AIRZON

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***Abstract* - The air quality of a given area can be utilized as one of the key determinants of the pollution index, as well as how well the city's industry and population are controlled. With the rise of industrialisation, monitoring urban air quality has become a persistent issue. All around the world, air pollution has remained a severe concern for the public and the government. Air pollution has a notable impact on both the environment and human health, resulting in acid rain, global warming, heart disease, and skin cancer. A metric called AQI is calculated by evaluating the concentration of various PM, such as PM 2.5 and PM10, present in the air to estimate the severity of air pollution. Our goal for this project is to design and construct a real-time AQI monitoring equipment that can be easily controlled and manufactured at a low cost, as well as an air purifier that continuously removes tiny particles (PM2.5 and PM10) from the air, decreasing the harmful impacts of pollution.**

***Keywords* - AQI ; PM ; Gases ; Air quality ; Detection ; Air purification**

I. INTRODUCTION

Because of the negative effects of poor air quality on human health, it is now required to properly and timely anticipate the air quality index (AQI).Air pollution has reached dangerous levels as a result of increased mobility, rising global heat, and abrupt climate shifts. Fine particles or particulate matter (PM) with a diameter of 2.5 micrometers or less are the main culprits (PM2.5).A metric known as the air quality index (AQI) is determined by evaluating the quantity of various PM, such as PM2.5 and PM10, present in the air to estimate the severity of air pollution.

II. PROBLEM STATEMENT

Because of its rapid population increase, India is among the world's most polluted countries, with many cities experiencing severe environmental impacts. Many scholars have recently become interested in air pollution monitoring, determining the hazardous zone, and forecasting future air quality. There is currently no simple and low-cost technology that measures air quality. Our goal is to create a device that will monitor particulate matter levels in the surrounding air, display these levels in a straightforward manner, log the data it collects, and allow for data transfer for further research.

III. AIR QUALITY INDEX

It is a numeric system that the environment protection agency uses to monitor air pollution .

AQI LIMIT VALUES

0-50	51-100	101-150	151-200	201-300	301-500
1	2	3	4	5	6

IV. OBJECTIVES

The principal sources of air pollution are gaseous pollutants such as SO_2, NO_x, CO_2, and particulate matter (PM) with a diameter of 2.5 micrometers or less (PM2.5) scattered throughout the air. India's industries are one of the most significant polluters.The project's main goal is to design and create a real-time AQI monitoring equipment that can be operated efficiently and built at a minimal cost.We also intend to incorporate an air purifier that removes fine particles (PM2.5 and PM10) from the air on a continuous basis, thereby lowering the negative impacts of air pollution.

V. METHODOLOGY

The following design prototype will measure particulate matter levels in the air, display them clearly, and filter the air that travels through the circuit. The air intake gathers ambient air, which is then passed via a gas sensor and a PM sensor (major pollutant) to determine the amount of pollutant in the air. The air is passed through PM 2.5 and PM 10 filters (Electrostatic Precipitator/ HEPA), and the filtered air is passed via gas and PM sensors to determine the amount of pollutants.The microcontroller is in charge of the entire system, gathering and analyzing data from sensors. An LCD display shows the equivalent readings before and after filtration.LEDs are also available to display the rate of pollution, with the LED blinking in response to particle concentration. The filtered air is returned to the environment via the air outlet.

VI. EXISTING SYSTEM

Origin and Concepts of Air Quality Index

Air is the most important resource for sustaining life, along with land and water. With the development of technology, a great amount of data on ambient air quality is produced and utilised to gauge the standard of the air in various locations. The extensive monitoring data produce encyclopaedic amounts of data that neither provide a decision maker with a clear picture nor the average person who just wants to know how good or awful the air is with a simple answer? Reporting the concentrations of all contaminants at permitted levels is one way to describe air quality (standards). Even for the scientific and technical community, such statements of air quality tend to be confused when the number of sampling stations and pollutant parameters (and their sampling rates) increases.

For the most part, the general people will not be satisfied with complex conclusions about air quality, such as statistical studies, time series charts, and raw data. As a result, individuals frequently lose interest and are unable to comprehend the current state of the air quality or the regulatory authorities' attempts to reduce pollution. Effective air quality communication should be implemented because persons who suffer from illnesses brought on by exposure to air pollution need to be aware of daily levels of urban air pollution. Additionally, a country's ability to improve air quality depends on the support of its populace, who must be aware of the issues with local and global air pollution and the status of mitigation measures.

Since the 1980s, many developed nations have successfully embraced the idea of an Air Quality Index (AQI) to solve the aforementioned issues (USEPA 1976, 2014; Ontario, 2013; Shenfeld, 1970). A general methodology that converts weighted values of various air pollution-related indicators (SO2, CO, visibility, etc.) into a single number or group of numbers is known as an AQI. Since a limited air quality monitoring programme was just initiated in 1984 and there was essentially no public awareness of air pollution, there have not been considerable efforts to develop and deploy AQI in India.The difficulty of communicating with the public in a way that they can understand involves two aspects: (i) converting complex scientific and medical information into clear, concise knowledge; and (ii) talking with the public in terms of the past, present, and future. For citizens and policymakers to make decisions to prevent and minimize exposure to air pollution and the illnesses brought on by the exposure, it is necessary to address these problems and subsequently build an effective and understandable AQI scale.

Current Model

According to Borghi et al the typical air monitoring system has substantial issues with highly advanced hardware innovation, unsafe operation, high cost, and cumbersome devices.Furthermore, advanced statistical techniques supported by tools like sensors, filters, humidity monitors, and temperature monitors are required for the equipment to give accurate precision and performance. These techniques, however, consume an enormous amount of energy from the large and expensive machinery .

As a result, they are not sustainable or energy-efficient. The technology is ineffective for distant monitoring and is unable to identify an increase in pollutant concentration due to the use of conventional procedures.The greatest option for monitoring the ambient air is ideally a sensor that is effective, affordable, and of a reasonable size. Due to the fact that these devices are used in industry but also partially in environmental monitoring is the inability to accurately measure large amounts of certain gas contaminants in environmental situations. Thus, low-standard monitoring tools will need to be used to compare the cost sensors efficiency.To date, thorough and widely disseminated estimates of productivity are typically rare, especially for diagnostic advances that are currently employed. The goal of the project is to create a portable, high-precision, low-cost air pollution monitoring device that can measure the concentration of several types of particulate matter pollutants in the air in real time.

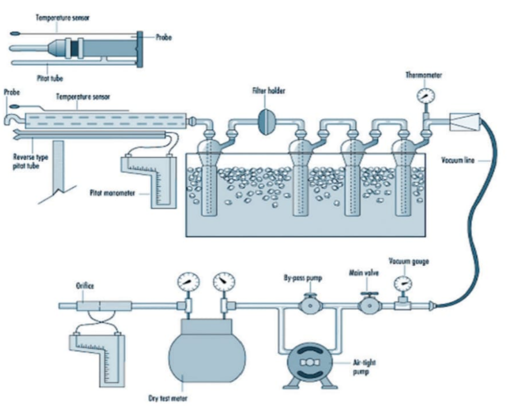


Fig : Traditional air quality monitoring device

Applications of Air Quality Index

Ott (1978) has listed the following six objectives that are served by an AQI:

1. Resource Allocation: To help managers choose priorities and allocate budgets. Make it possible to evaluate the trade-offs associated with alternative air pollution control methods.

2. Ranking of Locations: To assist in comparing air quality conditions at different locations/cities. Thus, pointing out areas and frequencies of potential hazards.

3. Enforcement of Standards: To ascertain the degree to which the legal requirements and accepted standards are being followed. Additionally aids in discovering flawed standards and weak monitoring initiatives.

4. Trend Analysis: To assess the degradation or improvement in air quality that has happened during a predetermined period. This makes it possible to forecast air quality (i.e., track the behaviour of pollutants in the air) and schedule pollution control procedures.

5. Public Information: To educate the public on environmental issues (state of environment). People with illnesses worsened or brought on by air pollution can benefit from it. When people are aware of excessive pollution levels, it helps them to change their everyday routines.

6. Scientific Research: while conducting a study of some environmental events, as a way of condensing a big quantity of data into a comprehensible form that provides the researcher with more insight. This makes it possible to determine specific pollutants' and sources' contributions to overall air quality in a more impartial manner. When used in conjunction with other sources, such as local emission surveys, such methods become more beneficial.

In short, an AQI is helpful for I the general public to understand air quality in a straightforward manner, (ii) politicians to enact swift actions, (iii) decision-makers to understand the trend of events and to map out corrective pollution control strategies, (iv) government officials to study the effects of regulatory actions, and (v) scientists who conduct scientific research using air quality data.

Broad Guidelines for Actions during Very Poor and Severe Categories of AQI

1. *Regulating Agencies*

In order to determine how emissions affect air quality, the regulatory agencies need develop source-receptor interactions. The appropriate actions must be done by further restricting the emissions that are having the greatest influence on ambient air quality in the event that the AQI category is severe or very poor. Examples of specific measures could be I strict vigilance and a zero-tolerance policy toward visible polluters like construction sites, industries, open burning, and vehicles; (ii) traffic regulation; and (iii) identifying the sources most responsible for the deteriorating air quality and taking steps to reduce their emissions.

2. *Public*

People should keep their cars maintained properly (such as by getting PUC inspections, replacing the air filter, and maintaining the proper tyre pressure), observe lane rules and speed limits, prevent prolonged idling, and turn off the engine at red traffic lights. Additionally, people should limit travel during periods of severe or extremely poor AQI, avoid driving private automobiles in favour of public transportation, bicycles or walking, and carpooling, and use smaller vehicles (e.g. avoid SUVs). Diesel generator usage ought to be kept to a minimum. People may think about avoiding unwarranted exposures, particularly those who have asthma or cardiac conditions.

VII. RELATED WORKS

This paper explains the development of a reliable and cost-effective air quality monitoring system (AQMS) that can measure the air quality at indoor and outdoor areas and to alert the user of the hazardous air quality index (AQI) level through an alarm system upon detection. By using Arduino platform and various sensors along with a flat-panel liquid crystal display (LCD) and Bluetooth module, the system detects the level of the hazard gasses, temperature and humidity of the area. The AQMS is a portable air quality index (AQI) acquisition device that is simple to carry and provides real-time measurement on the LCD. It is a user-friendly device and handy to operate. The AQMS gives the public an opportunity to monitor the air quality personally and helps to bring awareness on the real-time air quality around them and improve the air quality.[1]

In this study, it is aimed to predict the Air Quality Index (AQI) by the Extreme Learning Machines (ELM) algorithm. For this purpose, six parameters have been selected which can affect the AQI. These are temperature, humidity, pressure, wind speed, PM10 and SO2 respectively. First of all, “Forecast Sheet” application that presented in the Excel environment and the correlation analysis were used to determine the relationship status between these six parameters and AQI values of these six parameters were obtained by the “AQI Calculator” application. The obtained AQI values were classified mathematically from 1 to 6 considering the AQI limits determined by National Air Quality Monitoring Network of Ministry of Environment and Urbanization.[2]

A detailed study was conducted in the surroundings of the Chavara industrial area in Kollam district, South India, during the summer and winter seasons of the year 2011, to assess the status of air pollutants (TSPM, RPM, SO2, NO2 and Free Cl2) and the air quality of the industrial zone and its surroundings, which are also residential areas. The results of the study show that the concentrations of gaseous pollutants, SO2 and NOx were within the national ambient air quality standard limits of the Central Pollution Control Board and Ministry of Environment & Forests, India. The study stations in the northern, eastern and southern directions of the industrial area recorded chlorine contamination. The presence of PM10 and chlorine in the residential area in the vicinity of the KMML industrial zone may cause different health problems in the residents, especially in children and aged people. The air quality index in the study stations was assessed, and the results showed that the residential areas surrounding the KMML industrial area have moderate air quality. Some measures are also suggested to improve the air quality in the surroundings of the KMML industrial area.[3]

In this work, we aim to investigate a multi-source machine learning approach to approximate the local AQI scores at users’ location in a big city. We conduct different experiments on three primary data sets: “SEPHLA-medieval 2019”, “MNR-Air-HCM,” and “MNR-HCM,” collected in Ho Chi Minh City (Vietnam) and Fukuoka city (Japan). From the data sets provided, we extract different types of useful attributes for the problem: the timestamp information, the geographical data, sensor data (humidity and temperature), users’ emotion tags (such as greenness, calmness, etc.), the semantic features from images captured by users as well as the public weather data (including temperature, dew point, humidity, wind speed, and pressure) of the related cities. After that, we compare five distinct machine learning models for estimating the local AQI score and level, including Support Vector Machine [1], Random Forest [2], Extreme Gradient Boosting [3], LightGBM [4] and CatBoost [5].[4]

This study assessed the performance of nine low-cost PM monitors (AirVisual, Alphasense, APT, Awair, Dylos, Foobot, PurpleAir, Wynd, and Xiaomi) in a chamber containing a well-defined aerosol. A GRIMM and a SidePak were used as the reference instruments. The monitors were divided into two groups according to their working principle and data reporting format, and a linear correlation factor for the PM2.5 mass concentration measurement was calculated for each monitor. Additionally, the differences between the mass concentrations reported by the various monitors and those measured by the reference instruments were plotted against their average before and after user calibration to demonstrate the degree of improvement possible with calibration. Bin-specific calibration was also performed for monitors reporting size distributions to demonstrate coincidence errors that could bias the results. The tested monitors offer low-cost sensors in packages that are convenient for use and ready for deployment without additional assembly. However, to improve the accuracy of the measurements, user-defined calibration for the target PM source is still recommended.[5]

This paper uses data provided by the environmental protection department to predict Air Quality Index

(AQI) through temperature, PM2.5, PM10, SO2, wind direction, NO2, CO and O3. Firstly, this paper introduces the background, technical characteristics, development status and problems of air environment monitoring. Then, it will introduce the environmental prediction model. Finally, we make AQI predictions by using LSTM and analyze the error of the prediction results. The results show that LSTM can predict air quality index well.[6]

The goal of the combined model is to synthesize the advantages of each model and make up for the disadvantages so as to obtain the optimal prediction performance of the combination. Therefore, this paper proposes a scientific combined model of ARIMA+PSO-LS-SVM based on wavelet transform.
Firstly, wavelet analysis was used to preprocess the AQI time series.Then ARIMA model and LS-SVM model are used to predict the linear autocorrelation part and the nonlinear part. The PSO algorithm is used to optimize the parameters of the LS-SVM model. Simulation experiments show that, after selecting the appropriate wavelet decomposition function and parameters of the combined model, the combined model does reduce errors compared with the traditional ARIMA model and LS-SVM model, and has higher accuracy. It provides a new way to forecast the actual air quality index.[7]

VIII. PROPOSED SYSTEM

The project is divided into 2 stages

1. AIR Quality Detection
2. AIR purification

Air quality detection

In this phase the air collected is detected using different gas sensors and pm sensors and the AQI is obtained. The AQI value are depicted below :

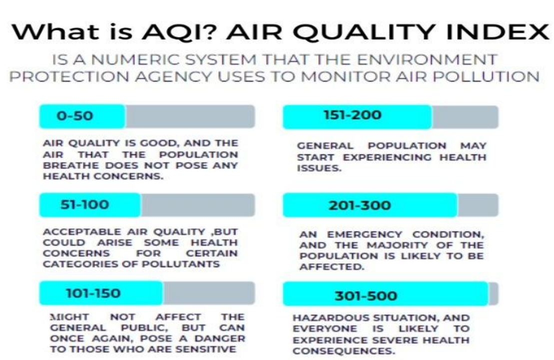
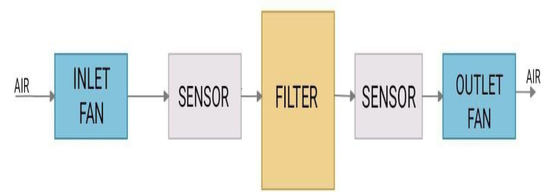


Fig : AQI Values

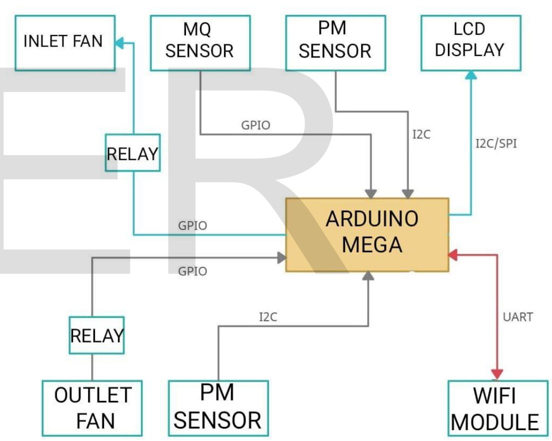
Air purification

The air entering into the device is passed onto hepa filter where the pm particles and other contaminants are removed and the fresh air is released back into the atmosphere. Thus the model purifies the entire air molecules circulating throughout the system.

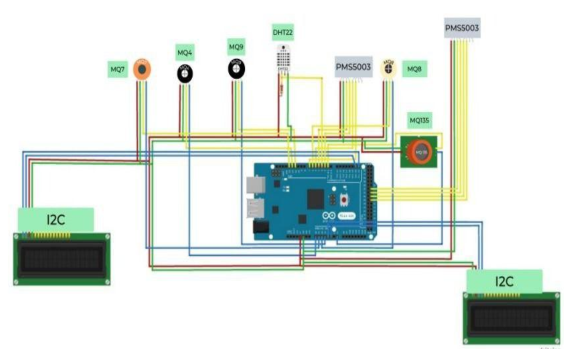
IX. FLOW CHART



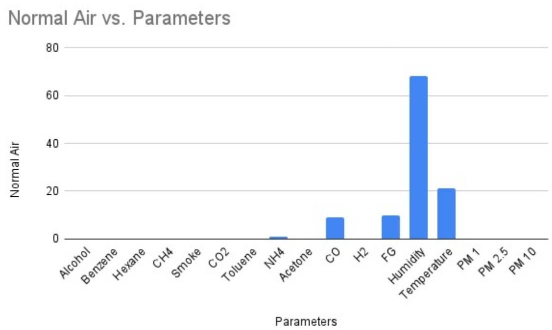
X. BLOCK DIAGRAM



XI. CIRCUIT DIAGRAM



XII. EXPERIMENTAL ANALYSIS



In the experimental analysis we give a comparison between normal air v/s various parameters that affect the air quality. We also give a comparison between normal air, incense stick burning, coconut husk burning v/s various parameters that affect the air quality at Decent Junction of Kollam district and comparison between normal air, air conditioned room at Ramankulangara of Kollam district .

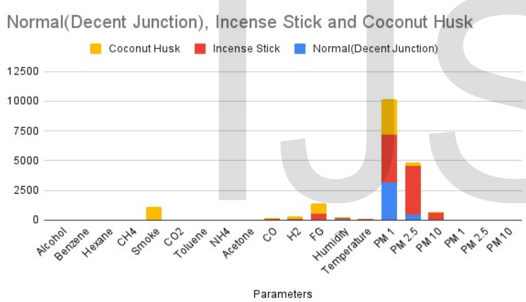


Fig: NORMAL AIR, INCENSE STICK, COCONUT HUSK (DECENT JUNCTION)

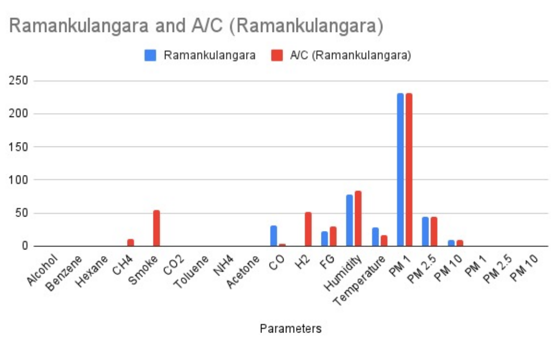


Fig : NORMAL AIR, A/C ROOM (RAMANKULANGARA)

XIII. RESULTS AND DISCUSSION

To make sure the suggested system satisfies the requirements, several different tests were carried out. A multimeter was used to test each component of the system individually to verify continuity and power ratings. Prior to integration into the system, a test was conducted to confirm their functionality. Unit testing is the name given to this kind of testing. Sub-unit testing was then put into practise. Before being incorporated into the suggested system, each sub-unit underwent testing to confirm its operation. The sensors and modules were tested at this stage to make sure they worked with the microcontroller. To calculate the current and voltage consumption, the components were assembled properly.Additionally, system testing for the full air monitoring system was carried out. At this stage, the planned system was thoroughly tested with all of the associated sub-units and parts, as depicted in the schematics. The system was powered during the testing, and it performed flawlessly. The whole system was cased airtight.

XIV. CONCLUSION

Our goal in this project is to design and create a real-time AQI Monitoring system This can be easily controlled and built at a low cost, as well as an air purifier that continuously removes tiny particles (PM2.5 and PM10) from the air, decreasing the detrimental impacts of air pollution.

XV. REFERENCES

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