IOT BASED AIR CONDITION SUPERVISING SYSTEM

A Project Report

Submitted in partial fulfilment of Requirements for the Award of the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

K. BHARGAVI DEEPIKA	**(208A1A0462)**
P. NAAZIYA	**(208A1A0470)**
D.SINDHUSHA	**(208A1A0455)**
D.V. ASHOK KUMAR REDDY	**(208A1A0483)**
T.SRI RAM	**(208A1A04A1)**

Under the Esteemed Guidance of

Dr. Ch. Venugopal Reddy M.E, Ph.D.

Professor & HOD

Dept. of ECE

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

RISE Krishna Sai Prakasam Group of Institutions::Ongole

(Approved by AICTE-New Delhi, Affiliated to JNTUK Kakinada)

(Accredited By NAAC with “A” Grade & NBA for B.Tech. in ECE, EEE, CE, ME and CSE)

An ISO 9001:2015 certified Institute

NH-16, Valluru, -523272, Ongole, Prakasam District, A.P

2020- 2024

RISE Krishna Sai Prakasam Group of Institutions: Ongole
(Approved by AICTE-New Delhi, Affiliated to JNTUK Kakinada)
(Accredited By NAAC with "A" Grade & NBA for B.Tech. in ECE, EEE, CE, ME and CSE)
An ISO 9001:2015 certified Institute
NH-16, Valluru, -523272, Ongole, Prakasam District, A.P

Department of Electronics & Communication Engineering

CERTIFICATE

This is to certify that the project work entitled **"IOT BASED AIR CONDITION SUPERVISING SYSTEM"** is a bonafide record of project work done jointly by **K. BHARGAVI DEEPIKA** (208A1A0462), **P. NAAZIYA** (208A1A0470), **D. SINDHUSHA** (208A1A0455), **D. V. ASHOK KUMAR REDDY** (208A1A0483), **T. SRI RAM** (208A1A04A1) under my guidance and supervision and is submitted in partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Electronics & Communication Engineering by Jawaharlal Nehru Technological University, Kakinada during the academic year 2023-2024.

PROJECT GUIDE	HEAD OF THE DEPARTMENT
Dr. Ch. Venugopal Reddy M.E, Ph.D.	**Dr. Ch. Venugopal Reddy** M.E, Ph.D.
Professor & HOD	**Professor & HOD**
Dept. of ECE	**Dept. of ECE**

EXTERNAL EXAMINER

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our guide, to **Dr. Ch. Venugopal Reddy M.E, Ph.D**. Professor & HOD, for providing his invaluable guidance, comments, suggestions and support throughout the course of the project.

We express our heart filled thanks to **Dr. Ch. Venugopal Reddy**, Head of the Department, Electronics and Communication Engineering, for his valuable support to bring out this project in time.

We pay our profound sense of gratitude to our Principal Prof. **Dr. A.V. Bhaskara Rao** for providing an excellent environment in our college and helping us at all points for achieving our task.

We express our sincere thanks to **the Management of RISE Krishna Sai Prakasam Group of Institutions, Valluru** for providing a good environment and infrastructure.

Finally, we thank all our faculty members, supporting staff of ECE Department and friends for their kind co-operation and valuable help for the completion of the project.

Project Associates

K. BHARGAVI DEEPIKA	**(208A1A0462)**
P. NAAZIYA	**(208A1A0470)**
D.SINDHUSHA	**(208A1A0455)**
D.V. ASHOK KUMAR REDDY	**(208A1A0483)**
T.SRI RAM	**(208A1A04A1)**

RISE Krishna Sai Prakasam Group of Institutions::Ongole

(Approved by AICTE-New Delhi, Affiliated to JNTUK Kakinada)
(Accredited By NAAC with “A” Grade & NBA for B.Tech. in ECE, EEE, CE, ME and CSE)
An ISO 9001:2015 certified Institute
NH-16, Valluru, -523272, Ongole, Prakasam District, A.P

Department of Electronics & Communication Engineering

Vision of the Institute	To be a premier institution in technical education by creating professionals of global standards with ethics and social responsibility for the development of the nation and the mankind.
Mission of the Institute	Impart Outcome Based Education through well qualified and dedicated faculty.
	Provide state-of-the-art infrastructure and facilities for application-oriented research.
	Reinforce technical skills with life skills and entrepreneurship skills.
	Promote cutting-edge technologies to produce industry-ready Professionals.
	Facilitate interaction with all stakeholders of foster ideas and innovation.
	Inculcate moral values, professional ethics and social responsibility
Vision of the Department	To become a center of excellence in Electronics and Communication Engineering to meet the global, technological and industrial requirements.
Mission of the Department	Provide modern technical knowledge, professional skills and attitude to meet industry needs.
	Promote innovations through professional training and development.
	Develop a team with professional ethics and social responsibility.

Program Educational Objectives (PEOs):

Graduates of the program will be able to

PEO1: Core Skills	Intensive and extensive engineering knowledge and skill to understand, analyze, design and create novel products and solutions in the field of Signal Processing, Communication Systems, Embedded Systems and VLSI.
PEO2: Problem Solving and Lifelong Learning	Capability to pursue career in industry or higher studies with continuous learning.
PEO3: Entrepreneurship Skills	Leadership qualities, team spirit, multi-disciplinary approach, character Moulding and lifelong learning for a successful professional career.
PEO4: Professionalism	Professional and ethical attitude, effective communication skills, and sense of responsibility toward society.

Program Outcomes (POs):

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

A student of the Electronics and Communication Engineering Program will be able to

PSO1	Design and implementation of complex systems by applying basic concepts in Electronics & Communication Engineering to Electronics, Communications, Signal Processing, VLSI, Embedded Systems (**Core Skills**).
PSO2	Solve complex Electronics and Communication Engineering problems, using hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions relevant to the society (**Problem-Solving Skills**).
PSO3	Quality in technical subjects for successful higher studies and employment (**Professional Career**).

RISE Krishna Sai Prakasam Group of Institutions::Ongole

(Approved by AICTE-New Delhi, Affiliated to JNTUK Kakinada)
(Accredited By NAAC with “A” Grade & NBA for B.Tech. in ECE, EEE, CE, ME and CSE)
An ISO 9001:2015 certified Institute
NH-16, Valluru, -523272, Ongole, Prakasam District, A.P

Department of Electronics & Communication Engineering

Project Outcomes

Name of the Course : Project Work **Year & Semester** : IV Year II Sem
Academic Year : 2023-2024 **Regulation** : R20

Co. No	Project outcome After completing this project the student will be able to	BTL
C421.1	Envisaging applications for societal needs	Evaluating
C421.2	Develops skills for analysis and synthesis of practical systems	Creating
C421.3	Acquire the use of new tools effectively and creatively	Creating
C421.4	Work in team to carry out analysis and cost-effective, environmental friendly designs of engineering systems	Creating
C421.5	Write Technical / Project reports and oral presentation of the work done to an audience	Evaluating
C421.6	Demonstrate a product developed	Creating

Department of Electronics & Communication Engineering

Name of the Course	: Project Work	**Year & Semester**	: IV Year II Sem
Academic Year	: 2023-2024	**Regulation**	: R20

CO Vs PO Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C421.1	2	2	3	3	3	3	2	2	3	2	2	2
C421.2	2	2	3	3	3	3	2	2	3	3	3	3
C432.3	2	2	3	3	3	3	2	2	3	2	2	2
C421.4	2	2	3	3	3	3	3	3	3	3	3	3
C421.5	2	2	3	2	3	3	2	3	3	3	3	3
C421.6	2	2	2	2	3	3	3	3	3	3	3	3
C421	**2.00**	**2.00**	**2.83**	**2.67**	**3.00**	**3.00**	**2.33**	**2.50**	**3.00**	**2.67**	**2.67**	**2.67**

CO Vs PSO Mapping

Course Outcomes(COs)	PSO1	PSO2	PSO3
C421.1	3	3	3
C421.2	3	3	3
C421.3	3	3	3
C421.4	3	3	3
C421.5	2	2	2
C421.6	3	3	3
C421	**2.83**	**2.83**	**2.83**

CONTENTS

Page no

List of Figures i
Abstract iv

CHAPTER-1: INTRODUCTION

1.1 Introduction 1
1.2 Introduction to embedded system 3
1.3 Definition of an embedded system 3
1.4 Features of embedded system 4
1.5 Characteristics of embedded system 4
1.6 Overview of an embedded system Architecture 5
1.7 Types of embedded system 6
1.7.1 Stand-alone embedded system 6
1.7.2 Real time embedded system 6
1.7.3 Networked information appliances 6
1.7.4 Mobile devices 6
1.8 Microprocessor and microcontroller 7
1.9 Microcontroller versus Microprocessor 8

CHAPTER-2: LITERATURE SURVEY

2.1. Mobile Environmental sensing system to manage transportation and urban air quality 9
2.2. Air pollution monitoring and GIS modeling 9
2.3. IOT based air quality monitoring system 10
2.4. Real- time Air Quality Monitoring Through Mobile Sensing in Metropolitan Areas 10
2.5. Design, characterization and management of a wireless sensor network for smart gas monitoring 11
2.6. An IOT based low-cost air quality monitoring system 11
2.7. IOT based air quality monitoring and control system 12
2.8. Design of air quality monitoring system using internet of things 12
2.9. IOT-Based air quality monitoring and forecasting system 13

CHAPTER-3: EXISTING SYSTEM

3.1. Sensor Network-based Systems 14
3.1.1. Sensor Nodes 14
3.1.2. Communication Technologies 14
3.1.3. Data Aggregation and processing 15
3.1.4. Centralized Server or cloud 15
3.1.5. Power Management 15
3.1.6. Security 15

3.1.7. User Interface 15
3.1.8. Alerting System 15
3.1.9. Calibration and Maintenance 15
3.2. Mobile and Personal Air Quality Monitors 16
3.2.1. Mobile Sensor 16
3.2.2. Microcontroller 16
3.2.3. Connectivity 16
3.2.4. Smartphone app 16
3.2.5. System Design 16
3.3 Satellite and Remote Sensing Methods 17
3.3.1. Satellite and Remote Sensing 17
3.3.2. IOT Network 18
3.4 Low-cost Sensor and DIY Approaches 18
3.4.1. Components 19
3.4.2. DIY Approach 19
CHAPTER-4: PROPOSED SYSTEM
4.1. Sensor nodes 20
4.2. Microcontroller unit 21
4.3. Connectivity Module 21
4.4. Cloud Platform 21
4.5. User Interface 22
4.6. Power Supply 22
4.7. USB Power 22
4.8. Batteries 22
4.9. Solar Panels 22
4.10. Hardware Requirements 23
4.10.1. Arduino 24
4.10.2 IOT Module 25
4.10.3. MQ6 Sensor 26
4.10.4. PM2.5 Sensor 26
4.10.5. DHT11 Sensor 28
4.10.6. LCD Display 29
4.10.7. Pin diagram 29
4.10.8. LCD interface with microcontroller 30
4.10.9. Power supply 31
4.10.9.1. power supply module 31
4.10.9.2. Transformer 32
4.10.9.3. Rectifier 32
4.10.9.4. Filter 32
4.10.9.5. Regulator 33
4.10.10. GPS 33

4.10.11. LDR 34
4.10.12. Buzzer 35

CHAPTER-5: RESULTS

5.1 Circuit Connection Diagram 36
5.2 LCD Display of humidity Value 36
5.3 LCD Display of PM2.5 Particle Value 37
5.4 LCD Display of Co2 Value by using gas sensor 37
5.5 LCD Display of LDR Value 38
5.6 Displayed Values from Telegram Application 38

CHAPTER-6: CONCOLUSION

6.1 CONCOLUSION 39

CHAPTER-7: FURURE SCOPE

7.1. FURURE SCOPE 40

CHAPTER-8: REFERENCES 41

APPENDIX

A. Arduino IDE 42
B. Telegram Application Using IOT 43

LIST OF FIGURES

S. No	Fig. No.	Figure Name	Page No.
1	Fig.2.1.	General-purpose microprocessor system	7
2	Fig.2.2.	Microcontroller	7
3	Fig.2.3.	Microcontroller vs Microprocessor	8
4	Fig.3.1.	Sensor network-based system	14
5	Fig.3.2.	Mobile and personal air quality monitors	16
6	Fig.3.3.	Satellite and remote sensing method	17
7	Fig.3.4.	Low-cost sensor and die approaches	18
8	Fig.4.1.	Proposed block diagram	20
9	Fig.4.2.	Microcontroller Unit	21
10	Fig.4.3.	Connectivity Module	21
11	Fig.4.4.	Mobile app	22
12	Fig.4.5.	Web dashboard	22
13	Fig.4.6.	Arduino	24
14	Fig.4 .7.	IOT Module	25
15	Fig.4.8.	MQ6 Sensor.	26
16	Fig.4.9.	Laser scattering	27

17	Fig.4.10.	Light scattering	27
18	Fig.4.11.	Electro chemical Sensor	27
19	Fig.4.12.	Piezoelectric senso	28
20	Fig.4.13.	DHT11	28
21	Fig.4.14.	LCD Pin Description	30
22	Fig.4.15.	Microcontroller	31
23	Fig.4.16.	Power supply module	31
24	Fig.4.17.	Transformer	32
25	Fig. 4.18.	Bridge rectifier	32
26	Fig. 4.19.	Output: full-wave	32
27	Fig. 4.20.	Filters	33
28	Fig. 4.21.	Regulator	33
29	Fig. 4.22.	LM7805 Pinout Diagram	33
30	Fig. 4.23.	GPS	34
31	Fig. 4.24.	LDR	34
32	Fig.4.25.	Buzzer	35
33l	Fig.5.1.	Circuit Connection Diagram	36

34	Fig.5.2. LCD Display of humidity Value	36
35	Fig.5.3. LCD Display of PM2.5 Particle Value	37
36	Fig.5.4. LCD Display of Co2 Value by using gas sensor	37
37	Fig.5.5. LCD Display of LDR Value	38
38	Fig.5.6. Displayed Values from Telegram Application	38

ABSTRACT

This study presents a novel method of air quality monitoring within an Internet of Things (IoT) architecture. The suggested system uses strategically positioned sensor nodes at certain areas to gather data on air quality continually. These nodes use a range of sensors to assess temperature, humidity, LPG, butane gas, and particulate matter (PM2.5). These sensors provide wireless data to a central server, where it is processed, examined, and made available via an easy-to-use interface. Real-time monitoring, data analytics, and the providing of insights into patterns in air quality are made possible by utilizing IoT technologies. This system also provides remote access, which speeds up decision-making and raises public awareness. A strong Internet of Things infrastructure, sensor calibration, data transmission protocols, and data visualization tools are all part of the process. By comparing the system's accuracy and dependability to conventional air quality monitoring stations, it is verified. In the quickly changing metropolitan environments of today, air quality has emerged as a major concern. Pollution growth presents serious health dangers as well as environmental difficulties. In order to solve these issues, this study presents a comprehensive Internet of Things (IoT)-based air quality monitoring system that collects, analyzes, and disseminates data in real time. From a methodological standpoint, this system's development takes a multifaceted approach.This Internet of Things-based air quality monitoring system's application goes beyond simple data gathering. It has broad ramifications for many fields, including as public health, urban development, and environmental governance. This system gives decision-makers the knowledge they need to put targeted actions, regulations, and public awareness campaigns into action to reduce air pollution by giving them access to historical trends and real-time data.

CHAPTER 1
INTRODUCTION

1.1. Introduction:

The air we breathe is an essential element of life, yet its quality is increasingly threatened by the consequences of modernization. Urbanization, industrialization, and various human activities have led to the emission of pollutants that pose significant health risks and environmental challenges. Over the years, traditional air quality monitoring systems have played a crucial role in assessing and understanding these issues. However, they face limitations in adaptability, coverage,and real-time data accessibility. In response to these challenges, the integration of Internet of Things (IoT) technology has emerged as a transformative solution in the realm of air quality monitoring.

This paper seeks to delve deeply into the development, implementation, and implications of an advanced IoT-based air quality monitoring system. At its core, this system is built upon a network of sensor nodes strategically positioned across diverse environments. Each node is equipped with a range of sensors capable of detecting and measuring various air pollutants, including particulate matter of different sizes, volatile organic compounds, carbon monoxide, nitrogen dioxide, and ozone levels. The integration of IoT technology in this monitoring infrastructure enables the continuous and seamless transmission of real-time data from these sensor nodes to a centralized data hub. This hub acts as a central repository for processing, analyzing, anddisseminating the collected data. Through intuitive user interfaces, the processed data is made available to stakeholders, offering detailed insights into air quality patterns, trends, and historical variations.

This innovative IoT-based system represents a paradigm shift in air quality monitoring, not merely as a data collection tool but as a catalyst for informed decision-making. By offering real- time data and historical trends, the system empowers decision-makers with the necessary information to implement targeted interventions and policies aimed at curbing air pollution and enhancing public health. The significance of this IoT-based system extends beyond urban centers;its scalability and adaptability make it applicable to a diverse array of environments, including industrial zones, rural areas, and regions vulnerable to environmental challenges. Its potential to cater to varied air quality monitoring needs is a testament to its versatility.

By examining its intricacies and implications, we aim to underscore the pivotal role of this innovative approach in reshaping the landscape of air quality monitoring in the contemporary era. As we delve deeper into the nuances of this IoT-based system, a comprehensive understanding ofits potential, implications, and transformative capabilities in the realm of air quality management will emerge. The subsequent sections will meticulously unravel the components, technological advancements, and the implications of this system, providing a comprehensive view of its role in shaping the future of air quality monitoring.

With the quality of air degrading everyday there is a big necessity of an air quality monitoring system that not only could sense the quality of air, but also inform people through theircellular devices so that they are aware of the quality of air where they are living in. The objective of this project is to measure the quality of air in real time and sending this data of air quality through a Wi-Fi module to mobile phone and various other devices. The value of the AQI along with the severity of pollution is continuously reported to the android application. Various other devices alsocould be connected and controlled through this Wi-Fi module and necessary steps could be taken depending upon the quality of air reported such as if the air quality gets severely poor, the buzzerscould be turned on through the mobile devices so that other people living nearby gets alerted.

Air Quality Index (AQI) is the parameter that is being sent out through the module alongwith the condition of the air such as good, bad, satisfactory etc. which is calculated depending of the previous data of AQI in that locality. Higher the value of the AQI indicates poorer quality of air. The data measured through the dust sensors as well as the humidity sensors are used to calculate the resulting AQI of the locality. This device could be used to measure and report the quality of aircontinuously and this data could be seen anywhere through internet. This device could be installedin homes as well as in industries where quality of air is a matter of concern. The main purpose of this project is to make it easier for the people to measure and monitor the quality of air around them.

1.2. Introduction To Embedded System:

Each day, our lives become more dependent on 'embedded systems', digital information technology that is embedded in our environment. More than 98% of processors applied today are in embedded systems, and are no longer visible to the customer as 'computers' in the ordinary sense. AnEmbedded System is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale. The increasing use of PC hardware is one of the most important developments inhigh-end embedded systems in recent years.

Hardware costs of high-end systems have dropped dramatically as a result of this trend, making feasible some projects which previously would not have been done because of the high cost of non-PC-based embedded hardware. But software choices for the embedded PC platform are not nearly as attractive as the hardware. Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Physically, Embedded Systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. In terms of complexity embedded systems can range from very simple with a single microcontroller chip, to very complex with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

1.3. Definition of an Embedded System:

Embedded system is defined as, for a particular/specific application implementing the software code to interact directly with that particular hardware what we built. Software is used for providing features and flexibility, Hardware = {Processors, ASICs, Memory,} is used for Performance (& sometimes security). There are many definitions of embedded system but all of these can be combined into a single concept. An embedded system is a special purpose computer system that is used for particular task.

1.4. Features of Embedded Systems:

The versatility of the embedded computer system lends itself to utility in all kinds of enterprises, from the simplification of deliverable products to a reduction in costs in their development and manufacture. Complex systems with rich functionality employ special operating systems that take into account major characteristics of embedded systems. Embedded operating systems have minimized footprint and may follow real-time operating system specifics. The special computers system is usually less powerful than general-purpose systems, although some expectations do exist where embedded systems are very powerful and complicated.

Usually, a low power consumption CPU with a limited amount of memory is used in embedded systems. Many embedded systems use very small operating systems; most of these provide very limited operating system capabilities. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Some embedded systems have to operate in extreme environment conditions such as very high temperature & humidity.

For high volume systems such as portable music players or mobile phones, minimizing cost is usually the primary design consideration. Engineers typically select hardware that is just "good enough" to implement the necessary functions. For low volume or prototype embedded systems, general purpose computers may be adapted by limiting the programs or by replacing the operating system with a real-time operating system.

1.5. Characteristics of Embedded Systems:

Embedded computing systems generally exhibit rich functionality—complex functionality is usually the reason for introducing CPUs into the design. However, they also exhibit many non-functional requirements that make the task especially challenging:

- Real-time deadlines that will cause system failure if not met;
- Multi-rate operation;
- In many cases, low power consumption;
- Low manufacturing cost, which often means limited code size.

Workstation programmers often concentrate on functionality. They may consider the performance characteristics of a few computational kernels of their software, but rarely analyze thetotal application. They almost never consider power consumption and manufacturing cost. The need to juggle all these requirements makes embedded system programming very challenging and is thereason why embedded system designers need to understand computer architecture.

1.6. Overview of an Embedded System Architecture

Every Embedded system consists of a custom-built hardware built around a central processing unit. This hardware also contains memory chips onto which the software is loaded. Theoperating system runs above the hardware and the application software runs above the operating system. The same architecture is applicable to any computer including desktop computer. However, these are significant differences. It is not compulsory to have an operating system in every embedded system. For small applications such as remote-control units, air conditioners, toys etc.

Some of the most common embedded systems used in everyday life are

Small embedded controllers:	8-bit CPUs dominate, simple or no operating system (e.g., thermostats)
Control systems:	Often use DSP chip for control computations (e.g., automotive engine control)
Distributed embedded control:	Mixture of large and small nodes on a real-time Embedded networks (e.g., cars, elevators, factory automation)
System on chip:	ASIC design tailored to application area (e.g., consumer electronics, set-top boxes)
Network equipment:	Emphasis on data movement/packet flow (e.g., network switches; telephone switches)
Critical systems:	Safety and mission critical computing(e.g., pacemakers, automatic trains)
Signal processing: Processing	Often use DSP chips for vision, audio, or other signal (e.g., face recognition)
Robotics:	Uses various types of embedded computing (especially Vision and control) (e.g., autonomous vehicles)
Computer peripherals:	Disk drives, keyboards, laser printers, etc.
Wireless systems:	Wireless network-connected “sensor networks” and “Motes” togather and report information
Embedded PCs:	Palmtop and small form factor PCs embedded into Equipment
Command and control:	Often huge military systems and “systems of systems” (e.g., a fleet of warships with interconnected Computers)

Home Appliances, intercom, telephones, security systems, garage door openers, answering machines, fax machines, home computers, TVs, cable TV tuner, VCR, camcorder, remote controls, video games, cellular phones, musical instruments, sewing machines, lighting control, paging, camera, pinball machines, toys, exercise equipment office Telephones, computers, security systems, fax machines, microwave, copier, laser printer, color printer, paging auto Trip computer, engine control, air bag, ABS, instrumentation, security system, transmission control, entertainment, climate control, cellular phone, keyless entry.

1.7. TYPES OF EMBEDDED SYSTEMS

Based on functionality and performance embedded systems categorized as 4 types

1. Standalone embedded systems
2. Real time embedded systems
3. Networked information appliances
4. Mobile devices

1.7.1. Stand-Alone Embedded Systems: -

As the name implies, standalone systems work in standalone mode. They take i/p, process them and produce the desire o/p. The i/p can be an electrical signal from transducer or temperature signal or commands from human being. The o/p can be electrical signal to drive anothersystem a led or LCD display.

Ex: digital camera, microwave oven, CD player, Air conditioner etc.

1.7.2. Real Time Embedded Systems: -

In this type of an embedded system a specific work has to be complete in aparticular period of time.

Hard Real time systems: - embedded real time used in missiles

Soft Real time systems: - DVD players

1.7.3. Networked information appliances: -

Embedded systems that are provided with n/w interfaces and accessed by n/w suchas area n/w or internet are called Network Information Appliances.

Ex: A web camera is connected to the internet. Camera can send pictures in real time to any computers connected to the internet

1.7.4. Mobile devices: -

Actually, it is a combination of both VLSI and Embedded System. Mobile devicessuch as Mobile phone, Personal digital assistants, smart phones etc. are special category of embedded systems

1.8. Microprocessor and Microcontroller

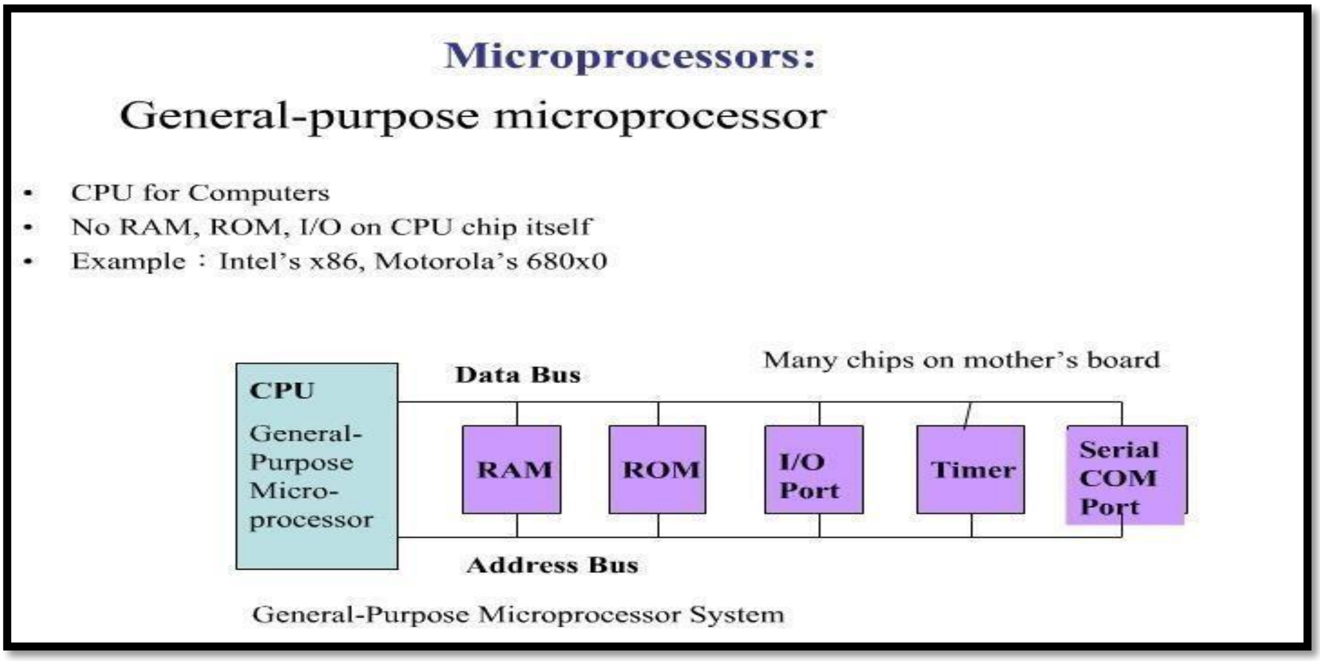


Fig 2.1: General-purpose microprocessor system.

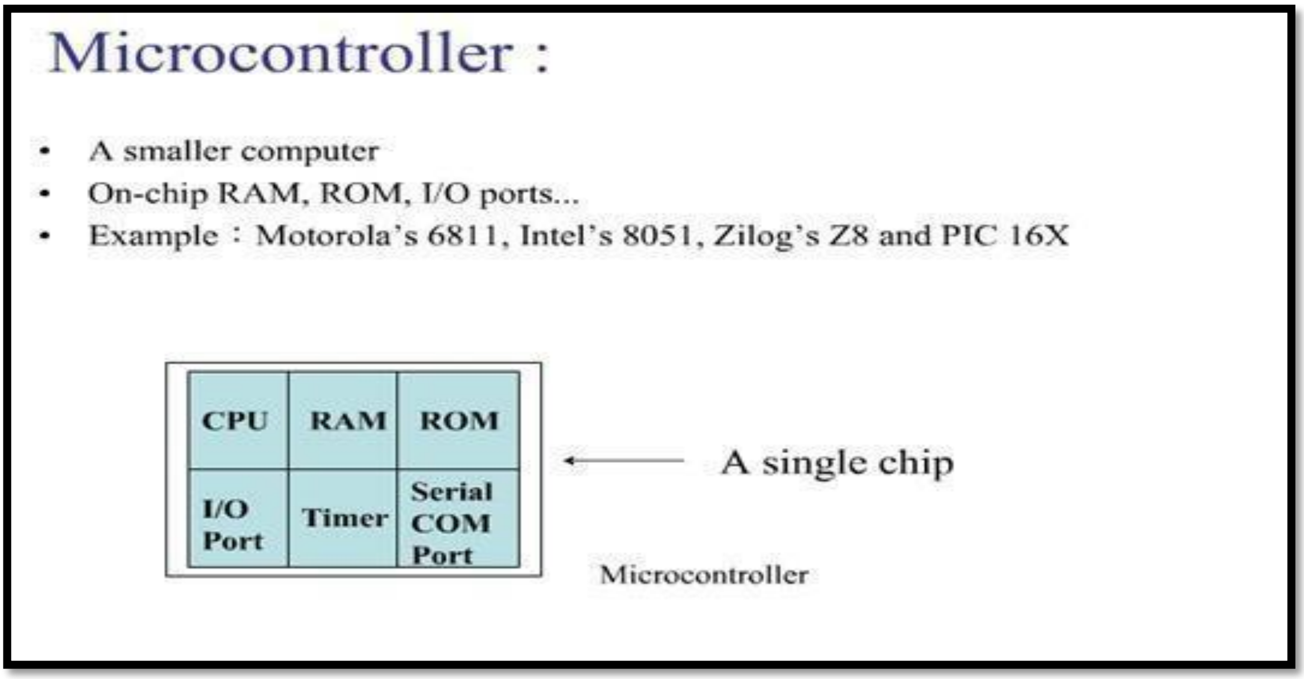


Fig 2.2: Microcontroller.

1.9. Microcontroller Versus Microprocessor

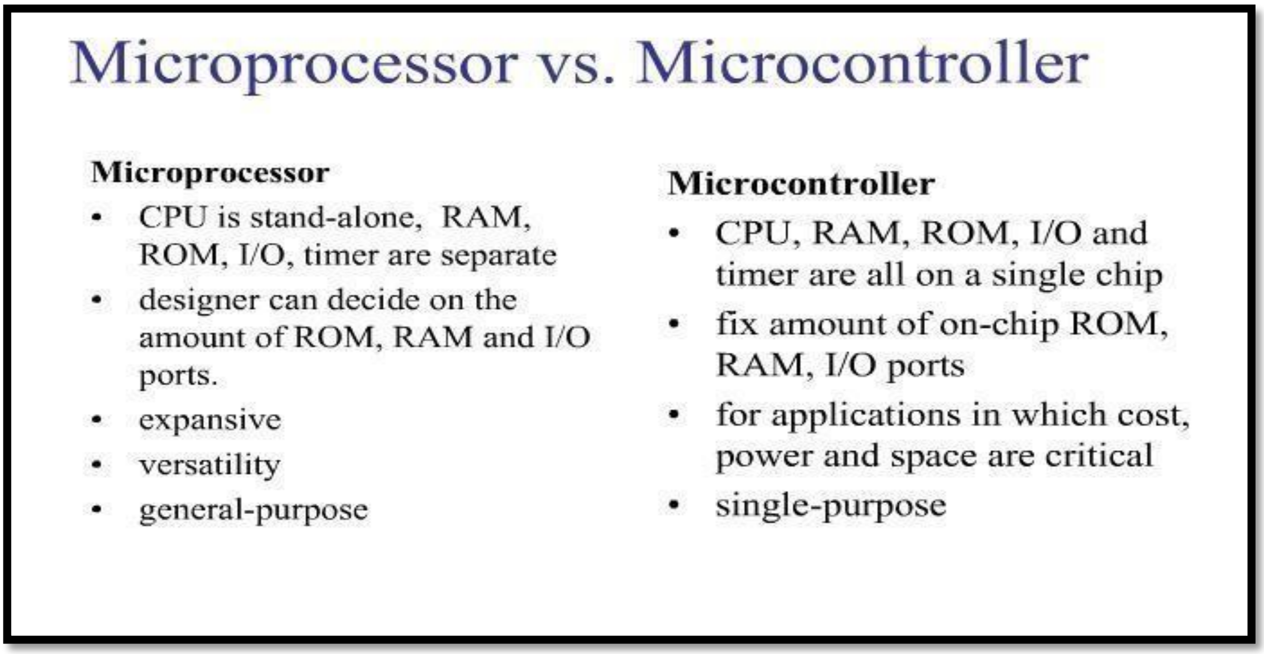


Fig 2.3: Microprocessor vs. Microcontroller.

A system designer using a general-purpose microprocessor such as the Pentium or the 68040 must add RAM, ROM, I/O ports, and timers externally to make them functional. Although the addition of external RAM, ROM, and I/O ports makes these systems bulkier and much more expensive, they have the advantage of versatility such that the designer can decide on the amount ofRAM, ROM and I/O ports needed to fit the task at hand.

A Microcontroller has a CPU (a microprocessor) in addition to a fixed amount of RAM, ROM, I/O ports, and a timer all on a single chip. In other words, the processor, the RAM, ROM, I/O ports and the timer are all embedded together on one chip; therefore, the designer cannotadd any external memory, I/O ports, or timer to it. The fixed amount of on-chip ROM, RAM, and number of I/O ports in Microcontrollers makes them ideal for many applications in which cost and space are critical.

CHAPTER 2
LITERATURE SURVEY

1. TITLE: Mobile Environmental sensing system to manage transportation and urban air quality

AUTHOR: M. Cohen, North, R. Richards, J. Hose and N. Hassard

ABSTRACT: In today's urban landscapes, the intersection of transportation and air quality presentspressing challenge. Mobile environmental sensing systems offer a pioneering solution by leveraging technological advancements to monitor and manage air quality associated with transportation. These systems, integrated with mobile platforms, sensors, and data analysis, provide a comprehensive approach to understanding and mitigating the environmental impact of urban transportation. This essay explores the critical role of mobile environmental sensing systems in managing urban air quality affected by transportation, shedding light on their significance, functionality, and potential for transforming our approach to sustainable urban living. The fusion of mobile environmental sensing systems with transportation management signifies a pivotal stride towards sustainable urban environments.

2. TITLE: Air pollution monitoring and GIS modeling

AUTHOR: O. Pummakarnchana. N. Tripathi, J. Dutta

ABSTRACT: Air pollution monitoring coupled with Geographic Information System (GIS) modeling represents a transformative approach in comprehending and managing the complexities ofair quality. By integrating advanced monitoring technologies with GIS, we gain a powerful tool to visualize, analyze, and predict air pollution patterns in spatial contexts. This essay delves into the significance of this synergy, exploring how the amalgamation of air pollution monitoring and GIS modeling contributes to a comprehensive understanding of the sources, distribution, and impacts. Embracing and expanding the use of air pollution monitoring and GIS modeling is pivotal for creating resilient, environmentally conscious communities and shaping policies that address the urgent need to curb air pollution.

3. TITLE: IOT based air quality monitoring system

AUTHOR: Ch.V. Saikumar, M. Reji, P.C. Kishore raja

ABSTRACT: IoT-based air quality monitoring systems have emerged as a beacon of hope. This advanced technology amalgamates Internet of Things (IoT) devices with air quality sensors, providing a sophisticated framework for real-time monitoring, analysis, and management of air pollutants. This essay delves into the profound significance of IoT-based air quality monitoring systems, exploring their pivotal role in revolutionizing the way we comprehend, track, and address air pollution. It highlights the potential of these systems in providing not just data but actionable insights for policymakers, urban planners, and communities. As we navigate the challenges of escalating air pollution, these systems emerge as a vital tool, promising a future where clean, breathable air is not just an aspiration but a tangible reality.

4. TITLE: Real- time Air Quality Monitoring Through Mobile Sensing in Metropolitan Areas

AUTHOR: Srinivas Devarakonda and Parveen Sevusu

ABSTRACT: In metropolitan areas, the quality of the air we breathe is a critical concern. Real-time air quality monitoring through mobile sensing presents a revolutionary solution to this issue. With the pervasive use of mobile devices, this technology harnesses the power of interconnected sensors to provide instant, granular data on air quality, enabling both authorities and individuals to make informed decisions about their health and environment. By leveraging the capabilities of these sensors, this approach offers a comprehensive and accessible means to monitor air quality levels, detect pollutants, and take proactive steps to address environmental concerns. However, to realize this potential fully, it's imperative to address challenges such as sensor accuracy, data security, and standardization. As technology continues to evolve, the integration of real-time air quality monitoring through mobile sensing stands as a promising strategy in our pursuit of cleaner, healthier metropolitan areas.

5. TITLE: Design, characterization and management of a wireless sensor network for smart gas monitoring

AUTHOR: Jelicic V., Magno M., Paci G. and Brunelli

ABSTRACT: The design, characterization, and management of a wireless sensor network for smartgas monitoring mark a significant advancement in the realm of environmental safety and industrial efficiency. This innovative technology harnesses the power of wireless sensors to continuously monitor gas levels in various environments, offering real-time data and insights that can revolutionize safety protocols and resource management. By exploring the intricacies of this wireless sensor network, this paper delves into the design principles, the characterization of data obtained, and the comprehensive management strategies essential for effective gas monitoring. This technology holdsthe promise of enhancing safety measures in industrial settings, ensuring a swift response to potential hazards, and optimizing resource utilization. In this context, the paper examines the crucial components and methodologies employed in this wireless sensor network, elucidating its significance in modern safety protocols and its potential impact on industrial.

6. TITLE: An IOT based low-cost air quality monitoring system

AUTHOR: Gagan Parmar, Sagar Lakhani, Manju K. Chattopadhyay

ABSTRACT: Air excellence monitoring in addition management has gained abundant attention latterly as the impact of air quality on several aspects of life. Besides the detrimental effects of toxic emissions on the environment and health, work productivity and energy efficiency are affected by air quality. This potential canbe attributed to their attractive characteristics' can be monitored remotely. WSNs adapt well to mobility. Potentials of WSNs in air quality monitoring have not been exploited to their fullest. Some WSN- based air quality monitoring systems have been introduced recently but they are not appealing enough to industry. Mostof these are too difficult to implement, require specific instrumentation that is not open- hardware or open software, and are application and location dependent. Thus, the planned framework provides measurements ofvarious air quality metrics which might facilitate in evaluating the impact of industrial emissions.

6. TITLE: IOT based air quality monitoring and control system

AUTHOR: S. MuthuKumar, W. Sherine Mary

ABSTRACT: The "IOT-based air quality monitoring and control system" is a paradigm-shifting solution, utilizing interconnected sensors and devices to provide real-time, accurate data on air quality. This system offers the potential not only to detect and monitor pollutants in the air but alsoto control and mitigate air quality issues promptly. In this context, this paper delves into the significance and implications of such a system, exploring its design, functionalities, and its potential impact on environmental sustainability and public health. Its ability to continuously and accuratelymonitor air quality, coupled with the potential for active intervention and control, holds immense promise for addressing air pollution issues actions aimed at enhancing air quality. However, for this system to realize its full potential, challenges such as ensuring data security, maintaining the accuracy of sensors, and managing the overwhelming volume of data must be addressed.

7. TITLE: Design of air quality monitoring system using internet of things

AUTHOR: S.K.S. Gupta and A. Kumaravel

ABSTRACT: The "Design of Air Quality Monitoring System using Internet of Things" harnesses interconnected sensors and IoT technology to provide a comprehensive and real-time approach to monitoring air quality parameters. This innovative system not only captures and analyzes air quality data but also utilizes IoT connectivity to relay information to a central system for analysis and dissemination. This paper delves into the intricate design elements, functionalities, and significance of this system, highlighting its role in providing a detailed and accessible framework for monitoring air quality. By leveraging the capabilities of IoT, this system aims to transform the landscape of environmental monitoring, providing insights that empower informed decision-making and proactive measures to improve air quality. Its fusion of IoT technology and air quality monitoring provides a foundation for more informed and effective strategies to improve air quality standards.

8. TITLE: IOT-Based air quality monitoring and forecasting system

The integration of IoT technology into air quality monitoring and forecasting marks a significant advancement in environmental science and public health. The "IoT-based air quality monitoring and forecasting system" represents a fusion of interconnected sensors and predictive analytics that provide real-time data on air quality parameters. This paper explores the significanceof this system, delving into its components, functionalities, and the potential impact on environmental management and public welfare. By leveraging the power of IoT, this system aims to offer not just data but foresight, empowering authorities and communities to anticipate and address air quality issues before they escalate, thus fostering a healthier and more sustainable environment. This amalgamation not only aids in understanding current air quality conditions but also equips decision-makers with the foresight needed to prepare for and potentially prevent adverse air quality situations. However, the system's effectiveness is contingent upon addressing challenges relate

CHAPTER 3

EXISTING SYSTEM

Existing Method for air quality monitor system using IOT is several existing methods utilize IoT technology for air quality monitoring, each with its limitations:

3.1. Sensor Network-based Systems

A sensor network-based system for air quality monitoring typically involves deploying a network of sensors that can measure various environmental parameters, such as air pollutants, temperature, humidity, and more. These sensor nodes are often connected through wireless communication technologies to form a network, and the collected data is usually sent to a central server for analysis and monitoring. This common approach deploys a network of sensor nodes equipped with various air quality sensors (PM, gas, etc.).

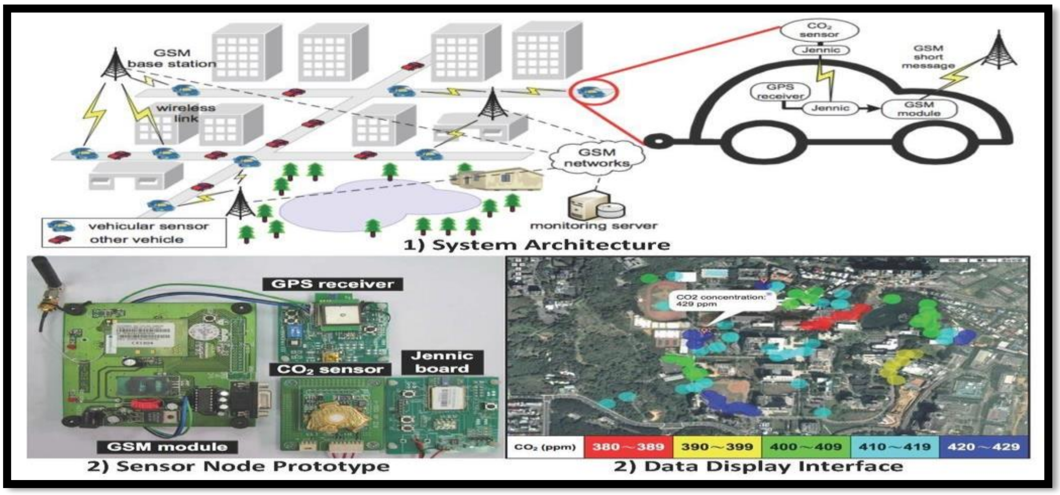


Fig 3.1: Sensor Network-based Systems

3.1.1. Sensor Nodes

1. Gas Sensors: These sensors can detect specific air pollutants like carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2), particulate matter (PM), and ozone (O3).

2. Environmental Sensors: Measure additional parameters such as temperature, humidity, and atmospheric pressure.

3.1.2. Communication Technologies

1. Wireless Sensor Networks (WSN): Sensor nodes communicate with each other and a central server through wireless protocols like Zigbee, LoRa (Long Range), Wi-Fi, or cellular networks.

2. IoT Protocols: MQTT (Message Queuing Telemetry Transport) and CoAP (Constrained

Application Protocol) are commonly used for efficient data transfer in IoT applications.

3.1.3. Data Aggregation and Processing

a) **Edge Computing**: Some systems process data at the sensor nodes (edge) to reduce theamount of data sent to the central server, optimizing bandwidth usage.

b) **Cloud Computing**: Centralized servers or cloud platforms analyze aggregated data,perform computations, and generate insights.

3.1.4. Centralized Server or Cloud

1. Database: Store and manage the collected data in a structured database.
2. Analysis and Visualization: Employ algorithms for data analysis, and provide real-timeor periodic visualization of air quality parameters.

3.1.5. Power Management

Energy-Efficient Design: Sensor nodes often operate on battery power, so energy-efficient design is crucial. Low-power modes and sleep cycles can be implemented to extend battery life.

3.1.6. Security

a) **Data Encryption**: Implement encryption protocols to secure data transmission and protect against unauthorized access.

b) **Authentication**: Ensure that only authorized devices can communicate with the sensor network and central server.

3.1.7. User Interface

Web Interface or Mobile App: Provide a user-friendly interface for stakeholders to accessreal-time and historical air quality data, receive alerts, and visualize trends.

3.1.8. Alerting System

Thresholds and Alarms: Set predefined thresholds for air quality parameters, triggering alerts when exceeded. This helps in timely response to deteriorating air quality.

3.1.9. Calibration and Maintenance

Regular Calibration: Calibrate sensors periodically to ensure accurate and reliable measurements.

Maintenance Alerts: Implement a system to detect sensor malfunctions and generate maintenance alerts.

Disadvantages

- High initial setup cost
- potential data transmission limitations in remote areas.

3.2. Mobile and Personal Air Quality Monitors

Fig 3.2: Mobile and Personal Air Quality Monitors.

3.2.1. Mobile sensor: This is a small, portable device that clips onto your clothes or bag andmeasures air quality as you move around. It typically includes sensors for PM2.5, PM10, CO, CO2, and VOCs.

3.2.2. Microcontroller: This processes sensor data and transmits it wirelessly to a smartphone app or cloud platform.

3.2.3. Connectivity: Bluetooth is the most common connectivity option for mobile sensors, as it provides low power consumption and a reliable connection to smartphones.

3.2.4. Smartphone app: This app displays real-time air quality data from the sensor, historical trends, and air quality maps. It can also send alerts when pollution levels exceed safe limits.

3.2.5. System Design:

1. **Compact Sensors**: Equipped with sensors typically focused on PM2.5 and/or specific gases like CO2, NO2, and O3, these monitors continuously collect data on your immediate surroundings.

2. **Data Processing**: Onboard microcontrollers or connected smartphone apps process the raw sensor data and translate it into easily understandable metrics like air quality index (AQI) or pollutant concentrations.

3. **User Interface**: Most devices feature LCD displays or smartphone app interfaces that present real-time air quality readings, historical data trends, and sometimes even contextual information like weather updates.

4. **Additional Features:** Some advanced models offer:

5. **GPS tracking:** Records your air quality exposure along your journey.

6. **Vibration or audible alerts**: Notifies you when safe air quality thresholds are exceeded.

7. **Data sharing**: Allows you to contribute to community air quality maps and research initiatives.

8. **Disadvantages:** Limited area coverage, potential calibration issues, dependence on user interaction. Remember, choosing the right air quality monitor depends on your individual needs and preferences. Consider factors like sensor accuracy, desired features, budget, and desired level of data analysis before making your decision.

3.3.Satellite and Remote Sensing Methods

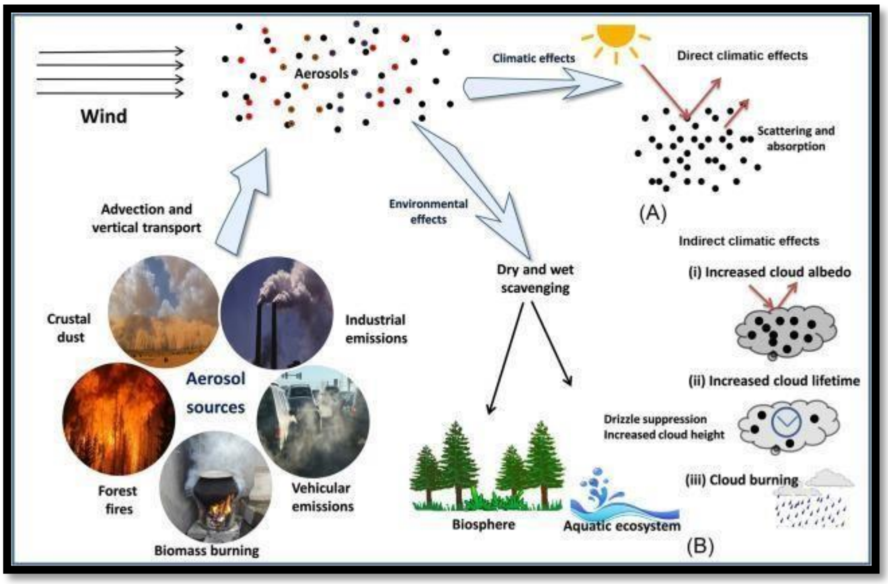


Fig 3.3: Satellite and Remote Sensing Methods**.**

3.3.1. Satellite and Remote Sensing:

- **Satellites:** Orbiting Earth, these capture large-scale data on various air quality indicators.
- **Aerosol Optical Depth (AOD):** Indicates the amount of particulate matter suspended in the atmosphere.
- **Nitrogen dioxide (NO2):** Linked to traffic emissions and power generation.
- **Ozone (O3):** Can be beneficial (stratospheric) or harmful (tropospheric) to human health.
- **Carbon Monoxide (CO):** Primarily from incomplete combustion processes.

3.3.2. IoT Network

- **Ground-based sensors**: Deployed in specific locations, these measure local air quality parameters like
- **PM2.5 and PM10:** Fine and coarse particulate matter, harmful to respiratory health.
- **Carbon dioxide (CO2):** Linked to greenhouse gas emissions and climate change.
- **Volatile Organic Compounds (VOCs)**: Released from various sources, impacting airquality and health.
- **Data transmission:** Sensors transmit data wirelessly to a central hub or cloud platform

Remember, choosing the appropriate air quality monitoring method depends on your specific needs and the information you want to obtain. Combine different methods like satellite data with ground-based networks and personal monitors for a comprehensive understanding of air quality at various scales.

Disadvantages

- Limited individual-level data
- High technological complexity.

3.4. Low-cost Sensor and DIY Approaches

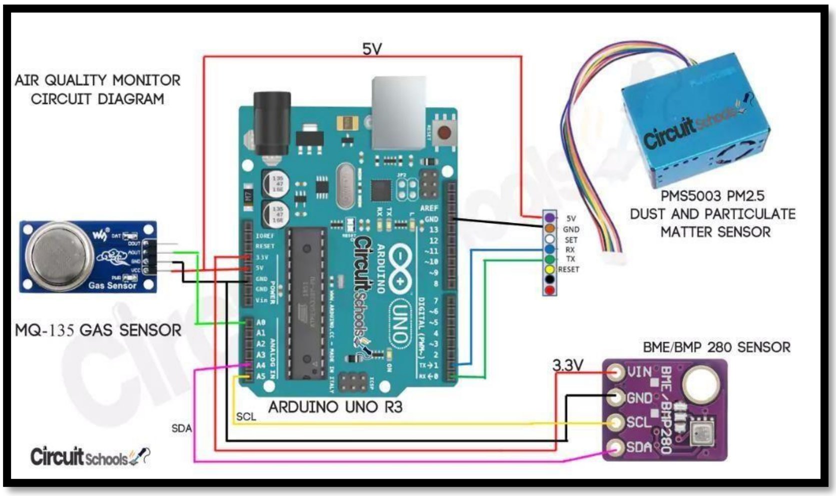


Fig 3.4: Low-cost Sensor and DIY Approaches.

3.4.1. Components:

- **Low-cost sensors**: Sensors like the MQ135 (CO_2), MQ7 (CO), and SDS018 (particulate matter) offer affordable options for measuring key air pollutants.
- **Microcontroller:** Arduino boards or Raspberry Pi are popular choices for processingsensor data and enabling connectivity.
- **Connectivity:** Wi-Fi modules or LoRa modules can connect your system to the internet forremote monitoring.
- **Cloud platform**: Free platforms like Thing Speak or Blink can store and visualize your sensor data online.

3.4.2. DIY Approach:

- **Choose your sensors**: Select sensors based on the air pollutants you want to monitor andyour budget.
- **Build the hardware**: Connect sensors to your chosen microcontroller according to the provided schematics and libraries.
- **Write the code**: Program the microcontroller to read sensor data, process it, and transmit itto your chosen cloud platform.
- **Set up the platform:** Create an account on your chosen platform and configure it to receiveand display your sensor data.

Remember, whether you're a hobbyist, researcher, or simply concerned about your air quality, low-cost sensor and DIY approaches provide a compelling option to explore. Be prepared to invest time and effort in learning and troubleshooting, but the rewards of taking control of your air quality data and contributing to a broader understanding of this critical environmental issue are well worth it.

Disadvantages

- Potential data accuracy issues
- Limited technical support
- Scaling challenges.

CHAPTER 4
PROPOSED SYSTEM

Proposed Method for Air Quality Monitor using Iot is based on your previous inquiries,here's a comprehensive proposal for an air quality monitor using IoT

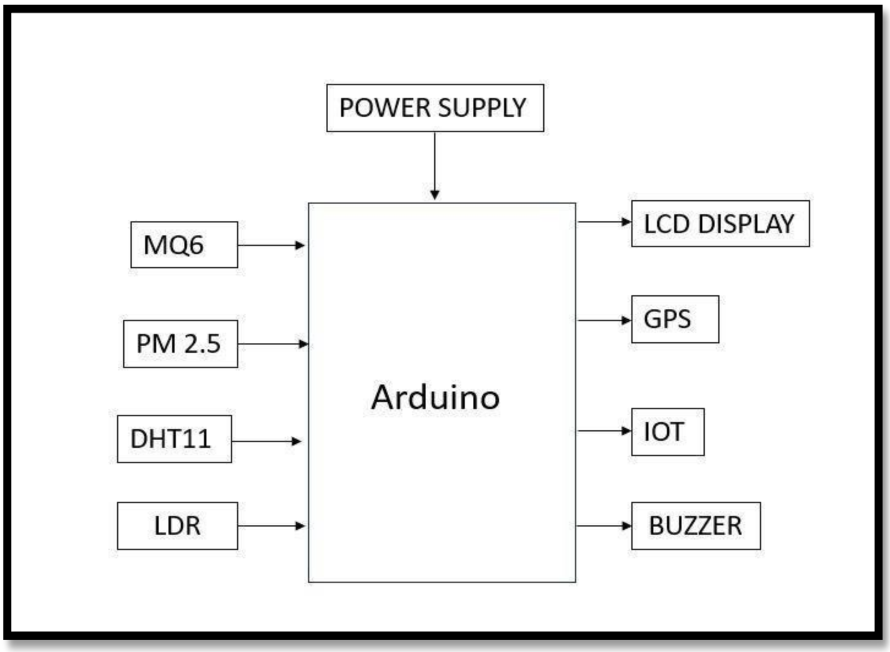


Fig 4.1: Proposed Block Diagram

Components

4.1.Sensor Node: This is the heart of the system, housing various sensors to measure air qualityparameters like:

- Particulate Matter (PM 2.5): Sensors like Nova Fitness SDS011 or Plan tower PMS5003 measure dust particles in the air.
- Gases (LPG and Butane): Electrochemical sensor like MQ6 and other can detect various gas concentrations.
- Temperature and Humidity: Sensors like DHT11 or BMP280 provide environmentaldata.

4.2. Microcontroller Unit (MCU): This processes sensor data, typically an Arduino Uno.

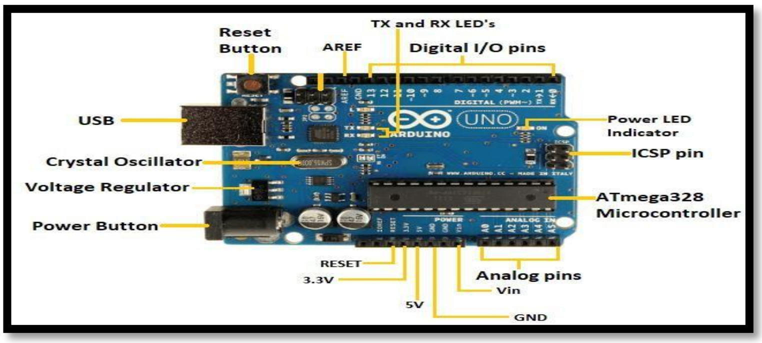


Fig 4.2: Microcontroller Unit (MCU)

4.3. Connectivity Module: This transmits data wirelessly to a central hub:

- Wi-Fi: For short-range, local network connections.
- Cellular: For wider coverage and remote monitoring.
- Lora WAN: Low-power, long-range option for large-scale deployments.

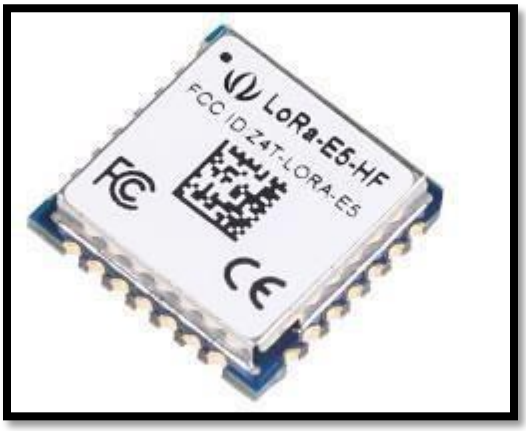


Fig 4.3: Connectivity Module

4.4. Cloud Platform: This stores, analyzes, and visualizes data:

- Telegram: Free, user-friendly platform for basic needs.
- Microsoft Azure IoT: Scalable and feature-rich platform for enterprise applications.
- Amazon Web Services (AWS) IoT Core: Another powerful option with various tools and services.

4.5.User Interface: This displays air quality data and insights:

- Mobile App: Provides real-time updates and notifications on smartphones.
- Web Dashboard: Offers detailed data visualization and analysis on desktops.

Fig 4.4: Mobile App.

Fig 4.5: Web Dashboard.

4.6.Power Supply: Consider your deployment location and desired functionality:

4.7. USB Power: Simple for indoor use with readily available power outlets.

4.8. Batteries: Suitable for portable or remote deployments but require regular replacement.

4.9. Solar Panels: Provide sustainable power for long-term outdoor deployments.

System Flow:

- Sensors collect air quality data at regular intervals.
- MCU processes and transmits data to the cloud platform.
- Cloud platform stores and analyzes data, calculating Air Quality Index (AQI).
- User interface displays AQI, historical trends, and potential health risks.
- Optional: Alerts can be triggered if pollution levels exceed safe limits.

Benefits:

- **Real-time monitoring**: Provides accurate and up-to-date information on air quality.
- **Scalability:** Can be easily expanded to cover wider areas with more sensors.
- **Data analysis**: Enables identification of pollution sources and trends.
- **Public awareness**: Raises awareness about air quality issues and empowers individuals tomake informed decisions.

Additional Considerations

- **Power source**: Choose a reliable power source for the sensor nodes, like solar panels orbatteries.
- **Data security**: Implement measures to protect sensitive data transmitted and stored in thecloud.
- **Calibration:** Regularly calibrate sensors to ensure accuracy of measurements.

With dedication and creativity, we can develop a valuable air quality monitor using IoT technologythat contributes to a healthier and more informed environment for yourself and your community.

4.10. Hardware Requirements

The following hardware is used in our project:

1. Arduino	6. LCD display
2. IOT module	7. Power Supply
3. MQ6 Sensor	8. GPS
4. PM2.5 Sensor	9. LDR
5. DHT11	10.Buzzer

4.10.1. ARDUINO:

Arduino is an open-source electronics platform that includes both hardware and software components. It is designed to be easy to use for hobbyists, artists, and anyone interested in creating interactive projects.

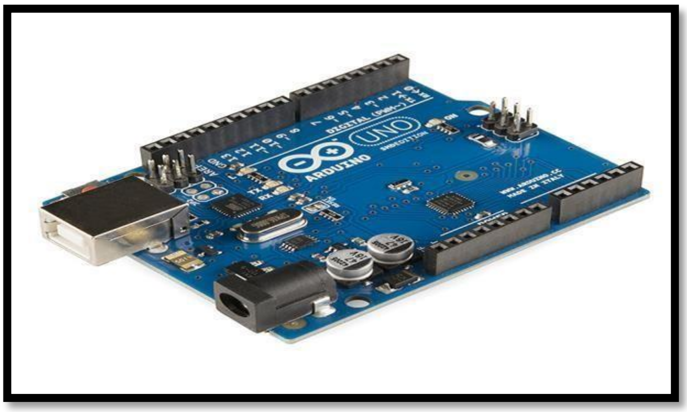


Fig 4.6: Arduino.

Arduino boards are microcontroller-based development boards that provide a platform for building and prototyping electronic projects. The most popular and widely used board is the Arduino Uno, but there are various other models catering to different needs.

The Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). 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 microcontroller; simply connect it to a computer with a USB cableor power it with a AC-to-DC adapter or battery to get started. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Features:

- 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 jacks
- 3An ICSP header
- A reset button

Applications

The Arduino Uno can be used for a variety of projects, including:

- Home automation
- Robotics
- Wearables
- Internet of Things (IoT)
- Environmental monitoring
- Data logging

4.10.2. IOT MODULE:

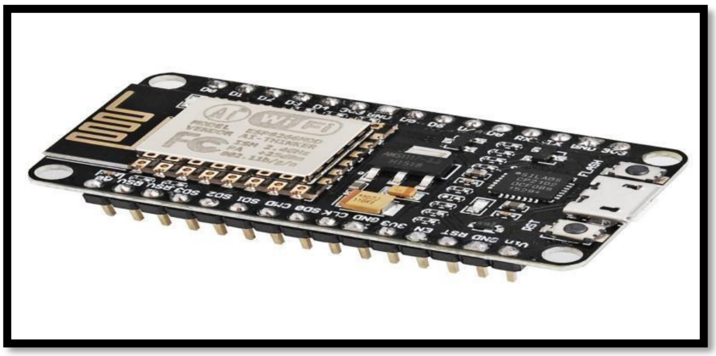


Fig 4.7: IOT Module.

The NodeMCU is a development board based on the ESP8266 Wi-Fi module. It is designed to facilitate the development of IoT (Internet of Things) projects by providing a convenient platform with built-in Wi-Fi capabilities. The NodeMCU development board is popular due to its ease of use, compatibility with the Arduino IDE, and affordable cost. The NodeMCU board typically includes a built-in LED that can be used for simple visual feedback during testing and development.

Here are key features and details about the NodeMCU development board:

ESP8266 Module:

The NodeMCU board is built around the ESP8266 Wi-Fi module, which includes a Ten silica-based microcontroller unit (MCU) and built-in Wi-Fi connectivity (802.11 b/g/n) The NodeMCU board features a USB-to-Serial converter (CH340 or CP2102) that allows easy programming and communication with the board using a USB cable.

The NodeMCU board provides a number of GPIO (General-Purpose Input/Output) pins, allowing users to connect sensors, actuators, and other electronic components to create IoT applications. The board can be powered using a micro-USB cable, and it supports a wide voltage range (typically 5V). The NodeMCU board can be programmed using the Arduino IDE, which is simplified the development process for users already familiar with Arduino programming.

There is a large and active community around the NodeMCU and ESP8266, providing a wealth of tutorials, documentation, and support for users. The NodeMCU firmware is a Lua-based firmware that can be used to program the ESP8266 directly in the Lua scripting language. However, many users prefer programming with the Arduino IDE using the ESP8266 Arduino core.

4.10.3. MQ6 Sensor

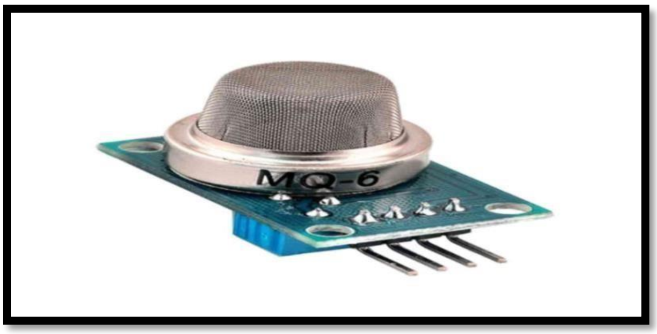


Fig 4.8: MQ6 Sensor.

MQ-6 Semiconductor Sensor for Combustible Gas. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.

Features

- Good sensitivity to Combustible gas in wide range
- High sensitivity to LPG, Propane and Hydrogen
- Long life and low cost
- Sensor Type - Semiconductor

4.10.4. PM2.5 Sensor

PM2.5 sensors, also known as fine particulate matter sensors, are devices used to measure the concentration of tiny particles in the air, specifically those with a diameter of 2.5micrometers or less. These particles are invisible to the naked eye and can pose significant health risks when inhaled.

Here are different types of PM2.5 sensors with images:

1. Optical particle counters:

Laser scattering: These sensors use a laser beam to illuminate the particles and measure theamount of light scattered by them. They are generally more accurate and expensive than other.

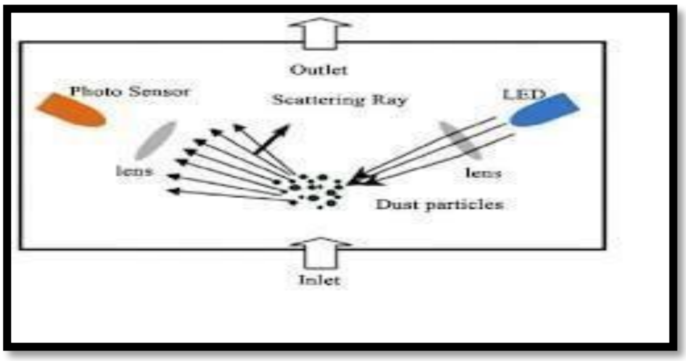


Fig 4.9: Laser scattering

Light scattering: These sensors use a LED light source to illuminate the particles and measure the amount of light scattered by them. They are less accurate than laser scattering sensorsbut are more affordable.

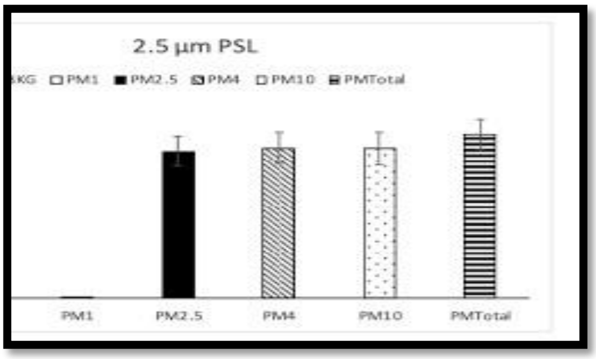


Fig 4.10: Light scattering

Electrochemical sensors: Metal oxide semiconductor (MOS): These sensors use a metal oxide film that changes its conductivity in response to the presence of PM2.5 particles. They are relatively inexpensive but can be less accurate and susceptible to interference from other gases.

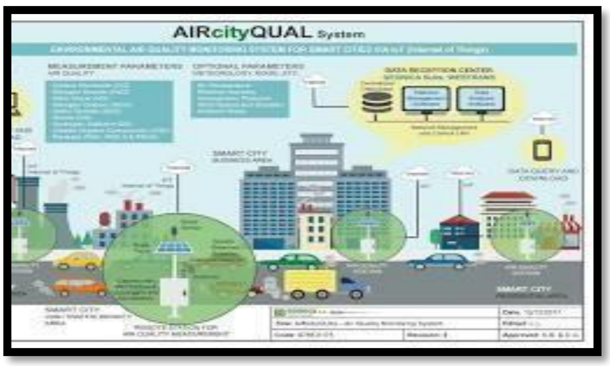


Fig 4.11: Electrochemical sensors

Piezoelectric sensors:

These sensors use a piezoelectric crystal that vibrates when exposed to PM2.5 particles. They are relatively new and still under development, but they offer the potential for high accuracyand low cost.

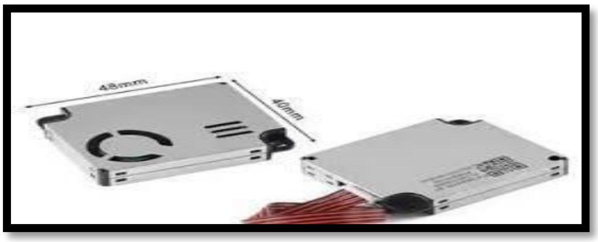


Fig 4.12: Piezoelectric sensor

Applications of PM2.5 sensors

1. Air quality monitoring: PM2.5 sensors are used to monitor air quality in homes, offices, and outdoor environments. This information can be used to assess health risks and take steps to improve air quality.

2. Air purifiers: Some air purifiers use PM2.5 sensors to monitor the air quality and adjust their settings accordingly.

3. Personal air quality monitors: Personal air quality monitors can be worn to track individual exposure to PM2.5. This information can be used to identify sources of pollution and take steps to reduce exposure.

4.10.5. DHT11

The DHT11 is a basic, digital temperature and humidity sensor. It is very affordable and easy to use, making it a popular choice for hobbyists and beginners. Here is an image of the DHT11.

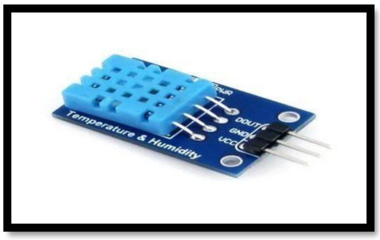


Fig 4.13: DHT11

The DHT11 has four pins:

1. VCC: Power supply (3.5V to 5.5V)
2. GND: Ground
3. DATA: Data output pin
4. NC: Not connected

The sensor uses a single data pin to communicate with a microcontroller. The data is transmitted serially, so you will need to use a library or code that supports this type of communication. Here are some of the specifications of the DHT11 sensor:

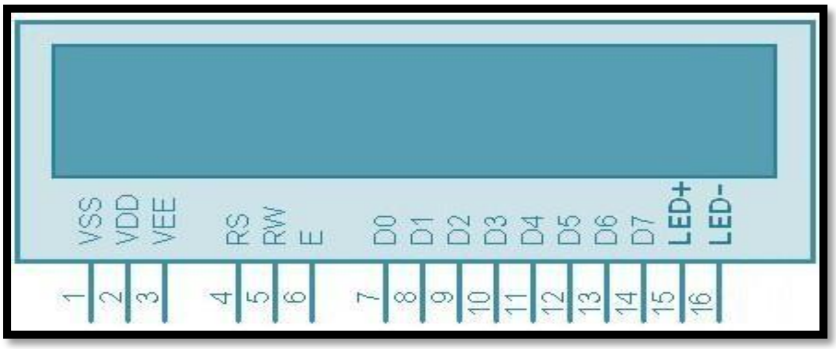
1. Operating voltage: 3.5V to 5.5V
2. Temperature measurement range: 0°C to 50°C
3. Temperature accuracy: ±2°C
4. Humidity measurement range: 20% to 80%
5. Humidity accuracy: ±5%

The DHT11 is a great sensor for measuring temperature and humidity in a variety of applications. It is small, low-cost, and easy to use, making it a popular choice for many projects.

4.10.6. LCD DISPLAY

Liquid Crystal Display also called as LCD is very helpful in providing user interface as well as for debugging purpose. The most commonly used LCDs found in the market today are 1Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controllers.

4.10.6.1. Pin Description



	Name	Description
1	VSS	Power supply (GND)
2	VCC	Power supply (+5V)
3	VEE	Contrast adjust
4	RS	0 = Instruction input 1 = Data input
5	R/W	0 = Write to LCD module 1 = Read from LCD module
6	EN	Enable signal
7	D0	Data bus line 0 (LSB)
8	D1	Data bus line 1
9	D2	Data bus line 2
10	D3	Data bus line 3
11	D4	Data bus line 4
12	D5	Data bus line 5
13	D6	Data bus line 6
14	D7	Data bus line 7 (MSB)
15	LED+	Back Light VCC
16	LED-	Back Light GND

Fig 4.14: LCD Pin Description

4.10.7. LCD INTERFACE WITH MICROCONTROLLER:

The LCD is generally interfaced in 8-bit mode or 4-bit mode. in this project LCD is connectedin 4-bit mode the interface connections of LCD with microcontroller are as follows

- RS of LCD is connected to p0.0 of microcontroller
- EN of LCD is connected to p0.1 of microcontroller
- D4 of LCD is connected to p0.4 of microcontroller
- D5 of LCD is connected to p0.5 of microcontroller
- D6 of LCD is connected to p0.6 of microcontroller
- D7 of LCD is connected to p0.7 of microcontroller

In 8-bit mode, the complete ASCII code is sent at once along with the control signals. But in 4-bit mode, the data is divided into two parts, i.e. MSB & LSB, and are called upper nibble & lower nibble. The control signals are RS, R/W & E. RS is used to select the internal registers i.e. data register & commandregister. . R/W is used to set the mode of LCD to read mode or write mode. E is used as chip select and is used to push the data internally to the corresponding registers.

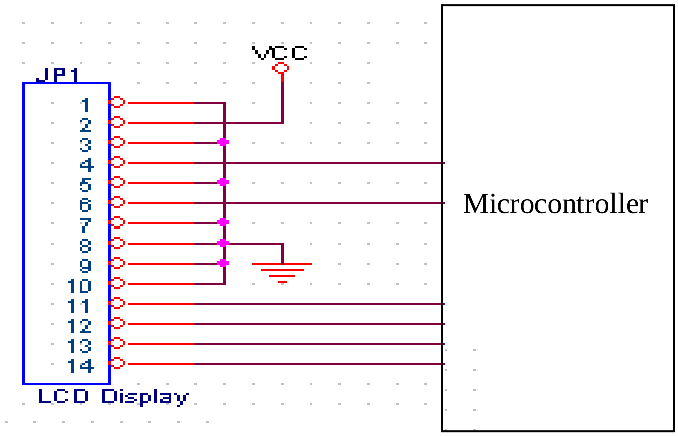


Fig 4.15: Microcontroller.

To transfer the data/command in 8-bit mode, the data is written to the 8-bit data bus after selecting the required register and setting the mode to write mode. The E signal pin is then given a high to low signal to transfer the data. To transfer the data/command in 4-bit mode, the higher nibble is first writtento the MSB of the data port and the E is given a high to low signal. After a little delay or when the LCD is not busy, the lower nibble is transferred in the same procedure.

4.10.8. Power Supply

In mains-supplied electronic systems the AC input voltage must be converted into a DC voltage with the right value and degree of stabilization. The common DC voltages that are requiredto power up the devices are generally in the range of 3 VDC to 30 VDC. Typically, the fixed typesof DC voltages are 5V, 9V, 12V, 15V and 18V DC.

4.10.8.1. POWER SUPPLY MODULES

- STEP DOWN TRANSFORMER
- BRIDGE RECTIFIER WITH FILTER
- VOLTAGE REGULATORS

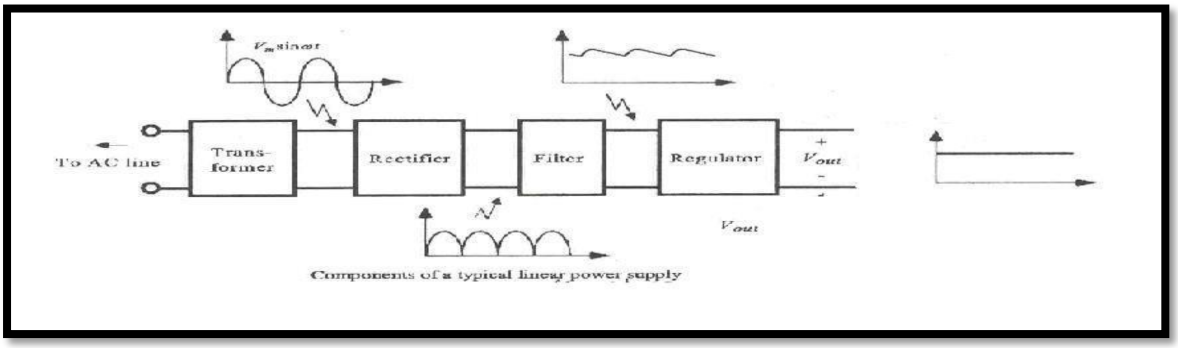


Fig 4.16: Power supply module

4.10.8.2. Transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step- up transformers increase voltage; step-down transformers reduce voltage.

A step-down power transformer is used to step down the AC voltage of 110 VAC or 220 VACS i.e., it converts higher voltage at the input side to a lower voltage at the output.

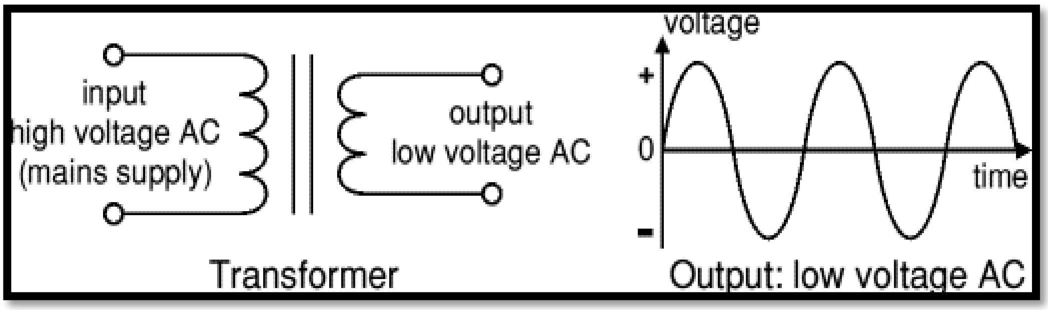
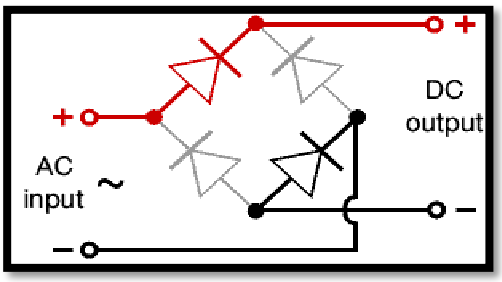


fig 4.17: Transformer.

4.10.8.3. Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC



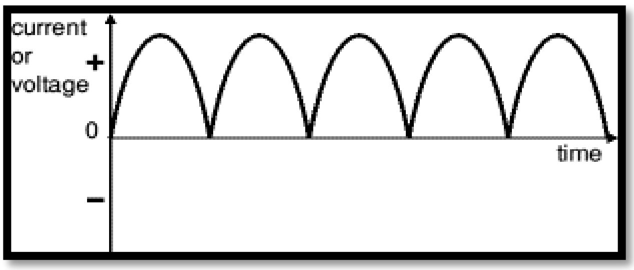


Fig 4.18: Bridge rectifier

Fig 4.19: Output: full-wave

4.10.8.4. Filter

Filtering is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from therectifier is falling. The diagram shows the unfiltered varying DC (dotted line) and the filtered DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges asit supplies current to the output.

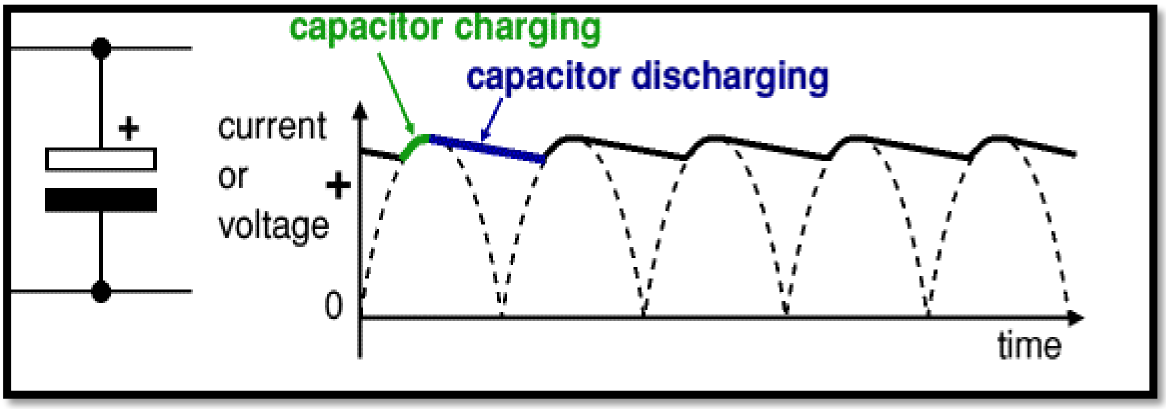


Fig 4.20: Filters

Typically 1000 µf capacitor is used in microcontroller of 8051.

4.10.8.5. Regulator:

This is a simple DC regulated supply project using 7805 voltage regulators to obtain a variable DC voltage range from 5V to 15V.

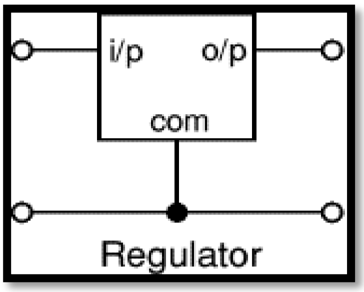


Fig 4.21: Regulator

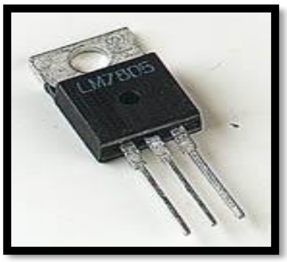


Fig 4.22: LM7805 Pinout Diagram

If you need other voltages than +5V, you can modify the circuit by replacing the 7805 chips with another regulator with different output voltage from regulator 78xx chip family.

4.10.8.6. GPS:

Global Positioning System (GPS) technology is changing the way we work and play. You can use GPS technology when you are driving, flying, fishing, sailing, hiking, running, biking, working, or exploring. With a GPS receiver, you have an amazing amount of information at your fingertips.

Here are just a few examples of how you can use GPS technology.

- Know precisely how far you have run and at what pace while tracking your path so you can findyour way home
- Pinpoint the perfect fishing spot on the water and easily relocate it
- Get the closest location of your favorite restaurant when you are out-of-town
- Find the nearest airport or identify the type of airspace in which you are flying

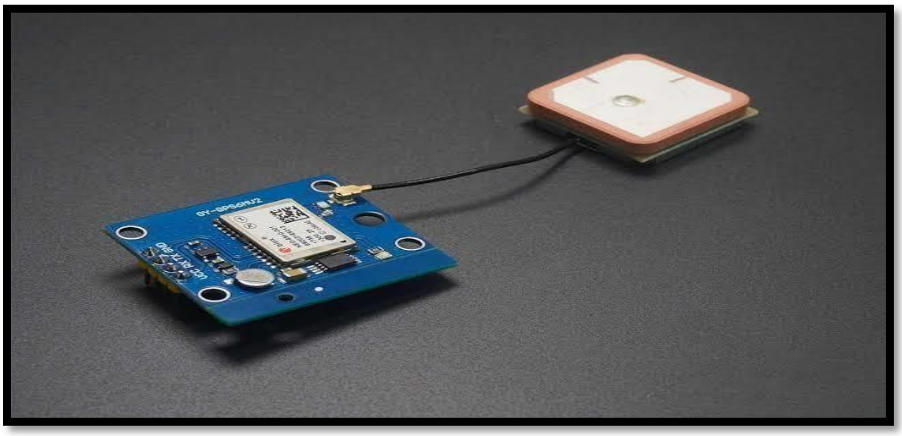


Fig 4.23: GPS.

The Global Positioning System (GPS) is a satellite-based navigation system that sends and receives radio signals. A GPS receiver acquires these signals and provides you with information. Using GPS technology, you can determine location, velocity, and time, 24 hours a day, in any weather conditions anywhere in the world—for free GPS, formally known as the NAVSTAR (Navigation Satellite Timing and Ranging) Global Positioning System, originally was developed forthe military.

The following points provide a summary of the technology at work:

- The control segment constantly monitors the GPS constellation and uploads information to satellites to provide maximum user accuracy.
- Your GPS receiver collects information from the GPS satellites that are in view.
- Your GPS receiver accounts for errors. For more information, refer to the Sources
- Your GPS receiver determines your current location, velocity, and time.
- Your GPS receiver can calculate other information, such as bearing, track, trip distance, distance to destination, sunrise and sunset time, and so forth.

6.9 . LDR

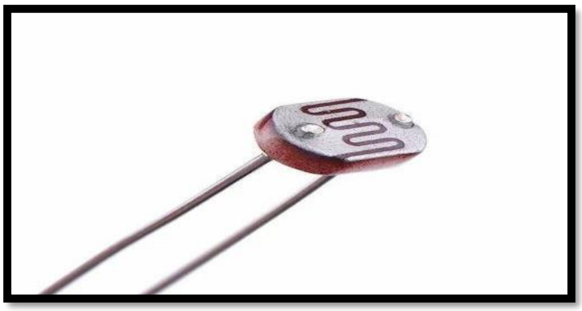


Fig 4.24: LDR

In air quality monitoring using IoT, LDR (Light Dependent Resistor) sensors detect ambientlight levels, indirectly indicating air quality. LDRs operate based on the principle of photoconductivity, where their resistance changes in response to incident light intensity.

As air quality worsens due to pollutants like smoke or smog, light penetration decreases, causing a decrease in LDR resistance. This change is measured and transmitted to an IoT system, alerting users to deteriorating air quality. Through continuous monitoring of LDR output, users can take timely actions to mitigate pollution levels, promoting healthier living environments and reducing health risks associated with poor air quality.

6.10 . BUZZER:

Fig 4.25: Buzzer

In air quality monitoring using IoT, buzzers play a crucial role in providing audible alerts to users regarding changes in air quality levels. Buzzers operate based on the principle of electromagnetic or piezoelectric vibration, where an electric signal causes a diaphragm to vibrate, producing sound waves. When sensors detect hazardous levels of air pollutants, the buzzer emits a loud sound, signaling the need for immediate attention. This audible feedback ensures that users arepromptly alerted to potential health risks, allowing for swift actions to mitigate exposure and improve air quality, enhancing overall safety and well-being in indoor and outdoor environments.

CHAPTER-5

RESULTS

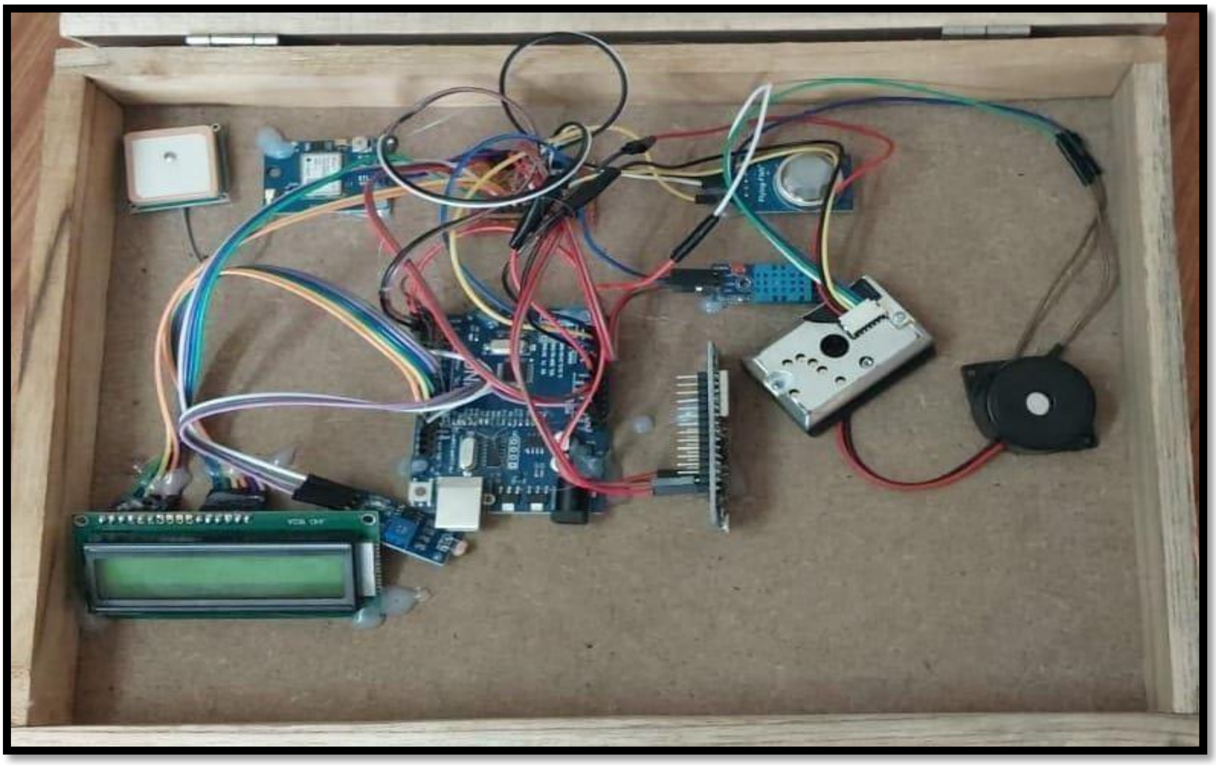


Fig 5.1. Circuit Connection Diagram

The above circuit diagram consists of combination of various sensors to Arduino and the information will be shared through IOT. The LCD Display will display all the outputs of various sensors.

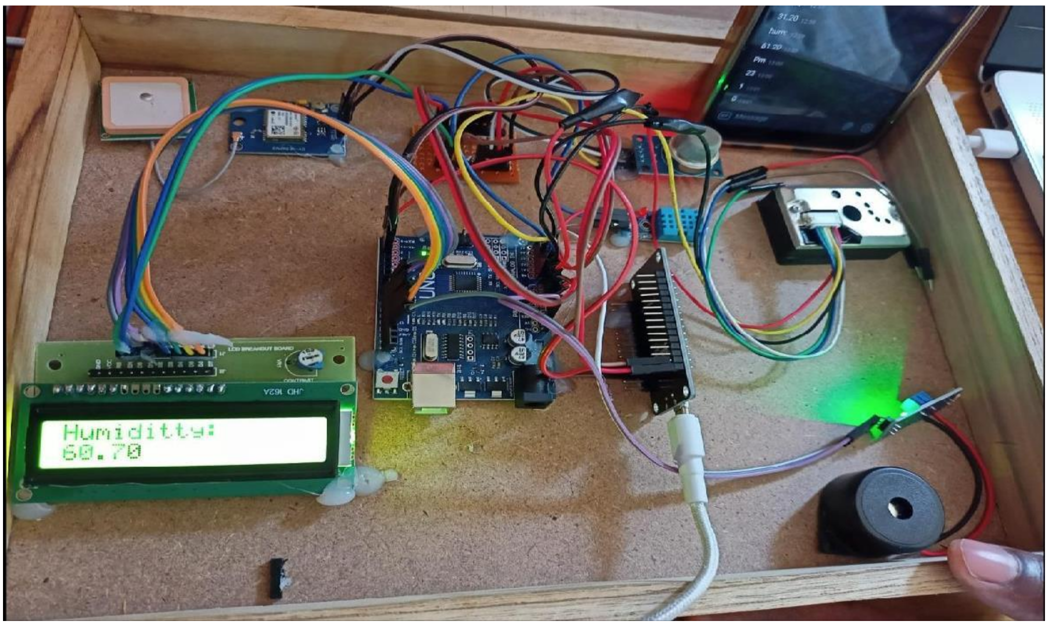


Fig 5.2. LCD Display of humidity Value

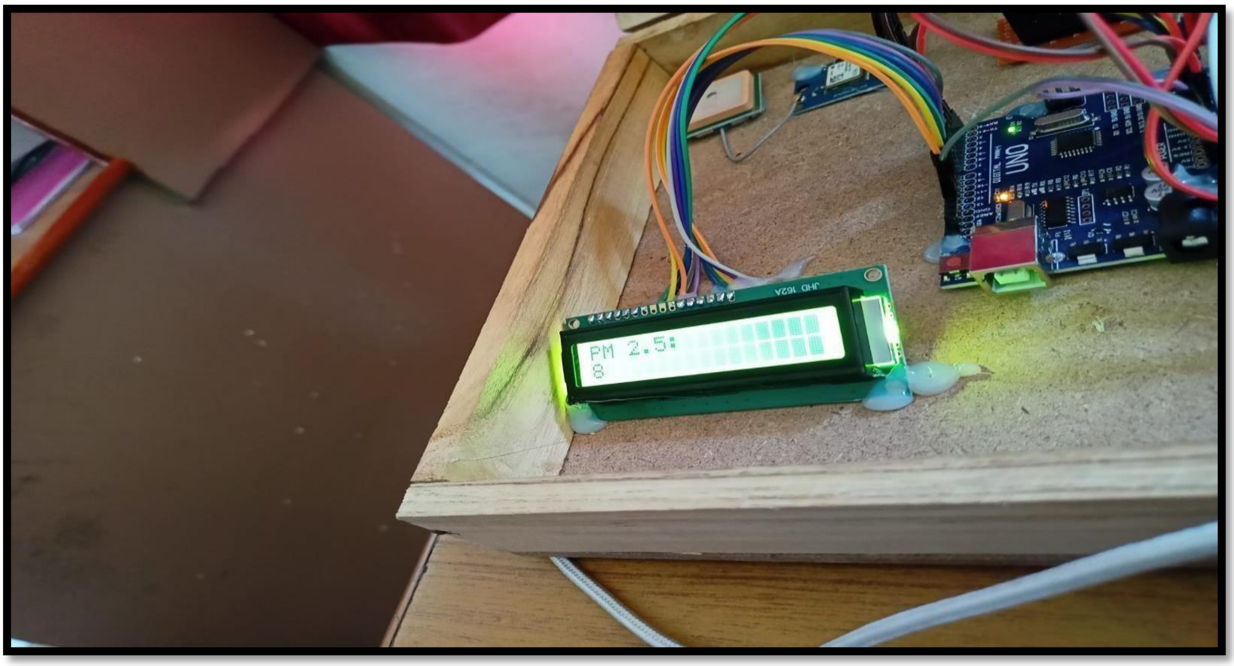


Fig 5.3. LCD Display of PM2.5 Particle Value

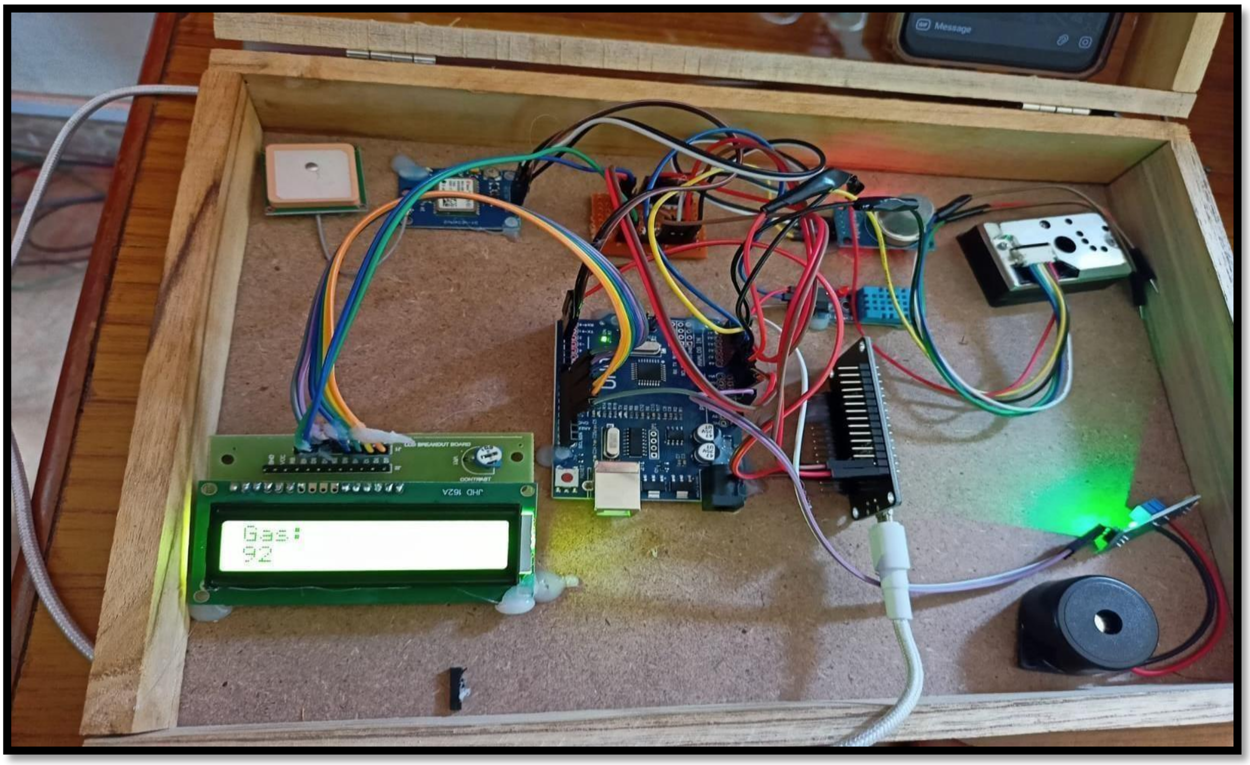


Fig 5.4. LCD Display of Co2 Value by using gas sensor

Fig 5.5. LCD Display of LDR Value

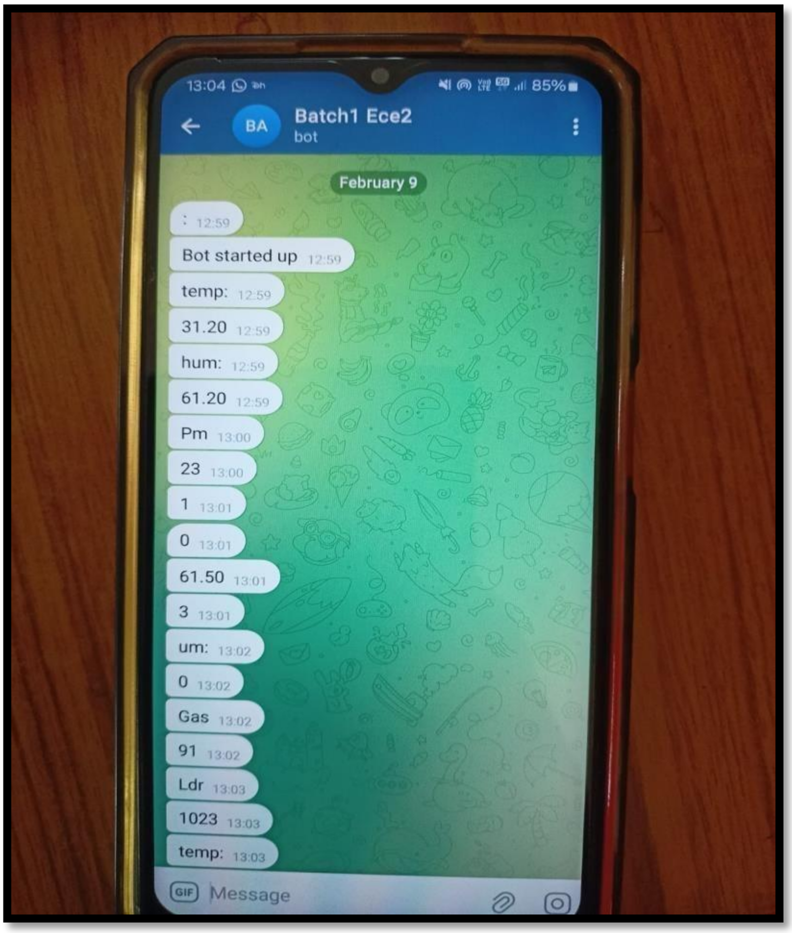


Fig 5.6. Displayed Values from Telegram Application

CHAPTER 6
CONCLUSION

The sensors used in this project include the MQ6, PM2.5, LDR, and DHT11, which measure temperature, humidity, CO2, LPG, and butane gas concentrations in the air, as well as dangerous PM2.5 particles in the surrounding area. The LDR sensor is also used to detect ambient light levels, which indirectly indicates air quality. Light penetration reduces and buzzer rings occur when air quality becomes contaminated by smoke or smog. An LCD display will be used to indicatethe figures for the temperature, humidity, gas concentrations, and PM2.5 particles. Every time the air concentration in our surroundings changes, Arduino and IOT will update the data. The tracking of airquality concentrations in particular locations is referred to as GPS. Light penetration reduces and buzzer rings occur when air quality becomes contaminated by smoke or smog. An LCD display willbe used to indicate the figures for the temperature, humidity, gas concentrations, and PM2.5 particles. Every time the air concentration in our surroundings changes, Arduino and IOT will update the data. The tracking of air quality concentrations in particular locations is referred to as GPS. Thus, we are able to determine whether the environment is clean or not. If the air is hazardous, a buzzer will sound and an alarm will be sent out. The primary goal of this project is for each person to adopt new behaviors by taking steps to protect the environment, avoid releasing dangerous gases into the atmosphere, and use fewer automobiles for both essential and village transportation. This means that if there are industries close to villages, the unexpected discharge of industrial gasses throughout thenight can cause many people to pass away from breathing. Therefore, by keeping this project's equipment in the hamlet, people can be saved from certain death by hearing the buzzer.

CHAPTER 7
FUTURE SCOPE

The future scope of air quality monitoring using IoT (Internet of Things) is promising, offering numerous opportunities for advancements in environmental monitoring, public health, and sustainability. Here are some key aspects of its future scope:

1) IoT-enabled sensors will continue to provide real-time data on air quality parameters such as particulate matter, gases, and volatile organic compounds (VOCs), allowing for timely interventions and better management of pollution sources.
2) Integration of IoT sensors into smart sensor networks will enable extensive coverage of air quality monitoring in urban and remote areas, facilitating comprehensive data collection and analysis for informed decision-making.
3) Air quality monitoring will be seamlessly integrated into smart city frameworks, enabling data-driven urban planning, traffic management, and policy development to mitigate pollution and enhance quality of life.
4) The development of mobile and wearable air quality monitoring devices integrated with IoT technology will empower individuals to monitor their personal exposure to pollutants in real-time, facilitating informed decision-making and behavior changes to reduce health risks.
5) IoT-based air quality monitoring platforms will facilitate community engagement and citizen science initiatives, empowering citizens to actively participate in monitoring local air quality, raising awareness, and advocating for policy changes. IoT-enabled air quality monitoring systems will support regulatory compliance and enforcement efforts by providing transparent, reliable, and verifiable data on pollution levels, enabling authorities to enforce environmental regulations effectively.
6) The integration of IoT-based air quality monitoring data with healthcare systems will facilitate better understanding of the health impacts of air pollution, enabling targeted interventions, public health initiatives, and policy advocacy to protect vulnerable populations.

Overall, the future of air quality monitoring using IoT holds great promise in improving environmental sustainability, public health, and quality of life by leveraging the power of connectivity, data analytics, and collaboration to address pressing environmental challenges.

CHAPTER 8
REFERENCES

[1] M. Cohen, North, R. Richards, J. Hose, N. Hassard,: “Mobile environmental sensing system to manage transportation and urban air quality”, Circuits and Systems, 2008. ISCAS 2008.The IEEE International Symposium on, pp. 1994 – 1997,May 2008.

[2] “Air pollution monitoring and GIS modelling”: Ang, A., a new use of nanotechnology based solid state gas sensors, Remote Sensing and GIS FoS,School of Advanced Technologies, Asian Institute of Technology , Thailand, 25th February 2005.

[3] Ch.V.Saikumar,M.Reji,P.C.Kishoreraja., “IOT based air quality monitoring system”, International Journal of Pure & Applied Mathematics, Vol 117, No. 9, pp. 53- 57,2017

[4] “Real- time Air Quality Monitoring Through Mobile Sensing in Metropolitan Areas”: by Devarakonda, from The Department of Computer Science , Rutgers University, NJ.

[5] “Design, characterization and management of a wireless sensor network for smart gas monitoring” by Jelicic V., Magno M., Paci G., Brunelli D.,and BeniniL :Advances in Sensors and Interfaces (IWASI), 2011 at the 4th IEEE International Workshop on, pp.115-120, 28-29 June 2011.

[6] Ch.V.Saikumar,M.Reji,P.C.Kishoreraja., “IOT based air quality monitoring system”, International Journal of Pure & Applied Mathematics, Vol 117, No. 9, pp. 53- 57,2017

[7] S.Muthukumar ,W.Sherine Mary :“IOT based air quality monitoring and controlsystem” in ICIRCA 2018.

[8] Gagan Parmar, Sagar Lakhani, Manju K. Chattopadhyay “An IOT based low cost airquality monitoring system” in RISE 2017.

[9] Dongyun Wang,Chenglong Jiang,Yongping Dan “Design of air quality monitoringsystem using internet of things” in SKIMA,2016.

[10] Chen Xiaojun ,Liu xianpeng,Xu Peng “IOT-Based air quality monitoring and forecasting system” in ICCCS,2015

APPENDIX-I

ARDUINO IDE

Arduino is a both an open-source software library and an open-source breakout board for the popular AVR micro-controllers. The Arduino IDE (Integrated Development Environment) isthe program used to write code, and comes in the form of a downloadable file on the Arduino website. The Arduino board is the physical board that stores and performs the code uploaded to it. Both the software package and the board are referred to as "Arduino". To begin, download the Arduino IDE from the Arduino website. Make sure to select the right version for your Operating System (OS). For a full getting started guide for each OS, please refer to the Arduino guide. Once the arduino.zip file has been downloaded, extract the file to a folder somewhere on your computer. There is no install simply open the folder and double click the .exe.

Fig (a): Arduino IDE

Key Features:

- Text editor: Write and edit your Arduino code.
- Compiler: Converts your code into a format that the Arduino board can understand.
- Uploader: Uploads your code to the Arduino board.
- Serial monitor: Allows you to communicate with your Arduino board from the IDE.
- Board manager: Install additional libraries and boards for extended functionality.

The Arduino IDE is open-source and available for Windows, macOS, and Linux. It plays a crucial role in the Arduino ecosystem, making it easy for users to develop projects using Arduino boards and a wide range of sensors and actuators.

APPENDIX-II

TELEGRAM APPLICATION USING IOT

Using Telegram with the Internet of Things (IoT) for air quality monitoring is a brilliant and practical idea. It allows us to remotely track our environment' s air quality and receive real-time updates right on our phone. Here's a breakdown of how it works:

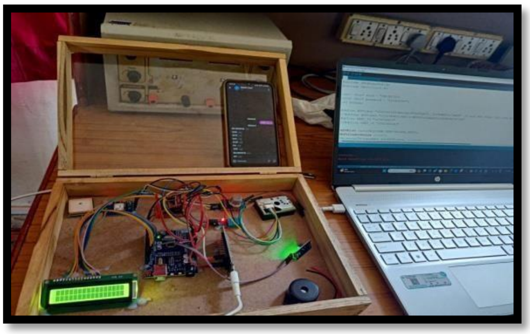


Fig (b): Telegram Application Using IOT.

Components:

1. Air quality sensors: These capture data on various pollutants like PM2.5 particles, LPGgas, Butane gas, Humidity and Temperature. Popular options include the MQ6, PM2.5, and DHT11.
2. Microcontroller board: This processes sensor data and transmits it to the cloud. Arduino Uno, ESP8266 are common choices.
3. Telegram bot: Sends air quality information and alerts to your Telegram app. You cancreate one using Bot Father or third-party services.

Process:

1. Sensor data collection: The sensors gather air quality readings at regular intervals.
2. Data processing: The microcontroller board cleans and formats the sensor data.
3. Data transmission: The data is sent to the cloud platform via Wi-Fi.
4. Data visualization: The cloud platform stores and visualizes the data over time. You canaccess it through a web dashboard.
5. Telegram notifications: The Telegram bot retrieves data from the cloud and sends youalerts if air quality levels exceed safe limits.

Benefits:

1. Remote monitoring: Track air quality from anywhere with an internet connection.
2. Real-time alerts: Get notified instantly when pollution levels rise.
3. Data visualization: Analyze air quality trends over time
4. Actionable insights: Take steps to improve indoor air quality, like opening windows orusing air purifiers.