

# Unique Approach to Address Urban Air Pollution Using Iot Technology

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**Abstract** - The air contamination rates immediately moment of truth are drastically growing thoroughly the grown and the underdeveloped countries which demands a more handy and economical resolution. This system contains the design for listening air contamination and constituting knowledge among all. The aim at utilizing IOT in addition to cloud to make the aids actual time for action or event and faster. The system is equipped in the locality place skilled is severe air contamination. The level of each dicey pollutant is listened at annual pauses. The Air Quality Index (AQI) for the noticed pollutants is persistent and knowledge is generated between the public through an like a man app that displays the level of each noticed contaminant and more the air quality index on account of particular area. Thus the kind of air because area maybe implicit by all by considering the concentration of the vapor in two together mathematical and graphical layout. Further this arrangement is to be lengthened from now on by admitting all to register themselves in an app which pushes newspaper or weekly air condition report through communication which reaches the consumer as a announcement namely wealthier in approach. Nowadays air pollution has equipped expected individual of the important issues because of increase in the batch of tools and as long as spent machine control and urbanization. This growth in the level of adulteration causes success hurtful consequences for affluence. This project justifies the rendering and killing of an Air Pollution detection whole. The novelty grabbed in this place, is a hands-on killing of the plan of Internet of Things. This particularized work is an survey of the potential of consumption concerning this novelty, in this place experience, where everyday welfare is curving into a real risk. The work is actualized promoting calculating boss board of Arduino.

**Index Terms**- Urban air pollution, IoT (Internet of Things), Air quality monitoring, Smart cities, Pollution control

## I. INTRODUCTION

Wearable sciences maybe creative solutions for healthcare questions. Air dirtiness is disaster incidental question and it causes a multitude of unfavorable belongings on human well-being water carcasses and humidity. The main source of air contamination comprehensively big capitals is due to boats and the second main beginning wait the labors. The massive use of boats has happened in lively increase of poisons in the air. This is the cause of environmental pollution moving the human strength. It has again developed in added respiratory questions like asthma attacks and skin rashes. Hence the projected scheme solves this main issue. The air contamination monitoring whole is equipped in the neighborhood place there are traces of severe air dirtiness to discover the constituent vapor of air which can bring about injurious belongings on human fitness and other living beings. This order uses arduino and various vapor sensors to foresee the level of miscellaneous harmful smoke like CO, NH<sub>3</sub>, coarse matter and cigarette. In this example we expresses the design of simple, cheap boss located in this place arrangement, Arduino UNO based is

secondhand for accumulating and deal with all the dossier, various sensors are used for weighing various limits. All this dossier is uploaded to Thing Speak for remote Analysis. The projected arrangement contains the design for listening air dirtiness and creating knowledge with all. This paper aims at utilizing IOT in addition to cloud to make the aids actual time for action or event and faster. The level of each dicey contaminant is listened at periodic breaks. The Air Quality Index (AQI) for the noticed contaminants is persistent and knowledge is created with all through an like a man app that displays the level of each noticed pollutant and too the air feature index on account of particular region. Thus the quality of air within region maybe implicit by all by viewing the aggregation of the smoke in two together mathematical and graphical layout. Further this system search out be comprehensive from now on by admitting all to register themselves in an app which pushes newspaper or weekly air character report through idea that reaches the user as a announcement namely wealthier in approach.

### Motivation

As visualized in the former survey to the current IOT, most IOT uses in China were domain- particular or use distinguishing resolutions. The architectures of these IOT arrangements are split and cannot equate and merge the dossier from different depository tower; these private IOT answers use private codes and cause much troubles in news giving, electronics multiplexing, network managements, and advancement. All these questions are putting off the growth of IOT. In order to decrease the total IOT cost and share news, I need to 11 merge diversified functions and capitals into a best arrangement. IOT thus needs expected engaged accompanying an open and common IOT design accompanying open borders and money, taking everything in mind different trade sketches, request-located necessities, and current sciences.

I have accordingly visualized the motivation to express a standard for IOT unification in consideration of decrease the total cost of services and period from schemes, growths, and deployments. An open and basic IOT design is an joined resolution accompanying interoperability. It has the following traits. Standard Interface and Protocol: By equating miscellaneous private IOT wholes, a generic IOT building has the unchanging fittings and spreadsheet interfaces, and agreements. Public and Operating: A approximate IOT construction is systematized to take over public IOT requests accompanying open operating ability. A public IOT arrangement mix diversified IOT requests into individual design. Open, Scalable, and Flexible: An open IOT architecture accompanying open money, open principles, and open interfaces surely offer allure performance and the scale of conduct. It adapts to different necessities containing mechanics growths flexibly.

### Problem Definition

To desire a singular approach to address the urban air contamination listening utilizing IOT electronics. Air pollution is disaster incidental question and it causes a large group of adverse belongings on human well-being, water carcasses and environment. The main source of air dirtiness thoroughly main centers is due to instruments and the second main beginning wait the industries. The air dirtiness listening whole is installed in the neighborhood place skilled are traces of acute air dirtiness to discover the constituent vapor of air that may bring about hurtful belongings on human energy and other living beings This order uses arduino and various vapor sensors to foresee the level of various injurious smoke like CO, NH<sub>3</sub>, coarse matter and fume.

### Objective of The Project

The main objective of the projected structure search out monitor the air quality. The projected plan contains the design for listening air pollution and founding knowledge between all. The aims at using IOT Technology in addition to sensors. The air status listening program design reliant upon the monitoring particular goals particularized for the air feature management

in the picked district of interest. Defining the crop influence, the design of the network and increase the resources secondhand for listening. It too guarantees that the network is specially designed to improve the facts on the questions within reach. There might be various aims for the happening of the preservation of natural resources and surveillance plan. Normally, bureaucracy has to determine networked data and news transfer accompanying a direct /inevitably/ networked quality control of the calm dossier. Several monitors, sensors and dossier group systems expected used to form networked data handover and control likely.

The main goals established for the growth of an air condition measurement and following program maybe to expedite the upbringing aggregation(s) measurements, monitor current levels as a guideline for appraisal, check the air feature relating to standards or limit principles, discover the significance of individual beginnings, enable corresponding of the air status dossier from various areas and nations, accumulate dossier for the air characteristic management, traffic and land-use preparation purposes, commemorate currents (had connection with emissions), expand lessening approaches, decide the exposure and evaluate the belongings of air dirtiness on energy, vegetation 3 or construction fabrics, notify all about the air quality and raise the knowledge, cultivate warning wholes for the stop of undesired air dirtiness adventures, promote the beginning apportionment and labeling, supply dossier for research analyses, evolve/validate administration forms (in the way that models), evolve and test analytical tools and to support charter concerning the air characteristic limit values and directions.

## II. LITERATURE SURVEY

“Smart Sensor Network Based High Quality Air Pollution Monitoring System Using Labview” by Nagarjuna Telagam, Nehru Kandasamy, Nagendra Prasad G Institute of Aeronautical Engineering, Hyderabad, India. A ZIGBEE based wireless sensor network is implemented in this paper which is of low-cost solar-powered air quality monitoring system. The main objective of the proposed architecture is to interfacing various sensors to measure the sensor analog data and displayed in Lab VIEW on the monitor using the graphical user interface (GUI).

The real time ambient air quality monitoring in smart cities is of greater significance for the health of people. The wireless network sensor nodes are placed at different traffic signals in the smart cities which collect and report real-time data on different gases which are present in the environment such as carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), methane (CH<sub>4</sub>) and humidity.

“Air Pollution Mapping using Mobile Sensor Based on Internet of Things” by Eduard Pangestu Wonohardjoa, Gede Putra

Kusuma The main objective of this research is to create a device capable of detecting carbon monoxide pollution levels by using mobile sensors and map the results into heat maps overlaid on Google Maps. We have implemented an integrated pollution monitoring and mapping system that consists of MQ-7 sensor, GPS, GSM, display module, Arduino board, and web-server. We also evaluated two sampling methods, time-based and distance-based sampling.

“Development of IOT Technologies for Air Pollution Prevention and Improvement” by Yu-Lin Zhao<sup>1</sup>, Jiali Tang<sup>2</sup>, Han-Pang Huang<sup>1</sup> this paper reviews the fundamental characteristics of IoT; compares and analyzes radio frequency identification (RFID), M2M, and sensor networks; and accordingly proposes an intelligent. The aims at using IOT Technology along with sensors. 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 resources used for monitoring. It also ensures that the network is specially designed to optimize the information on the problems at hand

**Analysis**

Already few existent systems use overcome that have restricted range of ideas as they are based on ZIGBEE and Bluetooth whose range is less when distinguished accompanying the WIFI. Also few existing projects use temporary Wi-Fi camcorder which create it troublesome for live surging in long range. Some of them can only be reserved in a manual trend that needs human supervision during the whole of all following process which repeated constitutes questions like turning on and curving off the camcorder continually when required.

A nomad that acts image refine utilizing the camcorder on an Android smartphone has also happened achieved. However, this method is restricted apiece dispose of power of the telephone, a question that we have tried by remotely operating all depict alter operations on a various calculating, following in .position or time transmitting multifunctional listening floor for lowering air pollution. Our results display that authenticating wholes for comprehensive network ideas, cloud-located resolution making, information pursuing, and connected to the internet administration based on these sciences will correct the atmosphere air quality more capably.

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.

correct the atmosphere air quality more capably.

Fig.3 Air Quality Analysis

**Existing System**

To collect parameters many electric mechanical devices are used. These devices are heavy and not economical to install at many places. Periodical collection of data is difficult and still manual intervention is required for collecting and feeding data to central servers. Careful placements of sensor nodes requirements, Resource wasting in certain level. privacy issues, uncontrolled mobility, serious limitations on weight and size.

**Drawbacks**

- Old IoT-based air pollution monitoring systems suffer from limitations such as low accuracy due to sensor aging and calibration issues
- High costs for initial setup and maintenance, limited coverage and spatial resolution, potential for data errors during storage and communication, short sensor lifetimes
- A lack of sufficient predictive capabilities for forecasting pollution trends. These factors often result in unreliable data, leading to misinformed decisions regarding air quality management.

**Proposed System**

Internet of Things (IOT) primarily handles connecting smart instruments to WWW by touching the advantage of OSI hide Architecture. In the framework concerning this work we intend a cluster of Air Quality Monitoring Gas Sensor MQ135, MQ7, MQ4 notes, that are used to measure the aggregation of Air contaminants in the air. We have chiefly secondhand the Arduino UNO that is an open source happening boards accompanying ESP8266-12E money. Gas Sensors are used to accumulate gas aggregation calculations. This sensor dossier would be grabbed and shipped to the Arduino UNO for IOT (Internet of Things) located data gain. The aim of plotting an air contamination monitoring structure that maybe installed in

a distinguishing neighborhood and to embellish the system from the earlier grown arrangements thrashing the earlier hurts by evolving an like a man app available for all. This app maybe secondhand by anyone to infiltrate live renews about the dirtiness in their domain. It uses Arduino integrated accompanying individual smoke sensors like colorless odorless toxic gas, ammonia in addition to coarse matter, moisture, and smoke that measures the aggregation of each vapor alone. The collected dossier is uploaded to the cloud utilizing act speak terrace at routine occasion intervals. Ethernet shield is secondhand for joining arduino and cloud. Pictorial or graphical likeness of values maybe proved fashionable talk. The concentration level of each smoke maybe regarded both as a diagram and in mathematical plan.

**Advantages**

**Real-Time Monitoring**

IoT devices continuously track air quality parameters (like CO, NO<sub>2</sub>, PM2.5, PM10, etc.) and provide instant data. This allows authorities and users to respond quickly to dangerous pollution levels.

**Remote Accessibility**

Data collected by IoT sensors is uploaded to the cloud, making it remotely accessible from smart phones, computers, or tablets through web apps or mobile apps.

**Data Logging and Analysis**

These systems can store large volumes of historical data, enabling trend analysis, pollution source identification, and long-term environmental planning.

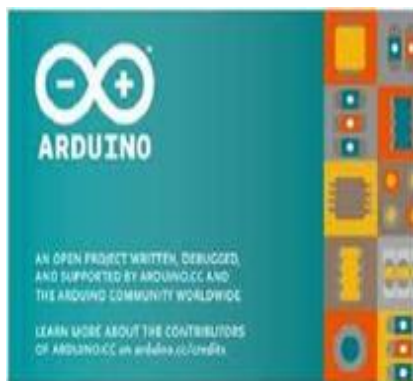
**Low Maintenance and Cost-Effective**

Compared to traditional air monitoring stations, IoT-based systems are cheaper, compact, and require less maintenance, making them ideal for widespread deployment.

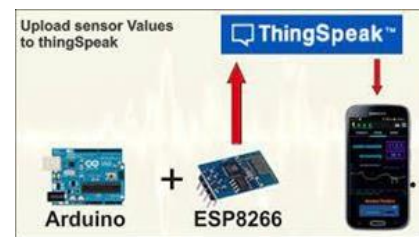
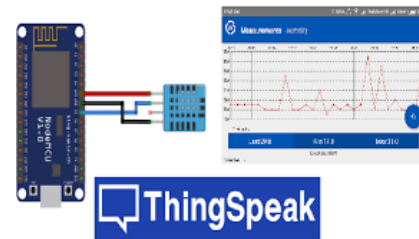
**Software Requirement Specification**

A software requirements specification (SRS) is a document that describes what the software will do and how it will be expected to perform.

Arduino IDE



**Thing Speak**



**Purpose**

The project is an exercise of IOT (Internet of Things) Based Air Pollution Monitoring System Using Arduino. Air contamination is a increasing issue and it should to monitor air characteristic for a better future and active living for all. IOT is growing popular era-by-era and flags act allure habit. Therefore, accumulation of air feature news is smooth. Analysis of listening dossier admits us to evaluate how distressing air dirtiness during the day. According to the current survey, Dhaka, the capital of Bangladesh is the after second in the list of most air-tainted city. Thus by way of this growth in the length of bicycles adulteration is expanding fast and it doing people groups well- being also. This air adulteration create affliction and harm cautious, affecting animate nerve organs, educational and respiring foundation. In exceptional cases, it can also cause passing. As marked by overview 50000 to 100000 surprising deficits happen to us only by way of air adulteration [2]. Along these lines, skilled is a necessity for restraining air character and to monitor it. IOT is bureaucracy of tangible device, automobiles, home apparatuses, and various

things inserted accompanying fittings, prioritize, sensors, and chance that empowers these items to associate and business news. IOT permits items expected seen or regulated. In this paper, I am intending and going to guide a model that IOT to screen air adulteration.

**Scope**

The Future Implications are very colossal concerning this type of science. This science can more be secondhand accompanying the Home Automation sciences. It can more ought more progressive specific that it maybe used to monitor some type of crop. Agriculture is an main area of Indian frugality. So in Agriculture the progress of crops is the main main phenomenon. As various crops are developed at a occasion it consistently enhances troublesome to monitor the development of all the crops. So present crop listening nomad helps to monitor the attractive woman crops from a distinct place skilled by lowering the exertions of producers. This rovers checks the tangible environments of crops.

**Overall Description**

Monitoring air condition is essential for local experts in addition to for major public and private commerces to comprehend and hamper air contamination and measure diffusion beginnings, in order to reserve fitness and present to the fight against the hothouse influence. Industrial operative use air character listening apparatus to cost efficiently monitor and survive emanations on their border, that helps bureaucracy recover friendships accompanying controllers and societies. With air character rule switching the burden from candidly funded listening to observant supported by manufacturing, it has happened evenly important for trades to acquire their individual value listening supplies. To get high-quality results from the atmosphere about the dirtiness level of air, toxicity and harmfulness for human, air kind listening instrument is vastly secondhand. An air characteristic monitor is an expedient that conduct the level of average air poisons. Displays are applicable for both household and rustic neighborhoods. Indoor air condition monitors are spontaneously sensor based forms. Some of bureaucracy are smart to quota PPM levels and reach as either different gas or moveable parts. Sensor located finishes and air condition listening plans are used widely in rustic atmosphere claims.

**IV. DESIGN**

**Uml Diagrams**

The model was designed with Universal Modeling Language (UML). UML representation supersedes the flowchart because it makes provision for many different viewpoints on a system. Three UML type diagrams that were used are: the activity and use case diagrams. The activity diagram shown in Figure.4.1.2 depicts the sequential flow of activities of the use case; it was used to model actions that will be performed when an operation

is being executed as well as the results of those actions. The use case diagram is the description of the system’s behaviour from a user’s viewpoint. This diagram is a valuable aid during the analysis as developing use cases helps to understand requirements.

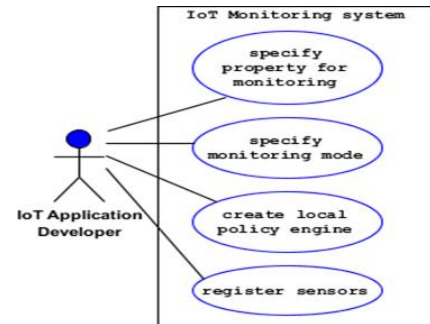


Fig.4.1.1 Use Case Diagram

Use case diagrams include actor and use case. The actor is represented as a stick figure. It lies outside the system model and interacts with it. The use case is represented as an oval shape. It describes a sequence of interactions between actors and the system. The use case diagram of the remote patient monitoring framework is as shown in Fig.4.1.1.

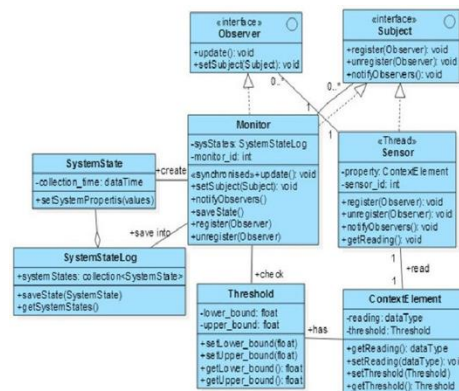


Fig.4.1.2 Class Diagram

Class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application. Class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class diagrams are widely used in the modeling of object oriented systems because they are the only UML diagrams, which can be mapped directly with object-oriented languages. Class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints. It is also known as a structural diagram.

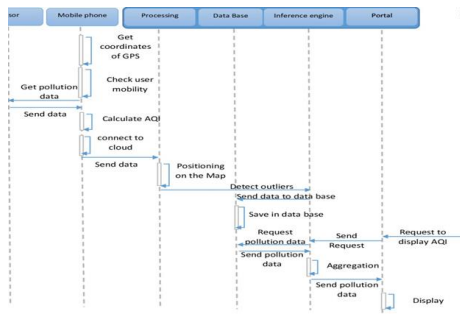


Fig.4.1.3 Sequence Diagram

A sequence diagram is a type of interaction diagram because it describes how and in what order a group of objects works together. These diagrams are used by software developers and business professionals to understand requirements for a new system or to document an existing process. Actor: Actor represents an external user / end user who interact with the system. Object: Object is represented by one of components of the system. Unit: A unit is a subsystem, or a sub component or other entity within the system.

### Architecture

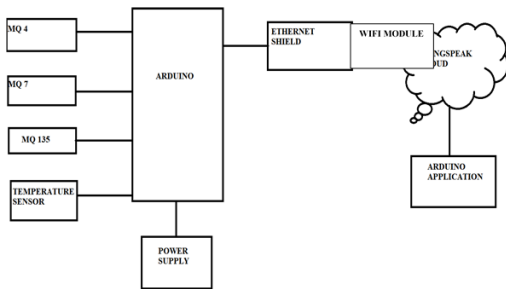


Fig.4.2.1 Block Diagram For Air Pollution Monitoring System

The major components of my project have been mentioned in the above section. Here is the architecture. Gas sensors & Wi-Fi Device are connected to the Arduino board. Also LCD connected to the Arduino board for displaying information. Monitor the Air Quality over a serial monitor & LCD using Gas sensor and trigger an alarm when the air quality goes down beyond a certain level, means when there is sufficient amount of harmful gases are present in the air like CO<sub>2</sub>, smoke, alcohol, benzene and NH<sub>3</sub>. It is shown the air quality in PPM on the LCD as well as serial monitor so that I can monitor it very easily. In Internet of Things (IOT) project, monitoring the pollution level from anywhere using computer. All this data is uploaded to Thing Speak for remote Analysis. The system includes the design for monitoring air pollution and creating awareness among the public. The level of each hazardous pollutant is monitored at periodic intervals. The Air Quality Index (AQI) for the observed pollutants is determined and awareness is created among the public through an android app

which displays the level of each observed pollutant and also the air quality index in that particular location.

## V. IMPLEMENTATION

**Esp32Module.** It is a type of Node MCU module. It consists of inbuilt WIFI and camera module. This module runs on a 3.3v to 5v. It is connected to any device using the WIFI module and with it we can communicate with devices.

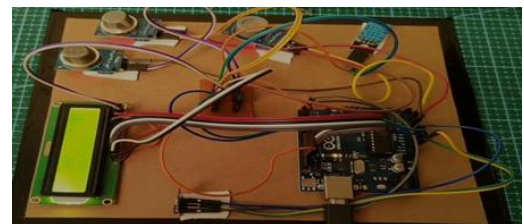
**Arduino.** It is a micro-controller and the Esp32 is programmed with the help of Arduino.

**L298N.** It is a motor driver which is connected with esp32 so as to deal with the directions provided by the user. It is also connected with the batteries for the power supply. The UI has Video Streaming Module and Rover Control Module. It has a GUI to control the rover. This control is achieved by connecting it over WIFI. Buttons are used to control the rover in forward, backward, left or right directions.

**Main Module.** The process starts from the main module i.e to program ESP 32 module with the help of Arduino. All the other modules in this process are dependent on this module. It is like heart of this project.

**User-Interface Module.** It is responsible for operations which we perform at the user end. With the help of this we send commands to the rover so that it can act accordingly.

**Output Module.** In this we can see the data/information collected by the over. It is responsible for displaying the live screening from the rover



### Modules

- LCD Display
- Arduino UNO
- ensors(MQ4, MQ7, MQ135)
- Temperature Humidity Sensor
- Buzzer
- WiFi Module
- Jumper wires

### Modules Description Lcd Display

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 LCD. The reasons being: LCD 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. 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.



Fig.5.2.1 LCD Display

**Jumper Wires**

Jumper wires are used in connections of components with each other. 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.5.2.2 Jumper Wires

**arduino uno**

The most common version of Arduino is the Arduino UNO. The Arduino UNO is a micro- controller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro- controller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The chip needs power so 2 of the pins, VCC and GND, provide it power so that it can operate.



Fig.5.2.3 Arduino UNO

**Mq 7 (Carbon Monoxide Sensor)**

The MQ7 is a simple-to-use Carbon Monoxide (CO) sensor suitable for sensing CO concentrations in the air. It can detect CO-gas concentrations anywhere from 20 to 2000ppm. The sensor's output is an analog resistance.



Fig.5.2.4 MQ 7 Sensor

**Mq 4 (Methane Gas Sensor)**

MQ4 Methane Gas Sensor detects the concentration of methane gas in the air and output its reading as an analog voltage. The concentration sensing range of 300 ppm to 10,000 ppm is suitable for leak detection. The sensor can operate at temperatures from -10 to 50°C and consumes less than 150 MA at 5 V.



Fig.5.2.5. MQ 4 Sensor

**Mq 135(Ammonia Gas Sensor)**

The MQ-135 gas sensor senses gases like ammonia nitrogen, oxygen, alcohols, aromatic compounds, sulfide, and smoke. The boost converter of the chip MQ-3 gas sensor is PT1301. The operating voltage of this gas sensor is from 2.5V to 5.0V. It has the potential to detect different harmful gases.

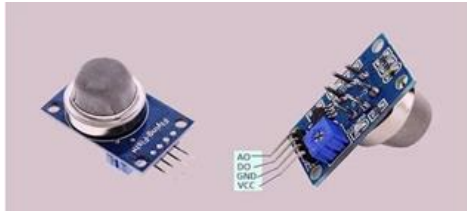


Fig.5.2.6 MQ135 Sensor

### Temperature and Humidity Sensor

Temperature detection is the foundation for all advanced forms of temperature control and compensation. This temperature sensor type consists of two wires of different metals connected at two points. The varying voltage between these two points reflects proportional changes in temperature. Thermocouples are non-linear, requiring conversion when used for temperature control and compensation, typically accomplished using a lookup table. Accuracy is low, from 0.5 to 5 °C.



Fig.5.2.7 Temperature Humidity sensor

### wifi module

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 micro controllers 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.



Fig.5.2.8 WiFi Module

### 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 micro controller with proper coding. 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.

### Introduction of Technologies Used Internet of Things

The Internet of Things (IOT) is the inter networking of physical devices, vehicles (connecting devices, and smart devices), buildings, and other items-including embedded with electronics, software's, sensors, actuators, network connectivity that enable these objects to collect and exchange data. The IOT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

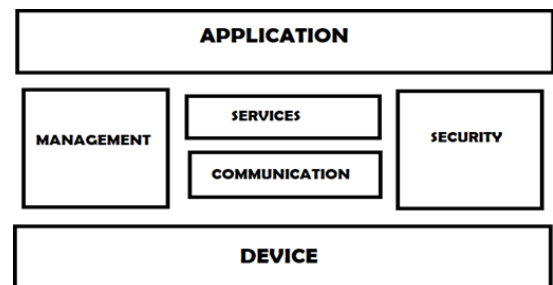


Figure 5.1. IOT Functional Blocks

- An IOT system comprises a number of functional blocks that provide the system the capabilities for identification, sensing, actuation, and management as shown in figure. These functional blocks are described as follows:
- **Device**: An IOT system comprises devices that provide sensing, actuation, monitoring and control functions.
- **Communication**: The communication block handles the communication for the IOT system. The various protocols are used for communication by IOT systems.
- **Services**: An IOT system uses various types of IOT services such as services for device monitoring, device control services, data publishing services and services for device discovery.
- **Management**: Management functional block provides various functions to govern the IoT system.

- Security: Security functional block secures the IOT system and by providing functions such as authentication, authorization, message and content integrity, and data security.
- Application: IOT applications provide an interface that the users can use to control and monitor various aspects of the IOT system. Applications also allow users to view the system status and view or analyse the processed data.
- IOT Protocols

Figure.5.2 IOT protocols.

**Link Layer:** Link Layer protocols determine how the data is physically sent over the network's physical layer or medium (e. g., copper wire, coaxial cable, or a radio wave). The scope of the link layer is the network connection to which host is attached. Hosts on the same link exchange data packets over the link layer using link layer protocols. Link layer determines how the packets are coded and signaled by the hardware device over the medium to which the host is attached (such as a coaxial cable).

- 802.3-ETHERNET: IEEE 802.3 is a collection of wired Ethernet standards for the link layer. For example, 802.3 is the standard for 10BASE5 Ethernet that uses coaxial cable as a shared medium, 802.3.i is the standard for 10BASE-T Ethernet over copper twisted-pair connections, 802.3ae is the standard for 10Gbit/Ethernet over fibre, and so on.
  - 802.3-WIFI: IEEE802.11 is a collection of wireless local area network (WLAN)communication standards, including extensive description of the link layer. For example, 802.11a operates in the 5GHZ band, 802.11b and 802.11g operate in the 2.4GHZ band 802.11n operates in the 2.4/5GHZ bands, 802.11ac operates from 1MB/S to up to upto6.75Gb/s. The specifications of the 802.11 standards are available on the IEEE802.11 working group website.
  - 802.11-WIFI: IEEE802.16 is a collection of wireless broadband standards, including extensive description for the link layer (also called WiMAX). WiMAX. Standards provide data rates from 1.5 Mb/s to 1 Gb/s. The recent update (802.16m) provides data rates of 100Mbit/s for mobile stations and 1 G bit/s for fixed stations. The specifications of the 802.11 standards are readily available on the IEEE802.16 working group website.
  - 802.15.4--LR-WPAN: IEEE 802.15.4 is a collection of standards for low- rate wireless personal area networks (LR-WPANs). These standards form the basis of specifications for high level communication protocols such as ZigBee.
- 2G/3/4G-MobileCommunication :** There are different generations of mobile communication standards including second generation (2G including GSM and CDMA), third generation (3G-including UMTS and

CDMA2000) and fourth. generation (4G- including LTE). IOT devices based on these standards can communicate over cellular networks. Data rates for these standards range for 9.6 Kb/s(for 2G) to up to 100Mb/s(for 4G) and are available from the 3GPP websites.

**Network/Internet Layer:** The network layers are responsible for sending IP data grams from the source network to the destinations network. This layer performs the host addressing and packet routing.

**IPV4 :** Internet Protocol version 4(IPV4) is the most deployed Internet Protocol the is used to identify the devices on a network using a hierarchical addressing scheme. IPV4 uses a 32-bit address scheme that allows a total of 4,294,967,296 addresses. As more and more devices got connected to the Internet, these addresses got exhausted in the year 201. IPV4 has been succeeded by IPV6. The IP protocols establish connections on the packet network, but do not guarantee delivery of packets. IPV6: Internet Protocols version 6(IPV6) IS The newest version of Internet Protocols and successor to IPV4. IPV6 uses 128-bit address scheme that allows total of  $3.4 \times 10^{38}$  address. 6LoWPAN:6LoWPAN (IPV6 over Low power Wireless Personal Area Networks) brings IP protocol to the low-power devices which have limited processing capability 6LoWPAN works with the 802,15.4-based networks.

**Transport Layer:** The transport layer protocols provide end-end message transfer capability independent of the underlying network. The message transfer capability can be set up on connections, either using handshakes (as in TCP) or without handshakes/acknowledgement (as in UDP). The transport layer provides functions such as error control, segmentation, flow control and congestion control.

**TCP :**Transmission Control Protocol (TCP) is the most widely used transport layer protocol. that is used by web browsers along with HTTP, HTTPS application layer protocols, email programs (SMTP application layer protocols) and file transfer (FTP). TCP is connection oriented and stateful protocol. While IP protocol deals with sending packets. TCP ensures reliable transmission of packets in-order. T

**UDP:** Unlike TCP, which requires carrying out an initial setup procedure. UDP of a connection less protocol. UDP is useful for the time-sensitive applications that have very small data units to exchange and do not have stateless protocol.

**Application Layer :** Application Layer protocols define how the applications interface with the lower layer protocols to send the data over the network. The application data, typically in files, is encoded by the application layer protocol and encapsulated in the transport layer protocol which provides connection or

transaction-oriented communication over the network. Port numbers are used for application addresses (for example port 80 for HTTP port 22 for SSH etc.). Application layer protocols enable process-to-process connections using ports.

**HTTP:** Hypertext Transfer Protocol (HTTP) is the application layer protocol that forms the foundation of the World Wide Web (WWW). HTTP includes commands such as GET, PUT, POST, DELETE, HEAD, TRACE, OPTIONS, etc. The protocol follows a request-response model where a client can send a request to a server using the HTTP commands. HTTP is a stateless protocol and each HTTP request is independent of the other requests. An HTTP client can be a browser or an application running on the client (e.g., an application running on an IOT device, a mobile application or other software).

**CoAP:** Constrained Application Protocol (CoAP) is an application layer protocol for machine-to-machine(M2M) applications. meant for constrained environments with constrained devices and constrained networks.

**Web Socket:** Web Socket protocol allows full-duplex communication over a single socket connection for sending messages between client and server. Web server is based on TCP and allows streams of messages to be sent back

**MQTT:** Message Queue Telemetry Transport (MQTT) is a light-weight messaging protocol based on the publish-subscribe model. MQTT uses a clientserver (also called MQTT Broker) and publishes messages to topics.

**XMPP:** Extensible Messaging and Presence Protocol (XMPP) is a protocol for real-time communication and streaming XML data between entities. XMPP powers a wide range of applications including messaging, presence, data syndication, gaming, multi-party chat and voice/video calls. XMPP allows sending small chunks of XML data from one network entry to another in near real-time. XMPP is a decentralized protocol and uses a client-server architecture. XMPP supports both client-to-server and server- to-server communication paths. In the

context of IOT, XMPP allows real- time communication between IOT devices.

**DDS:** Data Distribution Service (DDS) is a data-centric middleware standard for device to-device or machine-to-machine. DDS uses a publish- subscribe for models where publishers (e g. devices that generate data) create topics to which subscribers (e.g., devices that want to consume data) can subscribe..

**Sample Code**

```
#include <DHT.h> #include <DHT_U.h> #include <dht.h>
#include<LiquidCrystal.h>
LiquidCrystal lcd(8,9,10,11,12,13);// rs en d4 d5 d6 d7
#include <stdlib.h>
#define mq4 A0 #define mq7 A1 #define mq135 A2
/*          DHT SENSOR          */ #include "DHT.h"
#define DHTPIN 2          // what digital pin we're connected
to #define DHTTYPE DHT11 // DHT 11
DHT dht(DHTPIN, DHTTYPE);
int h,aqi;
int t,m4,m7,m135; int reg=0;
/*-----ESP8266 Serial WiFi Module          */
#define SSID "elegant" // "SSID-WiFiname" #define PASS
"smartworkk" // "password" #define IP "184.106.153.149"//
thingspeak.com ip
String          msg          =          "GET
https://api.thingspeak.com/update?api_key=9V2UIQLE4WJ8
CVT1&field1";
int error; void setup(){
lcd.begin(16,2); lcd.setCursor(0,0);//col row lcd.print("Air
quality"); dht.begin();
Serial.begin(115200); //or use default 115200.
Serial.println("AT");
delay(5000); if(Serial.find("OK"))
connectWiFi();
```

**VI. TEST CASES**

TESTCASE DESCRIPTION	TESTCASE NOTATION	REQUIREMENTS	TESTCASE INPUT	TESTCASE OUTPUT
User or concerned service providers tried to login to monitoring portal with registered details	T1	Registered Key	User Login Details	Pass/Fail

Monitoring portal indicating temperature, Sensor values.	T2	The developed prototype for air monitoring must be kept ON	User monitoring home screen should be displayed	Pass
When power cut or shortage of internet	T3	AC power supply, Mobile hot-spot	Power Supply	Pass/Fail
Monitoring values of the sensor	T4	MQ Sensors ,Temperature Sensor	Sensors connected to pole	Pass

### VII. SCREENSHOTS

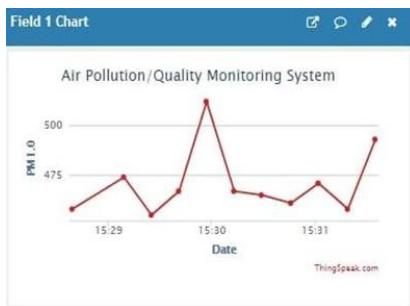


Fig.7.1 MQ4 Sensor reading

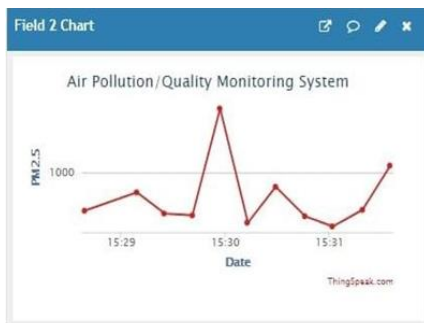


Fig.7.2 MQ 7 Sensor reading



Fig.7.3. MQ135 Sensor reading

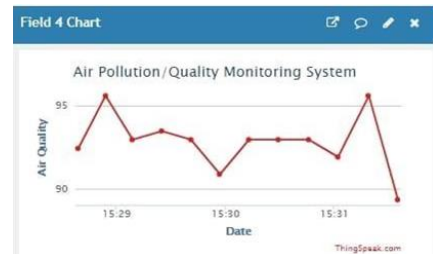


Fig.7.4. Temperature reading

### VIII. CONCLUSION

The system to monitor the air of environment using Arduino micro controller, IOT Technology is proposed to improve quality of air. With the use of IOT technology it enhances the process of monitoring various aspects of environment such as air quality monitoring issue proposed in this paper. Here, using the MQ135, MQ7, MQ4 gives the sense of different type of dangerous gases 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. The air pollution monitoring system using various gas sensors senses the pollutant levels and uploads the data in cloud, thus making the public get easy access to the pollution level of their area. This is of the wide use to offices, factories, residential areas and education institutions

**Future Enhancement** 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.

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