

SMART AIR AND WATER QUALITY MONITORING SYSTEM USING ARDUINO SENSOR

Submitted in partial fulfillment of the requirements for the award of a Bachelor of
Technology degree in Biotechnology.

By

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DEPARTMENT OF BIOTECHNOLOGY

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

CATEGORY -1 UNIVERSITY BY UGC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Swasti Swati (41230065)** and **Tanisha Sutradhar (41230068)** who carried out the project entitled **"SMART AIR AND WATER QUALITY USING ARDUINO SENSOR"** under supervision from

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Internal Examiner

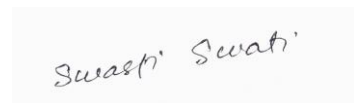
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DECLARATION

I, **SWASTI SWATI** hereby declare that the project report entitled “**SMART AIR AND WATER WATER QUALITY USING ARDUINO SENSOR**” is done by me under the guidance of **Dr. PRAKASH** at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of requirements for the award of Bachelor of Technology degree in biotechnology.

Date: 08.05.2024

Place: Chennai

A rectangular box containing a handwritten signature in cursive script that reads "Swasti Swati".

Signature of the candidate:

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ABSTRACT

This Project investigates air and water quality monitoring systems based on arduino sensors. Due to the rapid development and urbanization, the quality of air and water is degrading year by year, and it leads to air-borne diseases, water-borne diseases, and it creates a bad impact. Water plays a vital role in our human society and India 65% of the drinking water comes from underground sources, so it is mandatory to check the quality of the water. In this model it is used to test the air as well as water samples and through the data it analyzes the quality of the air and water. This Project delivers a power efficient, effective solution in the domain of air and water quality monitoring; it also provides an alarm to a remote user, if there is any deviation of air and water quality parameters.

The degradation of water resources and air pollution has become a common problem. The conventional methods of monitoring involve the manual collection of water and air samples from different locations. These samples are tested in the laboratory using rigorous skills. Such approaches are time-consuming and are no longer to be considered to be efficient. Moreover, the current methodologies include analyzing various kinds of parameters of quality such as physical and chemical. The old method of quality detection and communication is time-consuming, low precision and costly. Therefore, there is a need for continuous monitoring of water and air quality parameters in real time. By focusing on the above issues, a low-cost monitoring system is used that can monitor air and water quality in real time using an arduino sensor. Each device has a unique identification and must be able to capture real-time data autonomously. In the system, water quality parameters are measured by different sensors such as pH, turbidity, dissolved oxygen, temperature, CO2 level and Air quality for communicating data onto a platform via an arduino microcontroller based system

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CHAPTER 1

INTRODUCTION

Traditionally, pollution measurements are performed using expensive equipment at fixed locations or dedicated mobile equipment laboratories. The automatic air quality monitoring system using Arduino can save cost and is easy to access. The project that we have undertaken has helped us gain a better perspective on various aspects related to our course of study as well as practical knowledge of electronic equipment and communication. Moreover, the project of air quality monitoring system has achieved to monitor and prevent the effect of high temperature and dusty air on the child and human just like the objective of the project needed.

Water is one of the essential natural resources that has been gifted to mankind. But the rapid development of the society and numerous human activities speeded up the contamination and deteriorated the water resources. For above water quality monitoring is necessary to identify any changes in water quality parameters from time-to-time to make sure its safety in real time. The Central Pollution Control Board (CPCB) has established a series of monitoring stations on water bodies across the country which monitor the water quality on either a monthly or yearly basis. This is done to ensure that the water quality is being maintained or restored at the desired level. It is important that it is monitored on a regular basis. Water quality monitoring helps in evaluating the nature and extent of pollution control required, and effectiveness of pollution control measures.

As our project is based on an Arduino sensor, a type of sensor that is compatible with Arduino microcontrollers and can be easily integrated into Arduino-based projects. Arduino sensors come in various types and functionalities, each designed to measure specific physical parameters such as temperature, humidity, light intensity, motion, gas concentration, sound, and more.

These sensors typically consist of a sensing element, signal conditioning circuitry, and a connector that allows them to be connected to an Arduino board.

Arduino sensors are commonly used in DIY electronics, robotics, home automation, IoT applications, and scientific experiments. They play a crucial role in collecting real-world data and interfacing with the Arduino microcontroller, which then processes the sensor data and performs various actions based on programmed instructions.

Arduino sensors are typically interfaced with Arduino boards using digital or analog pins, and their output can be read and processed using Arduino programming languages like C/C++. They provide a cost-effective and versatile way to add sensing capabilities to Arduino projects

The escalating concern over environmental pollution and its detrimental effects on human health has underscored the urgent need for effective monitoring of air and water quality. In this context, Arduino microcontrollers have emerged as a versatile platform for developing smart monitoring systems. By leveraging Arduino-compatible sensors for **air quality** (such as gas sensors and particulate matter sensors) and **water quality** (including pH sensors and turbidity sensors), this project aims to design, implement, and evaluate a comprehensive monitoring system. The objectives encompass hardware design, software development for data acquisition and analysis, connectivity setup for remote access, and rigorous performance evaluation. The significance of this work lies in its potential to provide actionable environmental data, empower decision-makers, and promote sustainable environmental management practices.

This project aims to design and implement a smart air and water quality monitoring system using Arduino sensors. The system will be capable of real-time data collection, analysis, and visualization, providing valuable insights into environmental conditions. It can detect the temperature and dust density and besides that it will send alerts to the user when detecting the air quality is unhealthy. Focusing on the device produced, it detects high temperature and senses the dusty air immediately. Once the sensitivity is high, the buzzer module will activate to alert the user.

CHAPTER 2

LITERATURE SURVEY

Nikhil Kedia, in his paper titled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project" presented at the 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) in Dehradun, India, delves into comprehensive water quality monitoring techniques. The paper discusses sensors, embedded design, information dissemination processes, and the collaborative efforts of government, network operators, and local communities in ensuring effective information dissemination. It also explores the realm of Sensor Cloud technology. While fully automating water quality improvement remains a challenge, leveraging technology efficiently alongside economic practices can enhance water quality and raise awareness among communities.

Jayti Bhatt and Jignesh Patoliya's work titled "Real-Time Water Quality Monitoring System " advocates for continuous monitoring of water quality, particularly for safe drinking water. They propose an innovative Internet of Things (IoT)-based approach for real-time water quality assessment. Their system utilizes various sensors to measure parameters such as pH, turbidity, conductivity, dissolved oxygen, and temperature. These sensor readings are processed by a microcontroller and transmitted wirelessly to a central controller (Raspberry Pi) using Zigbee protocol. The data is then accessible via a cloud-based internet browser application, facilitating real-time monitoring and management.

Michal Lom, Ondrej Pribyl, and Miroslav Svitek explore the convergence of Industry 4.0 and Smart Cities in their paper "Industry 4.0 as a Part of Smart Cities." They highlight the interplay between these concepts, emphasizing the need for sustainable urban models and enhanced quality of life. The paper underscores the multidimensional nature of smart city initiatives, encompassing not just technical aspects but also

Zhanwei Sun, Chi Harold Li, Chatschik Bisdikian, Joel W. Branch, and Bo Yang's work on "QOI-Aware Energy Management in Arduino microcontroller Sensory Environments" focuses on optimizing energy usage in environments while maintaining Quality of Information (QOI). They propose a framework that dynamically manages energy resources based on sensor capabilities and task requirements, minimizing energy consumption without compromising data quality. Their case study on water level monitoring demonstrates the effectiveness of their algorithms in achieving energy efficiency and maintaining QOI levels.

Sokratis Kartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann's paper "Adaptive Edge Analytics for Distributed Networked Control of Water Systems" introduces a burst detection and localization scheme for water distribution networks. By combining compression techniques, anomaly detection, and graph analytics, they reduce communication overhead and accurately pinpoint water burst events. Their approach significantly reduces communication overhead compared to traditional reporting methods, showcasing the potential for efficient water network management.

These studies collectively contribute to advancing water quality monitoring and management practices, incorporating cutting-edge technologies and interdisciplinary approaches to address the challenges faced in ensuring clean and safe water resources.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 AIM OF THE PROJECT:

It aims to accurately measure and monitor the levels of various pollutants and contaminants in the environment by providing real-time data on environmental quality, identifying pollution sources and assessing the potential health risks.

3.2 SCOPE OF THE PROJECT:

The scope of the "Smart Air and Water Quality Monitoring System using Arduino Sensor" project encompasses a comprehensive approach to addressing environmental monitoring challenges. This includes designing and integrating Arduino-compatible sensors for measuring crucial air quality parameters like particulate matter, as well as water quality parameters such as pH and turbidity.

The Air and Water quality monitoring will be useful to determine the pollution level of the air and water and can thus help the government agencies to take necessary actions. This system collects data about the air and water quality and determines its purity.

- **Air quality monitoring circuit assembly:**

The Air Quality Monitoring system will check the temperature and ppm value of air at the given location. The sensors in the circuits will check the ppm value of air i.e.

it will check the value of suspended particles in the air.

- **Water quality monitoring assembly:**

The Water Quality monitoring system will check the turbidity of water for the given sample. Turbidity sensor detects water quality by measuring the levels of turbidity. It uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water.

3.3 Present investigation

- **Hardware Design and Integration:** Designing and integrating Arduino-compatible sensors for measuring air quality parameters (e.g., gas concentration, particulate matter) and water quality parameters (e.g., pH, turbidity) into a cohesive monitoring system.
- **Software Development:** Developing software algorithms for data acquisition, processing, and visualization to enable real-time monitoring and analysis of environmental data collected by the sensors.
- **Real-Time Data Monitoring:** Creating a user-friendly interface for monitoring air and water quality data in real-time, providing insights into environmental conditions.
- **Documentation and Reporting:** Documenting the system design, implementation details, software code, test results, and user manuals to facilitate understanding, replication, and further development of the monitoring system.
- **Performance Evaluation:** Conducting thorough testing and evaluation of the system's performance in terms of accuracy, reliability, responsiveness, and usability under various environmental conditions.

CHAPTER 4

EXPERIMENTAL OR MATERIALS AND METHODS USED, ALGORITHMS USED

4.1 METHODOLOGY:

- Determine the specific parameters you want to monitor (e.g., pollutants, particulate matter, pH levels) and the locations where monitoring will occur.
- Sensor Selection: Choose appropriate sensors for measuring air and water quality parameters. Consider factors like accuracy, sensitivity, durability, and compatibility with the monitoring platform.
- Data Transmission: Decide how sensor data will be transmitted to a central database or monitoring platform. Options include Wi-Fi, cellular networks for remote locations.
- Data Processing: It develops algorithms to process raw sensor data and derive meaningful insights. This may involve filtering noise, calibrating sensors, and analyzing trends over time.
- User Interface: It designs a user-friendly interface for accessing and visualizing air and water quality data. This could be a web portal, mobile app, or dashboard that provides real-time updates and historical trends. Its Alert System implements an alert system to notify users of any abnormal readings or potential health risks. Alerts can be sent via email, SMS, or push notifications.
- Integration that Integrates the monitoring system with existing environmental monitoring networks or government agencies for data sharing and collaboration.
- Testing and Validation: Conduct thorough testing of the monitoring system to ensure accuracy, reliability, and compliance with regulatory standards. Deployment that Install sensors at designated monitoring locations and ensure proper calibration and maintenance procedures are followed then it can
- Maintenance and Upgrades which establish a schedule for regular maintenance and calibration of sensors, as well as updates to the monitoring system software and hardware.
- Develop a program in the Arduino IDE that reads the analog value from the arduino sensor and outputs it via the Serial Monitor. This program should continuously monitor the data and provide real-time feedback for analysis
- Arduino software is used to read the board that connects to the laptop while the Processing software is used to generate the output. The processing code enables the display of an Arduinoscope which shows the output.

- Visualizations are created to illustrate some changes over time and quality impact points using Arduino Sensor.
- Results are compiled into a comprehensive report, including methodology, analysis, conclusions, and recommendations.

By following these steps, we can create an effective smart air and water quality monitoring system to help protect public health and the environment.

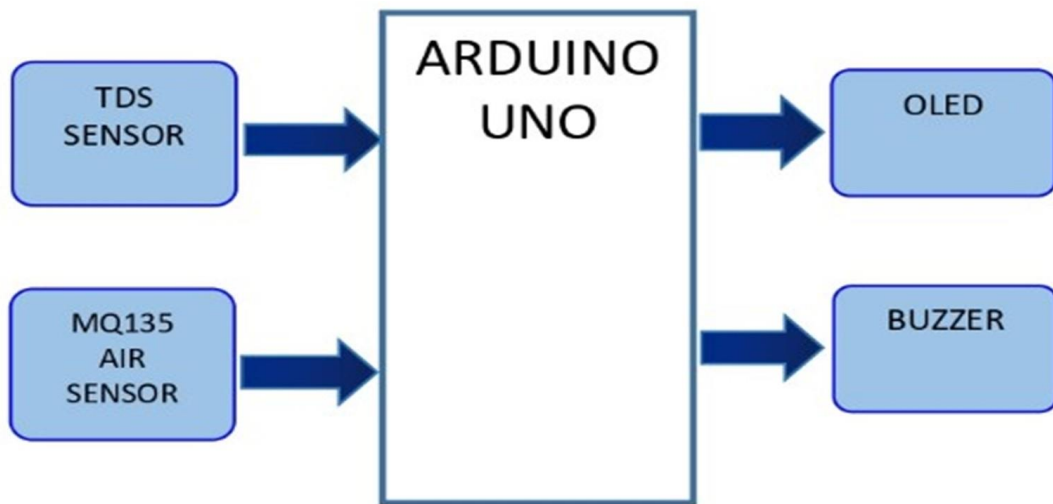


Fig:4.1:BLOCK DIAGRAM

4.2 COMPONENTS:

The components that are used in this project are:

- MQ135(Air Sensor)
- TDS Sensor
- Arduino UNO
- Jumper Wires
- Bread Board

Now let us see the description and working of all components individually.

COMPONENTS USED

4.2.1 MQ135 (AIR SENSOR)

MQ135 is an air quality sensor that can detect a wide range of gasses, including NH_3 , alcohol, smoke, carbon dioxide, and benzene. And, hence ideal for offices, industries or factories, or workplaces. The MQ135 gas sensor has an acute sensitivity to Ammonia, Sulfide, smoke, and other toxic gasses. Because of its low cost, it is suitable for air quality monitoring applications. The MQ135 alcohol sensor comprises a tin dioxide (SnO_2), a perspective layer inside aluminum oxide micro-tubes (measuring electrodes), and a heating element inside a tubular casing. There is an enclosed stainless steel net at the end face of the sensor and the backside holds the connection terminals. When the ethyl alcohol smoke appears at the sensitive layer of the tin dioxide, the resistance decreases.

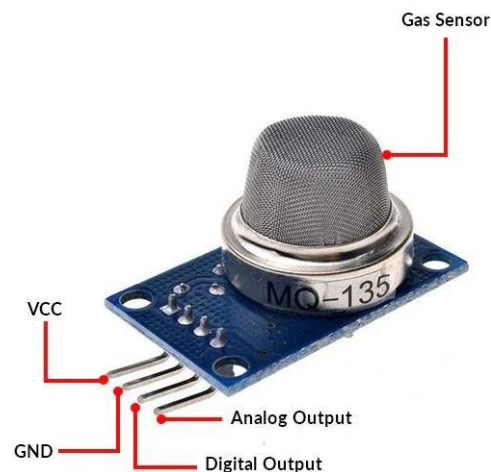


Fig:4.2:MQ135 (AIR SENSOR)

4.2.2 TDS Sensor

A TDS meter is a small hand-held device used to indicate the Total Dissolved Solids in a solution, usually water. Since dissolved ionized solids, such as salts and minerals, increase the conductivity of a solution.

A TDS meter measures the conductivity of the solution and estimates the TDS from that reading. TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids are dissolved in one liter of water.

In general, the higher the TDS value, the more soluble solids are dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one reference point for reflecting the cleanliness of the water. This can be applied to domestic water, hydroponic and other fields of water quality testing and monitoring. So, in this project, we will interface Gravity Analog TDS Sensor with an Arduino Microcontroller and read the value in 16×2 LCD Display. Since TDS Value depends upon the temperature. So will also add DS18B20 Waterproof Temperature Sensor to measure Water Temperature. The measured temperature is used with TDS Sensor to compensate for the reading with high calibration and high accuracy. TDS is an abbreviation for Total Dissolved Solids in a liquid, including organic and inorganic substances in a molecular, ionic, or micro-granular suspended form. TDS is generally expressed in parts per million (ppm) or as milligrams per liter (mg/L). TDS is directly related to the quality of water i.e., the lower a TDS figure, the purer the water. As an example, reverse osmosis purified water will have a TDS between 0 and 10, whereas tap water will vary between 20 and 300, depending on where you live in the world.

The materials that constitute dissolved solids in water include materials such as minerals, salts, anionic and cationic substances. They can also include pollutants such as heavy metals, and other substances such as organic materials that may have leaked into your water supply system. The water contains no soluble materials and is pure, it will not conduct a charge and will, therefore, have a 0 ppm figure. Conversely, if the water is full of dissolved materials, it will conduct a charge, with the resulting ppm figure being proportional to the number of dissolved solids. This is because all dissolved solids have an electrical charge, which allows conduction of electrical charge between the electrodes.

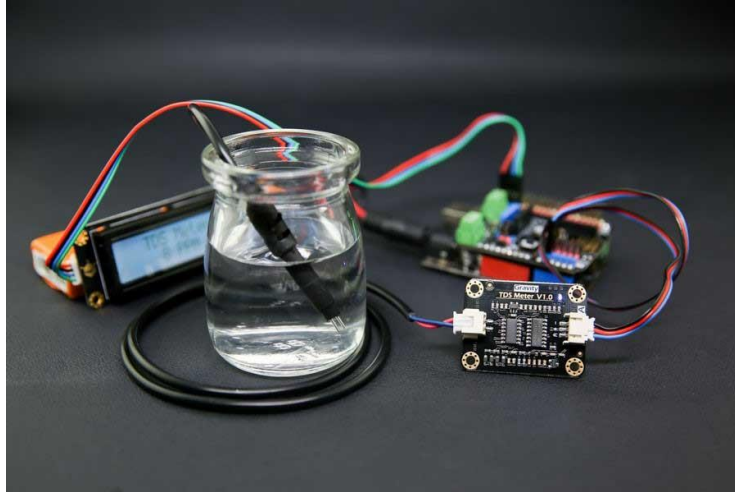


Fig:4.3:TDS Sensor

4.2.3 ARDUINO

Arduino contain a number of different parts and interfaces together on a single circuit board. The design has changed through the years, and some variations include other parts as well. But on a basic board, you're likely to find the following pieces:

A number of pins, which are used to connect with various components you might want to use with the Arduino. These pins come in two varieties: Digital pins, which can read and write a single state, on or off. Most Arduino have 14 digital I/O pins. Analog pins, which can read a range of values, and are useful for more fine-grained control. Most Arduino have six of these analog pins. These pins are arranged in a specific pattern, so that if you buy an add-on board designed to fit into them, typically called a “shield,” it should fit into most Arduino - compatible devices easily.

A power connector, which provides power to both the device itself, and provides a low voltage which can power connected components like LEDs and various sensors, provided their power needs are reasonably low. The power connector can connect to either an AC adapter or a small battery.

A microcontroller, the primary chip, which allows you to program the Arduino in order for it to be able to execute commands and make decisions based on various input. The exact chip varies depending on what type of Arduino you buy, but they are generally Atmel controllers, usually an ATmega8, ATmega168, ATmega328, ATmega1280, or ATmega2560. The differences between these chips are subtle, but the biggest difference a beginner will notice is the different amounts of onboard memory.

A serial connector, which on most new boards is implemented through a standard USB port. This connector allows you to communicate to the board from your computer, as well as load new programs onto the device. Oftentimes Arduino can also be powered through the USB port, removing the need for a separate power connection.

A variety of other small components, like an oscillator and/or a voltage regulator, which provide important capabilities to the board, although you typically don't interact with these directly; just know that they are there. Arduino Uno R3 board with ATmega328P MCU in DIP-28 package.

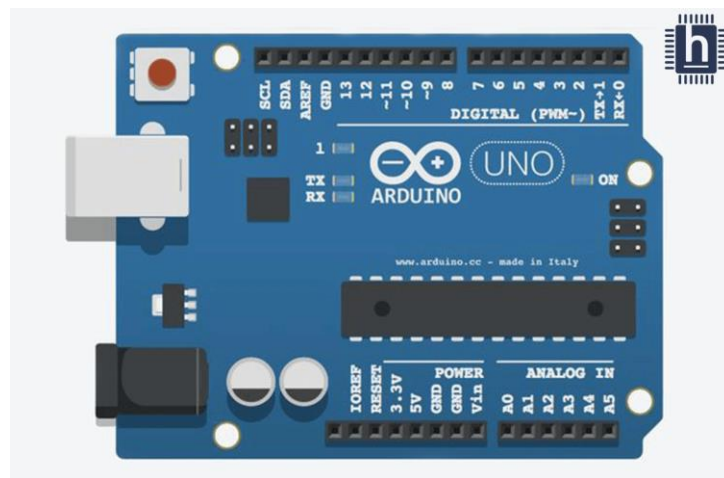


Fig:4.4:ARDUINO

Power Sources

USB connector. USB bus specification has a voltage range of 4.75 to 5.25 volts. The official Uno boards have a USB-B connector, but 3rd party boards may have a mini USB / USB-C connector.

5.5mm/2.1mm barrel jack connector. Official Uno boards support 6 to 20 volts, though 7 to 12 volts is recommended. The maximum voltage for 3rd party Uno boards varies between board manufacturers because various voltage regulators are used, each having a different maximum input rating. Power into this connector is routed through a series diode before connecting to VIN to protect against accidental reverse voltage situations.

VIN pin on shield header. It has a similar voltage range of the barrel jack. Since this pin doesn't have reverse voltage protection, power can be injected or pulled from this pin.

When supplying power into the VIN pin, an external series diode is required in case the barrel jack is used. When the board is powered by a barrel jack, power can be pulled out of this pin.

4.2.4 Jumper wire

Jumper wires are essential components in Arduino-based projects and electronics prototyping in general. They are used to create electrical connections between different components such as sensors, LEDs, motors, and the Arduino board itself. Jumper wires play a crucial role in the rapid development, testing, and modification of electronic circuits, making them an essential tool for makers, hobbyists, and engineers working with Arduino and other microcontroller-based systems.

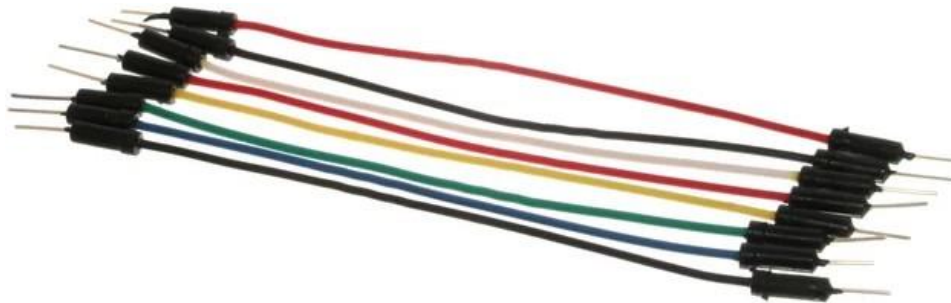


Fig:4.5:JUMPER WIRE

4.2.5 Breadboard

A breadboard is a reusable plastic board with rows and columns of interconnected metal tie points. Components with leads can be inserted into holes on the board to create electrical connections without soldering. Breadboards are used for prototyping and testing electronic circuits, offering a convenient and versatile platform for experimentation and troubleshooting before finalizing designs on printed circuit boards (PCBs).

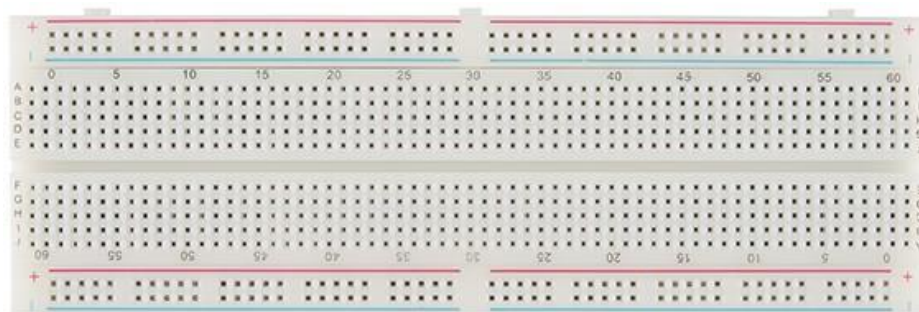


Fig:4.6:BREADBOARD

4.3 EXPERIMENTAL ALGORITHM:

```
1  #include <Arduino.h>
2  #include <Wire.h>
3  #include <EEPROM.h>
4  #include <WiFi.h>
5  #include <OneWire.h>
6  #include <DallasTemperature.h>
7  #include <Adafruit_ADS1015.h>
8  #include <DFRobot_ESP_EC.h>
9  #include <Adafruit_GFX.h>
10 #include <Adafruit_SSD1306.h>
11
12 #define SCREEN_WIDTH 128 // OLED display width, in pixels
13 #define SCREEN_HEIGHT 64 // OLED display height, in pixels
14
15 // Declaration for an SSD1306 display connected to I2C (SDA, SCL pins)
16 Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);
17
18 #define ONE_WIRE_BUS 14 // this is the gpio pin 13 on esp32.
19 OneWire oneWire(ONE_WIRE_BUS);
20 DallasTemperature sensors(&oneWire);
21
22 DFRobot_ESP_EC ec;
23 Adafruit_ADS1115 ads;
24 float voltage, ecValue, temperature = 25;
25
26 String apiKey = "*****"; // Enter your Write API key from ThingSpeak
27
28 const char *ssid = "*****"; // replace with your wifi ssid and wpa2 key
29 const char *pass = "*****";
30 const char* server = "api.thingspeak.com";
```

```
30 const char* server = "api.thingspeak.com";
31 WiFiClient client;
32 void setup()
33 {
34   Serial.begin(115200);
35   EEPROM.begin(32); //needed EEPROM.begin to store calibration k in eeprom
36   ec.begin();
37   sensors.begin();
38   if (!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) { // Address 0x3D for 128x64
39     Serial.println(F("SSD1306 allocation failed"));
40     for (;;);
41   }
42   delay(2000);
43   display.clearDisplay();
44   Serial.println("Connecting to ");
45   Serial.println(ssid);
46
47   WiFi.begin(ssid, pass);
48   while (WiFi.status() != WL_CONNECTED)
49   {
50     delay(500);
51     Serial.print(".");
52   }
53   Serial.println("");
54   Serial.println("WiFi connected");
55 }
56 void loop()
57 {
58   voltage = analogRead(A0); // A0 is the gpio 36
59   sensors.requestTemperatures();
```

```

58 voltage = analogRead(A0); // A0 is the gpio 36
59 sensors.requestTemperatures();
60 temperature = sensors.getTempCByIndex(0); // read your temperature sensor to execute temperature compens.
61 ecValue = ec.readEC(voltage, temperature); // convert voltage to EC with temperature compensation
62 Serial.print("Temperature:");
63 Serial.print(temperature, 2);
64 Serial.println("°C");
65
66 Serial.print("EC:");
67 Serial.println(ecValue, 2);
68
69 display.setTextSize(2);
70 display.setTextColor(WHITE);
71
72 display.setCursor(0, 10);
73 display.print("T:");
74 display.print(temperature, 2);
75 display.drawCircle(85, 10, 2, WHITE); // put degree symbol ( ° )
76 display.setCursor(90, 10);
77 display.print("C");
78
79 display.setCursor(0, 40);
80 display.print("EC:");
81 display.print(ecValue, 2);
82 display.display();
83 delay(1500);
84 display.clearDisplay();
85 ec.calibration(voltage, temperature); // calibration process by Serial CMD
86 if (client.connect(server, 80)) // "184.106.153.149" or api.thingspeak.com
87 {

```

```

88
89 String postStr = apiKey;
90 postStr += "& field1=";
91 postStr += String(temperature, 2);
92 postStr += "& field 2=";
93 postStr += String(ecValue, 2);
94 postStr += "\r\n\r\n";
95 delay(500);
96
97 client.print("POST /update HTTP/1.1\n");
98 client.print("Host: api.thingspeak.com\n");
99 client.print("Connection: close\n");
100 client.print("X-THINGSPEAKAPIKEY: " + apiKey + "\n");
101 client.print("Content-Type: application/x-www-form-urlencoded\n");
102 client.print("Content-Length: ");
103 client.print(postStr.length());
104 client.print("\n\n");
105 client.print(postStr);
106 delay(500);
107 } client.stop();
108 }
109

```

CHAPTER 5

RESULT AND DISCUSSION

5.1 RESULT

This project successfully developed an Arduino-based sensor system for monitoring air and water quality. Utilizing components like the MQ135 Air Sensor, TDS Sensor, Arduino UNO microcontroller, Jumper Wires, and Breadboard, we created an efficient monitoring solution. Some of the key achievements include Accurate Air Quality Monitoring, Precise Water Quality Assessment, Reliable measurements of Total Dissolved Solids (TDS), enabling us to monitor water quality and detect contaminants. Efficient Data Processing using the Arduino UNO processed sensor data,

calculated quality parameters, and displayed real-time updates, ensuring accurate information for analysis.

Its benefits are it encourages Environmental Awareness as the system empowers users with insights into air and water quality, aiding in pollution control and resource management. Instantaneous continuous Monitoring, timely detection of changes in air and water quality allows for proactive measures to maintain environmental health and Cost-Effectiveness leveraging arduino technology, our solution offers a cost-effective approach to environmental monitoring, accessible across various applications.

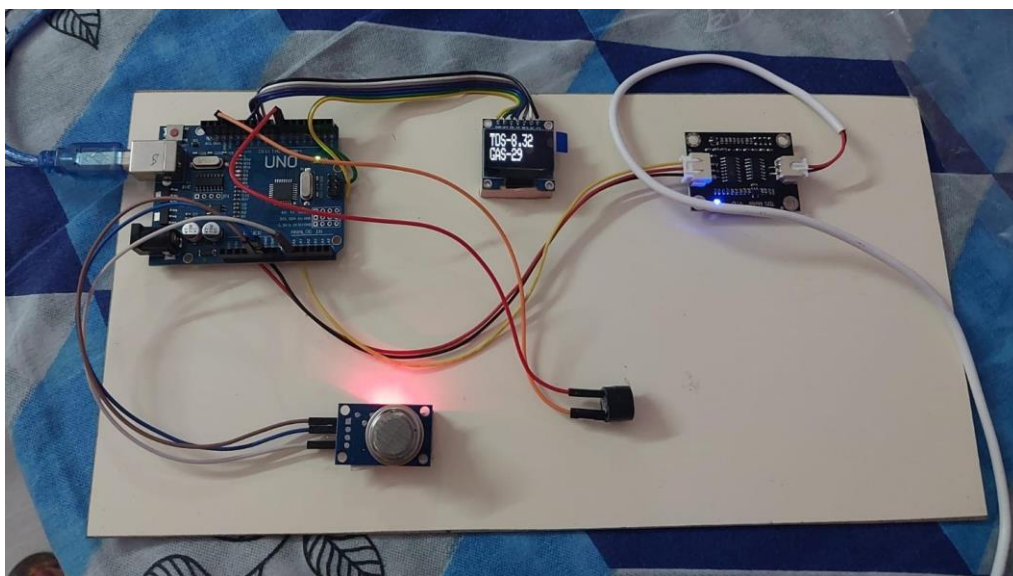


Fig:5.1:WORKING MODEL

5.2 DISCUSSION

5.2.1 GUIDELINES FOR DRINKING-WATER QUALITY

The Guidelines for Drinking-Water Quality are the result of collaboration between Chemical Safety, providing insights on chemical hazards, and the Radiation and Environmental Health Unit, contributing expertise on radiological hazards. All six WHO Regional Offices were actively involved in this process, consulting with Member States to ensure comprehensive input.

This edition of the Guidelines consolidates the third edition from 2004 with the first addendum (2006) and the second addendum (2008) to the third edition, surpassing previous editions and International Standards. It builds upon previous editions by refining concepts, methodologies, and information, notably emphasizing a preventive risk management approach established in the third edition for maintaining drinking-water quality.

Key considerations include:

- Drinking-Water Safety: Outlining minimum procedures, specific guideline values, and their practical applications.
- Derivation Approaches: Detailing the methods used for deriving the Guidelines and associated guideline values.

- **Microbial Hazards:** Highlighting microbial safety as a primary concern globally and stressing the significance of a systematic, multiple-barrier approach introduced in the third edition.
- **Climate Change Impact:** Addressing the implications of climate change on water quality, scarcity, and management strategies.
- **Chemical Contaminants:** Covering a range of chemical contaminants, including those previously not addressed, such as pesticides in drinking water.
- **Health Effects:** Providing guidance on managing key chemicals like arsenic, fluoride, lead, nitrate, selenium, and uranium.
- **Stakeholder Roles:** Discussing the roles and responsibilities of various stakeholders in ensuring drinking-water safety.
- **Non-Traditional Supplies:** Offering guidance for situations beyond traditional water supply systems, like rainwater harvesting and dual-piped systems.

Accompanying this edition are supporting publications, including internationally peer-reviewed risk assessments for specific chemicals and resources explaining the scientific basis of the Guidelines' development and implementation best practices. Volume 3—Surveillance and Control of Community Supplies (1997) offers further guidance on monitoring and assessing drinking-water quality in community supplies.

The primary audience for these Guidelines includes water and health regulators, policymakers, and advisors, aiding in the formulation of national standards. They also serve as a valuable resource for others interested in water quality, health, and effective management approaches. Recognized as the UN system's position on drinking-water quality and health, these Guidelines hold authority and are endorsed by "UN-Water," which coordinates water-related activities among 24 UN agencies and programs.

WHO'S GUIDELINES FOR DRINKING WATER

TABLE 5.1 BIOLOGICAL QUALITY

Sl. No.	Organism	Unit	Guide Line Value
01	Protozoa (Pathogenic)	-	NO VALUE
02	Helmintho (Pathogenic)	-	-do-
03	Free living organism (Algae others)	-	-do-

TABLE 5.2 MICRO BIOLOGICAL QUALITY

Sl. No.	Organism	Unit	Guide Line Value
01	Faecal Coli forms	Number / 100 ml	Zero
02	Coli form organism	Number/100 ml	Zero

TABLE 5.3 INORGANIC CONSTITUENTS OF HEALTH SIGNIFICANTS:

Sl. No.	Characteristic	Unit	Guide Line Value
01	Arsenic	Mg/L	0.05
02	Cadmium	Mg/L	0.005
03	Chromium	Mg/L	0.05
04	Cyanide	Mg/L	0.10
05	Fluoride	Mg/L	1.5
06	Lead	Mg/L	0.05
07	Mercury	Mg/L	0.001
08	Nitrate	Mg/L	10.0
09	Selenium	Mg/L	0.01

TABLE 5.4 TEST CHARACTERISTICS FOR DRINKING WATER

IS: 10500:1991

Sl. No.	Characteristic	Unit	Desirable Limit	Permissible Limit in absence of alternate source	Method of Test as per IS 3025
01	Colour	Hazen	5 max	25	4
02	Odour	-	Unobjectionable	-	5
03	Taste	-	Agreeable	-	7
04	Turbidity	NTU	5 max	10	10
05	pH	-	6.5 to 8.5	No relaxation	11
06	Total Hardness as CaCO ₃	Mg/L	300 max	600	21
07	Iron (as Fe)	Mg/L	0.3 max	1.0	
08	Chlorides (as Cl)	Mg/L	250 max	1000	
09	Residual, free chlorine	Mg/L	0.2 min	-	26
10	Fluoride (as F)	Mg/L	1.0 max	1.5	23
11	Dissolved solids	Mg/L	500 max	2000	16
12	Calcium (as Ca)	Mg/L	75 max	200	40
13	Magnesium as Mg	Mg/L	30 max	100	16,33,34
14	Copper(as Cu)	Mg/L	0.05 max	1.5	36
15	Manganese (as Mn)	Mg/L	0.1 max	0.3	35
16	Sulphate (as SO ₄)	Mg/L	200 max	400	24
17	Nitrate (as NO ₂)	Mg/L	45 max	No relaxation	34
18	Phenolic compound(as C ₆ H ₅ OH)	Mg/L	0.001 max	0.002	54
19	Mercury (as Hg)	Mg/L	0.001 max	No relaxation	
20	Cadmium (as Cd)	Mg/L	0.01 max	No relaxation	
21	Selenium (as Se)	Mg/L	0.01 max	No relaxation	28
22	Arsenic (as As)	Mg/L	0.05 max	No relaxation	37
23	Cyanide (as CN)	Mg/L	0.05 max	No relaxation	27
24	Lead (as Zn)	Mg/L	0.05 max	No relaxation	

25	Zinc (as Zn)	Mg/L	05 max	15	39
26	Anionic detergents (as MBAS)	Mg/L	0.2 max	1.0	
27	Chromium(as Cr+6)	G/L	0.05 max	No relaxation	38
28	Poly-nuclear aromatic hydrocarbons (as PAH)	Mg/L	-	-	
29	Mineral Oil	Mg/L	0.01 min	0.03	
30	Pesticides	Mg/L	Absent	0.001	
31	Radio-active materials				58
	a) Alpha emitters	Bq/L	-	0.1	
	b) Beta emitters	Pci/L	-	1.0	
32	Alkalinity	Mg/L	200 max	600	13
33	Aluminum (as Al)	Mg/L	0.03 max	0.2	31
34	Boron	Mg/L	1.0 max	5	29

5.2.2 Importance of Air Quality Monitoring

Air pollutants, whether indoors or outdoors, pose significant health risks. Hence, monitoring these pollutants is crucial for effective air quality management. Governments monitor air quality in various areas to assess pollution levels against health-based air quality standards. This monitoring serves several purposes:

- Determining compliance with national air quality standards.
- Identifying areas with the highest pollutant concentrations.
- Understanding pollutant behavior and its correlation with weather conditions.
- Validating pollution models for scenario testing.
- Forecasting air quality.
- Evaluating the effectiveness of pollution control programs.
- Assessing the impact of air pollution on public health
- Tracking progress towards meeting air quality standards.
- Analyzing air quality trends.
- Developing efficient pollution control strategies and policies.

5.2.3 Parameters Monitored under NAMP

The Central Pollution Control Board initiated the National Air Quality Monitoring Programme (NAMP) to monitor air quality across the country. This program regularly monitors three air pollutants: Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), and Particulate Matter equal to or less than 10 microns (PM₁₀). Additional parameters such as PM_{2.5}, Carbon Monoxide (CO), Ammonia (NH₃), Lead (Pb), Ozone (O₃), Benzene (C₆H₆), Benzo(a)pyrene (BaP), Arsenic (As), and Nickel (Ni) are also monitored at selected locations.

Meteorological parameters like wind speed, direction, humidity, and temperature are integrated with air quality monitoring. Monitoring is conducted 24/7 with specific sampling frequencies to ensure comprehensive data collection. This monitoring effort involves collaboration between various agencies like State Pollution Control Boards, Pollution Control Committees, National Environmental Engineering Research Institute, and Central Pollution Control Board.

SO₂ Levels in Different Zones

The country's SO₂ levels vary across different zones:

Central Zone (Madhya Pradesh, Chhattisgarh): Moderately rich in minerals with moderate temperatures and heavy monsoons.

East Zone (Andaman and Nicobar Islands, Bihar, Jharkhand, Odisha, West Bengal): Humid subtropical climate with hot summers, monsoons, and mild winters.

North Zone (Chandigarh, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Ladakh, Punjab, Uttar Pradesh, Uttarakhand): Varied climates including cool winters, hot summers, and moderate monsoons.

Northeast Zone (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura): Humid subtropical climate with severe monsoons and mild winters.

South Zone (Andhra Pradesh, Karnataka, Kerala, Lakshadweep³⁵, Puducherry, Tamil Nadu, Telangana): Tropical climate with dependence on monsoons for rainfall.

West Zone (Dadra & Nagar Haveli, Daman & Diu, Goa, Gujarat, Maharashtra, Rajasthan): Varied climates from arid to semi-arid, with diverse vegetation and precipitation patterns.

Developing Drinking-Water Quality Standards

The development of national or regional drinking-water quality standards is guided by health-based targets outlined in the Guidelines for Drinking-Water Quality. These targets, although not mandatory limits, serve as scientific benchmarks for setting standards considering environmental, social, economic, and other factors. Public participation in standards-setting processes is vital to ensure acceptability and effectiveness.

Initiatives for Control of Air Pollution

Government initiatives for air pollution control encompass regulatory, technical, and innovative solutions. These include strengthening air quality monitoring networks, implementing data dissemination systems, setting revised air quality standards, identifying non-attainment cities, and launching programs like the National Clean Air Programme. Sector-specific interventions, research collaborations, and public awareness efforts are integral to these initiatives aimed at improving overall air quality in the country.

CHAPTER 6

SUMMARY AND CONCLUSION

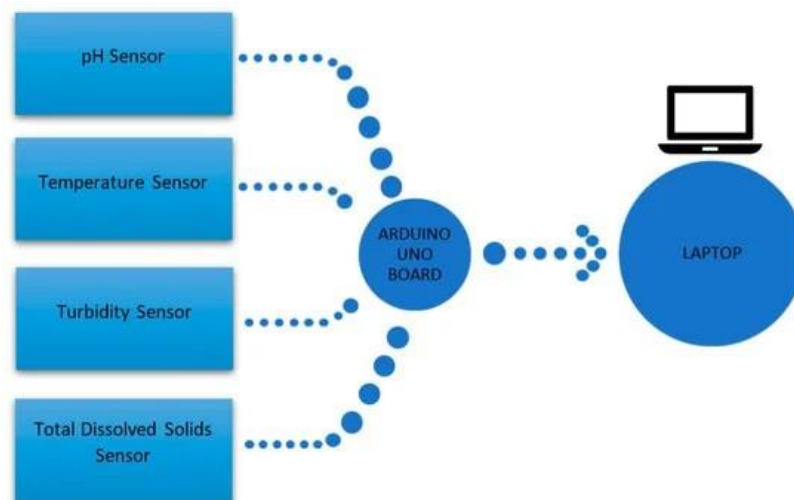
6.1 .Summary

A low-budget air and water quality monitoring system aims to provide cost-effective environmental data collection. Key considerations for such a system include data accuracy, sensitivity, and range. Regular sensor calibration, data integrity, and power efficiency are crucial. Additionally, user-friendliness, sensor longevity, and comparative analysis with established systems are essential. Cost-effectiveness is a central concern, encompassing initial setup, maintenance, and sensor replacements. Cross-referencing data and developing interpretation methodologies ensure meaningful results in compliance with quality standards and regulations.

6.2 Conclusions

In conclusion, the deployment of the integrated air and water quality monitoring system has marked a significant milestone in our mission to protect and preserve the environment for current and future generations. This conclusion summarizes the key takeaways and underscores the system's impact on both air and water quality monitoring .Throughout the monitoring period, the system has consistently demonstrated its ability to provide accurate and reliable data for both air and water quality assessments. Despite budgetary constraints, the system's sensors have proven their sensitivity and versatility in detecting fluctuations and trends in pollutant concentrations. This information has been invaluable in understanding the complex interplay of environmental factors affecting our region .The success of the system can be attributed to diligent calibration processes and ongoing maintenance efforts. These measures have ensured the integrity of the collected data, instilling confidence in its accuracy and usability. The system's data has been instrumental in early pollution detection, regulatory compliance, and informed decision-making regarding both air and water quality management .Data validation and interpretation have been cornerstones of our monitoring efforts. Robust validation procedures have maintained data integrity, while cross-referencing with external sources has enhanced its reliability. The ability to interpret this data within the framework of environmental standards and regulations has

Its intuitive interface and straightforward setup have empowered users with varying levels of technical expertise to operate it effectively. Training programs and comprehensive user documentation have facilitated a smooth user experience, as indicated by positive feedback from operators and stakeholders. From a financial perspective, the low-budget nature of this integrated system has proven to be a prudent investment. Initial setup costs were well within budget, and ongoing operational expenses, including maintenance and sensor replacements, have been managed efficiently. Our cost analysis has demonstrated that the total cost of ownership aligns with budgetary expectations while delivering crucial data for environmental stewardship. In our evaluation of system performance, we have recognized both its strengths and opportunities for improvement. While the system may not encompass the advanced features and granularity of more expensive alternatives, it has consistently fulfilled its primary objectives in air and water quality monitoring and environmental protection. In conclusion, this integrated air and water quality monitoring system stands as a testament to our commitment to responsible environmental management. The data it has provided will continue to guide our actions, inform policies, and drive us toward a sustainable and healthy future. Looking ahead, we recommend ongoing enhancements to optimize its capabilities, further maximize cost-effectiveness, and expand its applications to address the ever-evolving challenges of air and water quality conservation.



CHAPTER 7

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