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# PORTABLE ROBOT TO ANALYSIS OF AIR POLLUTION FOR CROP PROTECTION USING IOT

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***Abstract***: *Air pollution has been a vital issue throughout the 21st century, and has also significantly impacted the agricultural community, especially farmers and yield crops. This work aims to review air-pollution research to understand its impacts on the agricultural community and yield crops, specifically in developing countries, such as India. Humans can be adversely affected by exposure to air pollutants in ambient air. Hence, health-based standards and objectives for a number of pollutants in the air are set by each country. Detection and measurement of contents of the atmosphere are becoming increasingly important. Careful planning of measurements is essential. An IoT-based real time air pollution monitoring system is proposed to monitor the pollution levels of various pollutants also to protects the crops. This paper proposes an IoT system that could be deployed at any location and store the measured value in a cloud database, perform pollution analysis, and display the pollution level at any given location.*

***Keywords***: *IoT-based crop protection, air pollution analysis, impact analysis, agricultural damage.*

## I. INTRODUCTION

Many scientists are actively involved in the issue of environmental monitoring because they are concerned with this fundamental problem. In [1], the authors reviewed ARI cases from burning Indian stands, PC satellite television use, and nationwide fitness survey statistics. The first purpose of this study is to look at financial and health-related expenditures in North India. In [2], the authors confirmed that respiratory diseases are considered to

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be farmers' main causes of death. The study focused on breathable air particles released through the burning of agricultural crop residues (ACRB) and examined the resulting loads. The collected statistics indicate a large investment gap in the agricultural sector. Preventing farmers from burning crop residues and finding alternative solutions to dispose of crop residues is important, thus addressing an evolution in the respiratory health of the population. This study demonstrates the impact of improper crop-burning practices on farmers' mortality and current population mortality rates. The global community's air pollutant scores have been properly prepared. However, it can significantly affect the yield, nutritional protection and welfare of food crops, which may be important for food security crops. In developing countries like India, air pollutants have halved the production of wheat and rice crops. Recently, cultural and hostile movements have led to a new peak in pollutant levels worldwide, specifically in India, which has spread to rural areas where major agricultural sports are practised, hopefully affecting farmers' lives. Air pollutants are caused, particularly by emissions from commercial assets, electricity generation, waste disposal, operation of internal combustion engines, and burning straw and paddy fields. Air pollutants, including particles, liquid, and solid debris, can cause health risks such as sinusitis, bronchial asthma, natural dirt poisoning syndrome, nasal infection, major nervous system signs, and death [3]. Approximately 2.5 million farmers in the Indo-Gangetic Plain grow crops at the same rate as in India: rice and wheat. Rice is grown in such a way as to meet its water needs during the rainy season so that the fields are cleared of wheat in a short period of 10 to 20 days. A critical issue, in this case, is the domestic combustion of biofuels, which causes more deaths than a business interruption.


(a)

Fig.1 (a) The impacts of air pollution on farming land


(b)

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Fig.2(b) The impacts of air pollution on crops

Figures 1, a, and b show air pollution's impact on agricultural land and vegetation. With farmers forced to burn the remains of their harvested plants each year, the agricultural sector contributes just as much, if not more, to the pollutants that plague the United States. l. [4]. Farmers need to burn the paddy fields to eliminate the leftover residue after harvest because they have no other choice. Posada de farmers burn small filaments because they are easy and require minimal shipments. Renting combines is an option, but most farmers refuse to avoid additional fees. Burning husks makes the soil less fertile, so farmers make up for this loss in fertility by using more fertilizer, water, and energy for the same patch. This creates a cascade response of more pollutants, less fertile land, lack of technological improvements, and accelerated mortality and morbidity rates. If more sustainable production strategies are used, the harmful consequences of farming on the environment may be seen. Indeed, in some cases, agriculture plays a vital role in reversing it, for example, by storing carbon in the soil, increasing water infiltration, and preserving rural landscapes and biodiversity. Livestock farming accounts for 40% of global emissions, mineral fertilizers 16%, and the burning of biomass and crop residues 18%. Burning plant biomass is one of the major sources of air pollutants, along with carbon dioxide, nitrous oxide, and smoke particles. Humans are expected to burn 90% of the biomass, mostly through deforestation and deforestation, by burning the vegetation of forest areas with forage residues.

## II. LITERATURE SURVEY

The air and noise pollution monitoring system are fully important for detecting wide selection of gases, also sensors have long life time, easily available, less cost, easy to handle and are compact. Quality of air is often checked indoor also as outdoor. This system has simple drive circuit, works on real time and has visual output. The main objective of this paper is to make sure that the air and noise pollution is monitored and kept on top of things by taking measure accordingly. The proposed paper has certain limitations regarding humidity which should be but ninety-five percent and exact measurement of contaminating gases can't be detected in ppm. This paper is often used for monitoring pollution level and also to stop more than pollution which may cause huge problem in future. This paper gives a thought on how user can give instant aware of the authorities. The cost effective IOT technology is used. Hence air and

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noise pollution is monitored by using this technology.[1] The motive of creating a sensible city are often fulfilled by using technology, thus making the life better and also enhancing the standard of services, therefore meeting every individual's needs. With modern technology in fields of information and communication, it has become easy to interact with the authorized people of city to tell the where about of the area or city, how well the town is developing and the way to form it possible to realize a far better life quality.

In this system, an application was created to form another step within the fulfilment of the goal. An area is analysed for evaluating what proportion pollution affects the world. The components of gases and their amounts are calculated and checked. If the quantity is above normal then the officials are reported about it. After that the people are made to clear the world and brought to a secure place. The combined network architecture and the interconnecting mechanisms for the accurate estimation of parameters by sensors are being explained and delivery of data through internet is presented [6]. The Automatic Air & Sound management system may be a breakthrough to contribute an answer to the most important threat. The air & sound monitoring system overcomes the matter of the highly-polluted areas which may be a major issue. It supports the new technology and effectively supports the healthy life concept. This system has features for the people to watch the quantity of pollution on their mobile phones using the appliance. So, it becomes very reliable and efficient for the Municipal officials alongside the Civilians to watch environment. Letting civilians also involved during this process adds an additional value thereto. As civilians are now equally aware and interested by their environment, this idea of IOT is useful for the welfare of the society. And it's implemented using the newest technology [2]. This IOT based air and sound pollution monitor may be a great step towards a healthy livelihood. With the assistance of this device not only the municipal authorities but even the folk can participate within the process of controlling pollution and ensure safe environment. These automatic devices, once installed are capable of continuously tracking the pollution level and analyse the detected information. The most highlighting feature of this device is that the output is represented in digital also as analog format with the assistance of an easy mobile application which is usable on all android devices like smart phones, tablets, PDA’s etc.

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The device itself is extremely eco-friendly and doesn't harm the environment in any way. Moreover, it's supported one among the fashionable technology and also inexpensive as compared to other technologies developed thus far and may be installed anywhere. [3] For creating the system, first author did the research support the system about IOT and various sensors. Sensors of air and sound supported availability and economical price were selected. For the interaction of internet with the system employing a Wi-Fi module which is connected to the microcontroller through the interface. So, the measured data is shipped from the module to any location with it range from the info are often fetched employing a laptop / mobile [4]. The Automatic Air & Sound management system may be a breakthrough to contribute an answer to the most important threat. The air & sound monitoring system overcomes the matter of the highly-polluted areas which may be a major issue. It supports the new technology and effectively supports the healthy life concept. This system has features for the people to watch the quantity of pollution on their mobile phones using the appliance. To implement this got to deploy the sensor devices within the environment for collecting the info and analysis. By deploying sensor devices within the environment, system can bring the environment into real world i.e., it can interact with other objects through the network. Then the collected data and analysis results are going to be available to the top user through the Wi-Fi. The data are often a crucial source when addressing the difficulty of the impacts of motorcycles at idles (e.g., waiting for a green light) on air quality. Moreover, to realize real-time monitoring, the info of CO concentration during a particular place might be reviewed from mobile communication devices, like PDAs, smart phones, and tablet PCs to help keep air quality in check.

Marks et al. [5] revealed that the burning of biomass not only affects climate conditions, but it also damages plant nutrients. In this study, the environmental cost of paddy straw burning in northwest India was calculated. The west is the country's major crop producer and contributes to India's rising pollution problems. This study helps us focus on India's major cities and gives the statistical information about the cost effectiveness of current crop-burning techniques.

Daxini et al. [45] reviewed farmer characteristics to identify good health practices for farmers' wellbeing. The review also describes how better nutrient management can mitigate the risk of nutrient loss to the surrounding environment. This study, performed in

Ireland, focuses on optimizing resource use efficiency. Improper management of agricultural production can lead to an increased risk of the loss of natural resources in the environment; this study helps us establish important future directions for the use of this review paper.

## III. MATERIALS AND METHODS

### Layered Architecture of an IoT-Based Air-Quality Monitoring System for Agricultural Communities

Figure 1 represents the layered architecture of the IoT-based air-pollution monitoring system framework for the agricultural community. The layered architecture has been classified into five layers: a (i) sensing layer, (ii) communication and networking layer, (iii) cloud services layer, (iv) processing layer, and (v) application layer. The data collection was carried out between May 2019 and February 2020

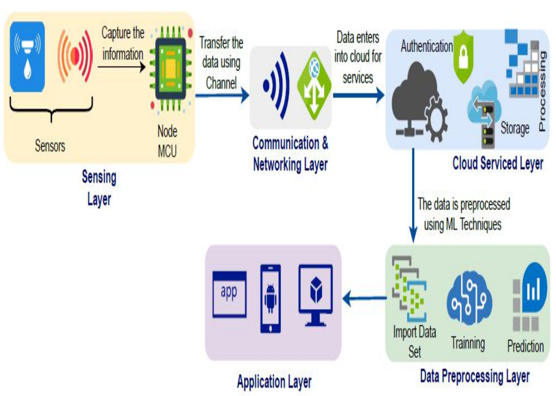


Fig.1 Layered architecture of IoT-based air-quality monitoring system for agricultural community

### Physical Sensing Layer

The sensing layer contains a variety of sensing units such as a SDS021 Particulate Matter Sensor and DTH11 Temperature and Humidity Sensor. The SDS021 sensing unit can measure dust particles present in the surrounding environments such as PM2.5 and PM10. The DHT11 sensing unit can detect the temperature and humidity values of a particular location. These sensing units are embedded with the NodeMCU(esp8266) micro-controller. These sensing units are placed to acquire the pollution-related updates of agricultural states and cities of India. Figure 3a–c, represents the design and experimental setup of IoT-based air-quality monitoring system for the agricultural community.

(a)

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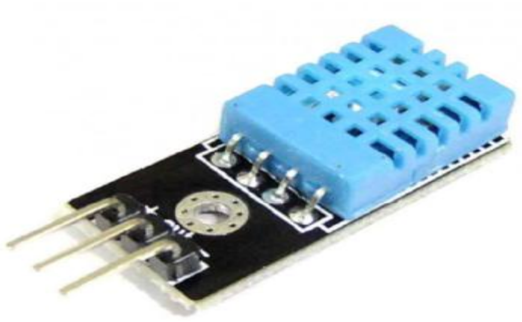

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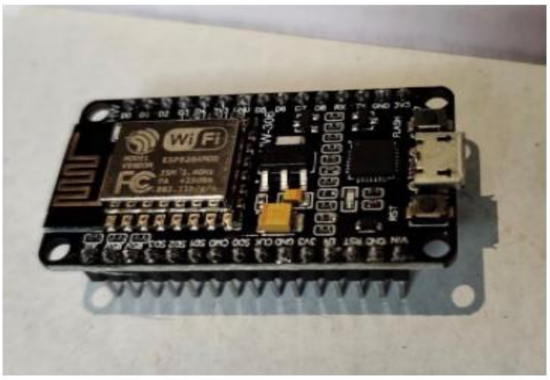

(c)

Fig.2 Design and experimental setup of IoT-based air-quality monitoring system for agricultural communities (**a**) SDS021 sensing unit, (**b**) DHT11 sensing unit, (**c**) NodeMCU(esp8266) microcontroller.

### Communication and Networking Layer

The communication and networking layer is responsible for establishing a connection between a sensing layer, a cloud broker architecture (an MQTT broker), a pollution-data storage server, and a web interface. The Wi-Fi access point is essential for transmitting pollution data acquired by pollution sensing units via a cloud broker via the Internet.

### Cloud Services Layer

The cloud services layer is responsible for storing various pollution data such as PM2.5, PM10, temperature, and humidity in the form of .csv files. This layer is also responsible for publishing the acquired air-quality data to the web interface via a cloud MQTT broker. This layer is also responsible for providing data privacy and security via third party SLAs (service level agreements.

### Processing Layer

The pollution-data processing layer analyses the received pollution data from various sensing units and generates different graphical results such as AQI analysis, PM2.5, and PM10 comparisons of India's agragarian states and cities as described in Section 4. Application Layer: the application layer provides real-time AQI monitoring updates of India's agricultural states and cities via a GUI-based web interface.

## IV. RESULTS AND DISCUSSIONS

Figure 3 represents the state-wise wheat loss (in million tons) in India due to increased ozone levels. It indicates a high wheat loss in crop-yielding states such as Rajasthan, Madhya Pradesh, Gujarat, and some regions of Himachal Pradesh. Variations in wheat loss are represented with red, yellow, green, and red colours on the scale of 0 to 70 million tons, as shown

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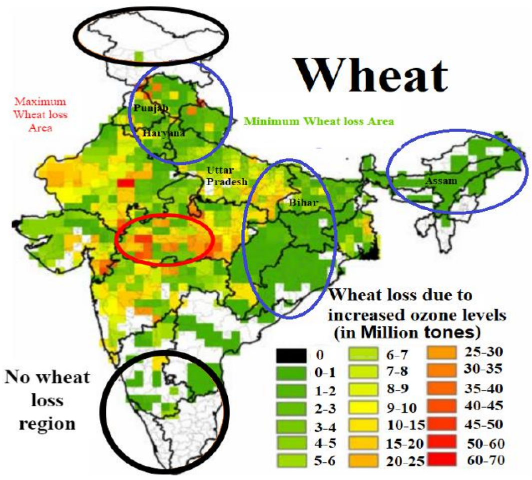
in Figure 3. The mass production of different types of crops throughout the year, in one place, increases the loss of crop yield, as well as increasing pollution due to its burning. Figure 5 represents the state-wise rice loss in India due to increased ozone levels. It also represents a significant wheat loss in Punjab, West Bengal, and Andhra Pradesh. Likewise, rice loss variations are represented with red, yellow, green, and white colors on the scale of 0 to 70 million tons, as shown in Figure 4.



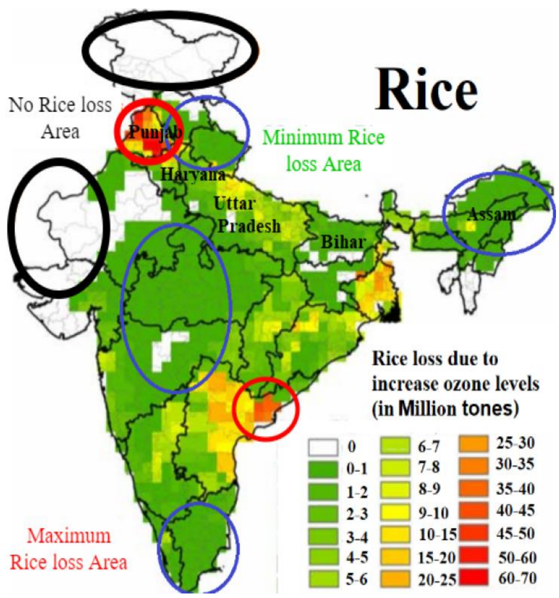




Fig.3 Wheat loss map of India (variations in wheat loss are represented with red, yellow, green, and white colors on the scale of 0 to 70 Million tons) (Source: http://www.wamis.org/agm/; accessed on 1 October 2020).

Figure 4. Rice loss map of India (variations in rice loss are represented with red, yellow, green, and white colours on the scale of 0 to 70 million tons) (Source: http://www.wamis.org/agm/; accessed on 1 October 2020).

Figure 5 compares the loss of rice and wheat produced in India in million tons. Due to this loss, the number of VOCs generated is higher than the number of NOx gases generated. Variations in NOx such as nitric oxide (NO) and nitrogen dioxide (NO2) and variation in volatile organic compounds (VOCs), and total are represented using red, blue, and green colours. Rice does not produce nitrogen oxide during its loss, wheat produces nitrogen-oxide variants, and when VOCs are mixed with nitrogen oxides in the air, they form smog. Totaling to almost 6 million tons of crop loss, the effects these practices and errors have on the climate and health conditions of people living nearby are immeasurable.

Figure 6 represents the state wise wheat loss in India. Among all states, Uttar

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Pradesh tops the list with 0.6 million tons of wheat yield loss, followed by Madhya Pradesh, whereas Uttaranchal has achieved the bottom position with wheat loss of 0.040 million tons lost. Figure 7 represents the state-wise rice loss in India. Punjab has the most loss, with almost 0.9 million tons of rice yield lost, followed by Andhra Pradesh, whereas Tamil Nadu is the lowest, with approximately 0.020 million tons lost. It can be observed that Punjab faces a significant issue of rice burning, and, as mentioned previously, farmers in this region tend to burn significant amounts of rice to get the fields ready for the future wheat yield.

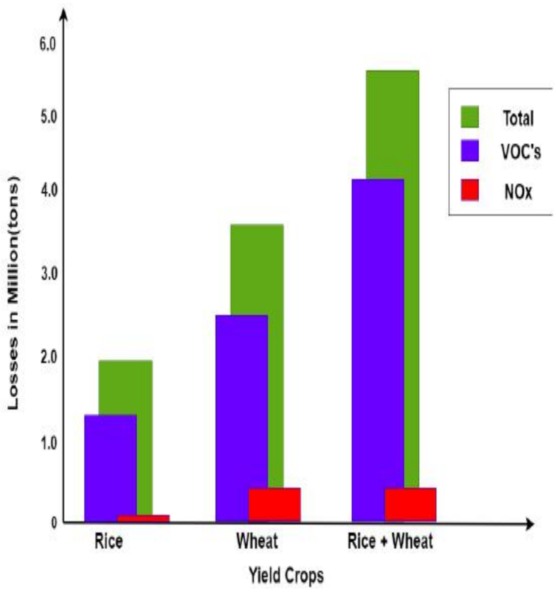


Fig.5 bar-chart representation of comparison of rice and wheat loss of India concerning variation in NOx such as a nitric oxide (NO) and nitrogen dioxide (NO2) (in red color) and variation in volatile organic compounds (VOCs) (purple color), total (in green color).

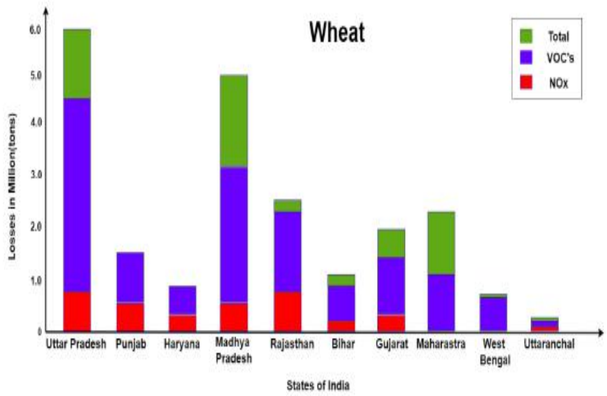


Fig.6 State-wise wheat loss bar-chart representation of India concerning variations in NOx such as a nitric oxide (NO) and nitrogen dioxide (NO2) (in red color) and variation in volatile organic compounds (VOCs) (purple color), total (in green color).

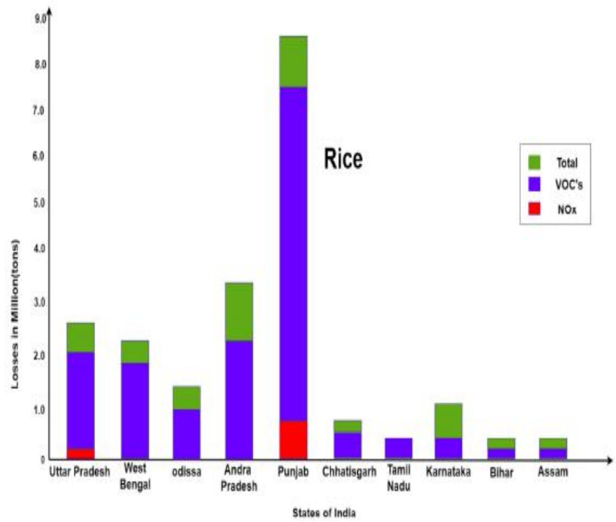


Fig.7 bar-chart representation of state-wise rice loss of India concerning variation in NOx such as a nitric oxide (NO) and dioxide (NO2) (in red color) and variation in volatile organic compounds (VOCs)

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(purple color), total (in green color) (Source)

In this study, we used available pollution data provided by the Indian government on their official portal (www.aqi.in, accessed on 4 September 2022). Table 3 lists a statistical analysis of the AQI values of agrarian states in India. Based on this analysis, Uttar Pradesh and Punjab are the most and second-most polluted states of India with AQI values of 249 and 235. Haryana remains the third most polluted state of India, with an AQI of 235. This analysis also indicates that all agriculture-dominated states can be considered more polluted Indian states than non-agricultural states. Table 3 also compares the PM2.5 and PM10 indices, as well as the variations in temperature and humidity for agrarian states with the highest AQI indices. According to a source appointment survey by TERI (TERI Reports, 2018), 17% of the PM10 and 19% of the PM2.5 emissions in NCR Delhi derive from agricultural burning in nearby states Uttar Pradesh and Haryana. Therefore, agricultural burning in Delhi NCR has a 36% contribution to the total pollution, which is only based on PM2.5 and PM10 measurements.

## V. CONCLUSION

Air pollution has become an important issue of the 21st century and significantly contributed to fatalities, especially in agricultural communities living in developing countries, such as India. Our analysis's unique feature is the color-coding-based AQI risk-metric classification of the impacts of air pollution on India's agrarian states and cities. We analysed India's most polluted agrarian states and cities in terms of AQI variations and PM2.5, and PM10 concentrations. The empirical study of the seasonal impacts of air pollution on the agrarian states and cities was presented for May 2019 to February 2020. Based on our results, we obtained several significant observations:

1. Higher AQI, PM2.5, and PM10 levels were found in agriculturally dominated states such as Uttar Pradesh, Punjab, and Haryana.

2. Among all the cities, India's capital is the most polluted city and has faced significant challenges, such that it may experience alarming pollution levels in the future

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