into the room; it also consists of filters that clean the air that comes from the outdoor unit. The existing air conditioning system has lots of drawbacks of its own. The user who spends a lot of time in an air-conditioned room suffers from suffocation at rare cases and are prone to respiratory-related diseases such as asthma, tightness of the chest etc. In other cases when the user smokes a cigarette or incense sticks in an air-conditioned room the air pollutants do not go out of the room for a long time and creates a greenhouse effect which leads to shortness of the breath. People with asthma see their health affected exposure to air conditioning. Additionally, prolonged exposure contributes to worsening asthma conditions and leads to lung infections.

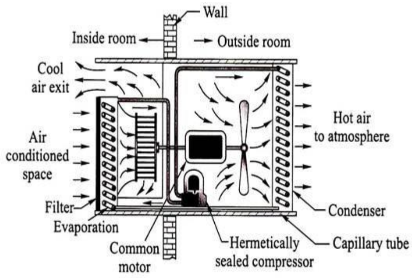


Fig 1.2 Air Conditioner

Air-conditioning that is set too cold can lead to or worsen other health symptoms and problems. Here are some examples:

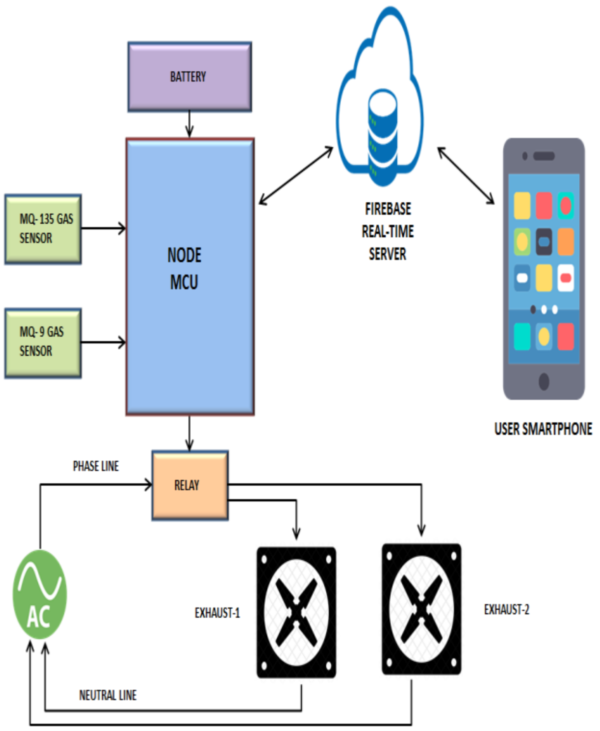
- Dry and irritated eyes, mouth, throat or nasal passages
- Headaches
- Sore throat
- Loss of voice
- Reynaud's disease
- Arthritis
- Breathing issues

3.2 DESIGN OF PROPOSED SYSTEM

The proposed system is designed to enhance the indoor air quality with optimized control over the airflow between indoor and outdoor. The indoor air quality is continuously monitored using gas sensors and monitored using a smartphone. The platform relies on an IoT and android technology to monitor indoor air quality in anywhere and anytime. Smart Indoor Air Quality Application has been developed based on the IoT technology to efficiently monitor the air quality and transmit data to the cloud database in real time.

The system(as shown in Fig) includes Arduino based air quality controller which uses a sensor to sense the number of gases present in the atmosphere and once the amount of carbon dioxide goes above the permissible level 350 ppm it sends this data to an Arduino programming board which then operates the exhaust unit which consists of an exhaust fan (50 CFM) which pumps out the air from the room into the external environment. At the same time, fresh air is allowed to flow inside the room which is rich in oxygen. In detail, the following environmental parameters are collected with the aim of controlling gas levels: Carbon Monoxide (CO), Carbon Dioxide (CO2), Nitrogen Dioxide (NO2), Methane (CH4), Hydrogen Sulfide (H2S), Ammonia (NH3), Particulate Matter (PM), Moreover, other parameters including temperature and humidity are measured. In this section, the design and implementation of the proposed system is discussed.

The main job of our system is to provide a healthy, pollution free environment and to maintain indoor air quality of every industry, office and households. Better air quality helps the user to prevent diseases caused due to poor and polluted environment. Our system can be adapted to any air-conditioned room irrespective of the air conditioner that is being used. This eligibility thus allows the user to provide enhanced indoor air quality to everyone who uses an air conditioner in a regular basis as well as in partial basis. The Fig 1.3 is the block diagram that represents working of our system which consists of 2 sensors (MQ 135, MQ 09), Node MCU, exhaust fans (2 No.), battery, real time server and also a mobile application.



1.3 Block Diagram of proposed System

The exhaust is placed at the extreme points based on the air ventilation requirements. The exhaust fans were operated through relay modules controlled by Node MCU microcontroller. The status of exhaust fan, gas ratio, gas composition, sensor volt and database entities are updated in real time. The smartphone applications through the real time database user can access the air quality statistics and the operations of the exhaust fans

3.3 FLOW CHART OF PROPOSED SYSTEM

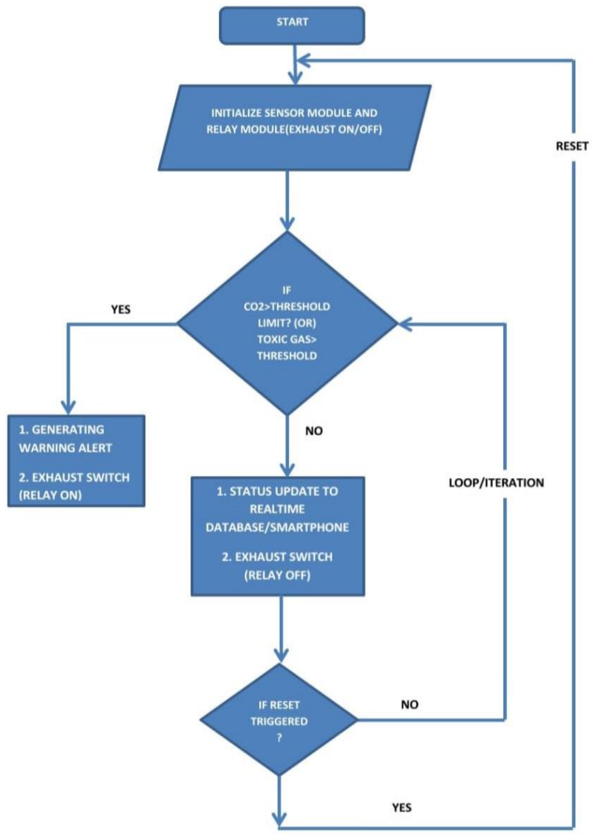


Fig 1.4 Flow diagram of Proposed System

3.4PROPOSED SYSTEM ALGORITHM

1. Initialize the entire device and check network connective
2. Wait for detection cycle time (30 seconds)
3. Locate the device
4. Loop
    i. Read sensor volt
    ii. Compute RS/RO
    iii. Check with Threshold
    iv. IF “YES” trigger Relay to ON wait until PPM to fall below threshold
    v. Update to Realtime Database
    vi. IF “NO”: LOOP
5. IF “RESET” triggered?
    i. YES: GOTO -1
    ii. NO: LOOP

4. FABRICATION AND TESTING OF A NEW SYSTEM

4.1 DESIGNING OF THE ENCLOSURE

The enclosure was designed as shown in figure 11 for the size of the Node MCU and the MQ-135 sensor to operate with good space and better accuracy. A hole has been drilled on the enclosure to mount the sensor on the top of the enclosure for better exposure to the gases in the environment. The enclosure covers the Node MCU microcontroller, relay and other wiring components to avoid external disturbances and provide protection to the circuitry. The air quality monitoring designed to be portable, flexible and handy to monitor the air quality parameters anywhere in real time.

Fig 1.5 Enclosure for Development Module

Fig 1.5 represents the enclosure which holds the wireless module. This wireless module can be placed in several indoor including offices, parking areas, laboratories, hallway and the tested with exposure of toxic gases and the following observations are listed in table-1. The threshold is set 400ppm below which the gases are free from hazardous particles and when the sensor detects, the Micro-controller triggers the relay the enable to increase the airflow between the indoor and outdoor. The fan becomes idle once the ppm falls below 400ppm and the statics of the indoor are updated to the real-time database for analysis.

TABLE 1.1: REALTIME TESTING IN DIFFERENT INDOOR CONDITIONS

Trail – 1		Trail – 2		Trail – 3		Trail – 4		Trail – 5	
RS/RO	PPM	RS/RO	PPM	RS/RO	PPM	RS/RO	PPM	RS/RO	PPM
0.025	200	0.0225	191.25	0.002	16.4	0.0248	213.28	0.0223	187.32
0.0268	214.4	0.0234	198.9	0.008	65.6	0.0252	216.72	0.0242	203.28
0.0278	222.4	0.0244	207.4	0.01	82	0.064	550.4	0.0267	224.28
0.0338	270.4	0.0333	282.05	0.0132	108.24	0.0278	239.08	0.0332	278.88
0.0344	278.2	0.0434	368.9	0.0221	181.22	0.0341	293.26	0.0345	289.8
0.0358	286.4	0.0352	299.2	0.0254	208.28	0.0356	306.16	0.0359	301.56
0.0362	289.6	0.0359	305.15	0.0278	227.96	0.0361	310.46	0.0364	305.76
0.037	296	0.0372	316.2	0.0304	249.28	0.0387	332.82	0.0377	316.68
0.0381	304.8	0.0381	323.85	0.0329	269.78	0.0424	364.64	0.0383	321.72
0.0396	316.8	0.0394	334.9	0.0348	285.36	0.0467	401.62	0.0396	332.6
AVERAGE									
Trail – 1		**Trail – 2**		**Trail – 3**		**Trail – 4**		**Trail – 5**	
RS/RO	**PPM**	**RS/RO**	**PPM**	**RS/RO**	**PPM**	**RS/RO**	**PPM**	**RS/RO**	**PPM**
0.0334	267.6	0.03328	282.88	0.02066	169.412	0.03754	322.84	0.0328	276.19

Table 1.1 shows the samples of the first five trails of Real-time testing in different indoor conditions

The data was tabulated and provides the indoor air quality status and the thresholds along with RS/RO values have been highlighted. The module was exposed to different Gases and practices and the observed value against the particle concentration is represented in Fig 1.6.

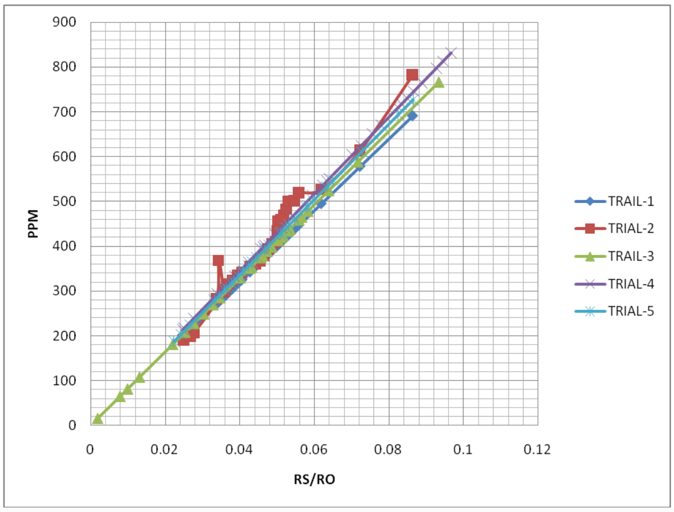


Fig 1.6 Gases Ratio vs. Particle Concentration

5. CONCLUSION

As a conclusion, the sensor-based air quality controller was designed and implemented to monitor the indoor air quality parameters. The portable devices tested in several locations on our campus and found the air quality is optimized through air exchange. The device is accurate and provides alert immediately to the user and automatically triggers the fans to exhaust the indoor air pollutants. The device enhances the air quality up to 20 percent by increasing the air exchange ratio. The devices are operated in cluster header topology, so even in the failure of neighboring devices; the monitoring operation of other deployed devices will not get affected. This method requires low maintenance and provides flexibility during extension while deploying the number of neighboring devices.

The device is low power can be operated by small modular battery and support the wireless monitoring over the indoor air quality parameters. In the future, the device can be upgraded up to 10 different sensors to find the exposure of various hazardous gases in the indoor environment. Moreover, a suction fan can be used in case the device is aided to measure outdoor air quality parameters.

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