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Air and Noise Pollution Monitoring using IoT

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Abstract: The level of pollution is increasing rapidly due to factors like industries, urbanization and increased vehicle use which can affect human health. IoT based Air and Noise pollution Monitoring System is used to monitor the Air Quality over the web server. It will upload the data to the cloud. The quality of air is measured by PPM and the noise level is measured in dB. The MQ135 gas sensor present in the system monitors air like CO2, Smoke, alcohol, benzene and NH3. The rover is in constant motion going through various places tracking the different data at different places. The consolidated data is then used to calculate the Air Quality Index(AQI) of a geographical location.
Keywords: AQI, Arduino UNO, MQ135, AdaFruit, ESP8266

I. INTRODUCTION

In this rapidly growing world, many things have been developed to benefit the humans and make our lives easier. The invention of new technologies and advancement of systems have also created few negative impacts on the nature. One among them is pollution. With increase in the number of industries and vehicles, the amount of harmful gases emitted into the atmosphere has also increased. It is very important to monitor the level of pollution and take necessary actions as soon as possible.

The systems that are currently being used to monitor the level of pollution consists of huge modules that uses satellite to determine the amount of dust particles present in the atmosphere. These systems are huge in size and high in cost making it difficult to employ it in many regions. In this proposed system, we have used gas and sound sensors to monitor the particulate matter and noise level present in the environment. A GPS tracker is also present in the system to track the location information. The whole system is mounted on a rover that is constantly in motion. The main idea of the system is that the rover continuously moves around with the monitoring system mounted on top of it. The system continuously tracks the level of pollution and location and keeps on updating it on the web server.

II. PROPOSED SYSTEM

1) In this IOT project, it can monitor the pollution level from anywhere using your computer or mobile.
2) This system can be installed anywhere and can also trigger some device when pollution goes beyond some level then check temperature, humidity level and sound by using some sensors and it keep on the records in IOT
3) This consists of a GPS module thus it gives the location information too thereby monitoring in several areas is easy.

A. Block Diagram

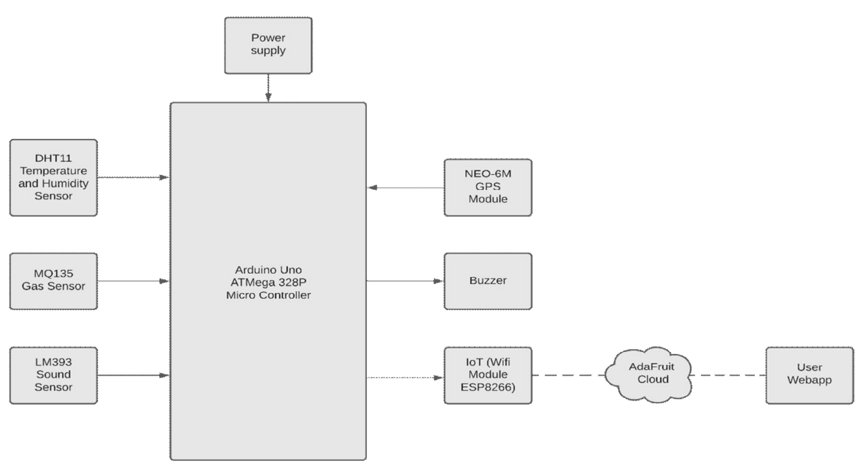

Fig. 1 Block diagram of the monitoring system

The above block diagram depicts the overall idea of how the data flows between different modules of the monitoring system. The air quality information is obtained by MQ135 sensor, the noise level from LM393 sound sensor, temperature and humidity from DHT11 sensor and the location coordinates by the NEO-6M GPS Module. All these data are fed to the Arduino Uno AtMega 328P microcontroller for further processing. The data is then sent to the AdaFruit Cloud through the NodeMCU ESP8266 Wifi module. AdaFruit cloud provides user controls and a interactive dashboard in which all the data from the ESP8266 can be displayed. Graphical interface is used for better data visualization. The user can use his/her mobile/computer to access the data from the AdaFruit Cloud platform.

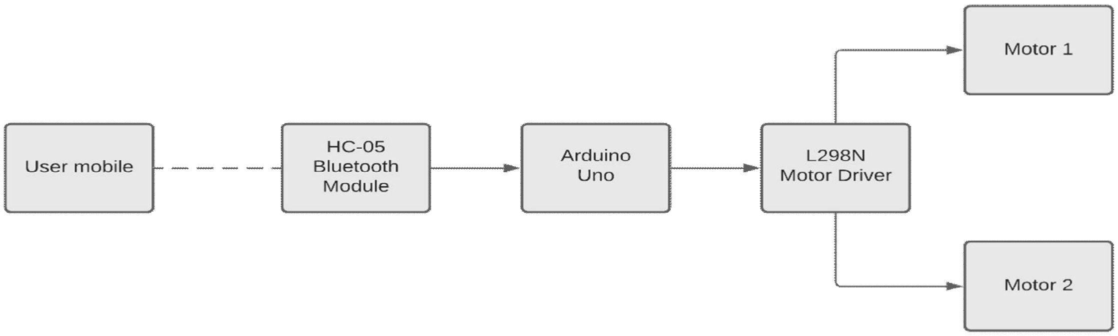

Fig. 2 Block diagram of the rover control system

Fig. 2 depicts the data flow among the various modules of the rover control system that is used to control the movement of the rover. An Android application for controlling the rover is created using the MIT App Inventor. This app consists of basic commands that are customizable to control our system. The user has to connect his/her mobile to the HC-05 Bluetooth Module. Once the connection is established, then the app can be used to control the movement of the rover. These commands are then transmitted to the Arduino Uno microcontroller for further processing. Depending upon the commands given, the microcontroller controls the respective motor through the L298N motor driver.

B. Circuit Diagram

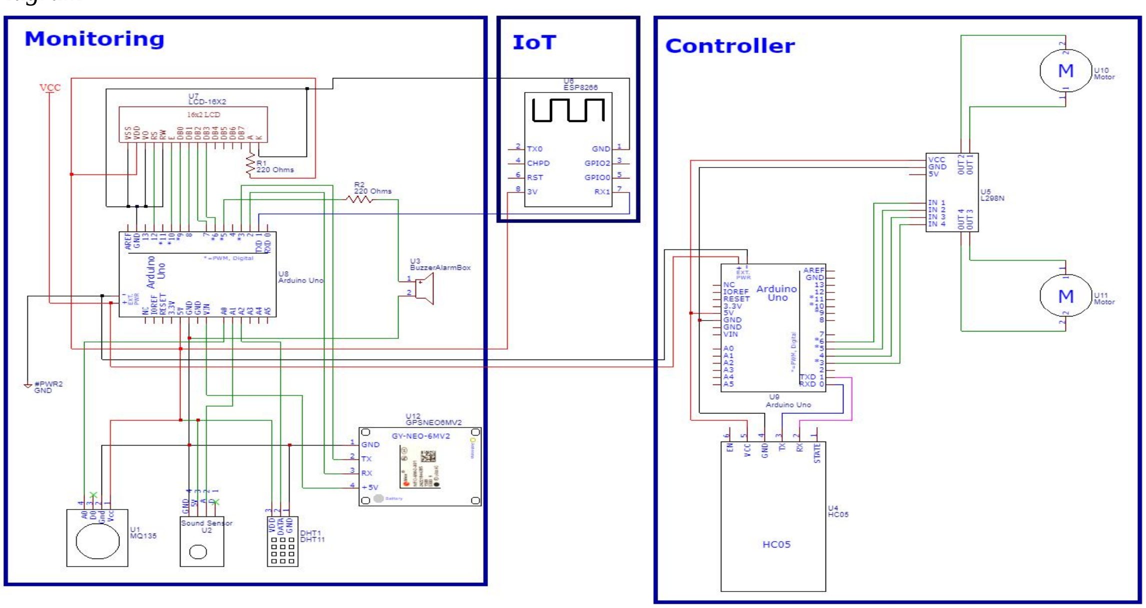

Fig. 3 Circuit diagram of the entire system

The above diagram depicts the circuit connections to be made. The MQ135 gas sensor reads the amount of particulate matter in the atmosphere in terms of PPM. The DHT11 Temperature and Humidity sensor reads the combined values in Celsius. The LM393 sound sensor reads the amount of sound in the environment in dB.

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C. Hardware Design

The system is a combination of about 2 hardware modules namely the monitoring and controller along with the respective software. The monitor part is used to monitor the environment and gather all the data from the environment. Thus, the monitor part consists of the sensors, GPS module, Arduino Uno and the NodeMCU 8266.

The controller part which is used to control the rover consists of a Arduino Uno controller, HC-05 Bluetooth module, L298N Motor driver and the motors used to drive the system. For the controller part, a separate microcontroller is used in order to avoid the resetting of the system when the monitor is reset.

The actual arrangement of the sensors, microcontrollers and GPS is shown below. The whole system is mounted on top of a metal board under which two wheels are driven using 2 DC motors i.e. if we try to reset the 8266 in order to obtain fresh feeds or the sensors, it would be tedious if the Bluetooth module has also reset as we would have to initiate the Bluetooth connection again to make the controller running.

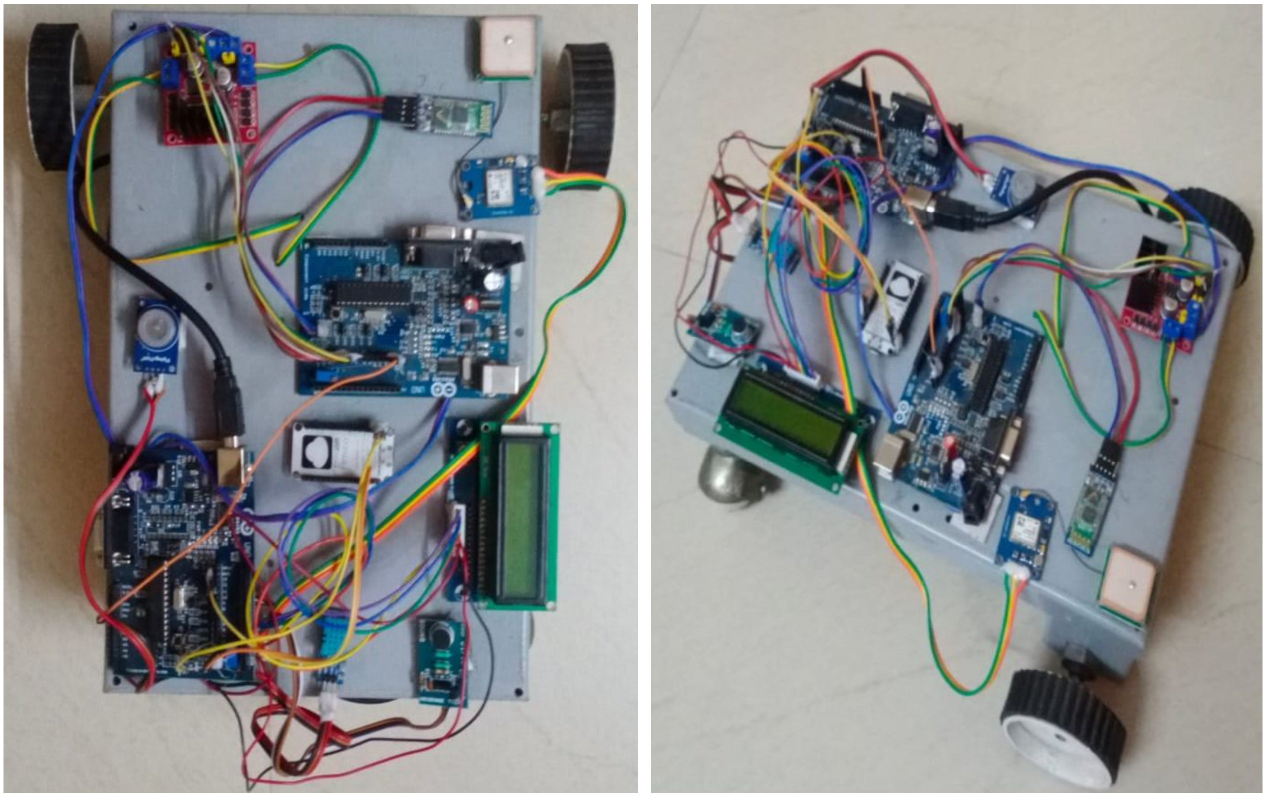

Fig. 4 and 5 Hardware model of the proposed system

III.METHODOLOGY

The whole system is powered from a 230V AC source down-converted to a 9V DC (1A current) power supply through an AC power adapter.

The actual data (air quality information, noise level, temperature and humidity and the location information) is obtained from the respective sensors and the GPS module and is transmitted to the Arduino UNO microcontroller. Simultaneously, the NodeMCU8266 is set up with the Wifi Router enabling access to the Internet. A threshold value is already set in the microcontroller. Whenever the sensor values goes beyond the threshold, the buzzer is turned on.

The NodeMCU ESP8266 receives the data from the Arduino UNO through serial communication. The wifi module present in the NodeMCU transmits it to the cloud through the Wifi router to the AdaFruit Cloud Platform where the data can be further processed.

In the same time, the rover control part is set up. The other Arduino UNO microcontroller interfaces the HC-05 Bluetooth module and the L298N motor driver. The Bluetooth is set up and connected to the user mobile. According to the controls given by the user through the mobile app, DC voltage is provided in the pins connected to the L298N motor driver.

The motor driver which consists of the H-Bridge circuit to amplify the current provided by the Arduino microcontroller, amplifies the current and provides it to the DC motors connected to the wheels.

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A. Flowchart

The below diagram clearly depicts the actual flow of data and control from one module to the other. The values taken as threshold are approximate values that are taken considering a moderate environment. These threshold values may vary depending on the region, climate and the place the system is used. For example, various countries have various Temperature and Humidity depending on the climatic conditions. Particulate matter in Indoor environment may be very less compared to outdoor environment with vehicle and industrial emissions.

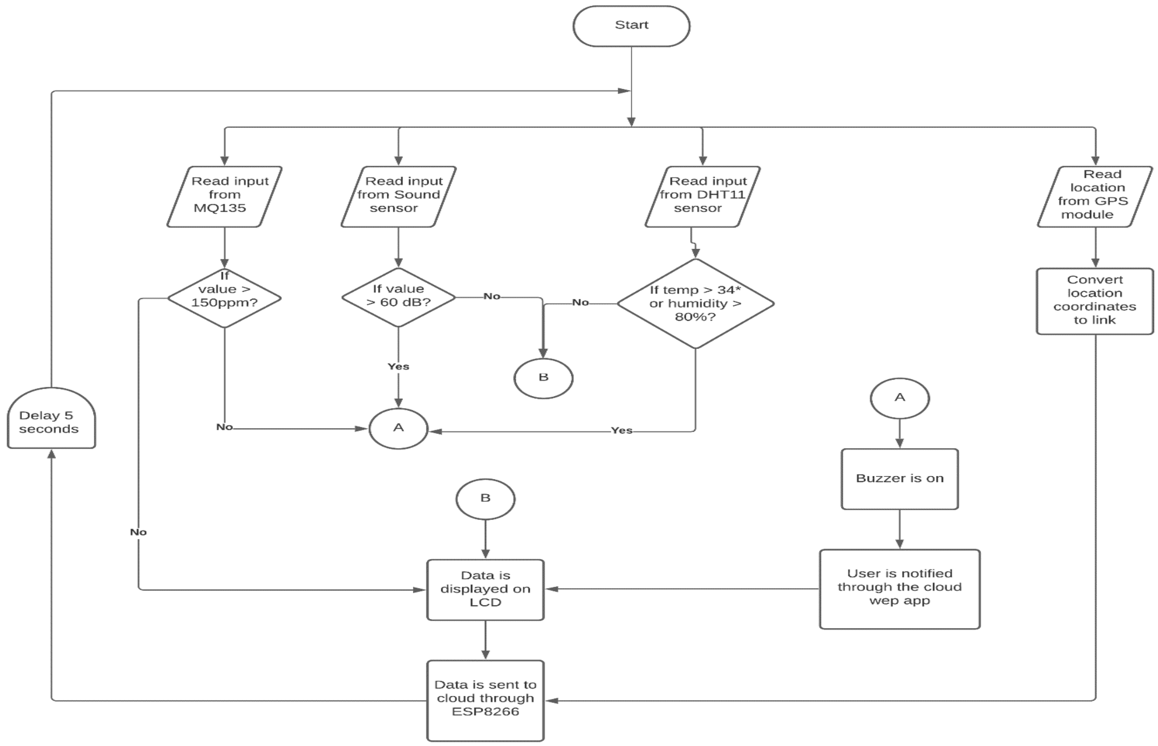

Fig. 6 Control flow of the monitoring system

B. Software Development

1) AdaFruit Cloud Platform

The following steps are followed to create a platform on the AdaFruit Cloud for our data to get stored and viewed.

a) Step 1: Open io.adafruit.com

b) Step 2: An account is created using a username and password

c) Step3: In the feeds section, the required number of feeds are created for the respective data. The following feeds are created for this project

- Air
- Sound
- Temp
- Humidity
- Location

d) Step 4: In the dashboard section, the required number of visual blocks are created for respective feeds to view the data graphically. Here, any type of animation can be added like the slider, gauge, indicator, etc.,

e) Step 5: A unique key is generated for our system, This key can be found under the "My Key" section. The code present over there is loaded on to our Arduino UNO.

```
#define IO_USERNAME  "iotdata1111"

#define IO_KEY       "aio_PmnL70h6HVL2CmRUCeWGJmh3auoo"
```

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2) *Bluetooth Rover Control App:* In the MIT App Inventor platform, an Android app is created using the eat-to-use drag and drop tools and the logic is given to the buttons. The visual appearance of the app is shown in the following diagram. Each button corresponds to the respective functions to be called in the Arduino UNO code uploaded in the rover controller.

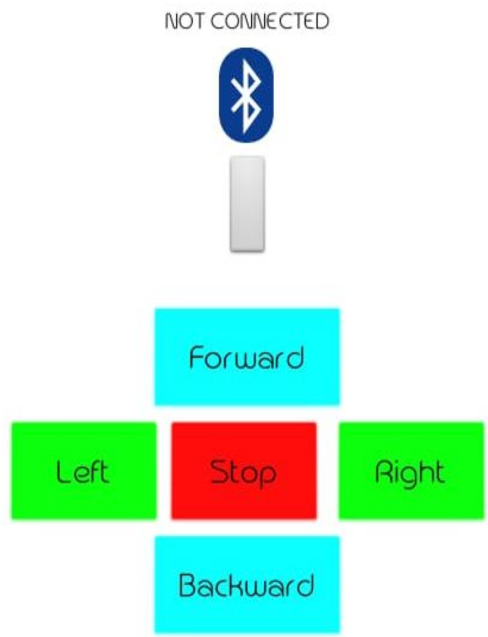

Fig. 7 Screenshot of the Bluetooth Rover Control App

Once the app is created as above, it is exported in form of .apk file which can be then sent to the user's mobile and installed over there.
Initially, the user has to pair his/her mobile Bluetooth with the HC-05 Bluetooth module by entering the password as "1234". Once it is paired, the user can then open the Rover Control app and connect to the HC-05 device.
Once it is connected, the buttons can be used to control the rover. The HC-05 module is configured in such a way that it automatically connects to a device that is already paired. Thus, it is easier to connect the devices once paired.

IV. RESULTS AND VALIDATION

The quality of the air in PPM, noise level in dB, temperature and humidity in Celsius is displayed both in the LCD and the AdaFruit cloud platform. The location information is stored directly in the AdaFruit cloud platform and displayed in form of a map indicating the current location.

Fig. 8 Output on LCD Display

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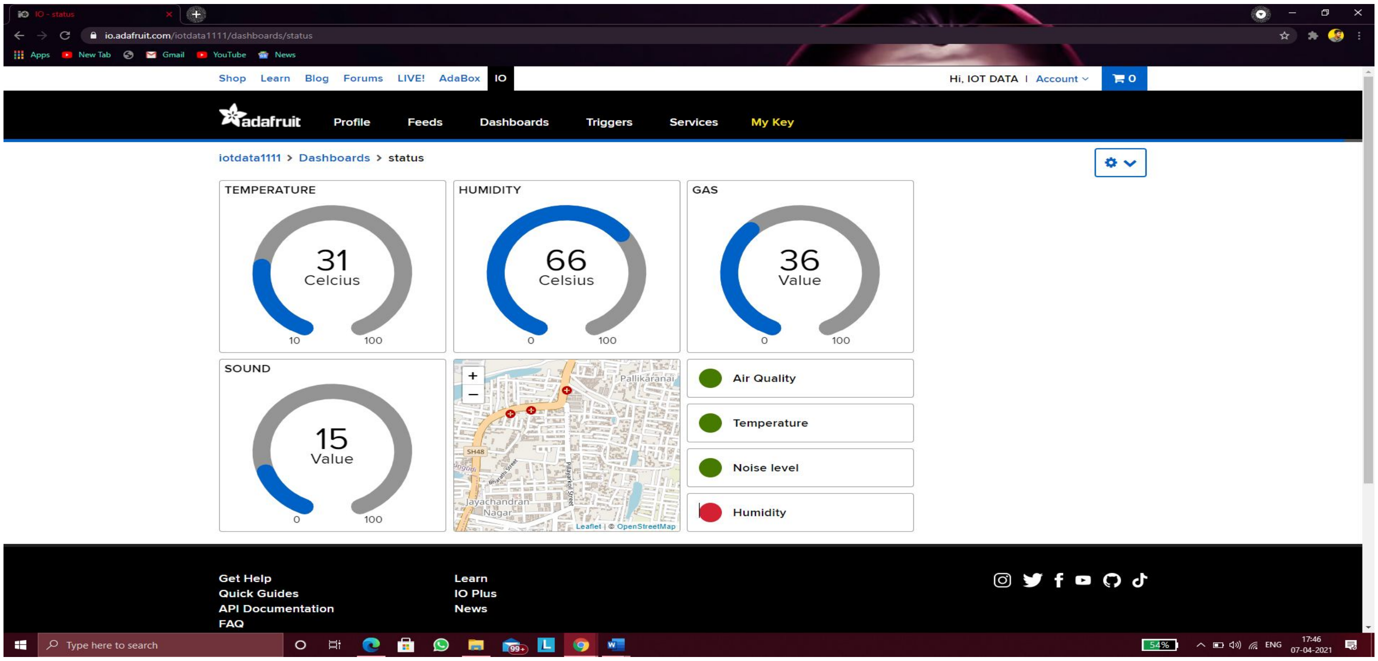

Fig. 9 Screenshot of the AdaFruit Cloud platform dashboard

A. Air Quality Index

The Air Quality Index (AQI) is used for reporting daily air quality. It tells us how clean or polluted your air is, and what associated health effects might be a concern for us. The AQI focuses on health effects we may experience within a few hours or days after breathing polluted air.

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Table. 1 AQI Scale

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B. Noise Levels

The permissible range of noise levels for various vehicles according to the Pollution Control board of India is depicted in the table below.

S. No.	Type of vehicle	Noise Limits from 1st January, 2003, dB(A)	Date of implementation
(1)	(2)	(3)	(4)
1.	Two wheeler		
	Displacement upto 80 cm^3	75	
	Displacement more than 80 cm^3 but upto 175 cm^3	77	Ist January,2003
	Displacement more than 175 cm^3	80	
2.	Three wheeler		
	Displacement upto 175 cm^3	77	Ist January,2003
	Displacement more than 175 cm^3	80	
3.	Passenger car	75	Ist January,2003
4.	Passenger or commercial vehicle		
	Gross vehicle weight upto 4 tonne	80	
	Gross vehicle weight more than 4 tonne but upto 12 tonne	83	Ist July,2003
	Gross vehicle weight more than 12 tonne	85	

Table. 2 Permissible Noise levels of vehicles

C. Data Validation

The system was tested at various places including indoor and outdoor environment. The various outputs obtained by taking an average of several readings in about 8 hours of time are listed as follows.

Nature of environment	Location	Concentration (in PPM)	Noise level (in dB)
Indoor	Guduvanchery	40	15dB
Outdoor	Guduvanchery	85	40dB
Indoor	Medavakkam	42	15dB
Outdoor	Medavakkam	74	46dB
Outdoor	Guindy	82	64dB
Outdoor	Velachery	86	56dB

Table. 3 Results obtained in various places in Chennai

Using the above obtained data, AQI values were calculated using the AQI formula mentioned in the earlier chapters. It is found that the AQI value of various areas fall around 40-45 in indoor environment, 70-80 in commercial areas and 110-120 in industrial areas. The AQI value provided by the pollution Control board of India is about 88AQI which approximates to the results gained through this system.

V. CONCLUSIONS

The system has been tested in various areas in different environments and it is found that it approximately matches the data provided by the Pollution Control Board of India. Moreover, the data obtained seem to have greater accuracy than that of those systems proposed earlier. Modifying the system further according to the area of application can make this system more effective and efficient than the existing ones to obtain accurate results.

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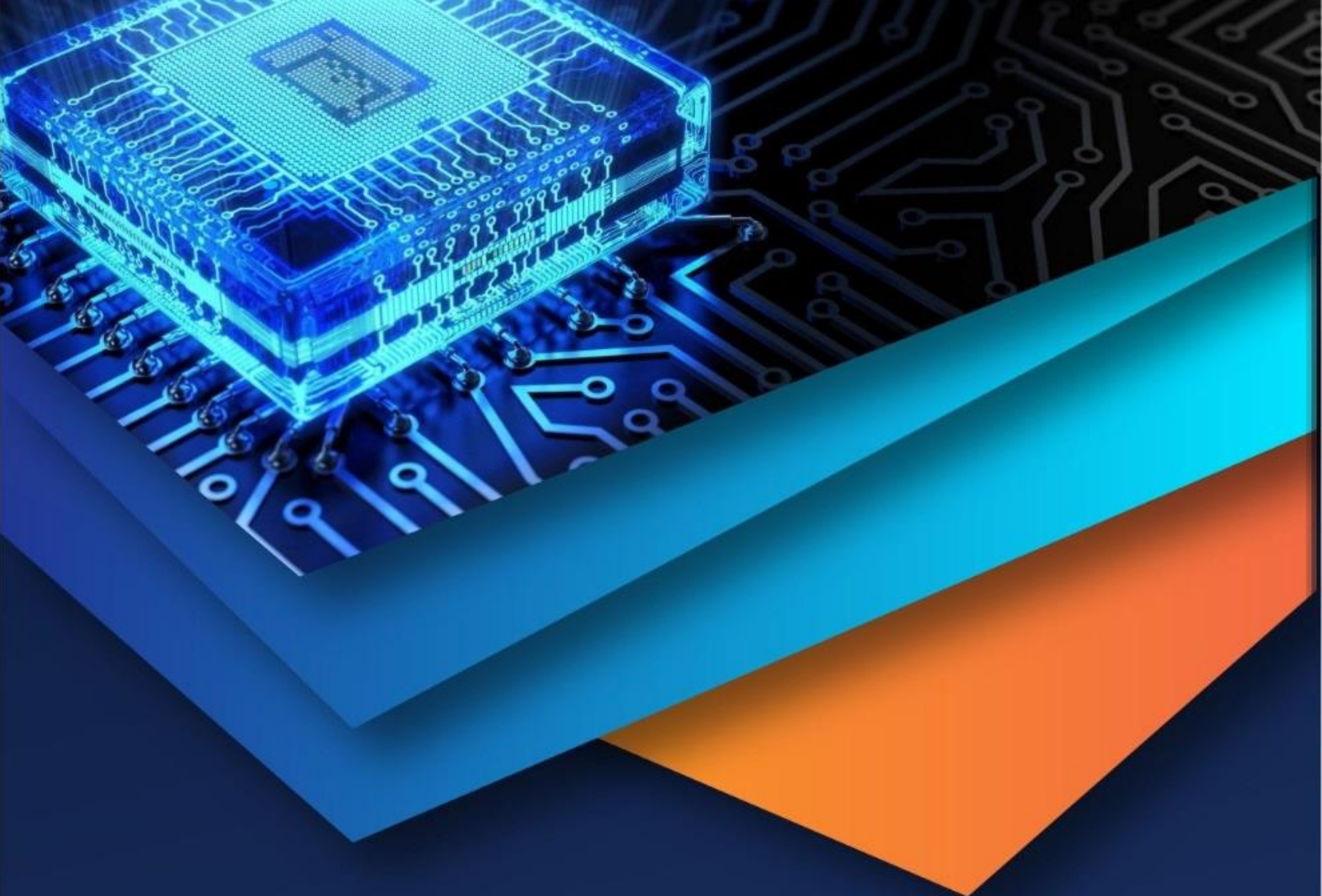

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