

IoT based Pollution Monitoring Device for Rooftop Plants

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Abstract

Nowadays people living in urban are highly increasing than in rural areas. Because of the increase in population, the air which we inhale is also getting contaminated; the people who live in the rural areas want all their needs to be satisfied. Due to air pollution, people suffer from heart disease, lung cancer, and other respiratory diseases. Air pollution has a negative impact on the growth of plants. When the leaves are in close contact with the atmosphere, many pollutants interfere with the growth.^[1] Because of this greediness, they set up many industries around their living areas. These industries not only satisfy their needs but also increase pollution. People are afraid of this pollution. It not only affects human beings but also the plants which give us oxygen, some of the plants can hold only a certain amount of humidity, if it increases then the plant will die. The plants in the route will also get affected by the vehicle which passes by the road. While passing the road it emits a lot of harmful gases which affect the plants in our house. So, we decided to stop these actions and thought to bring a healthy life to the plants. We come across a device that measures the pollutants in the air, it gave us some spark. And then we invented a device using IoT (Internet of Things) technology. This device helps us to find the harmful substances in the air so that we can stop the cause of air pollution and give a healthy life for the plants. It will also help us on the rooftop by providing more oxygen. Using smart wireless sensors, we can check the places.^[2]

Key-words: Roof-garden Plants, Air Pollutants, Noise Pollution, Sensors, IoT, Arduino.

1. Introduction

Humidity measures the amount of water content present in the air and it also measures how much of water vapor content present in the air. We can say that temperature is directly proportional to water vapor in air that is when temperature increase generally; colder air will not have that much capacity to handle moisture content when compared to warmer air. For example, during winter, colder air can hold up to 100 percent of humidity content at 41°F whereas during summer season air can hold up to 80 percent of humidity at 86°F an important factor to know that if humidity is not present in air our living area during summer will be soaking in wet. Certain humidity level must be maintained to get the best output from crops whether humidity in air is good for farming? The answer is YES; humidity control will always play a major role in food industry at the same time ^[3], high humidity is also cause problems to the crops because of the growth of fungal of bacterial diseases.

Air pollution is known as the mixture of solid composition of dusty air particles present in the air the major cause for the air pollutant will be emission of vehicles, chemical entrances from harmful industries, dust and mold spores may be involved as the particles in air pollution. ^[4] Noise pollution is considered as the unwanted sound which interferes in the life of humans and wild animals. It not only affects the creature on the earth surface but also affects the creatures which live inside oceans, noise pollution can be considered as invisible danger ^[5]

1.1. Roof Gardening

Heat increase in industrial growth affects the plants and wildfire. So, they started to follow a new method called rooftop gardening. To meet environmental sustainability not only growing plants in rooftop areas, but they also started to cultivate vegetables for human beings. The important goal behind this rooftop gardening is to keep up atmosphere air clean and to keep it safe for human use some of the countries like France, Canada, have passed some laws that every residual and commercial building should have carry out the concept of rooftop gardening by this method we can also say that it purifies the air which we inhale. It not only helps us by purifying the air but also gives some benefits like i) Helping us to cultivate non-vegetable and fruits ii) By observing noise, also controls noise pollution iii) reducing carbon dioxide emission iv) helping us to keep our rooftop clean, etc.,

2. Materials Required

Gas sensor, Mic module, Temperature and Humidity sensor, Potentiometer, Bluetooth hc05, Flame sensor, Arduino ATmega-338p.

3. Results and Discussion

The components used and working of proposed device is given below:

Components

Arduino

Arduino uno is a microprocessor which acts as an interpreter between developers of sensor. It equally distributes the work for each and every single part in sensor. It acts as a microcontroller and an inexpensive hardware and it has a lot of features, it can be easily erased ^[6] Arduino programming language is basically like c programming language the main advantage of Arduino is we don't need an external programmer. It generally acts as the brain of the system.

Fig. 3.1 - Arduino



Sensors

(i) Gas Sensor

Gas sensors will be one of the parts of the device which measures the number of harmful constituents present in air it detects the level of carbon mono oxide, toluene, ammonia, alcohol, carbon dioxide and acetone. Previously, detectors were produced to detect one single gas. Modern units will detect several toxic or combustible gases, newer gas analyzers can break up the component signals from a complex aroma in order to identify several gases simultaneously.^[7] The above-mentioned gases are very harmful for the growth of crops when they are in excess in amount in air (sensor) usually this air sensor when high in cost but nowadays it is available in affordable price.

Fig. 3.2. Gas Sensor



(ii) Noise Sensor

Noise sensor by the name itself we can say that it detects the noise pollution. When the noise exceeds certain level in atmosphere this sensor detects it. There are wide variety of these sensors, it is mostly used with Arduino in noise sensor noise is directly proportional to the wave nature in sensor. That is, if the noise increases the wave nature also increases. Generally, plant can with stand 50-120 Hz if the frequency of noise is more than 120 Hz it affects in the growth of several plants.

Fig. 3.3 - Noise Sensor



(iii) Temperature & Humidity Sensor

The humidity sensor generally measures the air content, and it shows the amount of nature content present in air. The humidity content which requires for a healthy and a prosperous life is 30-50%, certain plants can't withstand low level of humidity because they require certain amount of humidity to live in this earth.

Fig. 3.4 - Temperature & Humidity Sensor



(iv) Flame Sensor

From the name itself we can conclude that it detects the presence of fire. Generally, the output of this sensor will be in binary code. If the fire is present the output will be '1' and if the fire is not present the output will be '0'. Nowadays those kinds of devices are used in several areas it is necessary and very much useful in public areas like malls, theatres, etc. The flame sensor detects the presence of fire by using IR wavelength it is also very sensitive the corresponding wavelength is 260nm ~ 1100 nm light. It works by regulating the flow of gas entering the furnace and it automatically shuts the gas valve down if the furnace does not light up. The main purpose of this working principle is to prevent built-up gas or catastrophic explosions. The equipment which we use to detect must suit the damage, also the sensitivity has to match the emission sensitivity of the flame which have to be detected.^[8]

Fig. 3.5 - Flame Sensor



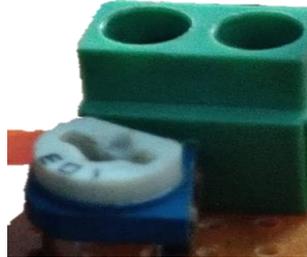
Potentiometer

Potentiometer is used to compare emf of 2 cells It was also be used as rheostat IR variable resistor by changing with one end. The voltage of that battery is known as driver cell voltage. Those all several types of potentiometers they are

1. Concentric potentiometer
2. Single-turn potentiometer
3. Servo potentiometer

This method was described by Johann Christian Poggendorff during 1841 and it became a standard laboratory measuring technique which is widely used till now.^[9]

Fig. 3.6 - Potentiometer



Bluetooth hc05

We all know that Bluetooth is a wireless communication technology which connects our device and the system which we used “HC-05” is the wireless Bluetooth which we used here. it communicates with microprocessors using serial communication. Bluetooth module can be changed by using certain AT commands.

Fig. 3.7 - Bluetooth hc05



Working

The air pollution and noise pollution along with humidity is based on the block diagram given below. The temperature and humidity sensor have a filament, when the filament catches heat the

resistance will increase, by this resource the sensor will give us the information whether the temperature is high or not.^[10] The next sensor is the gas sensor, or we can call it as air sensor. It has 2 coil voltage difference or resistance which is filled with sheeter. A sheeter heats up the air and it will react based on the air that is it will react in a different way for each different air. Based on that the gas sensor tells the amount of gas. It detects the level of carbon mono oxide, toluene, ammonia, alcohol, carbon di oxide, and acetone. So, gas sensor is dynamic. The mic module has a piezoelectric surface where the sound will be absorbed or be taken as an input and measures the frequency, when the frequency is high it will let us know, the sound is high. When we see the flame sensor it won't conduct the current at present when the tip is reached it conducts the current and let us know there is fire occurred and save us now here where the Arduino uno takes place, the Arduino uno acts as a microcontroller.

The Arduino uno which we use is Arduino atmega-338p Arduino will combine and store all the values given by the sensor as variables and be stored as an array with the help of Bluetooth connected with our mobile phone we will be notified if the values are high the Bluetooth which we use is Bluetooth HC-05 if the value is abnormal, we will get an alarm sound, so according to the model these sensors work as an input data and these transmit the data for letting us know which gas it is or is the sound is high, humidity, fire alarm. Finally, the LCD display has shown the data in respective units as shown in the Fig. 3.8.

Fig. 3.8 - IoT Device Monitoring Humidity and Temperature

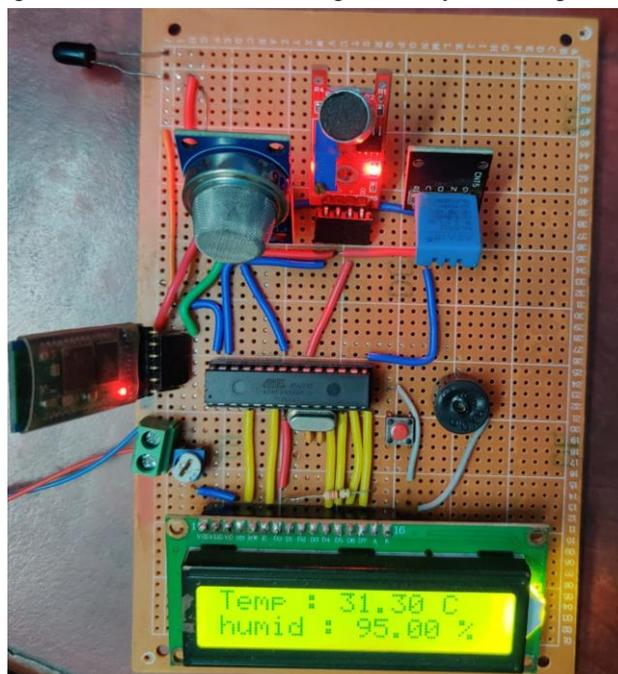


Fig. 3.9 - IoT Device is Getting Values by Detecting the Air Around the Area

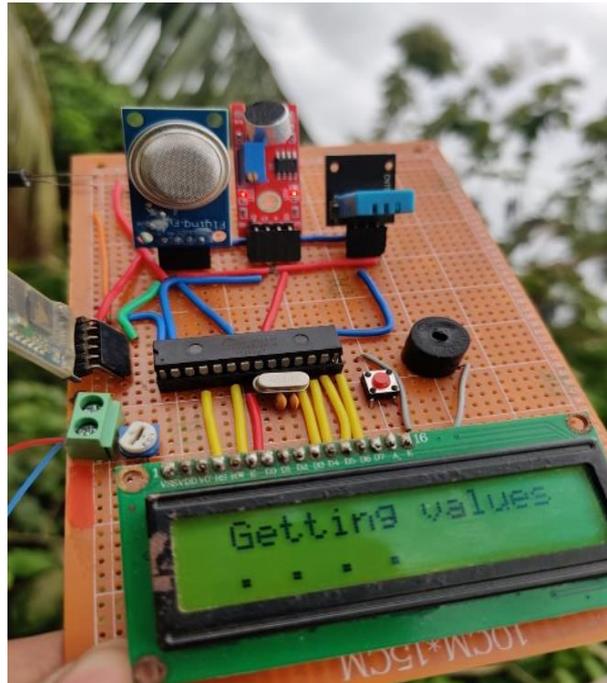


Fig. 3.10 - IoT Monitoring Air Composition

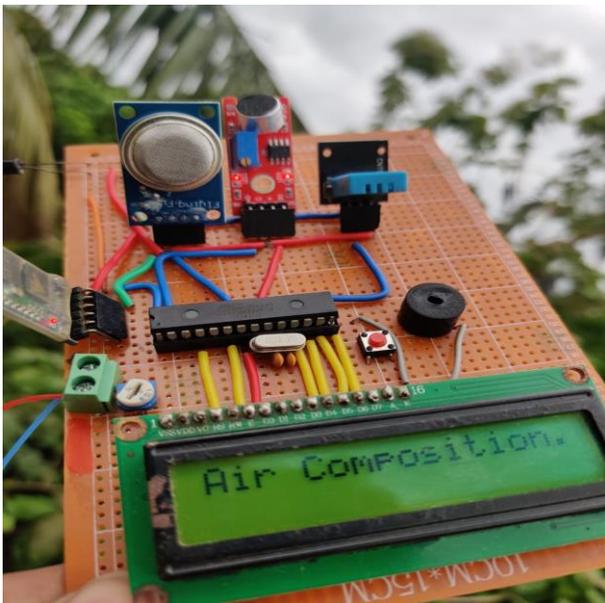
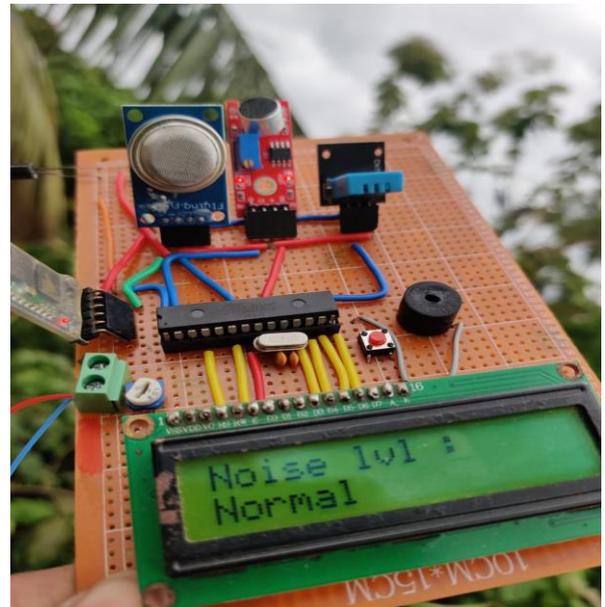
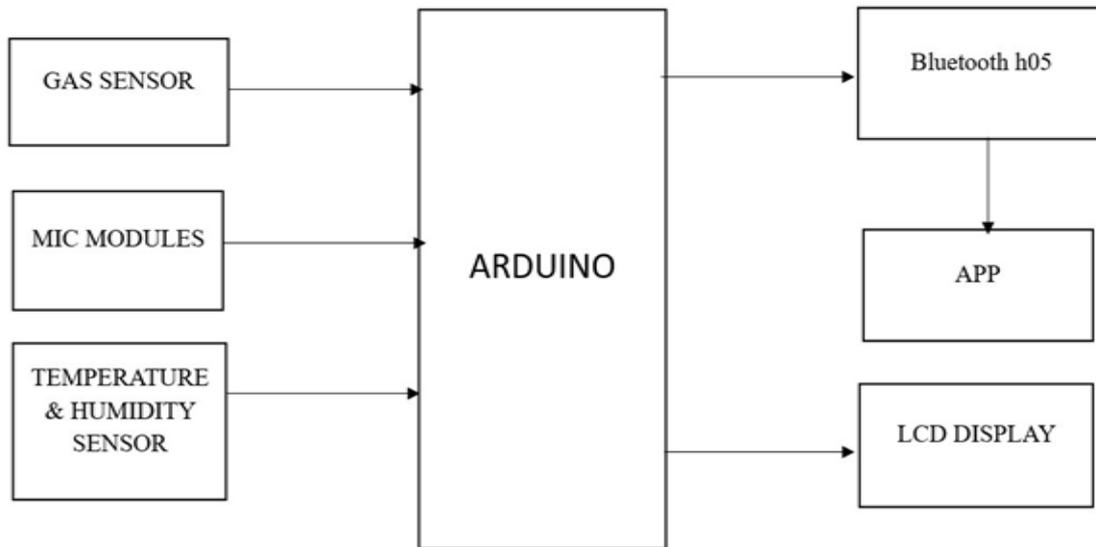


Fig. 3.11 - IoT monitoring Noise Level



As we can see in fig. 10 and 11 the device is monitoring and detecting the vales for air composition and it is detecting for noise level in the atmosphere after detecting the device will display the amount of carbon mono oxide, toluene, ammonia, alcohol, carbon dioxide and acetone. The device also displays the noise composition in the atmosphere and detects if there is presence of fire.

Fig. 3.12 - Block Diagram



IOT Device in Rooftop Garden Plants

A roof top garden has great decorative benefits and also can be used to plant food providing plants and helps in keeping the temperature in check. Also provides hydrological benefits. And when roof top gardening is done over a large surface area it can also provide noticeable ecological benefits to the environment. Starting a roof top garden is easy and has various benefits. Nowadays, novel biodegradable super absorbent polymers are used as fertilizers and antioxidants in rooftop plants. [11-15]

Fig. 3.13 - Rooftop Garden in Metropolitan City



Table 3.1 - Air Pollutants on Rooftop Garden before and during Covid19 Lockdown

Pollutants	Standard (Permissible Limit)	Concentration before covid19 lockdown				Concentration during covid19 lockdown			
		At 4 am	At 10am	At 6pm	At 10pm	At 4am	At 10am	At 6pm	At 10pm
CO	5.0ppm	4.2ppm	5.7ppm	5.3ppm	4.8ppm	3.9ppm	5.4ppm	5.2ppm	4.6ppm
CO ₂	500ppm	495ppm	680ppm	623ppm	525ppm	478ppm	562ppm	604ppm	510ppm
NH ₃	0.6 ppb	0.5ppm	0.64ppm	0.7ppm	0.6ppm	0.5ppm	0.61ppm	0.6ppm	0.54ppm
Toluene	5 ug/m ³	4ug/m ³	6ug/m ³	7ug/m ³	5ug/m ³	5ug/m ³	5ug/m ³	6ug/m ³	5ug/m ³
Alcohol (8 hr. basis)	1000ppm	923ppm	1007ppm	1111ppm	972ppm	917ppm	998ppm	1048ppm	960ppm
Acetone	140ppm	132ppm	149ppm	146ppm	136ppm	130ppm	144ppm	142ppm	131ppm
Humidity	50 – 60%	75%	64%	66%	72%	71%	60%	64%	69%
General Air Quality	Good (as per AQI)	Good	Average	Average	Good	Good	Good	Good	Good

From the above table 3.1, we conclude that before covid19 the planet earth is highly polluted due to a greater number of vehicles, industries etc., during covid-19 lockdown, and all the anthropogenic activities have been reduced which further decreases the air pollutants in the surroundings. The table data implies that the air pollutants like CO, CO₂, NH₃, Toluene, alcohol, acetone content in atmosphere is more than the permissible limit before lockdown and reduced to certain extent during lockdown. The high content of air pollutants creates a positive and negative impact on the rooftop plants affecting its growth and yield. So, the proposed IOT device helps to monitor air pollutant level in and around roof top garden plants and alarm us to control the air pollution surrounding it.

Table 3.2 - Impact of Air Pollutants on Plants

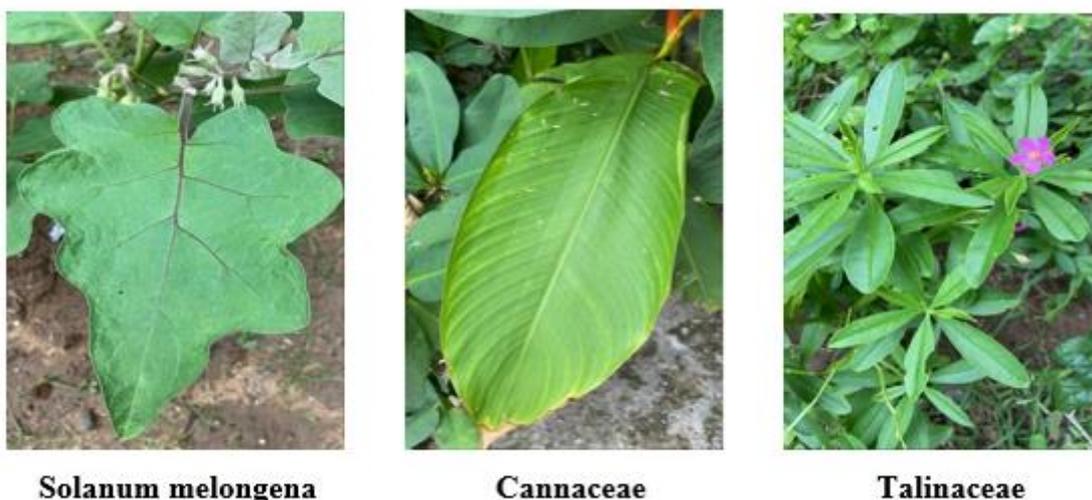
Air pollutants	Effect on plants
Carbon monoxide	Highly Positive Carbon monoxide has positive effects on seed germination, root development, and it enhances plant abiotic stress resistance
Carbon dioxide	Highly Positive and less negative High CO ₂ levels causes the plants to thicken their leaves, this might affect climate change patterns and also scientists say when CO ₂ levels increases, most plants do something unusual
Ammonia	Highly Positive Ammonia is present in the soil, water and air. And it is an important source of nitrogen for plants. Thus, helps in improved flower and fruit
Toluene	Highly Negative Toluene can cause membrane damage to the leaves of plants when exposed in high concentration
Alcohol	Highly Positive and less negative Exposure to alcohol on plants might make water absorption tough and this might lead to reduced plant growth. But alcohol can act as an effective pesticide at low levels.
Acetone	Highly Negative Exposure to acetone can lead to membrane damage, decrease in size and decrease in germination of various plants
Humidity	Positive and Negative High amount of humidity increases the toxic substance in air because of this dust which forms in our houses will also increases and it also affects the quality of air. It is a known fact that several bacteria will be affected by low or high level of humidity. Low level of humidity will be one of the ways for causing airborne germs. The bacteria and viruses which cause damage to plants are caused by low and high level of humidity. High level of humidity increases the toxic chemicals in air which cause severe problems for living organism and it also affects the ozone layer. So, when the quality of air decreases it affects plant growth, cannot continue transpiration, and sometimes plants even rots

The above table 3.2 reveals that some of the air pollutants such as CO, NH₃ shows positive effect, toluene, acetone show negative effect and the remaining pollutants shows both positive and negative impacts on roof top plants.

Noise Pollution in Rooftop Plants

The proposed IOT device also monitors the noise pollution in rooftop plants. The 3 types of plants as shown in the Fig. 14 taken into consideration and noise absorption of each plant has been measured using the device.

Fig. 3.14 - Plants Showing various Leaves



Noise Adsorption by Plants

Table 3.3 - Noise Absorbed by Leaves

Plants	Noise absorbed in dB
Broad Leaf	15-20
Moderate leaf	10-14
Short Leaf	7-10

The table 3.3 confirms the larger the leaf size of a plant, the more noise it can absorb, thereby reducing the noise pollution in the atmosphere. So as far as the research says that the broad leaves like Solanum Melongena dense plantation of wide 15-20 m could reduce the noise levels by 70 to 80 percent that is likely to 15-20 dB. A study shows that the lengthy narrow leaves like Cannaceae plantation of wide 15-20 m could reduce the noise levels by 10-14 dB.

Also, as for dense shrubs like *Talinaceae* of wide 15-20 m could reduce the noise levels by 7-10 dB and at a peak traffic noise a minimum of 30 m wide dense shrub will be needed to reduce the same 7-10 dB of noise.

4. Conclusion

Rooftop gardening is one of the most efficient method for garden lovers but nowadays it is also spoiled by the various types of pollution. To reduce the air pollution, there is a need to know how much the toxic pollutants are present in the atmosphere. Therefore, the air pollution is controlled to create a better atmosphere for plants. The proposed device will definitely play a major role in monitoring the pollution and alarming the gardeners to reduce the harmful contaminants around the roof top plants. It will also play a major role in knowing the humidity level in the atmosphere. Being the human individual, it is our responsibility to maintain our atmosphere and help the plants to grow in a better field of area. It is our primary duty to control different types of pollution producing sustainable products.

As we know that the noise pollution causes several problems to the living organisms, it doesn't matter which living organisms it is, but when it crosses certain limit, the organism will undergo various negative impacts. The noise sensor which is used in this device has the ability of sensing the noise pollution. When it crosses certain limit, the user will get an alarm. So, the proposed IOT device is highly helpful in monitoring and protecting the roof garden plants from various kinds of pollution.

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