

IOT BASED AIR POLLUTION MONITORING SYSTEM

A Project Report Phase – II

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering

by

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **GANGARAJU TEJASWINI(39130136)** who carried out the project title **"IOT BASED AIR POLLUTION MONITORING SYSTEM"** under our supervision from June 2022 to January 2023.

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DECLARATION

I, **Gangaraju Tejaswini(39130136)** hereby declare that the Project Report entitled “**IoT based Air Pollution Monitoring System**” is done by us under the guidance of **Dr. V. Balamurugan M.Tech., Ph.D.**, at Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication.

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ABSTRACT

Nowadays air pollution has turned out to be one of the significant issues because of increment in the quantity of vehicles and during the time spent industrialization and urbanization. This expansion in the level of contamination brings about destructive consequences for prosperity. This project explains the depiction and execution of an Air Pollution detection system. The innovation grasped here, is a hands-on execution of the idea of Internet of Things. This detailed work is an exploration of the possibilities of consumption of this innovation, in this world, where natural well-being is turning into a genuine risk. The work is actualized utilizing microcontroller board of Node Mcu09. In this project I am going to make an IoT based Air Pollution Detection Monitoring System in which I will monitor the Air Quality using BME280 sensor and will trigger alarm when the air quality goes down to a certain level means when there is amount of harmful gases present in the air like CO₂. It will show the air quality in PPM (Parts Per Million) as like "Fresh Air", "Poor Air", "Danger Air"

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Air Excellence Guide (AEG) may be a common indicator of air quality. The Air Quality Indicator (AQI) is calculated and supported on air pollutants like CO and NO₂ compounds that consume opposing possessions happening the atmosphere and human health. The Air Quality Indicator may be a range that represents the very finest meditation of a specific air unused matter at a particular time. I propose an air quality as well as air pollution monitoring system that allows us to monitor and check live air quality as well as air pollution in an area through Internet of Things (IoT). It uses air sensors (Gas Sensor MQ135) to sense presence of harmful gases/compounds in the air and constantly transmit this data.

In addition, system keeps measuring air level and reports it. The sensors interact with Arduino Uno (Microcontroller) which processes this data and transmits it over the application. This allows authorities to monitor air pollution in different areas and act against it [1]. In addition, authorities can keep awatch on the air pollution near schools, and hospitals areas. Normally, little concent rations areaunit measured exploitation ppb (parts per billion), that represents units of mass of a material per one billion units of total mass. Parts per million (ppm) may be similar and unremarkable used unit to measure concentrations of pollutants. It determines the requirements of a new system and analyze on product and resource requirement, which is required for the successfultsystem.

The product requirement contains input and output requirements it gives the wants in term of input to produce the required productivity. The resource requirements define in brief about the hardware that are needed to achieve the required functionality. In this project I am going to make an IoT based Air Pollution Detection Monitoring System in which I monitor the Air Quality over a web server using ESP8266 Wi-Fi device and a trigger alarm when the air quality goes down a certain level means when there is amount of harmful gases is present in the air like CO₂.

1.2 Aim and Purpose of Project

The project is an implementation of IoT (Internet of Things) Based Air Pollution Monitoring System Using Arduino. Air pollution is a growing issue and it is necessary to monitor air quality for a better future and healthy living for all. IoT is getting popular day-by-day and standards are on its way. Therefore, collection of air quality information is easier. Analysis of monitoring data allows us to assess how bad air pollution from day to day.

According to the recent survey, Dhaka, the capital of Bangladesh is the third in the list of most air-polluted city. Thus because of this expansion in the quantity of vehicles contamination is developing quickly and it influencing people groups wellbeing too. This air contamination makes disease and harmsafe, neurological, regenerative and respiratory framework. In extraordinary cases, it can likewise cause passing.

As indicated by overview 50000 to 100000 unexpected losses occurred to us only because of air contamination [2]. Along these lines, there is a requirement for checking air quality and to monitor it. IoT is the system of physical gadgets, vehicles, home apparatuses, and different things implanted with hardware, programming, sensors, and availability which empowers these articles to associate and trade information. IoT permits articles to be noticed or controlled. In this paper, I am proposing and going to piloting a model which IoT to screen air contamination.

1.3 Objectives of Monitoring Air Quality

The air quality monitoring program design dependent upon the monitoring specific objectives specified for the air quality management in the selected area of interest. Defining the output influence, the design of the network and optimize the or building materials, inform the public about the air quality and raise the awareness, develop warning systems for the prevention of undesired air pollution episodes, facilitate the source apportionment and identification, supply data for research investigations, develop/validate management tools (such as models), develop and test analytical instruments and to support legislation in relation to the air quality limit values and

guidelines.

The relationships between the data collected and the information to be derived from them must be taken into account when a monitoring program is planned, executed and reported. This emphasizes the need for users and potential users of the data to be involved in planning surveys, not only to ensure that the surveys are appropriate to their needs but also to justify committing the resources.

1.4 Air Quality Parameters

The important parameters that are considered in the proposed framework include: Carbon Dioxide (CO_2) – CO_2 is colorless, odorless gas and non-combustible gas. Also, it is measured under the category of smother gases that have ability of interfering the availability of oxygen for tissues. Carbon Dioxide is a gas vital to life in the world, because it is one of the most vital elements evolving photosynthesis process, which converts solar into chemical energy. The concentration of CO_2 has amplified due mainly to massive remnant fuels boiling. This increase makes plants grow rapidly. The rapid growth of undesirable plants leads to the increase use of chemicals to eliminate them [3].

Sulphur Dioxide (SO_2) - Sulphur Dioxide is a colorless gas, detectable by the distinct odor and taste. Like CO_2 , it is mainly due to fossil fuels boiling and to manufacturing processes. In high attentions may cause breathing problems, especially in sensitive groups, like asthmatics. It contributes to acid rains.

Nitrogen Dioxide (NO_2) – Nitrogen Dioxide is a brownish gas, easily detectable for its odor, very corrosive and highly oxidant. It is produced as the result of fossil fuels burning. Frequently NO terrified to the atmosphere is converted in NO_2 by chemical processes. In high absorptions, NO_2 may principal to respiratory problems. Like SO_2 , it contributes to acid rains.

Smoke - About 1 million people are in custom of tobacco smoking globally of which majority population is from rising countries. Every year nearly 4.9 million people expired due to smoking allow to 2007 report. In addition, second hand smoke is serious threat to the health of people of all age's causes 41000 deaths each year.

LPG - Liquefied petroleum gas (LPG) is an odorless and colorless liquid which evaporates readily into a gas. Leakage is generally noticed by adding an odorant into it. It is considered under the category of highly flammable gases and it can be classified as a carcinogen and mutagen if Butadiene content is more than 0.1%. LPG may escape in the form of a gas or a fluid. If it escapes in the form of a liquid, it vanishes quickly and will eventually form large cloud of gas in air, which is relatively thicker than air thus drops to the ground. Whereas, LPG vapors travel along the ground for a long distance and gets collected in drains or basements. Gas principals to burn or detonate after getting in touch with a source of ignition.

Temperature and humidity- Quantity of temperature is an important for safety of people and affects our life skills. Greenhouse outcome can be observed by measuring temperature and comparing temperature changes from historical to present time especially since the industrial revolution using climate data. Humidity is a type of gas that guards us from UV rays from the sun and helps trick heat on Earth, thereby making the climate on Earth, a pleasant one for living. However, as humidity increases, the warmth on Earth also increases which makes our life uncomfortable. Humidity is essential for various storage and food processing facilities.

1.5 Importance of Air Pollution Monitoring System

Air is one of the most basic and important elements for human being to survive. Clean and Sound air is the key to a good and healthy life. But now days in city life it has become the most threatened factor. Pollution of air has become the most concerned and affected issue now for us. A diversity of air pollutants has known or suspected injurious effects on human health and the atmosphere. In most areas, these toxins are principally the products of combustion from space warming, power generation or from motor vehicle traffic flow. Pollutants from these sources may not only prove a problem in the immediate locality of these sources but can travel long distances. Generally, if someone is young and in a good state of health, moderate air pollution levels are unlikely to have any serious short term effects. However, higher levels and long term exposure to air pollution can lead to more serious

symptoms and conditions causing human health. This not only affects the respiratory and inflammatory response systems, but can also lead to more serious conditions such as heart disease and cancer. People with lung or heart situations to be more vulnerable to the effects of air pollution. Air pollution has also been recognized by doctors as one of the world's greatest 10 killers seeing some 29,000 premature deaths in UK and 430,000 worldwide in one year. Air pollution can cause both short term and long term effects on health and many people are concerned about pollution in the air that they breathe. These people may include:

Monitoring air quality is essential for local authorities as well as for major public and private industries to understand and prevent air pollution and measure emission sources, in order to reserve health and donate to the fight against the greenhouse influence. Industrial operatives use air quality monitoring apparatus to cost effectively monitor and manage emanations on their perimeter, which helps them recover relationships with controllers and communities. With air quality rule shifting the burden from publicly funded monitoring to observing funded by industry, it has been progressively important for businesses to obtain their individual quality monitoring equipment. To get the best results from the environment about the pollution level of air, toxicity and harmfulness for human, air quality monitoring device is vastly used. An air quality monitor is an expedient that actions the level of common air toxins. Displays are available for both indoor and outdoor locations. Indoor air quality monitors are naturally sensor based tools. Some of them are able to quantify ppb levels and come as either varied gas or moveable units. Sensor based tools and air quality monitoring systems are used widely in outdoor ambient claims.

1.6 Benefits and Beneficiaries

1.6.1 Benefits

1. Achievement of proper facility to ensure pollution free environment
2. Reduction of health risk in day-to-day life

1.6.2 Beneficiaries

1. Society People
2. Special Care Units in the hospitals
3. Urban and Rural planning sector and green building management system

1.7 Advantages of Proposed Project

1.7.1 Portability

It is a compact device which consists of many sensors including cloud which are all combined by using internet of things (IoT).

1.7.2 Safety

One can avoid from going to particular location by redirecting themselves or by taking safety protections such as wearing mask and can reduce over dumped wastages in a particular locality area [4].

1.7.3 Cost

Compared to others it's efficient and low cost because sensor is clubbed by using internet of things (IoT) and Arduino microcontroller.

1.7.4 Simple Maintenance

As the Project deals with the software embedded C, so maintenance will be easy and this can also be installed in Arduino (arduino-1.8.10-windows.exe)

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

. The MCU samples the sensor outputs using an internal ADC, it then calculates the gas concentrations and transmits the computed data as packets using the GSM. A test incubator was designed and constructed to evaluate the performance of the sensor node. The sensor node was tested by placing it inside the incubator; pumping gas into the incubator and observing the measurements taken by the sensor node. The base station comprises a sink node serially connected to a computer which runs the GUI software. The sink or receiving node captures the data transmitted by the remote sensor node and serially forwards it to the computer. The data was then plotted on the GUI and stored in text files.

Poonam Pal Et al. in October 2017 developed a system to monitor the air using Arduino microcontroller. They used MQ135 gas sensor to sense the different type of dangerous gas and arduino to control the entire process. MQ135 gas sensor gives the output in form of voltage levels and needs to be converted into PPM. Wi-Fi module was used to connect the whole process to internet and LCD was used for the visual output. When the value is less than 1000 PPM, the LCD and webpage will display “Fresh Air” and when the PPM exceeds the limit then the buzzer starts beeping and the LCD and webpage will display “Poor Air, Open Windows”. If it will increase 2000 then the buzzer will keep beeping and the LCD and webpage will display “Danger! Move to fresh Air”.

Harsh Gupta Et al. in 2019 presented an IOT based Air Pollution Monitoring System which consists of sensors that were to constantly monitor the Temperature, Humidity, Carbon Monoxide, Smoke, LPG, PM2.5 and PM10 levels in the atmosphere. In their work, a one-way communication between Thing Speak, an open source cloud platform, and an Android Application has been developed. Raspberry Pi has been used as a gateway to interface the hardware system. Once the firebase API was included in Android or iOS App, firebase features like Analytics, Authentication, Storage, Messaging, Hosting, Crash reporting, Real-time Database etc. were used. The Graphs were plotted in Thing

Speak according to the sensors data received and the same were visualized in an Android App in a tabular format.

Nitin Sadashiv Desai Et al. in 2017 proposed a system that consists of Beagle bone Interfaced with air pollution measure sensors such as carbon dioxide [CO₂], carbon monoxide [CO] and noise sensor. Analog output from sensor was read from Analog pin of Beagle bone black which reads the input signal in the range 0 v to 1.8v. Data from sensor was uploaded on Azure Cloud with the help of python SQL. Reserved data base was created in the beagle bone itself in the form of .CSV file. At the end of each day, same data present in the .CSV file is uploaded in the cloud data base. Old data in the beagle bone have been deleted with the help of automated shell script. Data from different sensor was stored in the Azure data base. This data from database has been fetched as input for machine learning service. Machine learning service was used to train the module with the help of previous data. Power BI have been used to represent sensor data fetched by beagle bone black.

2.2 Opportunity, Status & Capability of IoT

2.2.1 Opportunity of IoT

The IoT create a huge network of billions or trillions of “Things” communicating each other. The IoT is not dissident revolution over the existing technologies, it is comprehensive uses of existing technologies, and it is the creation of the new communication modes. The IoT blends the virtual world and the physical world by transporting different concepts and technical components together: pervasive networks, reduction of devices, mobile communication, and new ecosystem. In IoT, applications, services, middleware components, networks, and end nodes to structurally planned and used in entire new ways. IoT proposals a means to look into complex procedures and dealings. The IoT implies a symbiotic communication between the physical and the digital worlds: physical entities have digital complements and virtual illustration; things become context aware and they sense, communicate, interact, and exchange data, information, and knowledge. New chances meet business requirements, and new services to be created based on

real-time physical world data. All from the physical or virtual world possibly be connected by the IoT. Connectivity between the things to be available to all with low cost and cannot be owned by private objects. For IoT, intelligent learning, fast placement, best information understanding and interpreting, against fraud attack, and privacy protection are vital requirements.

2.2.2 Status of IoT

The IoT regarded as an extension of existing interaction between people and applications through a new dimension of “Things” for communication and integration. The IoT development process is a multifaceted large-scale technological novelty process. The IoT is developing from the vertical application to polymeric application. At the early stage of IoT placement, driving of domain specific requests is the main development approach. A domain-specific application might be an industrial control system with its own industry features.

The application can provide various enterprise management services being combined with the industry manufacture and business processes. Polymeric requests are cross-industry applications founded on public information service stages. These requests provision both homeusers and industry users.

The application is provided and promoted by communication operators and solution providers with large scale. For example, a vehicle integrated with sensor networks, a global positioning system (GPS), and radio communication technology provide inclusive detection, navigation, entertainment, and other information services. By preserving such information through the public service platform, consumers, original equipment manufacturers (OEMs), maintenance providers, and vehicle organization agencies can share this information and segment services to improve the vehicle, the vehicle component design, and the fabrication process through the vehicle growth management.

2.2.3 Capability of IoT

In summary, the IoT applications have the following capabilities. Location Identifying and Sharing of Location Info: The IoT system can gather the location information of IoT stations and end nodes, and then offer services based on the collected location information. The location information includes geographical position information got from the GPS, Cell-ID, RFID, etc., and complete or relative position information between things. More representative IoT applications include at least the following.

Mobile asset tracking: This application track and display the status of product using the position sensing device and statement function installed on the commodity.

Fleet management: The manager of the fleet schedule the vehicles and drivers established on the business supplies and the real-time position information collected by the vehicles.

Traffic information system: This application gets traffic information such as road traffic conditions and congested locations by tracking the location information of a large number of vehicles.

Environment Sensing: The IoT system collect and process all kinds of physical or chemical environmental parameters via the locally or widely organized terminals. Typical environmental information includes temperature, humidity, noise, visibility, light intensity, spectrum, radiation, pollution (CO, CO₂, etc.), images, and body pointers. Representative applications include at least the following.

Environment detection: IoT systems offer environmental and ecological, such as forest and glacier, checking; disaster, such as volcanoes and seismic, monitoring; and factory monitoring.

Remote medical monitoring: IoT analyze the recurring indicator data collected from the device placed on patients' body and provide the users with health trends and health advice.

Remote Controlling: IoT systems control IoT terminals and execute functions based on application commands combined with information collected from things and service requirements.

Appliance control: People remotely control operating status of appliances through IoT system.

Disaster recovery: Users remotely start disasters treatment facilities to minimize losses caused by disasters according to the monitoring mentioned before.

Ad Hoc Networking: IoT system have rapidly self-organized networking capability and can interoperate with the network/service layer to provide related services [7]. In the vehicle network, in order to transfer the data, the network between vehicles and/or road infrastructures rapidly self-organized.

Secure Communication: IoT system further establish secure data transmission channel between the application or service platform and IoT terminals based on service requirements.

2.3 Motivation and General Description

As seen in the previous overview to the current IoT, most IoT applications in China were domain-specific or application specific solutions. The architectures of these IoT systems are split and cannot correlate and integrate the data from different storage tower; these isolated IoT keys use private protocols and cause much difficulties in information sharing, technology multiplexing, network managements, and advancement. All these problems are delaying the development of IoT. In order to decrease the total IoT cost and share information, I need to integrate multiple functions and capitals into a larger system. IoT thus needs to be intended with an open and generic IoT architecture with open borders and resources, considering different business scenarios, application-based requirements, and current technologies. I have thus seen the motivation to express a standard for IoT integration in order to reduce the total cost of money and time from devices, developments, and deployments. An open and basic IoT architecture is an integrated solution with interoperability. It has the following characteristics. Standard Interface and Protocol: By comparing various private IoT systems, a generic IoT structure has the same hardware and software

interfaces, and protocols.

Public and Operating: A general IoT architecture is organized to take over public IoT applications with open operating competence. A public IoT system integrate multiple IoT requests into one architecture.

Open, Scalable, and Flexible: An open IoT architecture with open resources, open standards, and open interfaces easily extend its functionality and the scale of performance. It adapts to different requirements including technical growths flexibly.

2.4 What is IOT?

The Internet of Things (IoT) describes the network of physical objects “things” that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools.

The field has evolved due to the convergence of multiple technologies, including ubiquitous computing, commodity sensors, increasingly powerful embedded systems, and machine learning. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), independently and collectively enable the Internet of things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", including devices and appliances (such as lighting fixtures, thermostats, home security systems, cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers. IoT is also used in healthcare systems. There are a number of concerns about the risks in the growth of IoT technologies and products, especially in the areas of privacy and security, and consequently, industry and governmental moves to address these concerns have begun, including the development of international and local standards, guidelines, and regulatory frameworks.

2.5 Open and General IoT Architecture

China Communications Standards Association (CCSA) planned a reference model for the IoT, which consists of sensing layer, network and business layers, and application layer. Fulfilling with this reference model, its open and general architecture, which is layered, open, and elastic. The architecture includes three functional stages as follows.

Sensing and Gateway Platform: This platform connects sensors, controllers, RFID readers, and location detecting device (e.g., GPS) to IoT network layer. Modularization of hardware, data format, and software edge is proposed for IoT terminal, IoT Gateway, and angle node. IoT terminal, IoT gateway, and tip node can include flexible modules combined with control module, common interface module, and communication module. Joint interface module collects physical interfaces of various sensors into a shared interface. Common control module can connect sensors, controllers, GPS, and RFID booklovers with a common connection protocol. The software and application parameters of an IoT terminal and IoT gateway ought to be able to self-configure and self-adapt. Modularization, shared interface, intelligent operation, self-adaption, and self-configuration are important characteristics of this stage.

Resource and Administration Platform: Network and service layer includes backbone networks and resource administration stages. The backbone network contains 3G, 4G, internet, optical fiber network, Ethernet network, satellite networks, and private network. The resource and

administration stage provides common capabilities which can be used by different IoT applications, such as data processing, data storage, security management, and application supporting. These abilities may also be invoked by specific IoT application support capabilities, e.g., to build other specific IoT application support capabilities. This stage also provides relevant control functions of network connectivity, such as access and transport resource control functions, mobility management, or authentication, authorization, and accounting for IoT terminals, services, applications, users, and developers.

Open Application Platform: Modularization design in this application stage provides common function and open application programming interface (API). An IoT application provider develop its application using these APIs. Meanwhile, this stage supports application managements. Various applications can be obtainable to the application

stage and users get application information and subscribe applications through this platform. Suitable and easy deployment, distribution, and flexible application environment are the characteristics of this stage.

2.6 Challenge & Prospect of IoT

IoT trends to be unified, seamless, and pervasive. Large-scale service deployment needs to be framed within a set of standards. However, IoT involves many manufacturers, spans multiple industries, and it differs widely in application scenarios and user requirements, which consequently gives impacts on large-scale commercial deployment of related services. The development of IoT is a step-by-step process. There are still many problems to be solved, such as low power nodes and computing, low cost and low latency communication, identification and positioning technologies, self-organized distributed systems technology, and distributed intelligence.

2.6.1 Challenge of IoT

The IoT provides many new chances to the industry and end user in many application fields. Currently, however, the IoT itself lacks theory, technology architecture, and standards that integrate the simulated world and the real physical world in an integrated framework. Following key challenges are thus recorded.

Architecture Challenge: IoT encompasses a life-threatening wide range of technologies. IoT involves a cumulative number of smart interconnected devices and sensors (e.g., cameras, biometric, physical, and chemical sensors) that are often nonintrusive, transparent, and invisible. As the communications among these devices are predictable to happen anytime.anywhere for any related services, generally, these communications are in a wireless, autonomic, and ad hoc manner. In addition, the services become much more mobile, regionalized, and complex. In IoT, data integrations over different environments are thus tough and to be supported by modular interoperable components. Infrastructure solutions require systems to combine volumes of data from various sources and control relevant features, to interpret data and show their relationships, to compare data to ancient useful information, and support decision-making. Single position architecture cannot be a blueprint for all applications. Heterogeneous situation architectures have to coexist in IoT. Architectures should be open, and following standards, they should not limit users to use fixed, end-to-end solutions. IoT architectures should be flexible to cater for suitcases such as identification (RFID, tags), intelligent devices, and smart objects (hardware and software solutions).

Technical Challenge: IoT technology to be complex for variety of reasons. First, there are legacy heterogeneous architectures in the present networking technologies and applications, e.g., different applications and environments need different networking technologies, and the ranges as well as other features of cellular, wireless local area network, and RFID technologies are much unlike from each other. Second, communication technologies, including fixed and mobile communication systems, power stripe communications, wireless communication, and short-range wireless communication technologies, for both fixed and mobile devices, either simple or complicated, should be low cost and with reliable connectivity. At last, there are thousands of unlike applications; it is in natural to have different requirements on what parties need to communicate with each other, what kind of security solutions are appropriate, and so on. To recap, complexity and alternative technologies may introduce problems; unnecessary competition and deployment barriers in markets may also introduce problems; systems and communication mechanisms with needless dependencies may block the relocation of IoT systems to the most economic and efficient stages. All the above may block IoT to join as many “Things” as possible.

Hardware Challenge: Smart devices with improved inter-device communication will lead to smart systems with high degrees of intelligence. Its independence enables rapid deployment of IoT applications and creation of new services. Therefore, hardware researches are focusing on designing wireless recognizable systems with low size, low cost yet sufficient functionality. As the bandwidth of IoT terminals could vary from kbps to mbps from sensing simple value to video stream, supplies on hardware are diverging. However, two requirements have been nevertheless the basics: one is the extremely low power consumption in sleep mode and the other is ultra-low cost. Suppose the snoozing time over active time is one million, the escape power of an IoT terminal at least be one million time less than that of active.

It is so far incredible when an IoT terminal is snoozing and receiving RF signals. It difficult when using advanced CMOS silicon with relatively more leakage power. Hardware and protocol code signfor snoozing has been thus the first hardware challenge of IoT. Billions of IoT terminals used; the cost of an IoT terminal necessity be ultra-low. Though, so far, there is no low cost locating solution for IoT, especially the positioning precision of a short-range IoT terminal must be high. Low energetic power is also a contest for low-cost terminal. Traditionally, low cost equalsto lower presentation or longer process latency. Longer treating latency ends up to higher energy consumption. As the range resource is

very limited at the lower part in L band, IoT may use higher RF such as the frequency bands higher than 5 GHz.

The higher the RF, the more power feasting from RF PA will be. In another way, not yet used very narrow spectrum band between two used bands have to be used by future IoT. To use very narrow band with strong power neighbors, the cost of passive component not be low and that will definitely be a potential challenge in the future.

Privacy and Security Challenge: Compared with outdated networks, security and privacy issues of IoT become more prominent. Much information includes privacy of users, so that defense of privacy becomes an important security issues in IoT. Because of the mixtures of things, services, and networks, security of IoT needs to cover more administration objects and levels than traditional network security. Existing security architecture is intended from the perception of human communication, may not be suitable and directly applied to IoT system. Using existed security instruments block logical relationship between things in IoT.

IoT needs low- cost- and M2M-oriented technical solutions to assurance the privacy and the security. In many use cases, the security of a system has been considered as a general feature. Related research shall focus on privacy control. Low cost, low latency, and energy-efficient cryptography algorithms and related supply hardware to be essential for sensor or device.

Standard Challenge: Standards play a significant role in forming IoT. A standard is important to allow all actors to equally access and use. Developments and coordination of standards and proposals promote efficient development of IoT infrastructures and applications, services, and devices. In general, standards developed by cooperated multi parties, and information models and protocols in the standards, shall be open.

The standard development process shall also be open to all participants, and the resulting standards publicly and freely available. In today's network world, global standards are naturally more relevant than any local arrangements.

Business Challenge: For a mature application, its business model and request scenario are clear and easy to be mapped into technical necessities. So the developers do not need to spend much time on business-related aspects. But for IoT, there are too many potentials and uncertainties in business models and application states. It is inefficient in terms of business-technology alignment, and one solution not fit possibilities for all. The

IoT is a stimulating traditional business model. Although small-scale applications have been lucrative in some industries, it is untenable when extended to other industries. In the early stage of IoT development, business aspects should be careful to reduce the risk of failure.

2.6.2 Prospect of IoT

With the development and adulthood of distributed intelligent information processing technologies, IoT systems make intelligent sensing widely available through information sharing and teamwork. The gradual founding and improvement of the standards system inescapably bring IoT into our daily life. The IoT creates an opportunity for the web-based services, thus attractive the commercial and social potential future of IoT. The growth of IoT keeps going forward along scale, collaborative, and intelligent. Promoted by technology, standardization, and application experiences, IoT applications expand the scale in the different industries, and more initiatives to be attracted to come in.

Interoperability: Information interoperability take place among unlike things, unlike enterprises, unlike industries, and unlike regions or countries; application models change from closed to open and the globalization of IoT application system helping different industries and fields to be constructed. Interoperability is the essential issue for adventure layers of physical, device, communication, function and application. These levels usually are built with different languages and protocols. Level and domain clear languages and protocols are, therefore, needed. A rounded approach is required in addressing and solving the interoperability of IoT.

Intelligent System: The IoT bring seamless business and social networking over fast reliable and protected networks into our society. System intelligence important for the development of IoT and the key point context awareness and inter-things information exchange. Therefore, increasing and familiarizing the intelligence at the device level will be a focus of research, such as the integration of sensors and actuators, high efficiency, multi standard and adaptive communication subsystems, and adaptable antennae. Intelligences can be presented using micro control unit (MCU) on upper layers.

However, physical layer so far has been far behind the mandatory intelligent level, for example, to adapt IoT devices under different radio infrastructures. Four parts in physical layer must be further advanced to adapt to and/or to form an intelligent IoT device, which are as follows. Programmable baseband processor used to adapt to different modulation algorithms, different error correction algorithms, different channel

bandwidths, and diverse channel scenarios.

Software-controlled RF essential for transceiver to adapt to the local radio frequency necessities. Fully digital RF PA the indispensable device to consume less low power and offer programmability for PA to adapt radio transmission requirements. Finally, controllable integrated passive components an essential glue to connect intelligent semiconductor components into a sensor node with low cost, low size, and low power.

Energy Sustainability: In the future, energy-efficient and self-sustainable systems key enhancing issues to the IoT. The ways to harvest energy from surroundings must be developed. Efficiency in dispensation and communication must also be increased through new circuits, new programming paradigms, and the further growth of energy-efficient protocols and smart antennae. The expansion of new, efficient, and compact batteries, fuel cells, as well as new energy generation devices join energy transmission methods or energy harvesting the key factors for the roll-out of autonomous wireless smart systems. Charging of global IoT terminals, power consumption of global IoT access points and gateways, as well as the power consumption of IoT data processing in IoT substructures one of the dominant power consumers in the future world. Mechanical energy harvests sufficient for body network as a part of IoT. Solar or wind energy is a provisional energy sources which may not be dependable.

2.7 CONCLUSION

The IoT incorporates several technologies such as information technology, cognitive sciences, communication technology, and low-power electronics. IoT creates a newer information society and information economy. But the trials from research, industries, and the government will keep pushing and investing. The expansion of IoT depend on technological advances in silicon scaling and energy-efficient devices, in getting the information from mixed sources, in reducing costs, and in refining efficiencies. The development of the IoT exposed many new challenges including the lack of essential theory supporting, unclear architecture, and undeveloped standards. To meet these challenges, I give a three-layer architecture including three platforms.

The proposed acting standard can confidently balance desires from different parties, can open the door for future important theory development, and can eventually stimulate/regulate IoT development. Recent years, Chinese government is pushing the expansion of the IoT. Following the Chinese 12th Five-Year Plan for IoT Development,

China has skillful a number of demonstration application projects such as the smart city and the intelligent transportation system in public IoT applications, intelligent coal mine, and the IOFs in industry claims. The future of IoT will be predictable to be unified, seamless, and pervasive. Large-scale service deployment needs to be enclosed within a set of standards. Thus, the developments of IoT as a brainy system can be proceeding with interoperability, energy sustainability, privacy, and security. IoT have become a predictable trend of development of information industry, which certain to bring new changes to our lives.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The paper aims at designing an air pollution monitoring system which can be installed in a specific locality and to enhance the system from the previously developed systems beating the earlier disadvantages by developing an android app available for the public. This app can be used by anyone to get in live updates about the pollution in their region. It uses Arduino integrated with individual gas sensors like carbon monoxide, ammonia along with particulate matter, humidity, and smoke which measures the concentration of each gas separately. The collected data is uploaded to the cloud using thing speak platform at regular time intervals. Ethernet shield is used for connecting Arduino and cloud. Pictorial or graphical representation of values can be shown in Thing speak. The users can install an android application through which they get the recent updates and graphical content up to date [6]. The average concentration of each gas is analyzed using matlab.

Then certain time control is assigned based on the standard level of each gas measured and the result can be viewed in android application. The architecture of air pollution monitoring and awareness creation system. The concentration level of each gas can be viewed both as a graph and in numerical format. Based on these values the air quality index value is calculated and the nature of the air quality in that area is determined which is also displayed through the app. Along with this, the health effects for the corresponding air quality is displayed to create awareness among the public. Additionally, they could also get to know the temperature and weather in that region. The users will not get disturbed with irrelevant data as the values displayed are location specific and help them stay tuned to the current status of air pollution.

3.2 Proposed System Architecture

Internet of Things (IoT) mainly deals with connecting smart devices to internet by joining the advantage of OSI layered Architecture. In the context of this work we propose a cluster of AirQuality Monitoring Gas Sensor MQ135 motes, which are used to measure the concentration of Air pollutants in the air. The Gas Sensors MQ135 is interface with a tiny entrenched platform equipped with other [7]. We have mainly used the Node MCU which is an open source development boards with ESP8266-12E chips. MQ135 Gas Sensor is used to collect gas concentration measurements. This sensor data would be captured and sent to the Arduino UNO for IoT (Internet of Things) based data acquirement.

Flow Chart for proposed model of the system

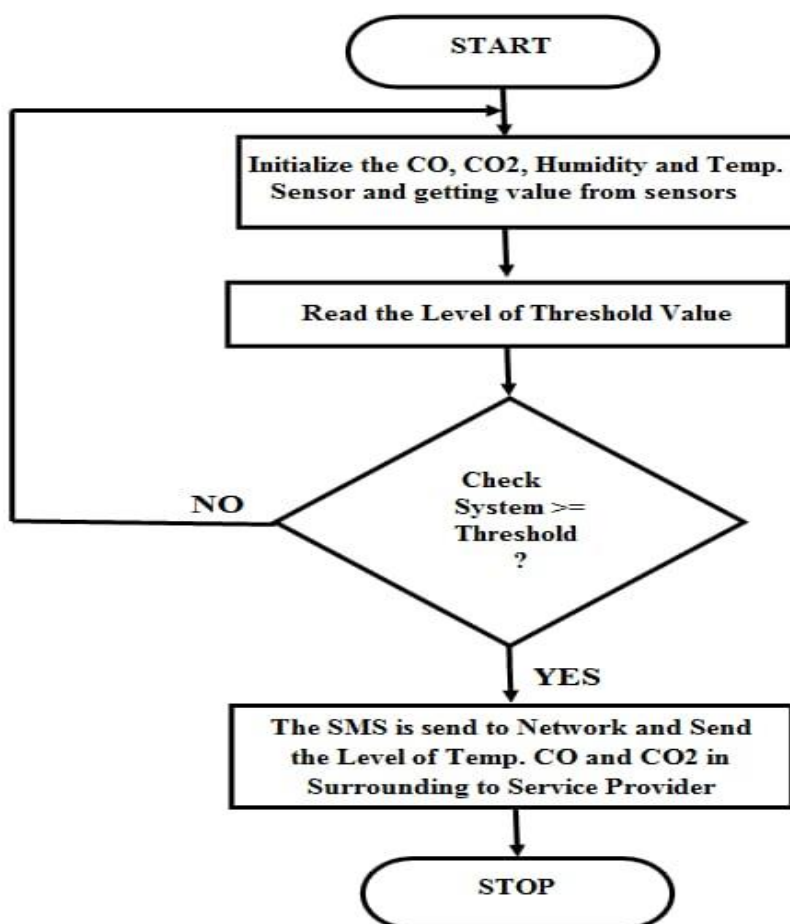


Fig 3.1 Shows the flowchart of the given system

3.3 Working Process

I have connected the MQ135 gas sensor and ESP8266 Node MCU . Connected the VCC and the ground pin of the sensor to the 5V and ground of the Node MCU and the Analog pin of sensor to the A0 of the Node. Connected a buzzer to the pin 7 of the Node MCU which is start to beep when the condition becomes true. The MQ135 sensor can sense NH₃, NO_x, alcohol, Benzene, smoke, CO₂ and some other gases, so it is faultless gas sensor for our Air Quality Observing Detection Project. When I connect it to Node MCU then it senses the gases, and I get the Pollution level in PPM (parts per million). MQ135 gas sensor gives the output in form of voltage levels and I need to convert it into PPM. Sensor is giving us value of when there is no gas near it and the safe level of air quality is 0.5 PPM and it is not exceeding 0.5 PPM. When it exceeds the limit of 0.5 PPM, then it starts cause Headaches, sleepiness and stagnant, stale, stuffy air and if exceeds beyond 1 PPM then it can cause increased heartrate and many other diseases.

3.4 Implementation Technologies

It's a device that takes data from the environment that has been selected for our research purpose. The device is built with various sensors and they take data by sensing from the environment. The sensors take analog data from the environment which later is converted into digital with the help of Arduino and then sent to the server where all the data are stored [11]. This device is consisting of the following components:

- i. Node mcu(ESP2866)
- ii. Gas sensor MQ135
- iii. DHT11 sensor
- iv. 16x2 LCD
- v. Wi-Fi Device
- vi. Buzzer
- vii. 0.5m Arduino A-B Cable
- viii. Jumper wires

Node Mcu

NodeMCU V3 is an open-source firmware and development kit that plays a vital role in designing your own IoT product using a few Lua script lines. Multiple GPIO pins on the board allow you to connect the board with other peripherals and are capable of generating PWM, I2C, SPI, and UART serial communications.



Fig 3.2 NodeMcu

- The interface of the module is mainly divided into two parts including both Firmware and Hardware where former runs on the ESP8266 Wi-Fi SoC and later is based on the ESP-12 module. The firmware is based on Lua - A scripting language that is easy to learn, giving a simple programming environment layered with a fast scripting language that connects you with a well-known developer community.

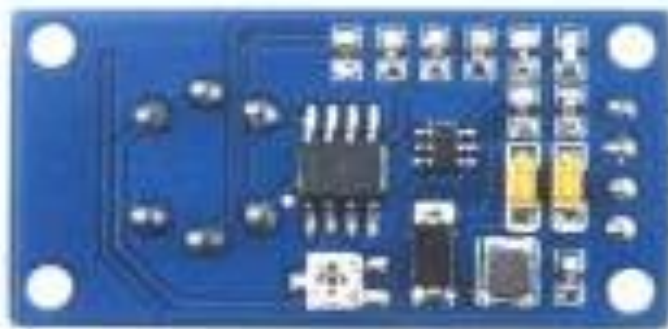
- **Gas sensor MQ135**

MQ-135 gas sensor can be implemented to detect the smoke and other harmful gases. It has the potential to detect different harmful gases, including NH₃, NO_x, alcohol, benzene, smoke and CO₂. MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benzene steam, also

sensitive to smoke and other harmful gases. This Module makes use of the MQ-135 air quality detector and hazardous gas detector chip.

components such as the LM393 analog comparator chip on this module makes it easy to integrate this module into a project that can detect hazardous gases. The Module requires a 5V power supply and provides a digital Logic output (1 or 0) and an analog level output (0-4V). The digital logic output is LOW (0)

when no gas is detected but goes HIGH (1) when hazardous gas concentration in the environment reaches the set threshold set via a potentiometer on the module. The analog level output provides an output voltage within the range of 0 to 4V based on the concentration of the hazardous gas in the environment; 0V for lowest concentration, 4V for maximum concentration.



Pin No.	Pin Name
1	Vcc(+5V)
2	Ground
3	Digital Out
4	Analog out

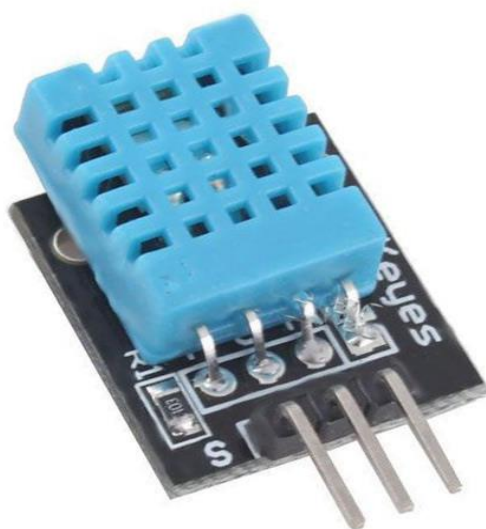
Fig 3.3 MQ135 Sensor

This Module makes use of the MQ-135 air quality detector and hazardous gas detector chip. Other circuit components such as the LM393 analog comparator chip on this module makes it easy to integrate this module into a project that can detect hazardous gases. The Module requires a 5V power supply and provides a digital Logic output (1 or 0) and an analog level output (0-4V). The digital logic output is LOW (0) when no gas is detected but goes HIGH (1) when hazardous gas concentration in the environment reaches the set threshold set via a potentiometer on the module. The analog level output provides an output voltage within the range of 0 to 4V based on the concentration of the hazardous gas in the environment; 0V for lowest concentration, 4V for maximum concentration. You can use it detects hazardous gases such as Ammonia, Nitrogen Oxide, Alcohol, Benzene, Smoke (Carbon Monoxide), Carbon Dioxide and other air contaminants in our DIY project. The MQ-135 device on this module uses a heating

element. After initial power ON, please wait at least 20 Seconds before reading outputs to ensure data validity. The Sensitive material used in MQ135 gas sensor is SnO₂. The conductivity of this material is lower in clean air. The sensor conductivity increases with the increasing concentration of target pollution gas. MQ135 can monitor different kinds of toxic gases such as sulphide, ammonia gas, benzene series steam and CO₂. The detection range is 10-10,000 ppm with the voltage rate of about 5.0V±0.1V AC or DC The important features are long life span, low cost, simple driver circuit and good sensitivity to toxic gases. MQ 135 gas sensor is widely used in industrial gas alarm, portable gas detector and domestic gas alarm as shown in Fig.6. MQ-135 is used in this framework for monitoring CO₂ in air. The amount of CO₂ present in the atmosphere is 400.7 ppm according to which the sensor is calibrated.

DHT11 Sensor

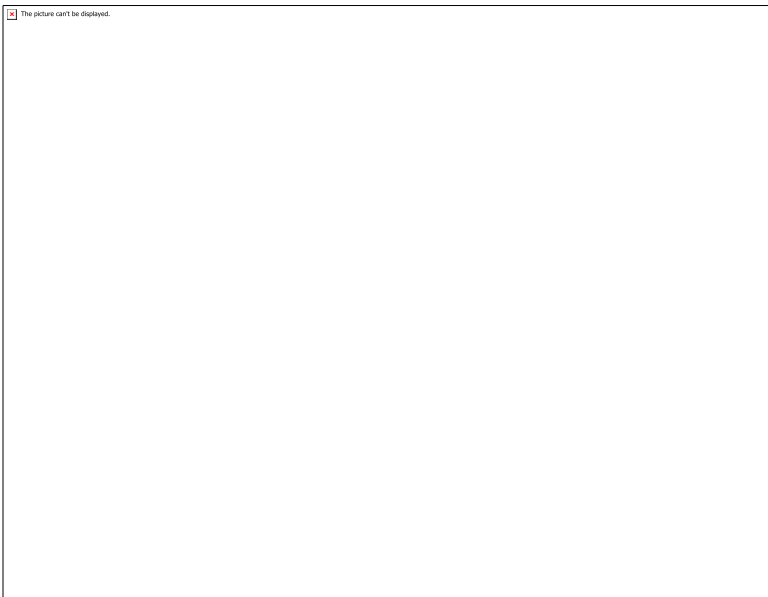
DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a highperformance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.



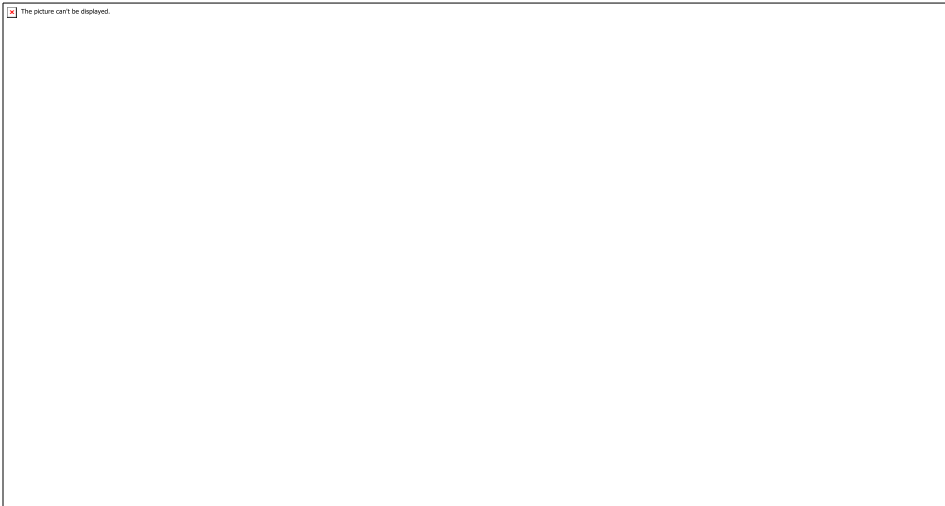
Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP

memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

16X2 LCD

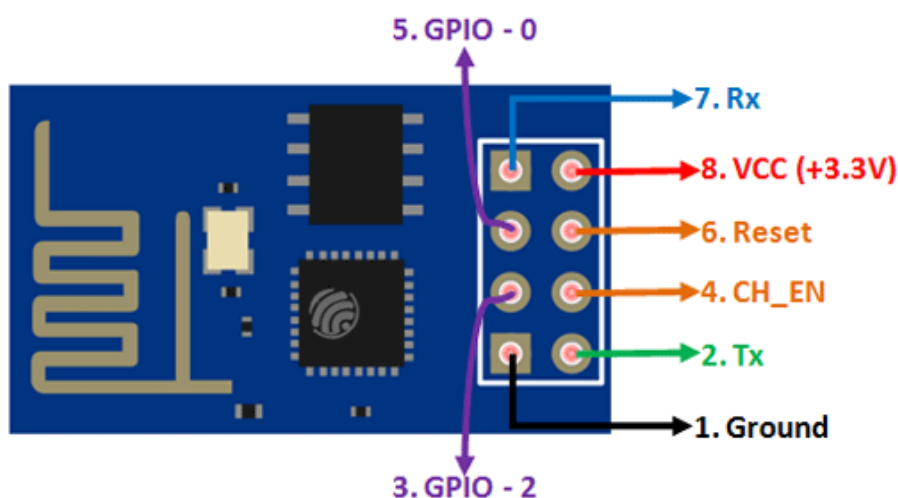


LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi-segment LEDs [4]. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.



ESP8266 Wi-Fi Device

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability. The chip first came to the attention of Western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.



The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. One of the main functions of ESP8266 is to host any application or offloading all Wifi networking functions. It is highly durable and is able to function consistently even in harsh industrial environments. This is only because of its broad range of the operating temperature. It also offers an energy-saving architecture and a Tensilica processor of 32-bit. ESP8266 Module gives you powerful onboard processing and storage capability, which allows it to integrate with sensors and other applications.

It has a high level of on-chip integration. The on-chip integration allows the user for very less external refer circuitry. The ESP8266 goes with APSD for the Bluetooth and VoIP applications coexistence interfaces. It also contains a self-calibrated radio frequency (RF) that allows it to work with all the conditions of operating and does not require any radio frequency parts. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts. ESP8266 modules can work with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs, or as self-sufficient MCUs with an RTOS-based SDK that can natively run connectivity applications. In both of these operation modes, customers can take advantage of using features like out-of-box cloud connectivity, low-power operation and Wi-Fi security support, including WPA3.

Buzzer

Buzzer is also known as Piezo Speakers (buzzers). You want to generate sound in our project you can use this simple magnetic buzzer. This is the same buzzer we have used in our development boards. This one generates a continuous beep usually when supplied with power but you can generate any tone as you wish by interfacing it with a microcontroller with proper coding.



Fig 3.4 Buzzer

A "piezo buzzer" is basically a tiny speaker that you can connect directly to an Arduino. From the Arduino, you can make sounds with a buzzer by using `tone`. You have to tell it which pin the buzzer is on, what frequency (in Hertz, Hz) you want, and how long (in milliseconds) you want it to keep making the tone. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Arduino A-B Cable (0.5m)

Standard USB 2.0 cable. Use it to connect Arduino Uno, Genuino Uno, Genuino Mega 2560, Genuino 101 or any board with the USB female A port of our computer. Cable length is approximately 50cm.



Jumper wire

A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.



Fig 3.5 Jumper wire (M to F, M to M, F to F)

3.5 Hardware of The Project

ESP8266 Wi-Fi device is connected with the Node MCU; VCC and the is connected to the 3.3V pin of Node MCU; GND is connected to the pin GND of MCU; MQ135 Sensor and Buzzer is connected with the Node MCU; VCC pin is connected to the pin 5 v of the Node MCU; DHT11 is connected to Node MCU; GND pin is connected to the GND of the Node MCU; AO is connected to the A0 of the Node MCU; The pin of Buzzer is connected to the GND & the pin 7 of the Node MCU; LCD is connected with Node MCU;

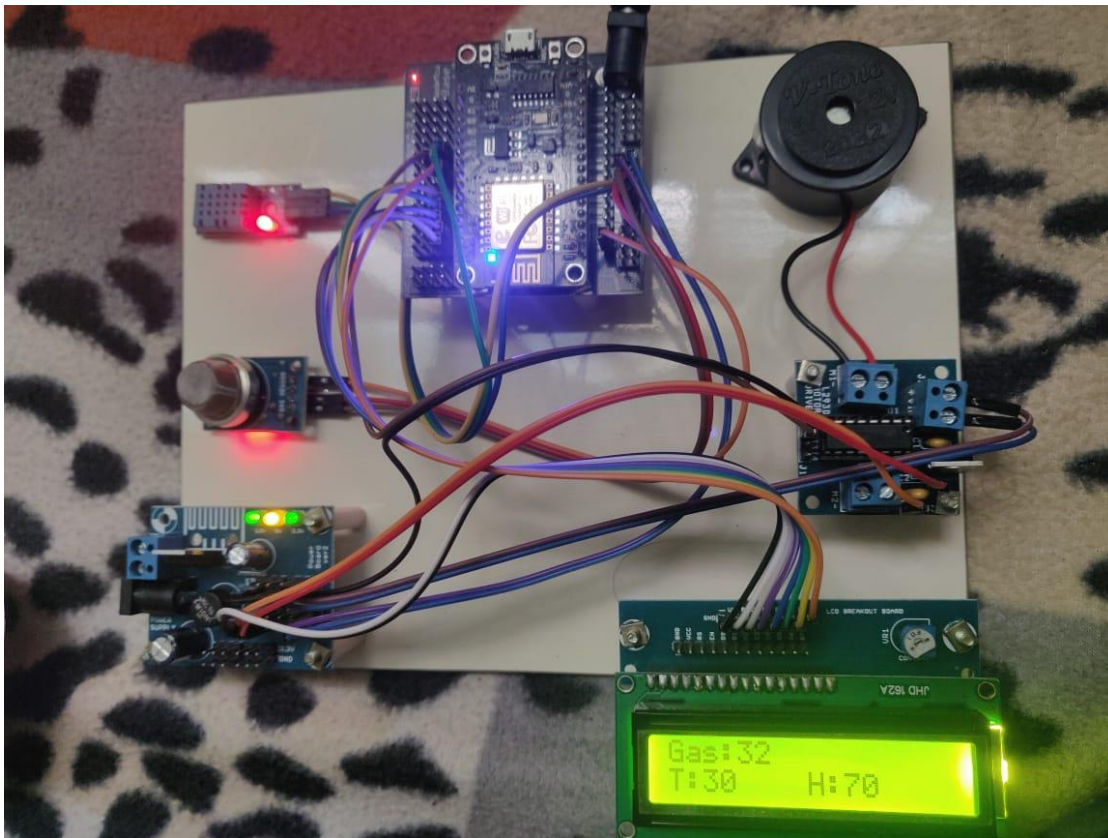


Fig 3.6 Hardware of the Project

CHAPTER 4

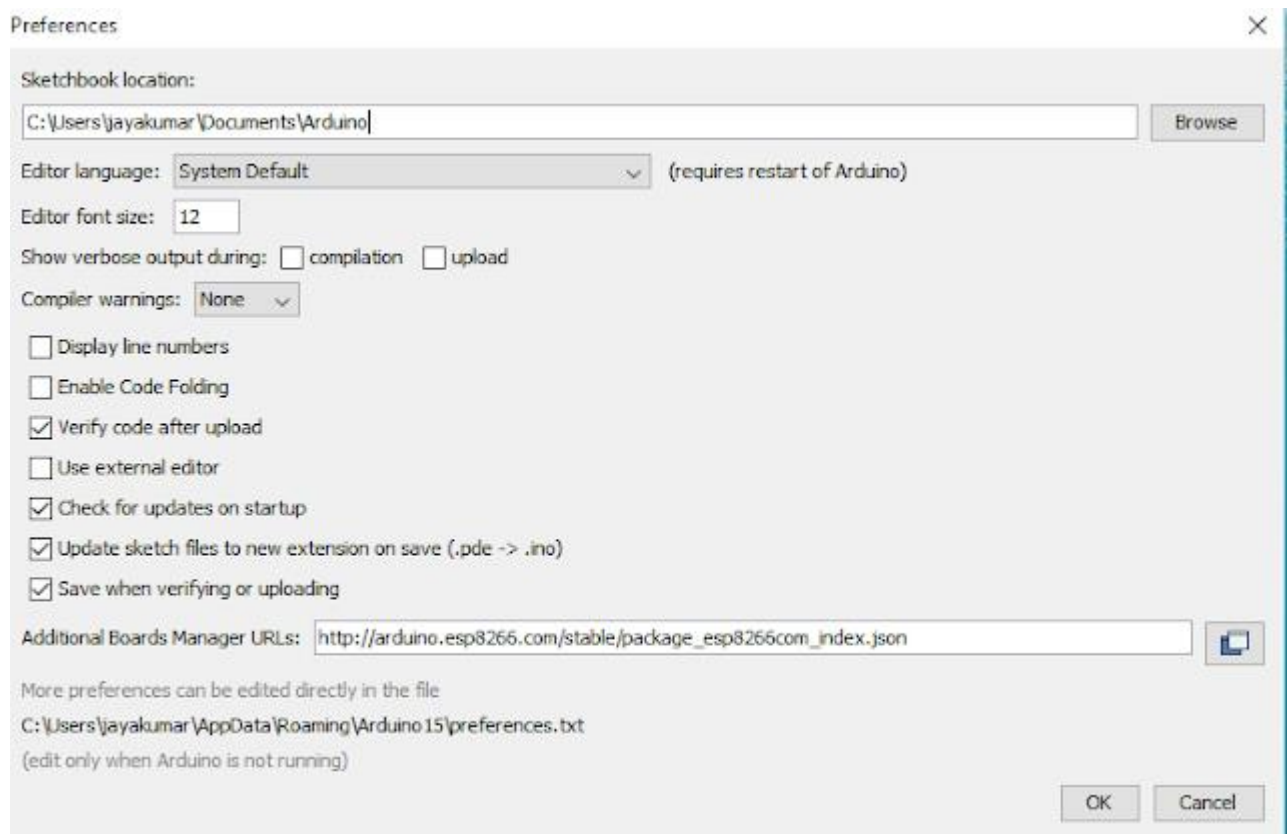
RESULT ANALYSIS

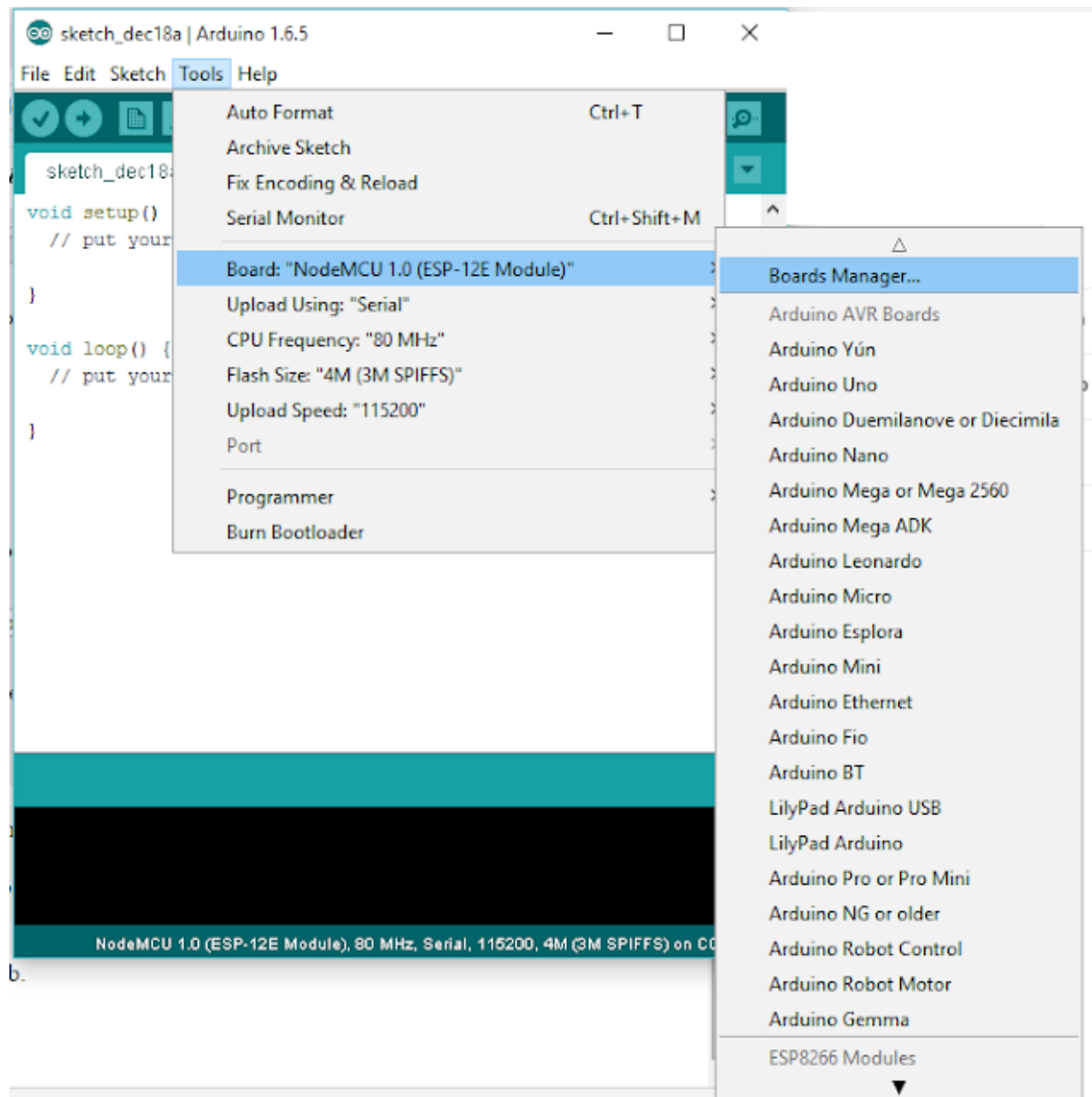
4.1 Coding Setup

The coding that is being used in this has written in Arduino UNO. Initially we have to convert into Node MCU since we are using Node MCU.

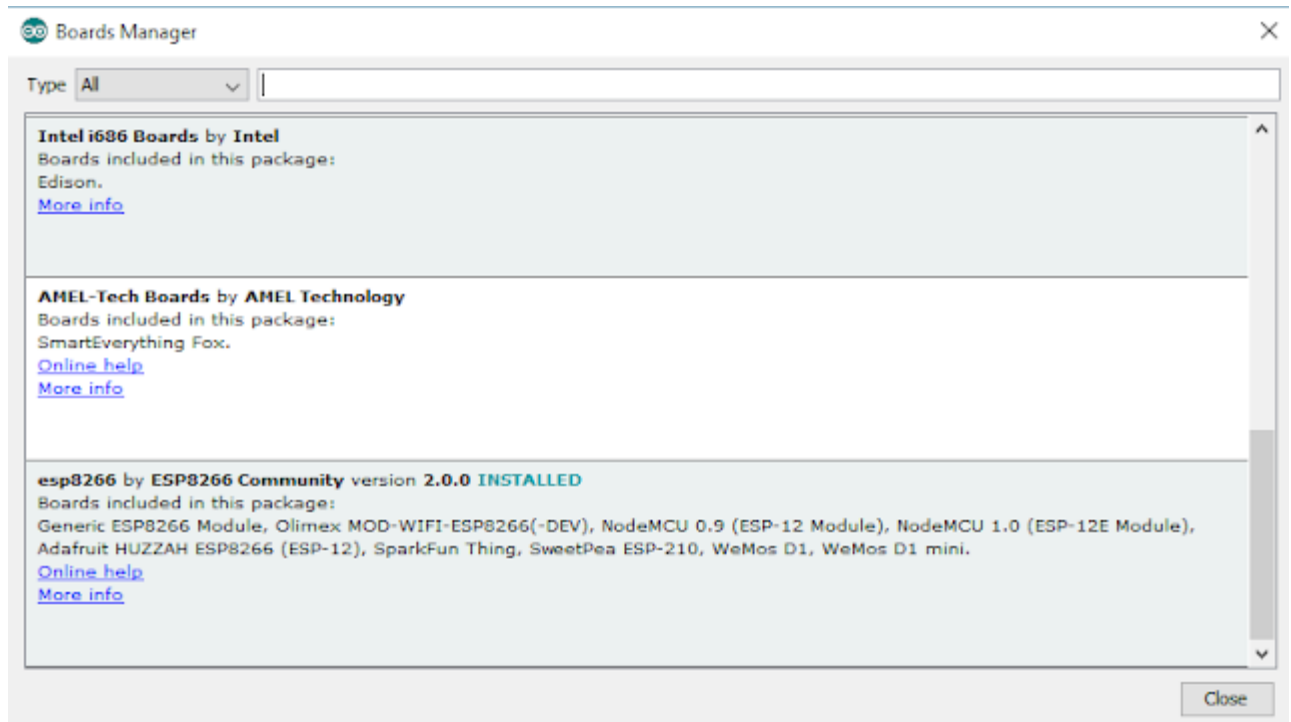
Firstly open the Arduino IDE

Go to files and click on the preference in the Arduino IDE





After completing the above steps , go to Tools and board, and then select board Manager



Navigate to esp8266 by esp8266 community and install the software for Arduino. Once all the above process been completed we are read to program our esp8266 with Arduino IDE.

4.2 Result Analysis

The table shows that the air quality health and its risk through a 0.1-1.0 base scale. It is divided into three parts like as Fresh Air, Poor Air & Danger Air. It detects the air pollution level and indicates the risk through this scale. The compared data is between 0.1-0.5 it shows that health risk is low and indicate open window, when it rises up to 0.6-1.0 it shows that the pollution in the air is considered dangerous for human being and I take some steps quickly.

Table 4.1 AQI levels and Connected Health Impacts

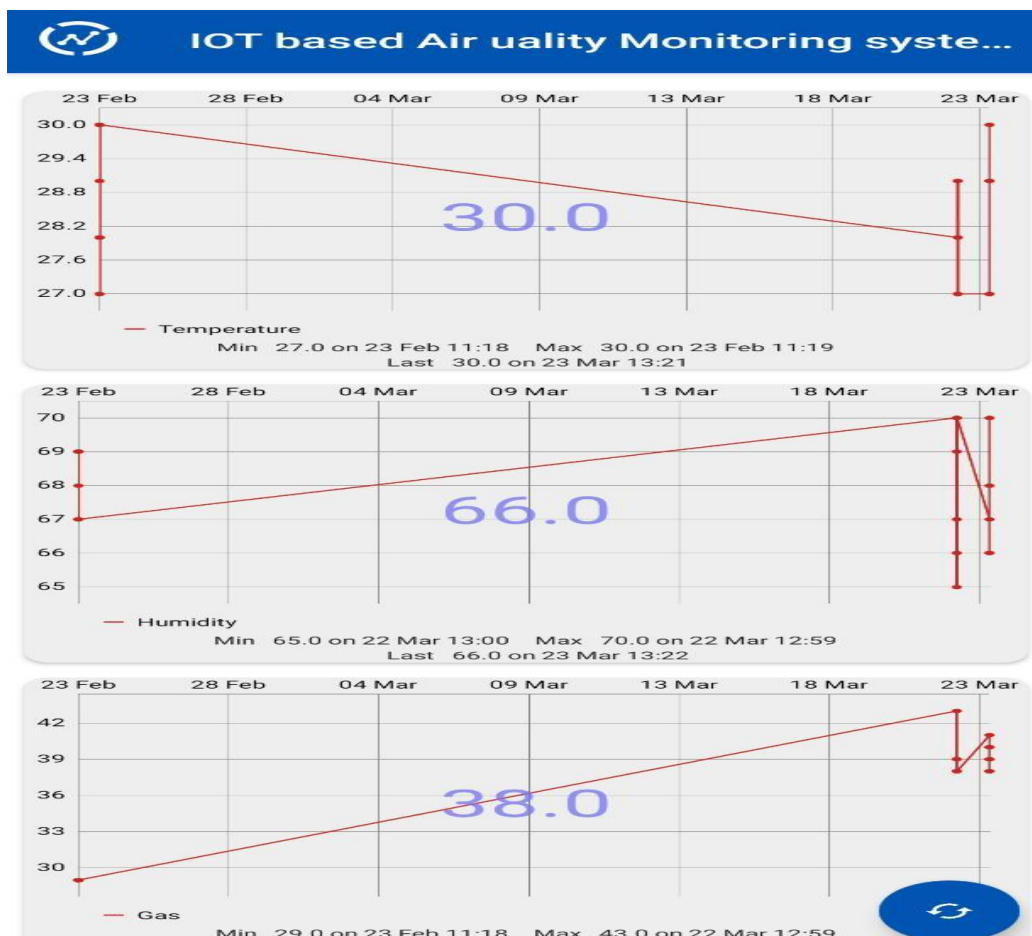
Air Quality Indicator Range (PPM)	Result	Health Impacts
0-0.5	Fresh Air	Minimal impact
0.6-0.9	Poor Air	May cause minor breathing discomfort to sensitive people.
1 to above	Danger Air	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.

The amount of gases present in the surroundings are displayed through LCD along with temperature and humidity. We can monitor it through android device using Thingspeak IOT cloud platform in real-time.

ThingSpeak™ is an IoT analytics service that allows you to aggregate, visualize, and analyze live data streams in the cloud. Thingspeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak, you can perform online analysis and process data as it comes in. ThingSpeak is often used for prototyping and proof-of-concept IoT systems that require analytics.

You can send data from any internet-connected device directly to ThingSpeak using a Rest API or MQTT. In addition, cloud-to-cloud integrations with The Things Network, Senet, the Libelium Meshlium gateway, and Particle.io enable sensor data to reach ThingSpeak over LoRaWAN® and 4G/3G cellular connections.

With ThingSpeak, you can store and analyze data in the cloud without configuring web servers, and you can create sophisticated event-based email alerts that trigger based on data coming in from your connected devices.



4.2 Mobile View of Air, Temperature and Humidity

CHAPTER 5

5.1 Conclusion

The system to monitor the air of environment using Arduino microcontroller, IoT Technology is proposed to improve quality of air. With the use of IoT technology enhances the process of monitoring various aspects of environment such as air quality monitoring issue proposed in this paper. Here, using the MQ135 gives the sense of different type of dangerous gas and Arduino is the heart of this project. Which control the entire process, Arduino module connects the whole process to LCD and serial monitor is used for the visual Output.

After performing several experiments, it can be easily concluded that the setup is able to measure the air quality in ppm, the temperature in Celsius and humidity in percentage with considerable accuracy. The results obtained from the experiments are verified through Google data. Moreover, the led indicators help us to detect the air quality level around the setup. However, the project experiences a drawback that is it cannot measure the ppm values of the pollutant components separately. This could have been improved by adding gas sensors for different pollutants. But eventually, it would increase the cost of the setup and not be a necessary provision to monitor the air quality. Since it's an IOT-based project, it will require a stable internet connection for uploading the data to the ThinkSpeak cloud. Therefore, it is possible to conclude that the designed prototype can be utilized for air quality, humidity and temperature of the surrounding atmosphere successfully. Air Pollution is the major affecting factor to our environment. Not only affecting the environment and also affects the human health. The mobile application is developed to monitoring system it tracking the how much the human has exposed in a day. The gas sensors was used for identifying the Leakage Gas, Carbon Monoxide, Smoke, and Propene. The sensor senses the gases and convert from analog to digital and displays in the application.

5.2 Future Scope

The future scope is that device which we are having can be done in a compact way by reducing the size of the device for further implementation or the modifications which can be is that detecting the vehicles amount of pollution which can be determined. In future the range can be made increased according to the bandwidth for the high range frequencies. Further research can be made by making the people in the right direction for their welfare. Therefore, there is another beneficiary by using this device in an app so the all can be used in an GSM mobile phones for their daily updates by increasing their range.

An IoT-based air pollution monitoring system that allows real-time and continuous monitoring of pollutant levels has proposed. The structure, working principle and benefits of this smart monitoring system are identified, compared to a conventional monitoring station. Due to the rise of IoT, smart city applications and cloud computing technology also have a significant effect on air quality monitoring systems. The IoT-based air pollution monitoring system is a key expression to the development of information technology and modern sensing. It solves the problem of air monitoring in urban or commercial areas under the strength of low energy, low cost and high coverage. Meanwhile, it promotes smart urban management and sustainable development. In the future, portable air monitoring systems are expected to be widely applied in the market. Apart from monitoring conventional gases and particles, the monitoring systems can also monitor greenhouse gases, photochemical smog or LIDAR gases.

The developed air quality monitoring and visualization system accurately measured the concentration of pollutants carbon monoxide, carbon dioxide, smoke and dust in atmosphere. The sensor has been integrated with IoT framework which has efficiently been used to measure and monitor the pollutants in real-time. This system overcomes the problem of pollution monitoring, health monitoring, The data's are automatically stored in the database; this information can be used by the authorities to take prompt actions. It also helps the normal people to know about the amount of pollutants in their area and to take control measures. This is a robust system which is very useful in industries because of the increasing pollution due to increase in industries. This system is user friendly and cost of the product is affordable. This system is monitoring only five parameters and hence can be expanded by considering more parameters that cause the pollution especially by the industries.

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APPENDIX

Source code

```
#include <ESP8266WiFi.h>;

#include <WiFiClient.h>;

#include <ThingSpeak.h>;

#include <LiquidCrystal.h>

#include "DHT.h"

#define DHTPIN 12

WiFiClient client;

const char* ssid = "ACTIVE GALAXY"; //Your Network SSID

const char* password = "ACTIVE_GALAXY" ; //Your Network Password

unsigned long myChannelNumber = 2042393; //Your Channel Number (Without Brackets)

const char * myWriteAPIKey = "R4FBPYF4AD23WVOC"; //Your Write API Key

LiquidCrystal lcd(16,5,4,0,2,14);

#define DHTTYPE DHT22

DHT dht(DHTPIN, DHTTYPE);

void setup()

{

  Serial.begin(9600);

  WiFi.begin(ssid, password);
```

```

ThingSpeak.begin(client);

lcd.begin(16, 2);pinMode(12,OUTPUT);

  dht.begin();

}


void loop()

{

  float humidity = dht.readHumidity();

  // Read temperature as Celsius (the default)

  float temp = dht.readTemperature();


  lcd.setCursor(0, 1); lcd.print("T:"); lcd.print(temp);

  ThingSpeak.writeField(myChannelNumber, 1,temp, myWriteAPIKey);delay(1000);


  lcd.setCursor(8, 1); lcd.print("H:"); lcd.print(humidity);

  ThingSpeak.writeField(myChannelNumber,2,humidity,
  myWriteAPIKey);delay(1000);


  lcd.setCursor(0, 0); lcd.print("Gas:");

  int Gas=analogRead(A0);lcd.print(Gas);

  ThingSpeak.writeField(myChannelNumber, 3,Gas, myWriteAPIKey);delay(1000);

```

```
if(Gas>320)

{

    digitalWrite(12,1);delay(50000);digitalWrite(12,0);

}

else

{

    digitalWrite(12,0);

}

lcd.clear();

}
```