Ingénierie des Systèmes d'Information
Vol. 28, No. 6, December, 2023, pp. 1479-1493
Journal homepage: http://iieta.org/journals/isi

IoT-Enabled Smart Anti-Smog Towers: A Novel Approach to Urban Air Pollution Control

Sangam Malla[1*], Prabhat Kumar Sahu[1], Srikanta Patnaik[2], Anil Kumar Biswal[3], Manjushree Nayak[4]

[1] Department of Computer Science and Engineering, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar 751030, Odisha, India
[2] Department of Computer Science, Interscience Institute of Management and Technology, Bhubaneswar 752024, Odisha, India
[3] Department of Computer Science, Udayanath Autonomous College of Science and Technology, Cuttack 754011, Odisha, India
[4] Department of Computer Science and Engineering, NIST Institute of Science and Technology (Autonomous), Berhampur 761008, Odisha, India

Corresponding Author Email: sangam.malla2015@gmail.com

https://doi.org/10.18280/isi.280605

Received: 31 August 2023
Revised: 24 November 2023
Accepted: 5 December 2023
Available online: 23 December 2023

Keywords:
green house effect, smog, Anti-Smog tower, cloud storage, pollution control, Internet of Things (IoT), environmental sensing, air quality monitoring

ABSTRACT

The escalating concern about anthropogenic influences on climate necessitates a comparative analysis of the impacts of various human activities, such as the greenhouse gas emissions from natural gas usage relative to other fossil fuels. Crucial in this context is the assessment of methane emissions vis-à-vis carbon dioxide emissions and their respective environmental impacts. Air pollution, exacerbated by rapid urbanization and industrialization, has led to a deterioration in air quality, resulting in the release of harmful pollutants. This degradation poses a significant threat to human health, with the World Health Organization (2016) reporting that over 85% of urban dwellers are exposed to pollution levels exceeding recommended limits. Addressing this, the proposed study introduces a smart air pollution monitoring system using an MQ2 sensor. This sensor detects airborne contaminants and outputs voltage pulses, which are then translated into parts per million to quantify air quality in specific areas. Furthermore, the paper presents the design and implementation of an innovative Internet of Things (IoT)-dependent structure incorporating anti-smog towers. These towers create a virtual greenhouse effect, which is posited as beneficial in mitigating the deleterious effects of atmospheric pollutants on human health. The objective of this study is to explore technological innovations and observational methods employed in smart smog towers for improving air quality. The research delves into the potential of such IoT-based systems in creating safer urban environments, underscoring the importance of technological advancements in environmental sensing and pollution control.

1. INTRODUCTION

Air pollution, characterized by the release of harmful or excessive quantities of chemicals, including gases, particles, and biological molecules into the Earth's atmosphere, poses significant health risks to humans, potentially leading to illnesses, allergies, or even mortality. Beyond human health, air pollution also impacts architectural and natural ecosystems, affecting other living entities such as animals and food crops. Sources of air pollution are diverse, encompassing both natural occurrences and anthropogenic activities [1, 2].

The concept of controlled atmospheres within renewable designs, particularly greenhouses, promises enhanced yields. These structures facilitate extended growing seasons, allowing for the cultivation of a variety of plant species, including exotic flora [3]. Greenhouses protect vegetation from harsh environmental conditions, such as strong winds and UV radiation, while allowing for diffused light penetration. This enclosed system also acts as a barrier against insects and stray animals, thereby reducing potential conflicts between wildlife and agricultural activities [4, 5].

Modern greenhouses, characterized by their ease of customization and portability, offer higher yields and improved planting efficiency, presenting a sustainable approach to agriculture with minimal environmental impact [6]. However, the pollution of immediate human environments raises concerns, including contaminated food, water, and indoor air polluted with CO_2, CO, NO_x, volatile organic compounds, radon, cigarette smoke, and oxygen deficiency. The rise of smog, a specific form of air pollution, is particularly notable in urban areas with high energy consumption and exhaust emissions, primarily attributed to vehicular traffic [7].

The preference for personal vehicles over public transport, often due to convenience or lack of alternatives, exacerbates road congestion, leading to increased dust and exhaust emissions from worn tyres and asphalt, further contributing to air pollution. The motion of vehicles also contributes to street-level pollution, as they often fail to meet emission standards. Rapidly developing countries face significant challenges with

air pollution and environmental degradation, adversely affecting human health. The composition and impact of smog, comprising various harmful components to human health, evolve over time [8-13].

Smog, a term coined in the early 20th century to describe smoky fog, its opacity, and odour, is primarily caused by environmental contamination with fine particles and ground-level ozone. This mixture of gases, dust, and water vapour results primarily from air pollution. The formation of smog occurs when natural phenomena such as heavy haze and lack of wind coincide with human-generated air pollution, creating a cloudy, difficult-to-breathe atmosphere. The gases and pollutants contributing to smog are released into the atmosphere during fuel combustion, interacting with sunlight and its heat. The precursors of smog are predominantly emitted by petrol and diesel-powered vehicles, industrial facilities, and human-caused heating, elucidating the composition of smog and its detrimental effects on humans, animals, plants, and nature, as discussed in studies [14, 15].

1.1 Motivation

Recent advancements in Smart Greenhouse Systems have been focusing on innovative combinations of technologies. These systems integrate elements such as monitoring, automation, and data analysis. The system architecture encompasses four primary components within the automated monitoring framework. It includes climate, humidity, and soil moisture monitoring with data storage in the cloud. In the event of deviations from optimal conditions, the system sends alert notifications to the farmer, enabling timely corrective actions. Furthermore, based on sensor data, the system facilitates automated irrigation switching. Additionally, it employs deep learning techniques for the detection of plant diseases.

Beyond agricultural applications, the significance of addressing air pollution cannot be overstated. Pollutants such as carbon dioxide, sulphur dioxide, ammonia, among others, pose threats not only to human health but also to the survival of various plant and animal species. Air pollution is a primary contributor to environmental degradation, leading to climate change and elevated global temperatures, alongside causing severe health issues in humans. The economic impact is substantial, with global annual losses amounting to billions of dollars due to air pollution.

The implications of poor air quality are particularly severe for vulnerable groups such as children, the elderly, and individuals with respiratory or heart conditions. Air quality varies significantly from one location to another, influenced by local sources such as industrial sites or densely trafficked roads, as well as regional pollution patterns and meteorological factors. It is imperative to monitor these variations to identify problem areas and implement measures to ensure the highest possible air quality for all individuals. This necessity underlines the importance of developing and deploying effective monitoring and control systems for air quality, particularly in urban and industrial environments.

1.2 Problem statement

Clean air is a fundamental necessity for all life forms on Earth. Humans, in particular, depend on the natural provision of clean air for survival. However, the escalating global population and rapid industrialization have led to a significant increase in air pollution, posing a threat to all life forms. This situation underscores the critical need for air quality monitoring systems capable of providing prompt responses to improve air quality when it is compromised. Major contributors to air pollution include the combustion of fossil fuels, building operations, industrial emissions, vehicle exhausts, and similar activities. A notable increase in lung-related illnesses in recent years has been primarily attributed to exposure to harmful gases such as carbon monoxide, sulphur dioxide, and nitrogen dioxide. Additionally, the substantial amount of carbon dioxide in the atmosphere is a primary contributor to global warming. Despite progress in air quality improvement and emission reduction, much work remains to be done globally to resolve air pollution issues, with air quality monitoring playing a key role in these efforts.

1.3 Contributions of this work

The essence of an air pollution monitoring system lies in its ability to detect and monitor the air quality index of a specific location at any given time. The proposed IoT-based air pollution monitoring system, utilizing an Arduino, WIFI, and GSM module, can detect air pollutant concentrations. Employing ESP8266 and GSM modules, it is capable of transmitting data in real-time to the ThingSpeak server, graphically displaying this data, and alerting users via email and SMS. The impetus for implementing such Air Pollution Monitoring systems stems from the increased levels of air pollutants and the consequent rise in health issues. Rapid industrialization and urbanization have led to heightened particulate matter levels in the air, necessitating the need for real-time air sampling and analysis to make informed decisions about health and environmental conditions. The WIFI module relays real-time data to the ThingSpeak server, while the GSM module sends messages to the user's mobile phone. IoT technology facilitates the updating of web pages with real-time data. The MQ2 sensor is used to detect harmful gases like carbon dioxide, benzene, and nitrogen oxides, providing output in voltage levels, with the potentiometer adjusting the input based on gas concentrations.

The structure of the paper is as follows: Section 2 presents a comprehensive literature review of current system approaches. Section 3 delves into the background details and examines the proposed system in depth. The methodologies employed in this study are detailed in Section 4. Section 5 provides an analysis of the results from the implemented system. The paper concludes in Section 6.

2. LITERATURE REVIEW

This section delves into various research areas within the current scope of investigation. Studies focused on greenhouses in agriculture and their increasing necessity are discussed. The relevance of greenhouses in addressing climate change and sustainable agriculture [16]. These studies demonstrate the adaptability and customizability of greenhouses, facilitating their implementation in advanced farming. The efficiency of greenhouses, leading to cost-effective results, is attributed to their minimal energy usage and their resilience against erratic climatic conditions and pests [17].

Previous efforts in the field have laid a foundation for current research. However, certain studies, such as those conducted within greenhouses, have limitations, focusing only

on a select few components and not addressing all variables that influence outcomes [18]. A review paper presented an analysis of different temperature and humidity levels suitable for various crops grown in greenhouses, along with methods proven to enhance crop yield [19].

The rise in pollution levels, driven by factors like increasing human population, vehicle usage, and accelerated industrialization and urbanization, directly impacts human health due to exposure to toxic gases. This project aims to construct an IoT-based air pollution monitoring system. The system will monitor air quality through an online server and alert when air quality drops below a certain threshold, indicating dangerous levels of gases such as CO_2, smoke, alcohol, benzene, and NH_3 [19]. The air quality will be displayed on an LCD and a webpage in parts per million (PPM), facilitating easy monitoring. The MQ135 sensor, known for its accurate detection of harmful gases, is employed in this system. This IoT project allows pollution levels to be monitored remotely via computers or mobile devices.

The application of machine learning to environmental monitoring is a significant area of research. A study focused on environmental condition monitoring and detection in greenhouses in Bangladesh, utilizing artificial neural networks (ANNs) [20]. This research also explores the development of models for adapting new technologies in greenhouse engineering. Further, an approach for early identification of leaf diseases based on vegetation extraction is provided [21]. Deep learning and transfer learning algorithms are employed in advanced systems for crop disease detection, utilizing a "Forest Classifier Algorithm" and a "Color Histogram" for filtering plant diseases with image analysis.

Moreover, research in IoT applications in agriculture, particularly in greenhouse monitoring using Wireless Sensor Networks (WSN) [22]. These studies collectively contribute to a comprehensive understanding of current technological advancements in greenhouse agriculture and air quality monitoring systems.

In addressing the limitations of previous studies, the current research advances by evaluating various deep learning models on an expanded and diverse dataset. Previous research in this field has been characterized as inadequate or incomplete in one way or another. This paper presents an innovative, comprehensive solution utilizing a smart Greenhouse system based on IoT, which leverages sensory data for energy efficiency [23, 24]. It implements continuous monitoring and automation, sending alerts in critical situations, such as when the temperature falls below or rises above the ambient temperature. The irrigation system is automatically activated when soil moisture levels drop below or rise above specific thresholds. Furthermore, this paper evaluates multiple deep learning algorithms and justifies the use of the most effective one for disease detection in plants through leaf images, enabling early detection to prevent yield loss [25]. Another study demonstrates the use of solar panel systems and sensors in greenhouses, focusing on determining stress levels within the greenhouse environment. The paper highlights the automation aspect, introducing an automated irrigation system to the greenhouse, thus reducing human intervention in greenhouse operations.

Air pollution has become a significant global concern, affecting countries at all levels of development. Health issues associated with air pollution have been rising, especially in cities in the developing world where industrialization and increased vehicle usage have led to the release of hazardous gases. Air pollution can cause a range of health problems, from minor allergies to severe conditions like bronchitis, heart disease, pneumonia, lung diseases, and exacerbated asthma [26]. It is estimated that air pollution leads to premature deaths of 50,000 to 100,000 Americans annually, with the figure reaching 300,000 in the EU and over 3,000,000 globally.

The proposed IoT-based air pollution monitoring system uses a web server to track air quality, triggering an alarm when air quality deteriorates below a certain level. The system displays air quality in PPM on both an LCD and a webpage for easy monitoring, especially when dangerous gases like CO_2, smoke, alcohol, benzene, NH_3, LPG, and NO_x are detected.

Toxins pose a significant threat to the natural environment due to air contamination. They can include solid, gaseous, or liquid substances, or energy in amounts or compositions that negatively impact human health, lifestyle, climate, soil quality, or water quality, or cause other detrimental changes such as corroded materials [27]. Environmental contamination is defined as the surpassing of environmental quality standards or emission factors, indicating the presence of harmful levels of pollutants [28]. Currently, the Middle East has been identified as one of the most dangerous zones for pollution, according to experts from UNESCO. Key pollutants in this region include CO_2, a major contributor to the greenhouse effect, carbon monoxide (CO), which causes acidification, and substances like phosphorous, sulphur dioxide (SO_2), nitrogen dioxide (NO_2), lead, mercury, oil, crude oil, DDT, and pesticides [29].

This paper employs three sensors to detect environmental parameters such as humidity, light intensity, temperature, dew point, and heat index. The Arduino microcontroller reads data from these sensors, processes it, and saves the results in a text file for further analysis. Additionally, the readings are displayed on an onboard LCD for easy perusal. By compiling and analyzing these readings, insights into local climate and weather patterns can be gained [30]. However, a limitation of this approach is the inability to accommodate remote monitoring, as there is no provision for uploading data to the cloud.

The preference for personal vehicle use over public transportation, often due to convenience or lack of alternatives, leads to significant traffic congestion. This increases the emission of exhaust fumes and the release of particulate matter from worn tyres and asphalt as vehicles pass by Sadhukhan et al. [31]. In response, IoT technology has been implemented to monitor gas concentrations and other substances through a series of sensors. This data is captured in real-time and uploaded to ThingSpeak channels via an Ethernet shield for processing [32]. The results are visually presented through ThingSpeak, and the average pollution level is computed using MATLAB analysis, with data subsequently displayed through a mobile app. This app also retrieves the air quality index value based on location and provides information on health impacts, allowing users to monitor pollution levels effectively [33].

Professor Fiona Marshall from the University of Sussex highlights that vehicle emissions are a primary precursor of ozone (O_3) in urban areas. The concentration of O_3 tends to be higher in warm, sunny conditions and is further exacerbated by global warming [34]. Marshall notes that relocating contaminating industries from urban to agricultural areas places pollutants closer to crops, significantly impacting yields. This trend is unlikely to change, especially given the high levels of smog in countries like India that often exceed safe limits [35]. The expansion of urban areas into agricultural

lands and the interspersion of farmland with built-up areas and industries are causing an increasing proportion of India's agricultural land to be affected by smog.

Katrina Sharps, a spatial data analyst from the Centre for Hydrology and Ecology in Wales, mentions that the critical ozone levels set by the United Nations in 2016 as targets for O_3 pollution are exceeded in many parts of the world [36, 37]. The highest ozone concentrations are found in major crop-growing regions. She notes that ozone levels are rising in rapidly developing regions like Southeast Asia and are expected to continue increasing. Sharps' research indicates that O_3 impacts are most pronounced in parts of the world with the largest yield gaps, such as East Asia, sub-Saharan Africa, and South America, where factors like nutrient limitations and irrigation access are known to affect yields [38]. This poses a threat to food security, particularly affecting farmers in Africa who rely on subsistence agriculture for survival.

3. BACKGROUND STUDY AND PROPOSED SYSTEM

The term smog is a mix of the text smog as well as fog. This freshly coined term or maybe term bunch has dispersed close to the planate. This particular trend appears to be wonderfully identified. Smog is synthetic fog, an artificial occurrence comprising of the coexistence of smog triggered by natural phenomena: and human activity. The weather condition is quite windless having a substantial haze [39]. There are two primary kinds of smog Los Angeles type smog, normally referred to as photochemical smog, takes place throughout the hottest months of the year and probably within sub-tropical places. The chemical based ingredients inside automobile exhausts are clearly converted the within the circumstances as well as oxidants are created underneath in the impact of effect natural life. It's made up of fumes including hydrocarbons, nitrogen oxides and carbon dioxides. Additionally, it forms a really poisonous murky haze. However, the London style is created in temperate local weather zones and also happens from November to Jan as well as into March in the winter times. It's made up of various dust particles containing soot, some particles of Nitrogen along with Sulphur and oxides of carbon [40].

Because the smoke cigarettes at chimneys increases greater, the temperature drops of its. For the regular weather circumstances, the environment heat reduces with level and also the smoke cigarettes increases unhampered in to top of the level of the environment. Within winter and autumn, nonetheless, we come across temperature inversion which generates the inverse circumstance. Increment of heat depends on the increment in altitude. Exposed to such situations, the contaminants temperature originated from the atmosphere as well as the chimney-neutralize faster. Consequently, originated toxins remain closer to soil since it cannot leave into the bigger levels of the environment. When, within addition, there's high humidity and no wind, the smog accumulates a lot more [41]. On the main hands, smog is a result of the environment blending with contaminants as well as fumes toxins created by man undertaking. Production facilities, the growing quantity of auto mobiles, burning up coals, and timber along with other stable energy sources in cookers are accountable just for this. On the flip side, weather, local weather as well as common problems of the spot impact its formation. Toxins lingering more than a community situated inside a basin, for windless environmental, can't spread or get diluted which results them to hover above the city inside issue [42].

Smog has a destructive influence on man health and wellbeing. It's indirect and direct consequences. The immediate people are heart diseases, cardiovascular, heart failure and allergies as well as decreases of common immunity of all of entire body. Indirect people are associate consuming smog-contaminated or alternatively grow beef. Harmful toxins keying in the respiratory process additionally aggravate its mucous membranes, lead to irritation, as well lead to problem much like all those of typical chilly-cough, runny nose, and then throat irritation. Additionally, smog places a role in the development of acid rainfall [43].

The biggest pollutants of smog, such as PM2.5 and PM10 contaminants, are generated by flaming up of coals of low qualities or sometimes badly controlled boiling machineries as well as family furnaces, and also by different kinds of misuse. PM2.5 is considered as aerosols originated in atmosphere which are less than 2.5-2.6 micrometers measured through diameter. It is hazardous to human being life. PM10 contaminant is a contribution of air-borne specks measuring less than 10micrometers. It's dangerous of the content of it's of components like as benzopyrenes, i.e., and dioxins, furans, carcinogenic weighty metals [44]. The building business possesses a resolve for renewable advancement. This particular way of farming is described as a lifestyle by which the requirements of existing model won't lessen the risks of fulfilling the needs of succeeding decades.

3.1 Proposed system for developing nano additives

Combination of nanoparticles are contribution of more than 1 dimension under 100-101nm. For a number of components, nanoparticles could be utilized as Nano modifiers. The most popular nanoparticles employed consist of anoplatin, nanotubes, graphene's, titanium dioxide, zirconium dioxide, nanoplatin, nanocopper, along with fullerenes. Additionally, they have CO_2 nanofibers. Nano-TiO_2, with certain chemicals and physical qualities is among the most often pre-owned nano additives. They contain photocatalytic pastime, hydrophilicity, and hydrophilicity absorption of effective UV rays as well as powerful UV rays. To clean up the encompassing atmosphere, one particular technique is removing most organic and natural material. Constructing supplies could be coated with nano TiO_2 coatings. Following absorption on the UV rays this particular preservatives gets proactive once again. Natural elements including VOCs (volatile natural elements), microorganisms as well as NOx toxins are usually decomposed efficiently by making use of light. photocatalytic task is catalytic [45, 46].

Nano ingredients call for direct sunlight entry, and therefore slim levels of coating of a couple of millimeters are adequate to get the preferred qualities. Titanium dioxide prevails within 3 compositions: the first one is anatase which is also considered as distorted tetragonal crystal structure then the second one is rutile, also termed as tetragonal, as well as brucite which is equally considered as rhombic crystal structure. Among all, only anatase and rutile proved beneficial only because of their broader semiconductor band gap. The corresponding utilization of rutile phase as well asanatase enhances the photocatalytic task when compared with every individual element. The substantial photocatalytic exercise of anatase has resulted in the widespread use of it's as a photocatalytic covering on numerous substances beneath

lower severeness, i.e., close to UV light source. For that reason, light which is visible isn't lively adequate to induce photocatalytic pastime found anatase. Absolutely no is regarded as a main pollutant which is primarily released straight into the atmosphere straight from high temperature combustion of transportation as well as, industrial activities while NO_2 is regarded as another pollutants as it's primarily created within the environment because of the interaction of NO with O_2 or maybe O_3 and also sunshine. Concrete building and pavements exteriors are perfect for photocatalytic program of supplies since the flat configurations of theirs would facilitate publicity of photocatalyst to the sun's rays.

• The range of the random value produced by the reading sensor is determined by the value of a "seriousness" variable.

• Transmitter for reading data: This device receives the value provided by the reading sensor and broadcasts it using the communicator.

• Power Supply: We simply call the "turn on" method that each node has, which will turn the node on. Power-saving settings will rely on the information the simulator gives us.

• Connector: the simulator implements this. Since sockets are typically used for inter-process communication, we anticipate that the simulator will also have methods like "send" and "receive" in addition to sockets.

• Implementer: Notifies the data collector to begin collecting data in accordance with the user-specified delivery method.

• Value Collector: obtains a list of nodes from which it must gather readings, notifies them via messages, and then gathers the necessary values.

• Aggregator: Executes the RCQ data aggregation technique that will be covered in the following section.

• Value Extractor: Access databases using SQL queries to retrieve data.

• Result Displayer: This displays data in a table and extracts data as needed by the user. It also calculates the AQI for the chosen area.

• Data Analyser: This tool collects past readings and analyses their relationships in order to predict future readings.

• Nodes Connector: Shows node deployment in the WSN field and the AQI colours associated with each node [47].

• Connection Compiler: The Java Driver Manager provides a method for opening a database, which accepts as parameters the database name, the user name, and the password. So, all this component needs to do is call this function and keep the return connection reference.

• Connection Flushing: Connection objects in the java.sql package often provide a close function that properly closes them, releases any associated memory, and saves their state. So, all this component needs to do is call this method.

3.1.1 Technologies and applications

The sensors along with the micro-controllers and other peripherals are displayed in the proposed design work as shown below in Figure 1. The internet of things (IoT) is a network of interconnected computing devices, services, and data that allows ordinarily physical objects with unique identifiers to communicate with one another and form the web. A system that can detect its environment and communicate with either the user or other systems is also known as an intelligent device system. Because its communication protocol determines which things or sensors can be addressed, the Internet of Things (IoT) is thus intelligent. Complete Internet of Things (IoT) architectures often include hardware components like sensor nodes, interface circuits, and embedded connectivity, middleware components like data storage and handling middleware, and a representation layer with efficient visualisation tools [48]. The Internet of Things (IoT) model consists of three designed layers: the application layer, the network layer, and the sensor layer. In the sensor layer, information is gathered by means of Internet Protocol (IP) cameras, readers, and pollution sensors. By bridging the gap between the sensor and application layers, the network layer facilitates data transmission over cellular, distant, and broadcast networks.

Smart monitoring in sectors including logistics, transportation, and industry is made possible by the application layer's merging and processing of received data. Further, smart technology, sensor networks, and machine to machine (M2M) system architectures. Specifically, Wi-Fi module is a wireless system that uses tags and readers. The Internet of Things can be tracked thanks to this technology [49]. Individuals are able to monitor their immediate environment and the whereabouts of objects. Because each micro-electro-mechanical system (MEMS) has its own operating system, data transfer paths, applications, and stored functionalities, a large sensor network can be built. It paves the way for IoT to keep tabs on people and keep them safe via things. "Machine to Machine" (M2M) refers to both a service and an application that enables intelligent communication between machine terminals. It allows for the intelligent control of objects.

Internet of Things (IoT) offers numerous advantages to society, which is why it has been dubbed the third revolution in the history of the global information business.The Internet of Things (IoT) has sparked the creation of networked, smart items and machinery, which might pave the way for a shift away from electric, mechanised production and towards a network-managed and controlled model. It ends the severe pollution, excessive use of resources, and huge gap between urban and rural areas in terms of development.It is able to combine resources efficiently by transmitting information without touching the receiver using radio frequency signals and then identifying the receiver using that data.

By incorporating IoT into bigger systems, operational efficiency and cost can be enhanced. Interactions between technological devices become more streamlined and rapid as a result [50].The Internet of Things (IoT) has improved our lives in many ways since its start, but it isn't without its problems. First and foremost, with the proliferation of IoT devices, security has emerged as a critical concern. Ensuring the security of the Internet of Things necessitates not just the protection of devices, but also software applications and network interactions. Consequently, protecting the privacy of companies and customers is challenging. Next, a single software or hardware failure might have major effects due to the broad and heterogeneous nature of the IoT network. If a node in a network gets broken and there isn't another node available to replace it automatically, the network won't work. Lastly, it becomes increasingly difficult to discover and monitor IoT compatibility as the number of connected devices and components increases. This is due to the fact that various devices have different interfaces and technical standards.

There will be shifts in production techniques, ways of life, and productivity as a result of the Internet of Things (IoT) in many different sectors, including transportation, agriculture,

industry, logistics, furniture, healthcare, power, the environment, etc. In addition to enhancing management efficiency, the Internet of Things propels economic growth and technological advancement across industries. In environmental monitoring, for instance, data processing and transmission are made possible by an IoT that integrates sensing devices with integrated communication technology.

The Internet of Things (IoT) will allow users and monitoring systems to communicate in real-time using a combination of communication and information technologies. By simulating fire detection and responding to forest fires in real-time, the Internet of Things can help mitigate forest damage. In order to combat air pollution produced by industrialization and urbanisation, the ratio of flammable or hazardous gases and the quantities of pollutants can be routinely assessed through the use of IoT technology [14]. To be more precise, the air pollution monitoring system relies on the Internet of Things (IoT) and a sensor network to accomplish intelligent air quality monitoring. The Internet of Things (IoT) is already revolutionising air monitoring and is a driving force behind societal progress. That is to say, the Internet of Things (IoT) enables the ongoing improvement of environmental management by facilitating the collection, transmission, storage, and analysis of air quality.

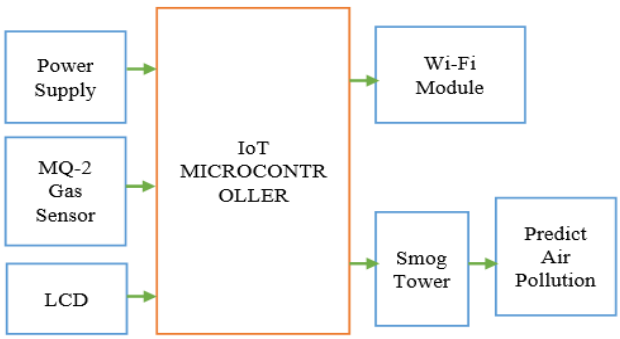


Figure 1. Proposed design for smog tower

3.2 Building works

Now a day, Portland cement is manufactured with Nano TiO_2 is now among the components for decreasing pollution. Because of its properties of transformation of non-chemical nitrogen oxides, compounds of Sulphur into innocuous things, i.e., CO_2 and water titanium dioxide causes it to be easy to cleanse air of contaminants. The use of its contained cement or concrete has already been recognized. As a result of the point that just a particular material thickness due to the nature of its Nano additive that got a chance being triggered by UV light, it's just utilized on best surfaces. Thus, the substances are utilized within the type of facades, substance coating or substance paints.

3.2.1 Substance facades

You'll find substance façade sections available which take in contaminants in the atmosphere. The science is known as Prosolve370e. The isolated modules are covered with extremely good contaminants of oxides of titanium. Based on investigate, the board structure cleanses air of smog from a 1000 automobiles one day. The science was utilized in numerous towns across the planet, together with all close within Mexico and other countries of the world.

3.2.2 Plasters

Applications of plasters or paints are routine of structures with complicated styles. This is since the coating's minimal thickness supply as the exact same functionality on the surfaces that are made concrete by lowering the mixture of dioxides of titanium which is ingested. A particular intriguing instance of the usage of color is a historic structure in the process of renovation, the Matrices church found Italy. A covering scanner with lower cement articles based upon all-natural hydraulic lime has been applied.

3.2.3 Paints

Artists also have consumed a concern inside the usage of Nano TiO_2 paints. They write murals to embellish the wall space of structure as well as neutralize nitrogen dioxide. They may be located in lot of urban centers across the planet.

3.2.4 Non-chemical layering

Nano ingredients may be mixed with natural components like acrylic or it can be mixed with fluorinated ethylenetetrafluoroethlene or it may have polymers of silane. It's additionally employed for crossbreed coatings as like as silica or some particles of polydimethylsiloxane.

3.3 Road surfaces

Within path building, substances having cement may be utilized with titanium dioxide ingredients. During the start of 21st century the very first anti-smog street building tasks have been completed. Belgiumhas a surface road of approximately 10,100-10,200 m^2 with Nano TiO_2 concrete bricks.

3.3.1 Concrete asphalt

Scientists from Netherlands obtained advantages of in between 19% as well as 45% decrease in air-borne contaminants with this particular content. Within the Country, identical scientific studies had been carried through in Chicago. Their productivity ranged through twenty to 70% decrease in contaminants. Nevertheless, usefulness hinges mostly on the weather conditions situations and also the road type getting travelled. Setup of these a method demonstrated to, nonetheless, it really works much better on neighborhood highways as compared to on motorways. Vehicles are definitely the reason behind this particular. There's much less visitors on the highway due to the shortage of molecules dropping upon the asphalt.

3.3.2 Paving blocks

The paver blocks include 2layers: the very best level as well as the starting level. Just towards the west. Nano titanium dioxide is put into the counter level (texture). These stones are accustomed to place the pavement. Aside from the motorcycle paths, there're additionally hiking paths. The answer is needed all around the globe. Pavements are one more air type filtering unit for highways. The paving blocks are produced of environmentally friendly concrete, like the highways. These kinds of tasks are performed in Poland. Some of others, it had been completed by Skanska. The answer is able to bring down the focus on the chemical. CO_2 is cut back by 30% and also by 70% lab problems. Floor tiles which employ photovoltaics are available. How can they get the job done? They are additionally employed for the building of cycle paths as well as pavements.

3.3.3 Acoustic screens

These types of screens are made from photocatalytic coating which decomposes oxides of nitrogen to innocuous elements on exposed to sun rays. These are likewise expelled as a result of precipitation facilities. Quite possibly during a rainy day, adequate natural light makes the screen work perfectly. Numerous variables prove usefulness on the photo catalysis activity such as porosity, sizing of particles, atmosphere exposure, time of radiations, along with pollutant awareness. This kind of display screens are able to bring down street pollution by 20-30%.

3.4 Sky-top roof tiles

Anti-smog components may additionally be created of ceramic roof tiles or cement. The Nano preservative, nonetheless, isn't put on towards the floor tile itself, but is coated with photocatalytic qualities by having an impregnation. Usefulness on the tiles: The nitrogen oxides created by an automobile operating 10,000 long distance a season may be oxidized by including a 2000 m^2 or feet roof structure. Scientists in the Faculty of California, Riverside have established top floor tiles which capture nitrogen oxides within the atmosphere. They used a level of anatase (a) to average floor tiles. Titanium dioxide (a specific sort of titanium dioxide) make an effort to cleanses the atmosphere. Then, they analyzed their photocatalytic qualities and also the atmosphere filtration performs inside a unique chamber, with respect to the thickness on the covering. The end result demonstrated the therapy was profitable. The quantity of TiO_2 levels had absolutely no considerable impact on un-usefulness, which the anatase level can eliminate as many as 97% of nitrogen oxides in the atmosphere, within cohesiveness with the sun's rays. The greater rigorous the UV light, the higher the result. With the ceramic tiles, the top can easily air filter twenty-one a lot of damaging oxides each day from the atmosphere.

3.5 Vegetation building

Vegetation can assist fight contamination by creating much needed oxygen. Big urban centers have an absence of room to produce brand new squares, gardens, and parks. These include thing like eco-friendly roofs, eco-friendly facades, as well as existing wall space are aspects of renewable construction. The utilization of eco-friendly roofs is utilized globally. Vertically eco-friendly methods (VSG), i.e., eco-friendly facades as well as existing wall space, are extremely hardly ever utilized. This is simply because which the number of vegetation easy to work with is tiny in comparison to the quantity of vegetation utilized in roofs that are green living your life wall space differ by using eco-friendly facades in the vegetation in grounded inside a structural structure and support. This's connected towards the hall structure itself. The vegetation gets nutrients and water coming from the vertical assistance instead of in the soil.

3.5.1 Structure facades decrementing pollution

The developing interest in eco-friendly facades has affected the quantity of answers readily preferable for constructional vegetation. These methods consist of things like 2 primary categories: eco-friendly facades as well as existing wall space. Eco-friendly facades work with plant life put on the earth in the foundation of the creating or even in containers during various facade heights. Self-supporting vegetation are able to develop directly stood towards the wall structure inside the situation of immediate eco-friendly facades: hanging or climbing vegetation are able to climb onto assistance construction positioned a brief distance through the structure such as a wall inside facades that are ecofriendly. Secondly, the atmosphere gap is produced in between structure of the wall with the level of vegetation. A few hanging species are able to bring about harm to the structure surface area if splits happen to be existing. Vertical eco-friendly methods are able to bring down the frequency of upkeep interventions on the structure envelope because of restricted climate variations of the wall structure top. A number of eco-friendly façade methods might be distinguished. The foremost is creating wall surface area for ascending plant life, guided around a unique framework made from stainless or even impregnated timber. The vegetation is next placed with the foundation on the wall structure. This removes the importance to install extra sprinkler system methods. This is essentially the most widely used method.

The other person is made up within developing a wall structure on the foundation of a method of containers, that are repaired to a unique building made from stainless. The benefit of this particular remedy is the chance to take a variety of kinds of greenery as well as incorporate it within the look on the façade. This process is a little bit more hi-tech compared to the very first phone system. A person is made up to keep the vegetation within good shape because of a the 3rda the 3rd instant sprinkler system process, on the foundation on the basic principle of horizontally positioned water lines with what pumping up of drinking water. The problem of flora and fauna on creating facades as well as roofs doesn't just pertain to how to create an environmentally friendly top or even residing wall structure, but foremost and first to what function they are playing during the social and natural element and also to what degree they match to today is fashion within shaping urbanized room. The environmentally friendly functionality of environmentally friendly vertical methods could be affected by different eco-friendly methods, atmospheric conditions, developing sorts, selected grow species, creating orientation, as well as supplies, etcetera. A natural façade decreases nitrogen oxide by as much as 20%, PM10 by 35%, so the heat fall round the wall structure by as much as 16 degree C. the eco-friendly wall in addition, shops 750 L of H_2O (100 m^2/ 24 h) and also creates much needed oxygen through photosynthesis (155 m^2 of environmentally friendly wall structure offers sufficient much needed oxygen for one individual for an entire day). It assimilates CO_2 and also harmonizes with superb effectiveness.

The façade greening of construction wall space, recognized as vertical eco-friendly methods (VSG), demands the usage of non-allergenic and climate-appropriate vegetation. Forest which possesses a positive and also huge effect on quality of the air consists of maples (Acer spp.). Evergreen forests are definitely better at detaching contaminants as the leaf pastime time period is a bit longer. The scale of the tree is crucial, because it establishment the quantity of CO_2 assimilated, kept, along with kept within the biomass, in addition to the entire leaf region prepared to take in contaminants coming from the environment, which includes particulate material.

3.5.2 Anti-smog towers

Anti-smog towers largely do the job by making use of ionisation. They take in for air which is polluted from previously mentioned as well as give off it inside a pure type

as output. The tower which is hexagonal in shape is referred to as Smog Free Tower, a concept by Dean Roosegaarde, is 7-8m in length. It's composed of aluminium and possesses building of 2 storeys. It cleans 30,000-30,500 m^3 of air flow every single hour. The functioning on the tower is grounded on engineering based on ionisation, i.e., recording poisonous contaminants. Solar power panels are used to run these towers. It's entirely green. The Smog Free Tower was made on 4th September in the year 2015 within the Roosegaarde design. It takes a trip of the planet, filtering air within most contaminated urban areas. In 2018, another tower was built, which may be observed for 2 weeks in Krakow. Nevertheless, exploration by experts on the AGH Faculty of Technology and Science didn't verify the scenarios announcedthrough the custom. This was established by assessments carried out within China. An alternative tower was created in the territory of India. The Symbiosis Studio in India has developed a system of two different anti-pollution towers. Bigger, 65-70m very tall towers are to get set up across the community campus to take in the harm being done on our environment. Each tower will cleanse air within a location of approximately 2.5km^2 as well as run inside a diameter of 1800-1900m. 18-19 m very tall towers will probably be positioned in various polluted hotspots of New Delhi. One of them can purify 30000-30500 m^3 of atmosphere. Furthermore, 65-75% of every tower is usually vegetation covered, that can additionally minimize dangerous materials, and also inside them there'll be docks for worker bees to keep track of the express of smog inside the community.

An additional land is having a big smog issue in China. Xi'an,one of the Chinese town is house on the earth's largest anti-smog tower. The greatest trouble comes up in cold weather when the heating time of year begins. The tower is hundred m very high & lets you thoroughly clean ten thousand m^3 of air flow each day coming from a space of ten km^2. It really works by inhaling air flow in greenhouses of about 3.5 1000m^2 on the surface of its. The environment will be warmed up by Ultraviolet rays, inducing it to increase. This is the way it becomes internal, wherever it's filtered many times as well as, subsequent to becoming washed, is published. As a result of verifying the tower fulfills the advertised attributes, Chinese technical engineers prepare to construct some other, possibly bigger towers.

3.5.3 Concrete with activated carbon

Utilization of anti-smog components depending upon underground car parks concrete or tunnels poses a significant struggle. Study is now becoming carried through in Poland. Overseas studies have shown the un-usefulness of concrete with triggered CO_2 within taking in NOx oxides as well as filtering the atmosphere. The scientist investigated triggered CO_2. Charcoal activated has antiseptic qualities inside a right. But how about the opposite things? is an adsorbent of NOx substances. Around the world literature accounts it implies that it indicates. With regards to reactivity and adsorption, considerable chemic affinity prevails for nitrogen oxides. The because of its stiletto particular area location per device mass, the content possesses a deep adsorbent electrical capacity.

It's nearly 3300-3400m^2 or g. This particular big area place is a result of the extremely porous inner framework on this content, that includes micropores and mesopores. The triggered Co2 starts working like a particle air filter in the event it enters touch with toxins. Contaminants are changed into innocuous nitrate ions by chemical substance responses. Within basic aqueous fixes, NO_2 is able to act in response to create nitrite as well as nitrate ions. The decrease of NO_2 might as a result be associated with the calcium hydroxide articles. The experts are. The theory is which NO_2 initially dissolves within the adsorbed aqueous level which includes alkali cement hydrates during 60% distant relative moisture. The experts state that the research is "in the passion on the authors." The response procedure for CO_2 altered concrete can be as follows: due to the triggered CO_2 particles 'low excess fat, it moves about the surface area on the slurry and also settles around the mashing area. The development surface area of triggered CO_2 debris is wanted to improve success. You are able to accomplish this particular by improving the roughness on the surface area and also by texturing the facial skin level. $2Ca(OH)_2+4NO_2=>(Ca_2,2NO_2)+2H_2O$.

The experts have created a storage area from Ac (activated carbon) concentrate. Since a consequence of tests, the experts discovered that a storage are built of concrete customized with triggered CO_2 experienced a 20%-25% NO_2 absorption. Some investigation organizations have claimed about the overall performance of triggered carbons in relation to NO_2. In terms of we all know, the vast majority of NOx originates from the engines of automobiles as well as strength plant life. A possible method for removing NO_2 by triggered carbons is no readily available. Furthermore, when it comes to distinct for example heat, soil moisture, CO_2 levels, along with gentle sereneness are administrated as well as synchronized with raspberry Pi and also Arduino.

The newspaper consists of the usage of IoT and sensors. Gets a drip sprinkler system mechanism with properly managed tubing a GSM module? The newspaper provides an abstract area searching within a tomato greenhouse within the Michurinsk, Tambov area of Russian federation with expansion of the internet of items determine the checking element of the green house and also the progress number of tomatoes (IoT) within the hands free operation of greenhouse locations, a comparable utilization of newspaper was completed: IoT (internet of thing). Newspaper eleven displayed a IoT operation using a bot alert on tomato raising phases to provide sensible agriculture strategies. The newspaper is design to create an automated greenhouse managing process for enhancing the output of vegetation as well as accelerating their improvement. An internet software is created to keep an eye on as well as monitor greenhouse details as well as grow development inside a green house.

4. METHODOLOGY

This project's operating model is relatively straightforward as shown in Figure 2. High pressure air is drawn from the environment with the aid of a suction motor, and this air flows through a cyclonic separator. The electrical energy from the power source is transformed into mechanical energy by this motor in the form of suction and air flow. Particles are removed from an air, gas, or liquid stream using cyclonic separation rather than filters when pressured air enters a cyclonic separator. Particulate matter in liquid is removed using a hydrocyclone, and in gas, it is removed using a gas cyclone. Particulate matter that are collected in vacuum chamber and combinations of solids and fluids are separated using rotational effects and gravity. The wet scrubber receives as an input the air outflow from the cyclonic separator. Wet scrubbers are used to separate liquid partials that cannot be separated by a cyclone separator due to differences in density.

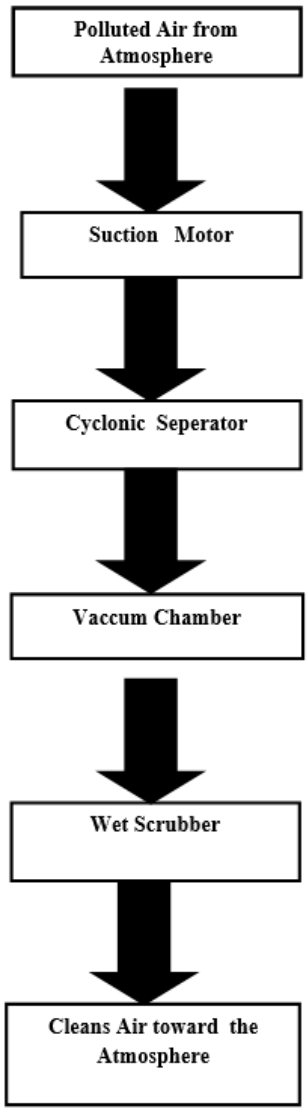


Figure 2. Block diagram of the operating model

4.1 Components used in smog tower

4.1.1 Suction motor

The suction motor is one of a vacuum cleaner's most important parts. The electrical energy from the power source is transformed into mechanical energy by this motor in the form of suction and air flow.In cleaning devices, the motor's name implies that it draws in air from the surrounding area, which is the device's primary function. A single suction motor serves as both an air purifier and a hoover cleaner in the suggested gadget.Nidec Ultraflo series H92C-A7 suction motors are utilised in this apparatus. The gadget needs an input current of 9.36 amperes and operates on 12 volts.

4.1.2 Cyclonic separator

A low-cost, low-maintenance method of removing particulate matter from air or other gas streams is to use cyclone separators. Centrifugal separators in their most basic form are cyclones, which have a barrel at the top and a cone at the bottom. The gas particle fluxes' inertia force is converted into centrifugal force through the use of a vortex created within the cyclone's body. A tangential entry at the barrel's top causes the particle-laden airstream to flow downward into the cone, creating an outer vortex. The particles are ejected from the air stream by a centrifugal force caused by the expanding air velocity of the outer vortex. As air enters the bottom of the cone and begins to radially rise and exit the top as clean air or gas, the particles fall into the dust collection chamber that is attached to the bottom of the cyclone. Items utilised include: Iron, stainless steel, and alloys are the materials utilised to construct cyclone separators as shown in Figure 3.

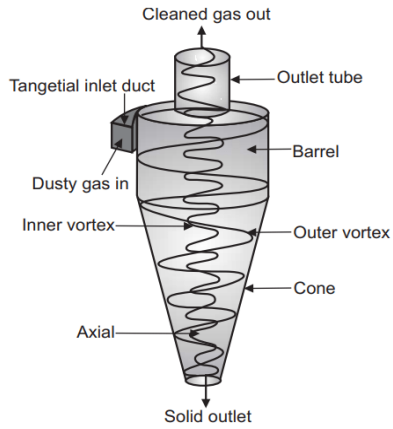


Figure 3. Operation of a cyclonic separator

4.1.3 Vacuum chamber

A vacuum pump removes air and other gases from a rigid enclosure known as a vacuum chamber. This creates what is known as a vacuum—a low-pressure environment—within the chamber. It is an enclosed vessel used to collect particle debris. The vacuum chamber is made of glass, stainless steel, and plastic.

4.1.4 Wet scrubber

A venturi scrubber accelerates the waste gas stream in order to atomize the scrubbing liquid and improve gas-liquid contact. A 'throat' section is incorporated into the duct of a venture scrubber to force the gas stream to accelerate as the duct constricts and then opens up. When the gas enters the venturi throat, both the gas velocity and turbulence increase. The cleaning liquid may be sprayed into the gas stream before it reaches the venturi throat, inside the throat, or upwards in opposition to the gas flow inside the throat, depending on the scrubber design. The turbulence in the throat atomizes the cleaning liquid into tiny droplets, increasing the droplet-particle contact. To increase the production of droplets, some designs use additional hydraulically or pneumatically atomized sprays. The working process is shown in Figure 4.

The disadvantage of these designs is that a clean liquid supply is required to avoid clogging. The mixture slows down and has additional effects after the throat region, which causes the droplets to clump together. After the particles have been captured by the liquid, they are separated from the gas stream by an entrainment section, which commonly consists of a cyclonic separator and/or a mist eliminator.The current designs for venturi scrubbers, which typically make use of the vertical downflow of gas down the venturi throat, incorporate three elements: 1. An entry section with a "flooded-wall" or "wet-approach" to avoid dust buildup at a wet-dry junction, 2. A venturi throat that is adjustable means that the throat size, gas velocity, and pressure drop may all be adjusted. To lessen wear from abrasive particles, there is a "flooded" elbow above the entrainment separator and below the venturi. The throat of the venturi is occasionally lined with refractory material to guard against abrasion from dust particles. It is used to gather

dust particles smaller than 2.5 microns. Cast iron, galvanised steel, and materials containing alloying elements like nickel and chrome are the materials used in wet scrubbers.

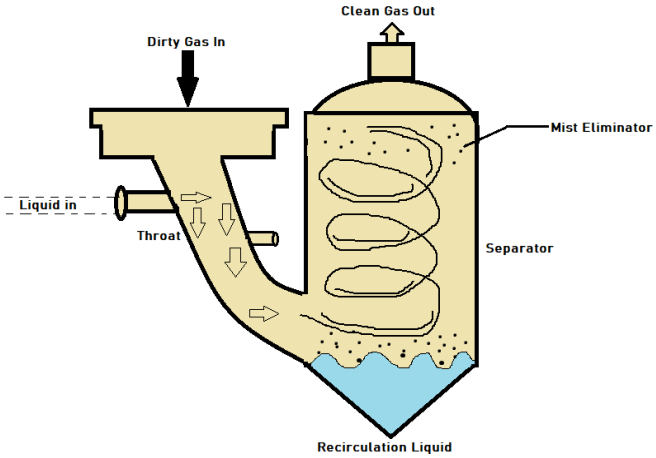


Figure 4. Working of a wet scrubber

4.1.5 IoT-based system

The MQ2 sensor, an ESP8266 WIFI module, an Arduino UNO microcontroller, a buzzer, an LCD display, cables, a power source, and various gases (CO_2, NH_3, etc.) for detection are all part of our project. The MQ2 sensor can detect a variety of gases, including NH3, alcohol, NOx, benzene, CO_2, and more, and it provides voltage levels as an output. Due to Arduino's lack of built-in WIFI or internet capacity, we must use the ESP8266 WIFI module to link our system to the internet. This cost-effective WIFI chip has full TCP/IP stack and MCU capability, operates on 3.3V, and helps in connecting our system to the internet. We are displaying our results on a liquid crystal display, sometimes known as a 16X2 LCD display. Displayed in PPM, the air and humidity data is typically organised over two rows and sixteen columns. After a specific amount of air pollution is reached, the buzzer we're employing will sound an alarm to let people know that the air quality is bad.

4.2 Cyclone design

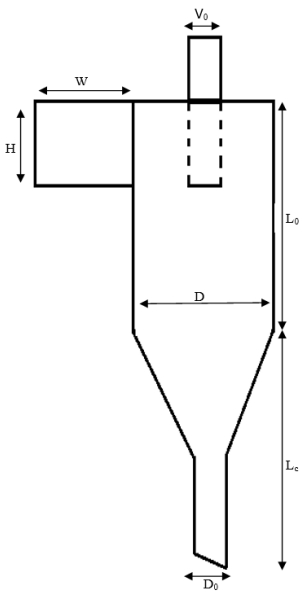


Figure 5. Design of a cyclonic body

The results are general since all dimensions are related to the cyclone's body diameter as shown in Figure 5.

H is considered as inlet duct's height.

W is the input duct's width.

Lb is the cyclone body's length.

Lc denotes the cyclone cone's vertical length. De = Gas Exit Diameter.

Dd is the dust outlet's diameter.

S is the vortex finder's length.

Lb+Lc=The cyclone's overall length.

4.3 The quantity of efficient turns (Ne)

The first stage in the CCD process is to calculate the number of effective rotations. The number of actual turns in the cyclone is equal to the number of rotations the gas makes when it passes through the outer vortex. The number of air stream rotations is increased to increase collecting efficiency.

$$\mathrm{Ne} = \frac{1}{H}\left(\mathrm{Lb} + \frac{Lc}{2}\right); N = 10.0779(0.3050 + 0.30450) \quad (1)$$

N = 7(No of Effective Turns)

where, N (without units) is the device's internal turn count; H=inlet duct height (in metres or feet); Lb=cyclone body-length which may be calculated in metres/foot; Lc is the cyclone cone's vertical length (in metres or feet); N=10.0779(0.3050 + 0.30450). Effective turns-7.

4.4 Cut point diameter

The second step in the CCD process is determining the cut-point diameter. The cut-point of a cyclone is the aerodynamic equivalent diameter (AED) of the particle collected with 51–53% efficiency. As the cut-point diameter increases, the collecting efficiency decreases.

$$\mathrm{dPc} = \mathrm{P}\left(\frac{9\mu W}{2\pi(PP - Pg)}\right)^{1/2} \quad (2)$$

where, the smallest particle that the cyclone will gather has a diameter of dp; Gas viscosity is equal to kg/m/s; W=(m) inlet duct width.

$$\textit{Number of turns equals } (\mathrm{NT}) = \frac{1}{H}\left(\mathrm{Lb} + \frac{Lc}{2}\right) \quad (3)$$

where, (M/s) Vi is the inlet gas velocity; P is for particle density (kg/m^3); pa=Fluid Density; dpc=(9×(1.83×10−5)×0.03892π×7×16.62×(1.310−1.232)) 12dcp = 0.3461 ×10^{-3}.

4.5 Pressure drop (ΔP)

The pressure decrease that the storm experiences is another crucial aspect to consider while designing a cyclone system. There are two steps in the Lapple method for calculating cyclone pressure loss. Equation is used to calculate the pressure decrease in the quantity of inflow velocity heads (Hv) at the beginning of the operation. Applying an equation to convert the amount of incoming velocity heads into a static pressure drop is the second phase in this procedure (P). The

dataset is given in Table 1.

Table 1. Cyclone separator dataset

	Variable	Power	Result
Cyclone Body: Diameter	D	D	0.1530
Body: Length	Lb	2D	0.3051
Cone: Length	Lc	2D	0.3052
Inlet: Height	H	D/2	0.0768
Inlet: Width	W	D/4	0.0389
inlet Pipe: Diameter	d	A=PIr2	0.061
Gas Exit: Diameter	Dc	D/2	0.0770
Dust outlet: Diameter	Dd	D/4	0.0390
vortex Finder: Length	S	0.629	0.0931
Sc: Length	Sc	D/8	0.023
Cyclone: Total Length	Lb-Lc	4D	0.1101

$$H_v = K\frac{HW}{\frac{2}{E}D} \tag{4}$$

where, *K* is a constant (K=12 to 18 for a typical tangential-entry cyclone) that varies with cyclone configurations and operating conditions, and pressure drop(H_v) is considered as inlet velocity head amount.

$$H_v = 18\left(\frac{0.0779\times0.0389}{0.0779^2}\right); H_v = 9; \Delta P = \frac{1}{2}PgV_1^2H_v;$$
$$\Delta P = \frac{1}{2}0.261\times16.592^2\times9; \Delta P = 323.33 kg/m^2s \tag{5}$$

5. RESULT ANALYSIS

One of the main issues we are currently dealing with is pollution. Our health is significantly impacted by the air we breathe. In modern cities, pollution reduction is necessary. Pollutants in the atmosphere, which include ozone at ground level and fine particles. A mixture of several gases, dust, and water vapour can also be referred to as pollution, which primarily results from air pollution. It also describes foggy air that is challenging to breathe. When fuels are burned, the gases or pollutants that make up the atmosphere are discharged into the atmosphere. Pollution is created when these gases and tiny particles in the atmosphere interact with sunlight and its heat. Air pollution alone is the sole culprit. These precursors are mostly produced by pollutants that are discharged into the air by petrol and diesel-powered cars, industrial facilities and operations, and human-caused heating.

The elements that make up smog and the potential repercussions of it make this fact abundantly clear. Humans, animals, plants, and the rest of nature are all harmed by it. Numerous fatalities were noted, particularly those caused by bronchial illnesses. The lungs might be filled with the microscopic harmful particles known as PM 2.5.According to research from Berkeley Earth, a non-profit organisation that carries out scientific investigations on climate change, 1.6 million people worldwide pass away from air pollution each year. This is a sobering reality of modernization.

The elements that make up smog and the potential repercussions of it make this fact abundantly clear. Humans, animals, plants, and the rest of nature are all harmed by it. Numerous fatalities were noted, particularly those caused by bronchial illnesses. The lungs might be filled with the microscopic harmful particles known as PM 2.5.According to research from Berkeley Earth, a non-profit organisation that carries out scientific investigations on climate change, 1.6 million people worldwide pass away from air pollution each year. This is a sobering reality of modernization. A general Anti-Smog Tower is presented as a project as shown in the Figure 6.

Figure 6. Smog tower for air purification

5.1 System discussion

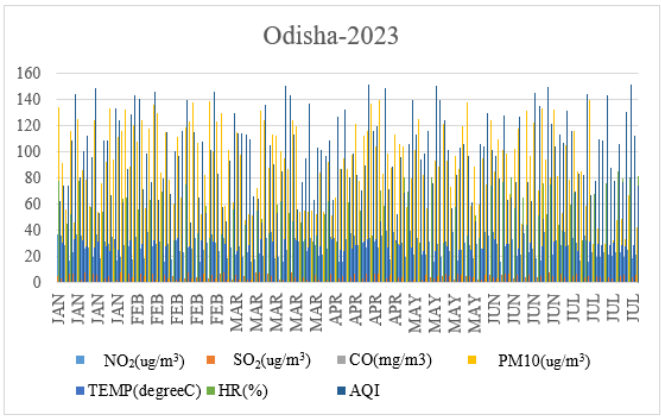
Start by connecting the VCC and CH_PD pins of the ESP8266 to the 3.3 pin of the Arduino. Then, use three resistors in series to link it to the rest of the circuit. Following this, we need to link the MQ2 to the Arduino UNO, with the VCC pin going into the 5V power source and the ground pin going into ground. The analogue pin should be linked to A0 on the Arduino UNO, and pin 8 should be associated with the buzzer. After that Whenever the MQ2 detects almost any gas, including CO_2, NO_2, NH_3, benzene, and so on. Because our desired output is in PPM and the MQ2 only provides voltage levels as input, we must convert it to PPM. In the absence of gas and other detectable, the sensor will provide a reading of 90. A safe level of production is 350 parts per million, and it should never go above 1000 parts per million. If the production exceeds 1000 ppm, individuals in that vicinity may encounter difficulties sleeping, headaches, stuffy noses, and a stale odour. Severe symptoms, such as irregular heartbeat and other breathing-related issues, may occur if it continues to above 2000ppm. As a result, a buzzer will sound an alarm and the LCD will show "Bad air quality" anytime the pollution level reaches 1000 ppm, advising the user to either leave the area or don a mask to protect themselves from the harmful air. With the ESP8266 WIFI module, the microcontroller may be linked to the internet. This allows for the storing and subsequent analysis of sensor data, making it easier to monitor air pollution through the internet and an application. When air pollution reaches a certain level that is, when it becomes dangerous for human health the system sends out an alarm message on watches and mobile phones. As a result of our work, air quality monitoring is an important tool in the fight against air pollution, since it allows for the accurate detection of air pollution and the subsequent effective control of that problem.

5.2 Analysis of air pollution in various years of odisha

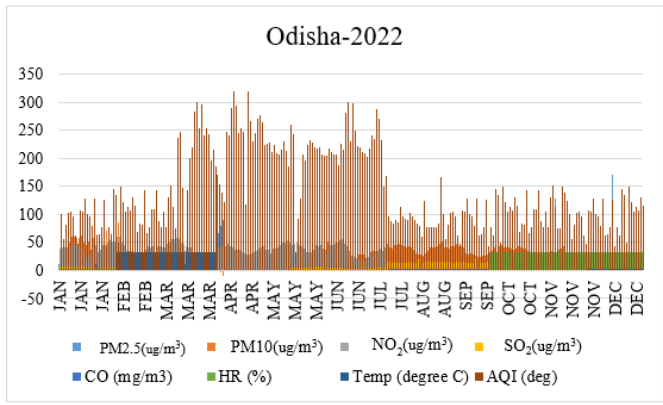
The AQI readings and PM2.5 and PM10 concentration in agrarian pollution-affected Odisha were provided, along with

a classification analysis of pollution risk. Based on the pollution data that is currently available, Due to huge air-pollution impacts in recent years, this analysis also shows that Odisha has risen to the top. More recently, AQI readings above 100 have been recorded in Odisha.The highest PM2.5 and PM10 concentrations occurred in Odisha, and describes the effect study of the agrarian Indian cities regarding the PM2.5 and PM10 concentrations and the fluctuations in temperature and humidity levels. As was previously mentioned, one of the main causes of these abnormally high values and concentrations is the burning of stubble and paddies in neighbouring farm states like Haryana and Uttar Pradesh. From May 2019 through February 2020, Figure 7 a-c displays an AQI seasonal analysis of the top most polluted in Odisha.

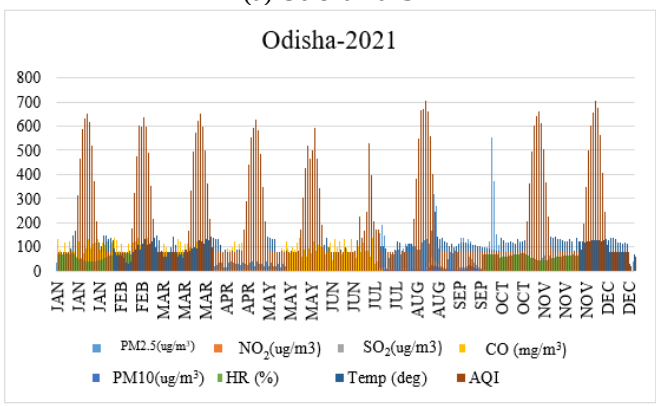
For India's agricultural states, we resorted to the same six-category, color-coded analysis of pollution risk metrics that we employed before. Our research shows that seasonal changes have had a major effect on AQI shifts in India's most populous cities. As we've shown, Odisha is still India's most polluted major city, with persistent problems like poor air quality and elevated PM2.5, PM10, and AQI readings.High levels of pollution were reported in more than 90% of Odisha areas in December 2020, frightening officials. Due to severe air pollution, all educational institutions were closed for nearly a month.



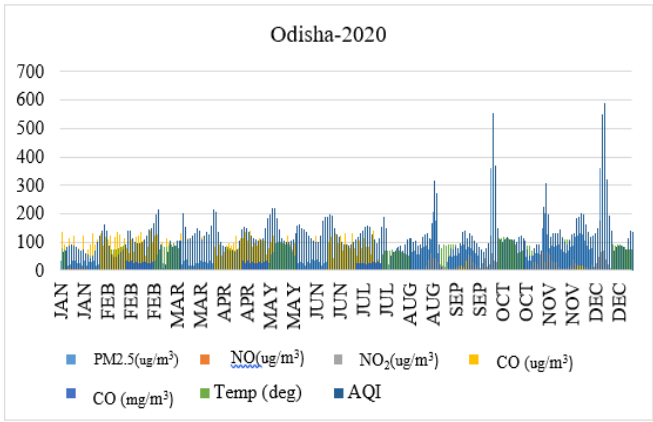
(a) Odisha 2023



(b) Odisha 2022



(c) Odisha 2021



(d) Odisha 2020

Figure 7. Analysis of air-pollution-affected in Odisha (from January 2020 to July 2023

6. CONCLUSIONS

This page presents an overview of techniques that can be applied to infrastructure and buildings in order to get rid of smog and other pollutants. There are several available responses. The first is the use of plants as a biophilic solution through the creation of green façades and roofs.The second is the use of anti-smog towers with different operational modes. Concrete and adding admixtures that alter the surface are the next two solutions. These include nano additions like nano titanium dioxide and nano activated carbon.Now that states, communities, and even the general public are aware of the problem, new, practical solutions can be adopted. Of course, just having structures, facilities, and infrastructure will not result in a thorough cleanup. Other sectors also need to change. To eliminate smog, anti-smog buildings are insufficient. Asthma, increased cardiac arrest, bronchitis, severe dermatological illnesses, and countless more acute health problems have been linked to the rise in air pollution in recent years, brought about by the fast progress of industrialization and urbanisation.

In light of the present situation, it is necessary to develop new technologies in order to control the rapidly declining air pollution level. However, in order to do so, it is necessary to monitor and identify the air quality in a specific area. Using an Arduino uno microcontroller, the suggested project would detect and monitor air pollution in a limited region.

This paper discusses the problem of air quality monitoring and how the principles of the Internet of Things (IoT) enhance the process of monitoring different parts of the environment.Our project's sensor of choice is the MQ2 model. The ability of MQ2 to detect a wide range of potentially hazardous substances in our environment is the reason for its employment here. Ammonia (NH_3), sulphur (S), benzene

(C_6H_6), carbon dioxide (CO_2), and other dangerous gases and smokes can all be detected by the MQ2 gas detector.

A combination of several gases, dust, and water vapour is another definition of pollution, the most common kind of which being air pollution. It also describes air that is so foggy that it's hard to breathe. The combustion of fossil fuels releases gases and other contaminants into the air. Pollution occurs when these gases and tiny particles in the air react with the heat of the sun. Air pollution is the only source of this. Air pollution from sources such as industrial plants and activities, automobiles powered by petrol or diesel, and human-caused heating are the primary causes of these precursors. The components and potential effects of smog make its harmfulness quite clear. All living things, including humans, animals, and plants, are negatively impacted by it. There were a lot of fatalities, especially from bronchial illnesses. Inhalation of PM 2.5, a type of small, harmful particles, can harm the lungs. One unfortunate consequence of industrialization is the fact that air pollution kills over 1.5 million people year, according to research from Berkeley Earth, a non-profit organization that studies climate change.

REFERENCES

[1] Stanaszek-Tomal, E. (2021). Anti-smog building and civil engineering structures. Processes, 9(8): 1446. https://doi.org/10.3390/pr9081446

[2] Zhang, H., Mao, S., Wang, X. (2021). How much are people willing to pay for clean air? Analyzing housing prices in response to the smog free tower in Xi'an. International Journal of Environmental Research and Public Health, 18(19): 10210. https://doi.org/10.3390/ijerph181910210

[3] Rath, P., Jindal, M., Jindal, T. (2021). A review on economically-feasible and environmental-friendly technologies promising a sustainable environment. Cleaner Engineering and Technology, 5: 100318. https://doi.org/10.1016/j.clet.2021.100318

[4] Mangla, M., Sharma, N., Mehta, V., Mohanty, S.N., Saxena, K. (2021). Statistical analysis for air quality assessment and evaluation: A data mining approach. In 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO), Noida, India, pp. 1-5. https://doi.org/10.1109/ICRITO51393.2021.9596299

[5] Yang, R., Wei, J., Lu, L., Li, L. (2020). Air pollution and green consumption of consumers in China's urban areas: A norm activation perspective. Human and Ecological Risk Assessment: An International Journal, 26(7): 1988-2010. https://doi.org/10.1080/10807039.2019.1646633

[6] Asher Ghertner, D. (2021). Postcolonial atmospheres: Air'S coloniality and the climate of enclosure. Annals of the American Association of Geographers, 111(5): 1483-1502. https://doi.org/10.1080/24694452.2020.1823201

[7] Rek-Lipczynska, A. (2019). Purification of the air in the historic cities of towns. In IOP Conference Series: Materials Science and Engineering, 471(10): 102029. https://doi.org/10.1088/1757-899X/471/10/102029

[8] Woźniak, J., Krysa, Z., Dudek, M. (2020). Concept of government-subsidized energy prices for a group of individual consumers in Poland as a means to reduce smog. Energy Policy, 144: 111620. https://doi.org/10.1016/j.enpol.2020.111620

[9] Dzikuć, M., Kułyk, P., Dzikuć, M., Urban, S., Piwowar, A. (2019). Outline of ecological and economic problems associated with low emission reductions in Poland's LubuskieVoivodeship. Polish Journal of Environmental Studies, 28(1): 65-72. http://dx.doi.org/10.15244/pjoes/83612

[10] Bonenberg, W., Kapliński, O. (2018). The architect and the paradigms of sustainable development: A review of dilemmas. Sustainability, 10(1): 100. https://doi.org/10.3390/su10010100

[11] Biswal, A.K., Singh, D., Pattanayak, B.K., Samanta, D., Yang, M.H. (2021). IoT-based smart alert system for drowsy driver detection. Wireless Communications and Mobile Computing, 2021: 6627217. https://doi.org/10.1155/2021/6627217

[12] Biswal, A.K., Singh, D., Pattanayak, B.K., Samanta, D., Chaudhry, S.A., Irshad, A. (2021). Adaptive fault-tolerant system and optimal power allocation for smart vehicles in smart cities using controller area network. Security and Communication Networks, 2021: 2147958. https://doi.org/10.1155/2021/2147958

[13] Biswal, A.K., Singh, D., Pattanayak, B.K. (2021). IoT-based voice-controlled energy-efficient intelligent traffic and street light monitoring system. In Green Technology for Smart City and Society: Proceedings of GTSCS 2020, Singapore, pp. 43-54. https://doi.org/10.1007/978-981-15-8218-9_4

[14] Bumbiere, K., Barisa, A., Pubule, J., Blumberga, D., Gomez-Bavarro, T. (2022). Transition to climate neutrality at university campus. Case study in Europe, Riga. Environmental and Climate Technologies, 26(1): 941-954. https://doi.org/10.2478/rtuect-2022-0071

[15] Schwartz, E.K., Krarti, M. (2022). Review of adoption status of sustainable energy technologies in the US residential building sector. Energies, 15(6): 2027. https://doi.org/10.3390/en15062027

[16] Kiciński, J., Chaja, P., Kiciński, J., Chaja, P. (2021). Transformation in Poland. Scenarios. Controversies. Programs. Climate Change, Human Impact and Green Energy Transformation, 53-78. https://doi.org/10.1007/978-3-030-69933-8_5

[17] Khera, G., Irshad, S.M. (2023). From environmental management to risk governance: Air pollution case of Delhi, India. International Journal of Environmental Technology and Management, 26(1-2): 135-152. https://doi.org/10.1504/IJETM.2023.127332

[18] Johnson, T., Fürst, K. (2022). Praying for blue skies: Artistic representations of air pollution in China. Modern China, 48(1): 73-104. https://doi.org/10.1177/0097700420967288

[19] Shamshiri, R.R., Jones, J.W., Thorp, K.R., Ahmad, D., Man, H.C., Taheri, S. (2018). Review of optimum temperature, humidity, and vapour pressure deficit for microclimate evaluation and control in greenhouse cultivation of tomato: A review. International Agrophysics, 32(2): 287-302.

[20] Chakrabarty, S., Boksh, F.M., Chakraborty, A. (2013). Economic viability of biogas and green self-employment opportunities. Renewable and Sustainable Energy Reviews, 28: 757-766. https://doi.org/10.1016/j.rser.2013.08.002

[21] Chegari, B., Tabaa, M., Simeu, E., Moutaouakkil, F., Medromi, H. (2021). Multi-objective optimization of building energy performance and indoor thermal comfort

by combining artificial neural networks and metaheuristic algorithms. Energy and Buildings, 239: 110839. https://doi.org/10.1016/j.enbuild.2021.110839
[22] Achour, Y., Ouammi, A., Zejli, D. (2021). Technological progresses in modern sustainable greenhouses cultivation as the path towards precision agriculture. Renewable and Sustainable Energy Reviews, 147: 111251. https://doi.org/10.1016/j.rser.2021.111251
[23] Badji, A., Benseddik, A., Bensaha, H., Boukhelifa, A., Hasrane, I. (2022). Design, technology, and management of greenhouse: A review. Journal of Cleaner Production, 373: 133753. https://doi.org/10.1016/j.jclepro.2022.133753
[24] Aslan, M.F., Durdu, A., Sabanci, K., Ropelewska, E., Gültekin, S.S. (2022). A comprehensive survey of the recent studies with UAV for precision agriculture in open fields and greenhouses. Applied Sciences, 12(3): 1047. https://doi.org/10.3390/app12031047
[25] Sekabira, H., Tepa-Yotto, G.T., Kaweesa, Y., Simbeko, G., Tamò, M., Agboton, C., Tahidu, O.D., Abdoulaye, T. (2023). Impact of CS-IPM on key social welfare aspects of smallholder farmers' livelihoods. Climate, 11(5): 97. https://doi.org/10.3390/cli11050097
[26] Nya, E.L., Mwamila, T.B., Komguem-Poneabo, L., Njomou-Ngounou, E.L., Fangang-Fanseu, J., Tchoumbe, R.R., Tepong-Tsinde, R., Gwenzi, W., Noubactep, C. (2023). Integrated water management in mountain communities: The case of feutap in the municipality of Bangangté, Cameroon. Water, 15(8): 1467. https://doi.org/10.3390/w15081467
[27] Sone, Rani, G.M., Pathania, D., Abhimanye, Umapathi, R., Rustagi, S., Huh, Y.S., Gupta, V.K., Kaushik, A., Chaudhary, V. (2023). Agro-waste to sustainable energy: A green strategy of converting agricultural waste to nano-enabled energy applications. Science of The Total Environment, 875: 162667. https://doi.org/10.1016/j.scitotenv.2023.162667
[28] Singuru, R., Praveen Kumar, G., Kumawat, A.S. (2023). Microbial fuel cell usage in treatment, resource recovery and energy production from bio-refinery wastewater. In Biorefinery for Water and Wastewater Treatment, pp. 425-443. https://doi.org/10.1007/978-3-031-20822-5_20
[29] Jain, P.C., Charan, V.S., Sahith, C., Singh, R. (2023). IoT based real time monitoring of delhi-ncr air pollution using low power wide area network. In IFIP International Internet of Things Conference. Cham: Springer Nature Switzerland, 3-13. https://doi.org/10.1007/978-3-031-45882-8_1
[30] Su-Ungkavatin, P., Tiruta-Barna, L., Hamelin, L. (2023). Methodological framework for life cycle assessment of sustainable aviation (SA) systems. Science of The Total Environment, 885: 163881. https://doi.org/10.1016/j.scitotenv.2023.163881
[31] Saini, M.K., Saini, R.K. (2022). Smart agriculture using Internet of Things: An empirical study. In Recent Innovations in Computing: Proceedings of ICRIC 2021, Singapore, 2: 163-175. https://doi.org/10.1007/978-981-16-8892-8_13
[32] Diamond-Smith, N., Puri, M., Neuhaus, J., Weiser, S., Kadiyala, S. (2022). Do changes in women's household status in Nepal improve access to food and nutrition? Maternal & Child Nutrition, 18(3): e13374. https://doi.org/10.1111/mcn.13374
[33] Mohammadi, L., Rahdar, A., Bazrafshan, E., Dahmardeh, H., Susan, M.A.B.H., Kyzas, G.Z. (2020). Petroleum hydrocarbon removal from wastewaters: A review. Processes, 8(4): 447. https://doi.org/10.3390/pr8040447
[34] Vasi, I.B., Strang, D. (2009). Civil liberty in America: The diffusion of municipal bill of rights resolutions after the passage of the USA PATRIOT Act. American Journal of Sociology, 114(6): 1716-1764. https://doi.org/10.1086/597177
[35] Rabiej-Sienicka, K., Rudek, T. J., Wagner, A. (2022). Let it flow, our energy or bright future: Sociotechnical imaginaries of energy transition in Poland. Energy Research & Social Science, 89: 102568 https://doi.org/10.1016/j.erss.2022.102568
[36] Mills, G., Sharps, K., Simpson, D., Pleijel, H., Frei, M., Burkey, K., Emberson, L., Uddling, J., Broberg, M., Feng, Z.Z., Kobayashi, K., Agrawal, M. (2018). Closing the global ozone yield gap: Quantification and cobenefits for multistress tolerance. Global Change Biology, 24(10): 4869-4893. https://doi.org/10.1111/gcb.14381
[37] Siebert, S., Döll, P. (2010). Quantifying blue and green virtual water contents in global crop production as well as potential production losses without irrigation. Journal of Hydrology, 384(3-4): 198-217. https://doi.org/10.1016/j.jhydrol.2009.07.031
[38] Aryal, J.P., Manchanda, N., Sonobe, T. (2022). Expectations for household food security in the coming decades: A global scenario. In Future Foods, pp. 107-131. https://doi.org/10.1016/B978-0-323-91001-9.00002-5
[39] Cardani, G., Massetti, G.E., Riva, D. (2021). Multipurpose retrofitting of a tower building in Brescia. Sustainability, 13(16): 8877. https://doi.org/10.3390/su13168877
[40] Ito, K., Zhang, S. (2020). Willingness to pay for clean air: Evidence from air purifier markets in China. Journal of Political Economy, 128(5): 1627-1672. https://doi.org/10.1086/705554
[41] Priya, M., Gurung, N., Mukherjee, K., Bose, S. (2014). Microalgae in removal of heavy metal and organic pollutants from soil. In Microbial Biodegradation And Bioremediation, pp. 519-537. https://doi.org/10.1016/B978-0-12-800021-2.00023-6
[42] Coutts, A., Beringer, J., Tapper, N. (2010). Changing urban climate and CO_2 emissions: Implications for the development of policies for sustainable cities. Urban Policy and Research, 28(1): 27-47. https://doi.org/10.1080/08111140903437716
[43] Khrushch, O., Moskalets, V., Fedyk, O., Karpiuk, Y., Hasiuk, M., Ivantsev, N., Arjjumend, H. (2023). Environmental and psychological effects of russian war in Ukraine. Technical Advisory Board, 6(1): 37-84.
[44] Zabbey, N., Sam, K., Newsom, C.A., Nyiaghan, P.B. (2021). The COVID-19 lockdown: An opportunity for conducting an air quality baseline in Port Harcourt, Nigeria. The Extractive Industries and Society, 8(1): 244-256. https://doi.org/10.1016/j.exis.2020.12.011
[45] Malla, S., Sahu, P.K., Patnaik, S., Biswal, A.K. (2023). Obstacle detection and assistance for visually impaired individuals using an IoT-enabled smart blind stick. Revue d'Intelligence Artificielle, 37(3): 783-794.
[46] Malla, S., Sahu, P.K., Sarangi, D., Patnaik, S. (2022). Role of smart dustbin in creating a smart environment. In Smart Cities and Smart Communities: Empowering Citizens through Intelligent Technologies, pp. 113-129. https://doi.org/10.1007/978-981-19-1146-0_6

[47] Malla, S., Sahu, P.K., Patnaik, P., Patnaik, S. (2021). Automated home safety through IoT. In Advances in Wireless Communications and Applications: Wireless Technology: Intelligent Network Technologies, Smart Services and Applications, Proceedings of 3rd ICWCA 2019, pp. 205-211.

[48] Singh, D., Biswal, A.K., Samanta, D., Singh, V., Kadry, S., Khan, A., Nam, Y. (2023). Smart high-yield tomato cultivation: Precision irrigation system using the Internet of Things. Frontiers in Plant Science, 14: 1239594. https://doi.org/10.3389%2Ffpls.2023.1239594

[49] Mohapatra, K., Singh, D., Biswal, A.K. (2023). IoAT-based smart farming technology. In 2023 IEEE 2nd International Conference on Industrial Electronics: Developments & Applications (ICIDeA), pp. 585-590. https://doi.org/10.1109/ICIDeA59866.2023.10295169

[50] Malla, S., Sahu, P.K., Patnaik, S., Nayak, M. (2023). Smart energy efficient techniques for IOT enabled wireless node. Journal of Theoretical and Applied Information Technology, 101(18): 7331-7346.