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Modelling the Application of Air Pollution Monitoring System Using IOT in Smart Buildings

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Research Article

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ABSTRACT

This research aims to use sensors to develop a framework for detecting weather emissions and measuring air quality in smart buildings. The suggested sensors are used in this application to measure and collect temperature, humidity, CO_2, and air quality data. The key goal of the paper is to monitor the weather, which can be done remotely with the aid of an Arduino UNO and the Internet of Things. This paper suggests a Real-Time Air Quality Control Device for smart buildings that will track air emissions data in the form of chemical and biological contaminants in the environment in the immediate region of indoor and outdoor areas. If the Air Quality Index (AQI) crosses a pre-set level, a short message system (SMS) transmits the unit to a cell phone in a dangerous state or saves data in think speak's cloud storage.

INTRODUCTION

With the introduction of lightweight, energy-efficient, integrated and low-cost air quality sensors, the world's cities have started to develop urban sensor networks so as to give a comprehensive view of the amount of air pollution that people encounter in their everyday lives. In this experimental study, we develop an environmentally friendly air pollution monitoring and warning program, which alerts people proactively to particular air quality requirements through mobile devices a region which exceeds user-defined threshold until approaching air pollution. In a given metropolitan area the service continuously decides the aggregation of particles, monitors closed areas of elevated air emissions and exchanges this knowledge with the mobile devices of the resident, who are liable for constantly comparing the position of the citizen toward areas with low air quality. Air infection is primarily the cause of conditions such as influenza, cancer, bronchitis, birth defects and the immune system, such as illnesses. The machine uses an android application, a browser, and a gas sensor to detect ambient air quality with chemical and biological contamination in air. To overcome the shortcomings of current air quality instruments, this system can be used to track chemical and biological contamination simultaneously. To view the device according to the daily air condition, the most difficult thing to do is to provide real-time air quality data. This Study proposes a Real Time Air Quality Monitoring Device project to monitor air pollution readings, chemical and biological contamination in air in the surrounding area of indoor and outdoor in smart building [1].

Smart buildings

In recent years, the concept of a smart buildings has become prominent in the political sphere. ICT technology appears to be at the center, but a significant range of research have also been performed on the status of human/educational resources, social and emotional programs, environmental issues and human/educational function. Relevant reasons for population growth. Smart buildings are a new development, but they are growing worldwide. This lively and creative urban design is intended as a significant way to counter the growth of urban development in five continents of large and medium-sized towns. Even if academics and practitioners understand and practice the subject, the content and boundaries of the word are sometimes misunderstood and endangered. It is often the product of a bottom-up pattern, where communities adopt their own smart vision further than academic science standards, pursuing spontaneous projects by municipal councils, enterprises and individuals. While the exact concept of a smart buildings is different, the ultimate goal is to maximize its operations and encourage economic development while also enhancing the quality of life of residents by smart infrastructures and processing of data. The smart buildings has worth dependent on the infrastructure and not just how much technology it has. Several main features are used to study an area's intellect. These attributes include:

- The infrastructure focused on technology;
- Sustainability projects;
- A highly operational infrastructure of public transport;
- Citizens live and work in the city and make use of their wealth.

The performance of a smart building based on its capacity, with administration and legislation, to form a close partnership between government and the private industry. This partnership is necessary, since much work is performed beyond the government to build and sustain a new, data-driven environment. Operating road monitoring equipment could involve one firm's controls, another's monitors, and another server [2].

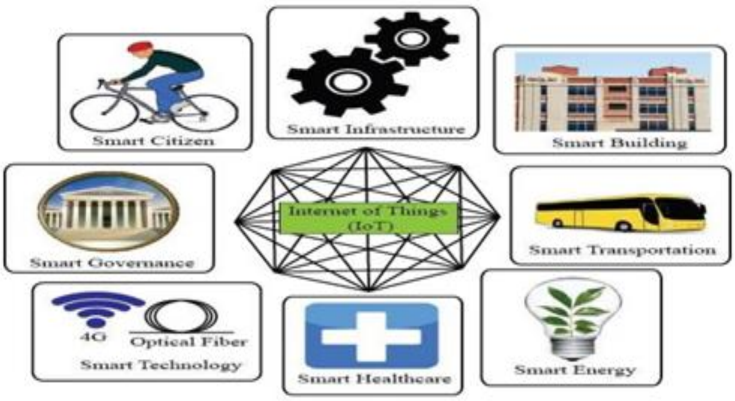
Smart building technology

Smart buildings utilize a mixture of IOT devices, infrastructure solutions, UIs and networking networks. Smart Communities are utilizing the Internet of Things. However, they rely primarily on the IOT. IOT is a network that can connect and embedded devices like motor cars, sensors, or home appliances share details. IOT devices and machines are stored in a cloud or on servers in the storage and dissemination of results. The partnership between these devices and Data Analytics aims to increase the productivity both in public service and in the private sector, by integrating physical and digital urban elements.

Implementations in smart building

Emerging technologies like robotics, computer training and IOT contribute to the introduction of smart communities. In the case of smart communities, every metropolitan management region is theoretically considered. The smart car park meter used to help drivers locate open parking spaces without widening the cycle of populated city blocks is a classic example. The smart meter often allows automated transfers, but no coins are missing with one meter. Smart traffic management is also used in transport to detect and quantify movements of traffic to enhance street lighting and to deter highways from overloading due to regular or peak hour plans. Another part of smart buildings is smart public transport. Smart transport businesses are able to manage preparations in real time for customer comfort, performance enhancement and brand satisfaction. The primary objective of smart buildings is energy saving and efficiency. With smart sensors, smart streetlights turn faint when cars or peasants are not on the road. Smart grid technology may be used to enhance processes, management and preparation, distribution capacity and track electricity interruptions on demand. Environmental issues, including weather variation and air pollution, should be pursued and discussed through the city's smart policies. In addition, the usage of smart technologies may be used to improve waste management and sanitation, be it Internet-based waste containers and IOT-compliant waste disposal systems, or Sensors to track water parameters and to ensure the safety of front- end drinking water, proper wastewater treatment and drainage (Figure 1).

Figure 1: Smart city components.



The application of Smart community technology is increasing from investigating of high crime to increased disaster alertness through sensors to enhanced public safety. Early warning devices may be critical components of smart sensors, for example in the event of droughts and floods. Smart buildings often form part of a smart city scheme. In addition to the real time room control and public protection, modern structures may be retrofitted and built utilizing a sensor, but also to track the structural health of buildings. Rain and tear can be identified by sensors and officials can alert when fixes are needed. People may aid Notifying the government, via a smart city application, of the need to upgrade infrastructure and other public properties, including potholes. The sensors may also be used to detect leakages in tubes, to reduce costs and to increase public workforce [3].

AIR POLLUTION

The most important aspect of life is air. The instrument's primary goal was to determine the environmental situation for humans as well as all other creatures on the planet in this critical situation. We just ought to realize how safe we are right now about our futures and how noise quality and sound can improve the atmosphere and nature. It would make it easier to know the reactions to air pollution. The system mainly employs four primary gas sensors, which are responsible for the largest amount of air pollution, to realize the best results of air quality. The most responsible air pollution shall be declared CO2, CO, LPG and humidity and shall be used in the process. The data was made available via a server and an Android Program, as virtually everybody already has an Android computing device and an Internet link. The environmental effects of human activity are polluted by the water we consume, the food we inhale and the dust in which plants flourish. Though it was a major technical change, socio-economic and utility accomplishment, it has also led to the production of large quantities of pollutants that are harmful to the well-being of human beings released into the world. Global pollution is certainly called a multi-faceted international public health problem.

This main concern applies to the problems and activities of culture, infrastructure, legislation and lifestyle. Clearly, the global proportions of urbanization and industrialization in our era are both extraordinary and upheavals. One of the main risks to global health in the world is anthropogenic pollution pollutants, which are responsible for almost 9 million lives a year. Without a reason, both of the above are directly related to climate change, and the effects for society will be severe in the event of danger. Multiple species are severely threatened by climate change and the impact of global planetary warming, affecting difficulties such as food protection concerns, ice and iceberg freezing, animal destruction, and plant damage.

Air pollution releasing from Industries

The World Health Organization (WHO) focuses on six large pollutants including particulates, nitrogen oxides and lead in smart communities causing multiple sources of emissions that are dangerous to human health. Air pollution will have devastating effects, like fresh water, land and air with all environmental materials. The risk for living beings is indeed important. Our primary interest here is to reflect on these toxins, since they are correlated with wider and more important societal and environmental problems. The big biological impacts on atmospheric pollution are acid platform, global warming, greenhouse impact and climate change.

Carbon monoxide (CO): When burning is insufficient, fossil fuel generates carbon monoxide. The poisoning with carbon monoxide inhalation is indicated by headache, dizziness, fatigue, nausea, vomiting and eventually loss of consciousness. The greenhouse emissions are affected by carbon monoxide and are tightly tied to climate and global warming. This could contribute to a rising temperature of the soil and water and severe weather or hurricane.

Nitrogen oxide (NO_2): Oxide is a pollutant generated from engines connected with traffic. Pulmonary system irritants when it penetrates deep into the lungs that induce respiratory discomfort and often pulmonary oedema when inhaled at elevated concentrations. Concentrations above 0.2 ppm appear to cause these adverse reactions in men, with concentrations above 2.0 ppm affecting T lymphocytes, especially $CD8^+$ cells and NK cells responsible for our immune response.

Sulfur dioxide (SO_2): Sulfur dioxide is a toxic gas created primarily through the combustion of fossil fuels or by industry. The SO_2 norm is 0.03 ppm per year (20). It influences the lives of people, animals and plants. Increased risk of injuries to those with illnesses, such as respiratory diseases, older people and children. Respiratory asthma, bronchitis, mucus and bronchospasm are main health challenges in urban countries associated with sensitivity to sulfur dioxide.

Lead: Lead is a heavy metal used in numerous manufacturing processes and produced in gas turbines, batteries, radiators, waste incinerators and drainage systems. Bone and metabolic, nervous and reproductive systems accumulate in skin, tissue, liver, lungs, bone, through inhalation. Adults have also observed a reduction in attention and memory as well as muscle and joint pain. Also at small levels of lead, children and newborns are highly vulnerable, since it is a neurotoxicant and induces cognitive disorders, memory failure, hyperactivity and even mental retardation.

Polycyclic aromatic hydrocarbons (PAHs): PAHs are commonly dispersed in the world, as the atmosphere is the most critical dispersal medium. It is found in sediments of coal and tar. Incomplete organic combustion, such as forest fires, incineration, and vehicles, is producing them. Chemicals considered to be toxic, mutagenic and carcinogenic, such as benzopyrene, acenaphthylene, and fluoranthene. They are a huge lung cancer risk factor.

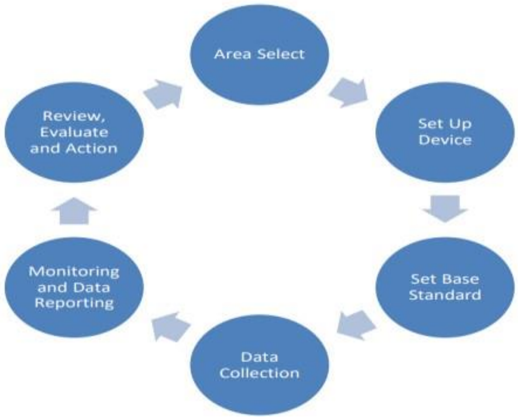
Volatile organic compounds (VOCs): Human cancer has been described as organic volatile chemicals such as toluene, benzene, ethylbenzene and xylene. At present, the usage of advanced materials and fabrics has led to higher VOC speeds. Contamination of indoor air with VOCs and adverse effects on human health can occur. The adverse consequences on human well-being are both short-and long-term. It is impossible to measure the predictable toxic effects of diverse VOCs since they can have synergistic, antagonistic or indifferent effects [4].

Dioxins: Dioxins derive from fields, but often occur naturally, such as forest fires and eruptions. These occur in foods such as meat, milk, seafood and chocolate, and in animal fatty tissues, in particular. Short-term exposure to high concentrations of dioxin can cause black spots and skin lesions (94). Long-term dioxin exposure can trigger problems with growth, weakening.

IMPLEMENTATION AND RESULTS

This chapter defines the approach and configuration of the air monitoring model. We investigated the characteristics and functions of the model design sensors. Indoor and outdoor ozone quality air pollution was also investigated. We prepare an air quality and its monitoring system through mail and SMS. This is the paradigm that has been suggested. The whole unit would run, as shown in Figure 2. The block diagram shows how the device will work in a given area. The machine is designed to gather environmental data and to have the standard base value. Based on the values, the machine receives and shows the output.

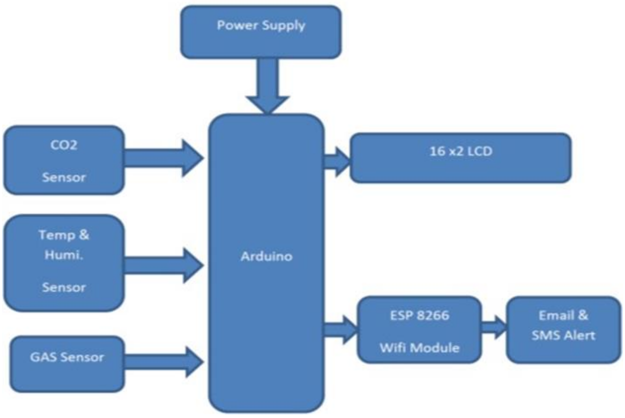
Figure 2: Proposed model of the system.



Methodology

Block diagram: A framework diagram for the structure during which all other operations are carried out would be the main stage in the application of the monitoring scheme (Figure 3).

Figure 3: Flow chart of methodology adopted.



Description

Arduino: It is the system's microcontroller.

CO_2 system: It's a MQ3 sensor used in the environment to feel CO2

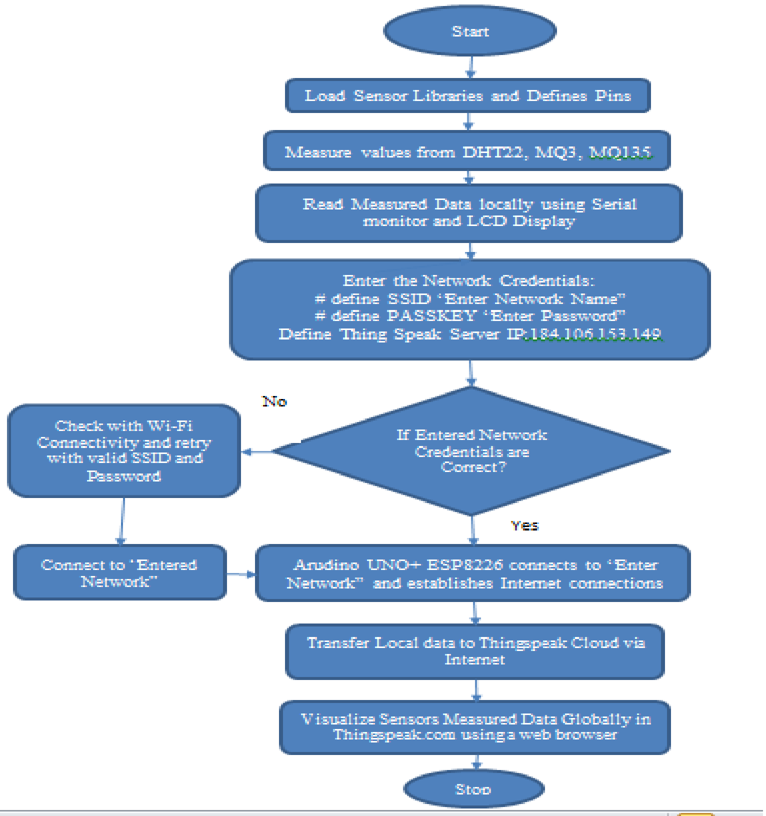
Gas sensor: The sensor MQ135 is used to track air quality in the atmosphere. For reading the sensor,

Lcd: A 16 X 2 LCD is used.

WiFi module: It is a module of the ESP8266 that is used to submit the cloud data i.e.

IFTTT: Used for sending the reply.

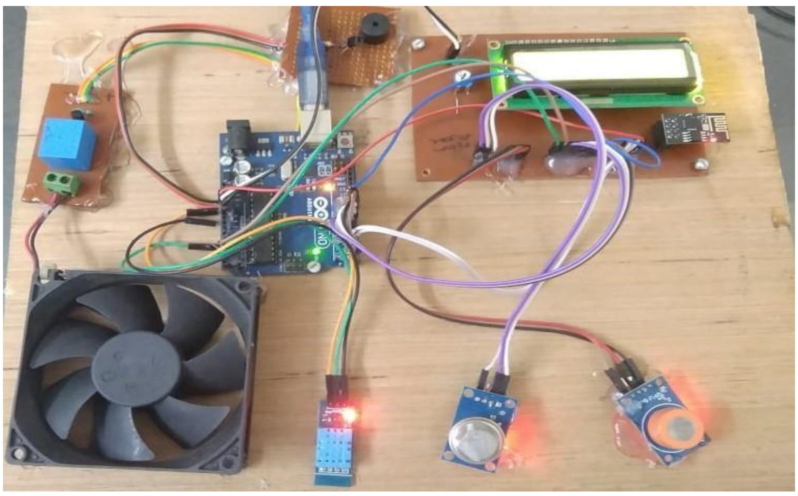
Figure 4: Block diagram of air pollution monitoring system.



SYSTEM DESIGN

The progress made in the design of a framework for reporting air quality in real time will be detailed in this part. This segment also addresses the design and construction of the new system as seen in Figure 4.

Figure 4: Real Model of air quality monitoring system.



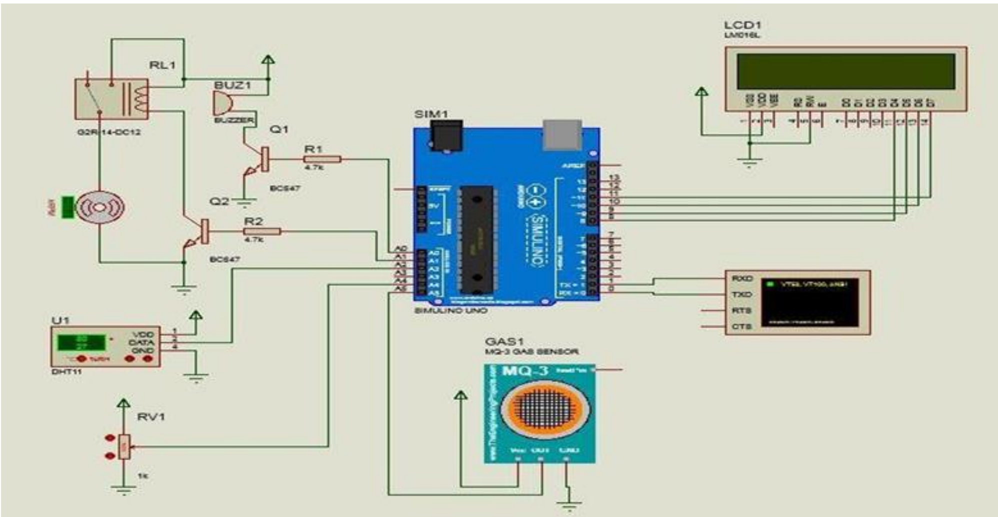
COMPONENTS OF DEVICE

It is a device that gathers data from the chosen environment. The device is built with various sensors and collects area data (Figure 5). The sensors receive analogue feedback from the environment and are then digitally converted using the pi of raspberries. Device modules are (Table 1):

Table 1: Types of sensors.

DHT 22 sensor	A2
Fan	A1
Buzzer	A0
MQ3	A5
MQ135	A4

Figure 5: Block diagram of air pollution monitoring system model.

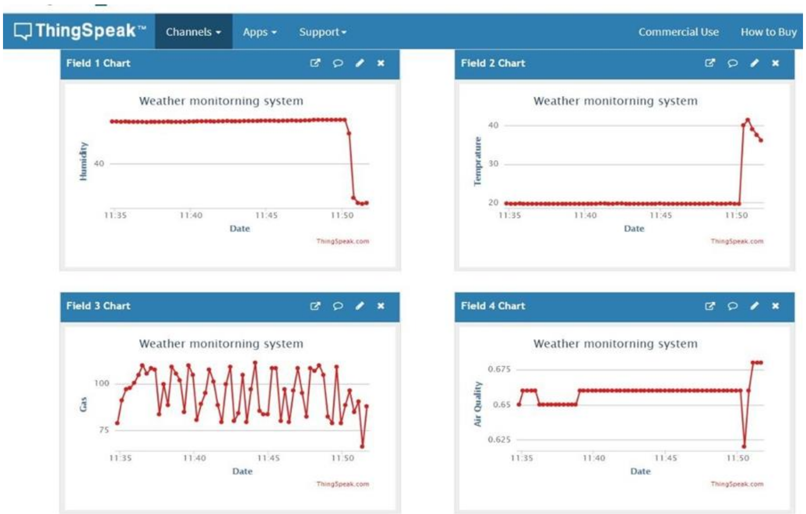


Analysis and software used

The modules were designed and assembled, and each component. Successful evaluation of each module is the most crucial element. Readings of any sensor are recovered and stored in an archive in a clear environment. Cloud changes the data automatically. Then we provide graphic charts with data that have a good sensor-centered weather analysis. This is how the testing procedure was carried out. That is performed in a very disciplined fashion. And, under real circumstances, we could perform other experiments of the same nature. Here we have an IOT project which provides you with a weather monitoring system to access different weather parameters from a distance through Thing Speak websites [5]. We are very reliant on rising technology in this modern era. We use our Microcontroller, WIFI module and different sensors like DHT22, MQ135, MQ3 etc. The computer was first mounted by independent sensors on the Arduino Uno and the breadboard. The time of uploading code was comparatively longer during the first phases. For indications, the DHT moisture sensor is useful.

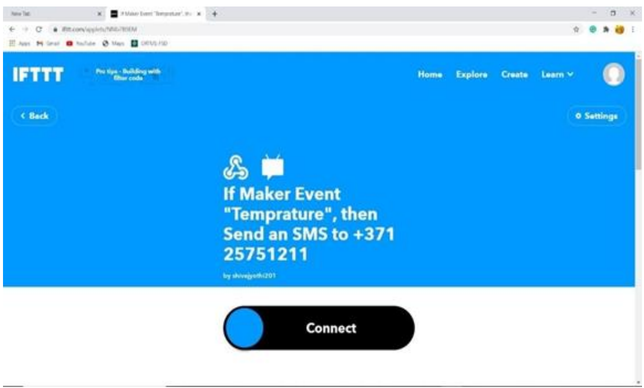
Data collection by DHT22, Mq135, Mq3 sensors

Figure 6: Shows the user interface of thing speak with received data graph.



We also transmitted information on our machine from the field to our server. For CO_2, CO and CH4, we have taken values. We also received randomly information equal to the rates we see as the normal meaning. We have also taken into account the environmental principles that our system will see in real time. These findings can be compared with the values in our tables as standard (Figure 6). On the website's user interface, temperature, dust, tone, and light portions are shown. Under freezing, there are three sections: temperature, moisture, coal, and air quality. SMS alerts are sent using an IFTT address. It receives data from the cloud storage and then sends it as an SMS warning with details. Figure 7 depicts the IFTT account's user experience. Following all gas, odour, temperature, and humidity observations, these values will be submitted to the machine, and from the computer, the data will be sent to the system, and from the device, the data will be sent to the application, and from the application, the data will be sent to the cloud storage server, and from the cloud computing server, the data will be sent to Thing Speak.

Figure 7: IFTT working environment.



Data received from server (SMS, Email)

The email and SMS Alert form details received. IFTT is a cloud storage account for the purposes of submitting SMS updates. Which means if the values are too high, it is too risky to give users an alert. If they are too high. At that point, the server will alert users and it will be recommended that users take the necessary steps to reduce the values. End users will view real-time diagrams and other values and show diagrams that appear after all values have been totally calculated (Figure 8 to Figure 17).

Figure 8: Data received by message alert.

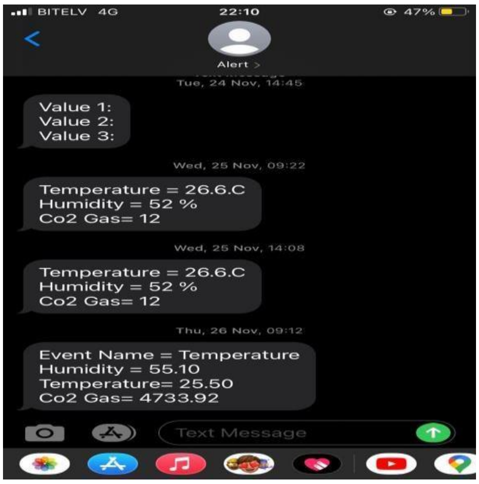
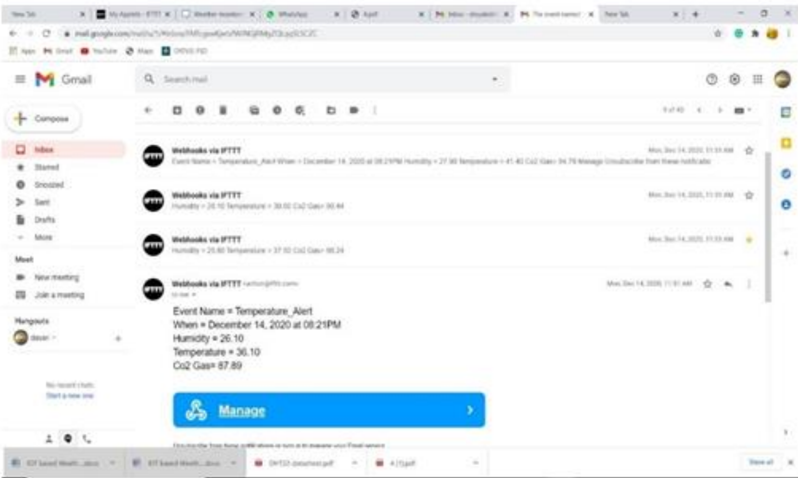


Figure 9: Shows data received by email alerts.



DATA COLLECTION FROM INDOOR AND OUTDOOR OF SMART BUIDING

Indoor data collection process performed

Figure 10: Shows air quality data of indoor.

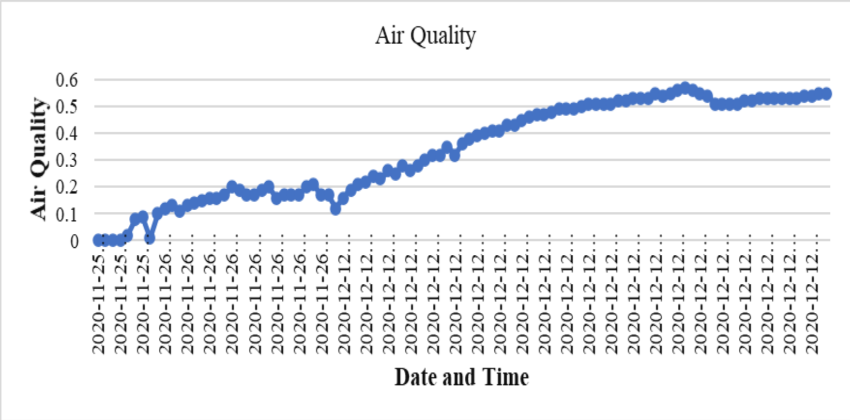


Figure 11: Gas values in indoor air.

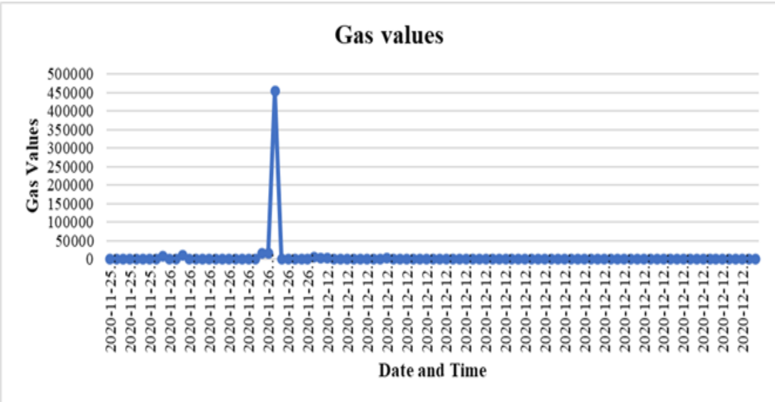


Figure 12: Humidity percentage data of indoor.

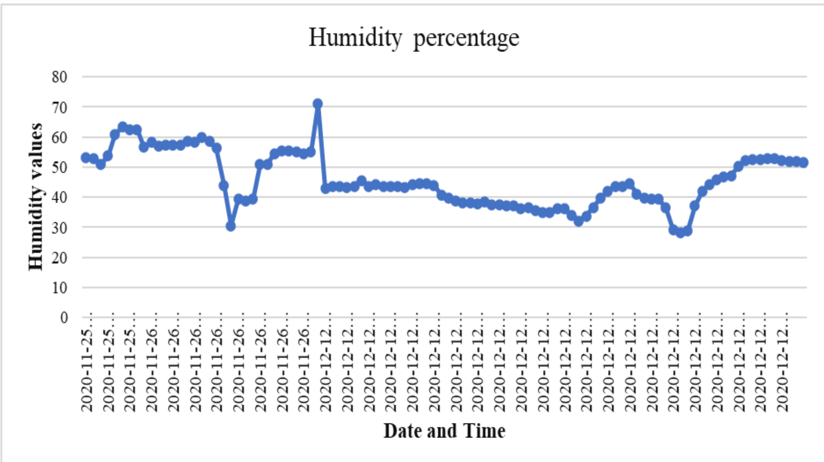
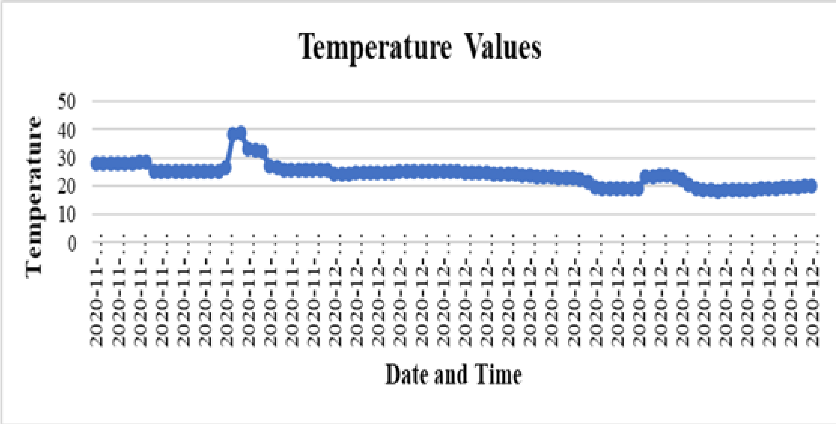


Figure 13: Temperature values of indoor air.



Outdoor data collection Process Performed:

Figure 14: Gases analyze in outdoor air.

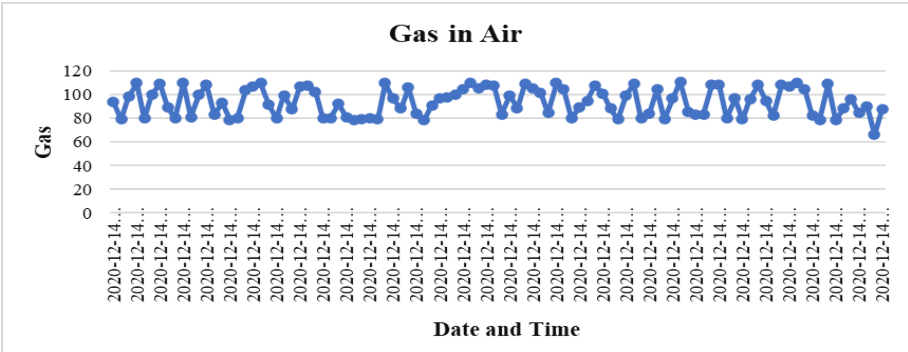


Figure 15: Humidity percentage studied in outdoor air.

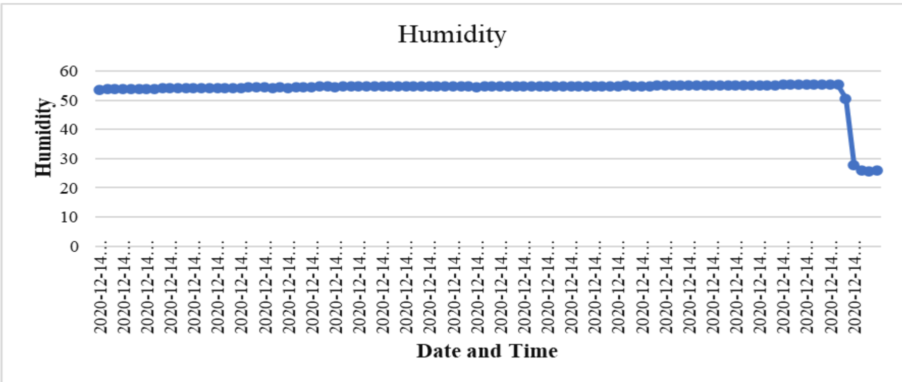


Figure 16: Temperature studied of outdoor air.

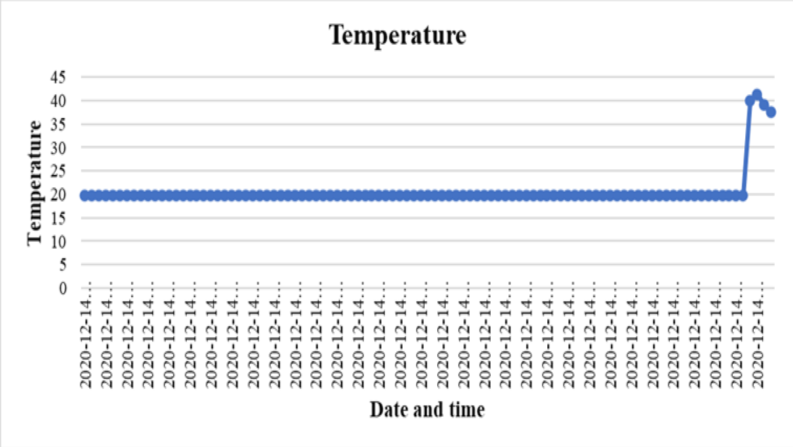
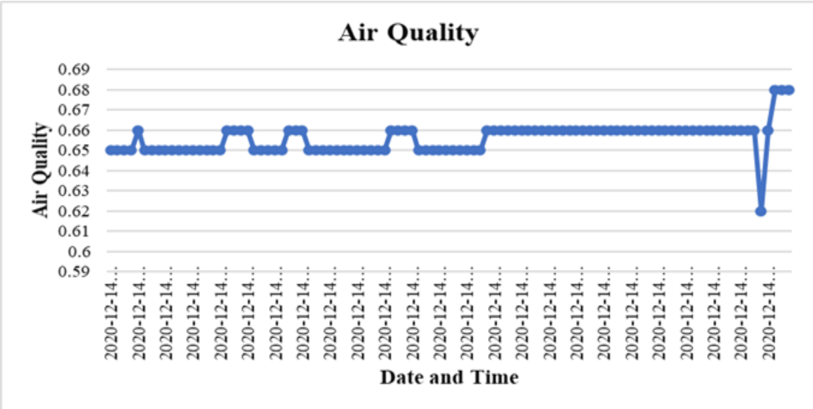


Figure 17: Air quality studied of outdoor air.



CONCLUSION

This paper proposes a low-cost, but successful and optimized device to ensure the smart tracking of environment and air quality as well as sound pollution. In the proposed design features, separate sensors and their operating process are discussed. Here you'll also read how they're moving, how they're going to function, how they're going to be optimal, and how they're going to take the data and match it to the standard database. The pollution and air quality control unit has been tested for gas levels in different areas of the planet. The data server has also received sensor parameters. Our project unit has proved itself to be efficient and inexpensive and will, ideally, be reliable for everybody with a collection of highly usable sensors, and the data is important in order to better society.

- Here we have learned how stronger and more efficient the present system is than the other systems. It's extremely compliant. It is restricting the efforts of residents.
- This concludes that new project activities are a huge success and will have a long way of preserving real-time meteorological parameters and helping producers, enterprises and ordinary people alike.
- It can be used for a period of years to gather relevant information for each region or area.

- The information gathered will be used to establish the best possible conditions for plant production if we talk about farming and farmers change the environmental conditions that are more appropriate to the growth plan. This will be of tremendous benefit to farmers everywhere and to agriculture.
- This device tracks and allows individuals to function according to the state of specific areas. Suppose a farmer wishes to plant a flower or tree that only develops in certain conditions. Thus, the temperature, humidity, wind, and other parameters from everywhere can be used through this method. Just once can someone install this device and extra work is immediately completed.

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