VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"Jnana Sangama ", Belgaum -590 018, Karnataka State, India

A PROJECT REPORT
ON

"AIR AND WATER QUALITY INDEXING AND ENVIRONMENT MONITORING"

Submitted on partial fulfillment of academic requirement for the academic year

2023-24

BACHELOR OF ENGINEERING
IN
INFORMATION SCIENCE AND ENGINEERING

Submitted by

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DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING
SRI JAGADAGURU CHANDRASHEKARANATHA SWAMIJI
INSTITUTE OF TECHNOLOGY
CHICKABALLAPUR – 562 101

2023-2024

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CHICKBALLAPUR-562101 (KARNATAKA)

DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project work entitled **"AIR AND WATER QUALITY INDEXING AND ENVIRONMENT MONITORING"** is a bonafide work carried out by **DEEKSHITHA RAM (1SJ20IS026)** in partial fulfilment for the award of **Bachelor of Engineering in Information Science and Engineering in Seventh semester of the Visvesvaraya Technological University, Belagavi** during the year **2023-24**. Itis certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the department library. The project report has been approved as it satisfies the academic requirements with prescribed for the Bachelor of Engineering degree.

....	....	....
Signature of the Guide	Signature of the HOD	Signature of the Principal
Dr. Susheelamma K H	Mr. Satheesh Chandra Reddy	Dr. G T Raju
Associate Professor,	Professor and HOD	Principal
Department of ISE,SJCIT	Department of ISE,SJCIT	SJCIT

Name and signature of the Examiners

Name	**Signature**
1.	**.........................**
2.	**.........................**

DECLARATION

I DEEKSHITHA RAM (1SJ20IS026) Student of 8th semester BE,S.J.C Institute of Technology, hereby declare that the project entitled “AIR AND WATER QUALITY INDEXING AND ENVIRONMENT MONITORING” **has been carried out by us under the supervision of internal guide** Dr Susheelamma K H Department of ISE **submitted in partial fulfillment of the requirement of the award in the degree of** Bachelor of Engineering in Information Science and Engineering by the Visvesvaraya Technological University **during the academicyear 2023-2024. This report has not been submitted to any other organization or University for any award of degree or certificate.**

Place :

Date:

DEEKSHITHA RAM

ACKNOWLEDGEMENT

With reverential pranam, I express my sincere gratitude and salutations to the feet of his holiness **Paramapoojya Jagadguru Byravaikya Padmabhushana Sri Sri SriDr.Balagangadharanatha MahaSwamiji**, his holiness **Paramapoojya Jagadguru Sri Sri Sri Dr. Nirmalanandanatha Maha Swamiji,**and **Sri Sri Mangalnatha Swamiji** of SriAdichunchanagiri Mutt for their unlimited blessings.

First and foremost, I wish to express our deep sincere feelings of gratitude to our institution, **Sri Jagadguru Chandrashekaranatha Swamiji Institute of Technology,** for providing us an opportunity for completing the Project work successfully.

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DEEKSHITHA RAM(1SJ20IS026)

ABSTRACT

The current state of the environment continues to be a pressing global matter resulting from various human activities that release harmful substances posing a threat to living beings. To combat this issue advancements in technology have paved the way for the creation of an Internet of Things (IoT) based Water and Air Quality Monitoring System providing real-time data on environmental conditions. Through web and mobile applications individuals can easily access this system and view graphical representations of water and air quality readings. This innovative system involves sensor nodes strategically placed in different locations collecting field data and evaluating it against the set standards in India. For water monitoring sensors such as the Turbidity Sensor PH Sensor DHT 11 and TDS Sensor are utilized while for air quality the DHT11 sensor MQ-7 sensor and MQ-135 sensor play a crucial role. With this advanced monitoring system timely and accurate information on the state of the environment can be obtained aiding in taking necessary measures to combat pollution.

ACKNOWLEDGEMENT

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DEEKSHITHA RAM (1SJ20IS026)

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CHAPTER –1

INTRODUCTION

OVERVIEW:

This project tackles monitoring air and water quality using the internet of Things (IOT). It aims to address the worsening environmental conditions, particularly in areas lacking proper monitoring infrastructure. The system utilizes sensor nodes to gather real-time data on air and water quality. Air quality is categorized using an ISPU index based on key pollutants, while water quality is assessed for suitability for drinking and sanitation. This data is then transmitted for public and government access through a website or mobile app, promoting environmental awareness and enabling informed decision making to combat pollution.

INTRODUCTION TO DOMAIN:

Our environment faces a growing threat: pollution. Human activities have significantly impacted the quality of our air and water, leading to a decline in monitoring infrastructure, when public awareness of pollution levels remains low. The consequences of this can be severe, with detrimental health effects for people exposed to contaminated air and water. This project is broken down to two key areas one Environmental pollution and another one is IOT, To address this challenge , this project delves into the exciting realm of the Internet of Things(iot). Iot offers a groundbreaking approach to environmental monitoring by enabling communication between various devices and sensors through the internet. This opens the door for real-time data collection, providing a more comprehensive picture of environmental health. The collected data from the sensor nodes wont simply sit idle. It will be transmitted seamlessly to a central server through internet connectivity. This server willact as a vital hub, storing and processing the data . Most importantly, this data will be accessible to public and government agencies through a user-friendly interface, such as a website and mobile application. This transparency allows for informed decision-making. By being aware of real-time environmental conditions, individuals can take precautions to protect their health, while policymakers can implement strategies to combat pollution and ensure a healthier environment for all.

PROBLEM STATEMENT:

Considering the importance of air and water to human existence, air pollution and water pollution are critical issues that require collective effort for prevention and control. Different types of anthropogenic activities have resulted in environmental dilapidation and ruin. One of the tools that can be used for such a campaign is Air Quality Index (AQI). The AQI was based on the concentrations of different pollutants: We are also familiar with the Water Quality Index (WQI), which in simple terms tells what the quality of drinking water is from a drinking water supply. There is a need for constant and continuous environment monitoring of air quality and water quality for the development of AQI and WQI, which in turn will enable clear communication of how clean or unhealthy the air and water in the study area is.

OBJECTIVES:

- To achieve immutability of forensic report using block chain technology.
- To avoid tampering of documents (involved in police complaints, generated by forensic department) securing them using concepts of block chain and provides transparency to the complainer, by allowing to track the status or the state of the case registered.
- To allow traceability of forensic evidence in case if any doubt of tampering is there by victim or justice system as well as Making the process fast, by adding penalties for not doing the task in required time.
- Develop a system capable of monitoring air and water quality in real-time, providing instant data on key parameters.
- Strategically deploy sensor nodes to gather field data on water and air quality parameters, ensuring comprehensive coverage for a holistic assessment.
- Utilize Turbidity, DS18B20, pH, DHT11, and Total Dissolved Solids (TDS) sensors for water quality assessment based on Indian standards.
- Employ DHT11, Mq-7, and MQ-135 sensors for air quality assessment, considering relevant parameters in accordance with established standards.

SEQUENCE DIAGRAM:

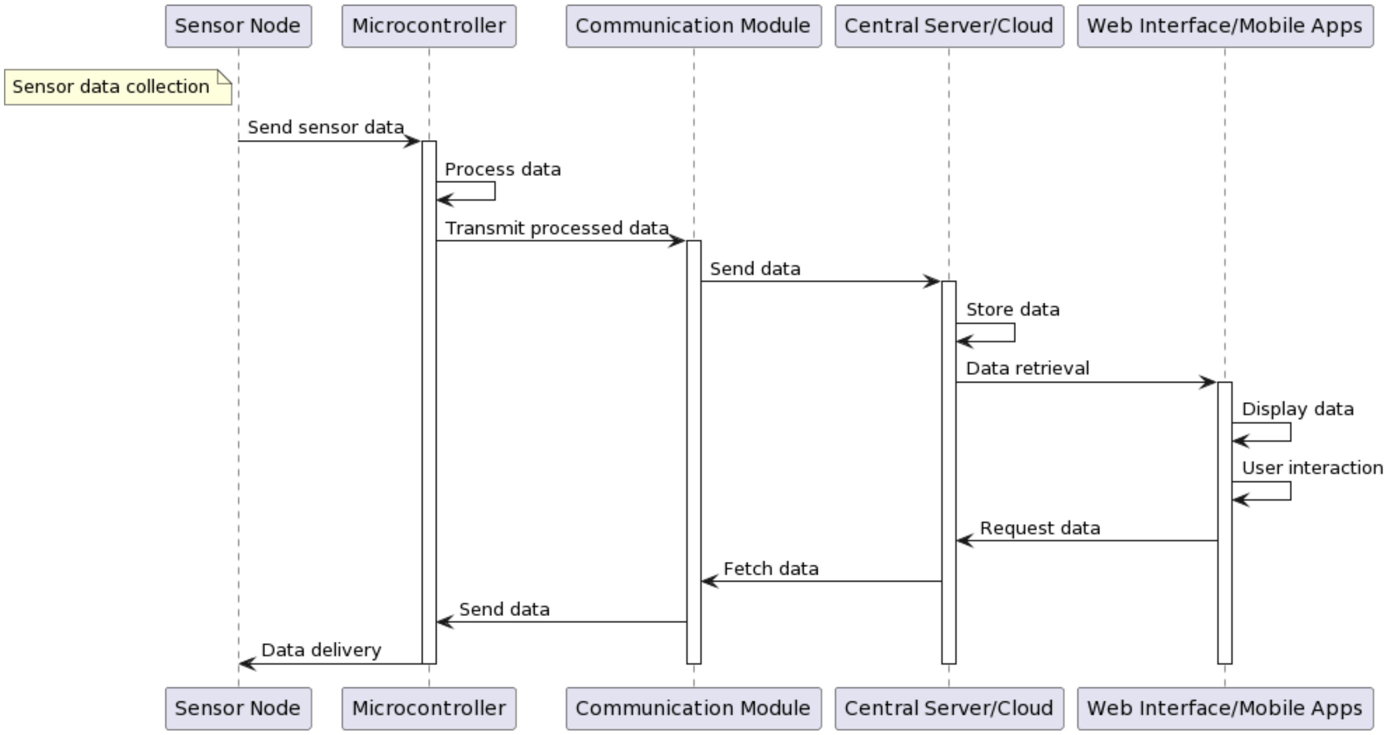

Fig 1.5.1: Sequence Diagram

CHAPTER -2

LITERATURE SURVEY

Hendrawati et al. (Reference [7]):

- Objective: Monitoring pollution in river water due to industrial activities.
- Parameters Measured: PH, turbidity, water temperature.
- Methodology: Sensor nodes transmit data through nRF24L01 radio communication modules to a server (ESP-8266). Users access information via web and Android applications.
- Contribution: Introduced a comprehensive water quality monitoring system with real-timedata access.

Waleed et al. (Reference [8]):

- Objective: Providing community information about river water quality.
- Parameters Measured: PH level, turbidity, water temperature.
- Methodology: Data transmission via Long Range Network (LoRa). Fuzzy Logic used forwater quality classification (low, medium, high).
- Contribution: Enhanced classification accuracy using TDS sensor based on Indian standards.

Teguh et al. (Reference [9]):

- Objective: Obtain air quality values in areas not covered by the Ministry of Environmentand Forestry measurements.
- Parameters Measured: MQ-7 (CO), Analog Infrared CO2, Dust Sensors (PM10), DHT-11, Wind speed direction.
- Methodology: Node MCU ESP-8266 used for data transmission to Ubidots for visualization. Users manually classify air quality based on AQI and ISPU standards.
- Contribution: Demonstrated a comprehensive air quality monitoring system for areaslacking official measurements.

Hakim et al. (Reference [10]):

- Objective: Address the problem of high air pollution in the city of Bandung.
- Parameters Measured: MQ-7 (CO), MQ-135 (NO), MQ-131 (O3), DHT22 (temperatureand humidity).
- Methodology: Data sent via SIM900A connection, monitored on Thingspeak IoT platform. Real-time air quality classification with ISPU standards.
- Contribution: Automated and real-time air quality classification, providing valuable insights for pollution management.

CHAPTER-3

SYSTEM ANALYSIS

PROBLEM IDENTIFICATION:

During system analysis, a crucial step is identifying the problems the project aims to solve. In this case, the project focuses on two key environmental issues:

A. Limited Air and Water Quality Monitoring:* Current infrastructure for monitoring air and water quality is inadequate, particularly in certain areas. This lack of data leads to a significantblind spot regarding the true state of the environment.

B. Public Health Risks from Pollution:* Due to limited monitoring, public awareness of pollution levels is often low. This can lead to people unknowingly being exposed to harmfulpollutants in the air and water, posing a significant health risk.

These limitations create a critical need for a more robust and accessible environmental monitoring system.

PROBLEM DEFINITION:

A. Limited Monitoring Capabilities:* Existing infrastructure for monitoring air and water quality is insufficient, especially in certain regions. This lack of data creates a significant gap in our understanding of the true state of the environment. We essentially lack a clear picture of how polluted our air and water have become.

B. Public Awareness Gap:* Due to the limitations in monitoring, public awareness regardingpollution levels remains low. This creates a dangerous situation where people can be unknowingly exposed to harmful contaminants in the air and water they breathe and consume,posing a serious threat to their health.

These deficiencies highlight the urgent need for a more comprehensive and accessible environmental monitoring system. This project aims to bridge this gap by providing real-time data on air and water quality, empowering both the public and policymakers to make informeddecisions for a healthier environment.

PROPOSEDSYSTEM:

This project proposes an Internet of Things (IoT) based system to address environmental pollution by deploying sensor nodes that gather real-time data on air quality (CO, NO2, PM10) and water quality (pH, temperature, turbidity, TDS). The system analyzes this data tocategorize air quality using an index and assess water suitability for drinking and sanitation. This data is then transmitted for public and government access through a website or mobile app, promoting environmental awareness and enabling informed decision-making to combatpollution.

3.3.1 ADVANTAGES OF PROPOSED SYSTEM:

- This project's IoT-based system offers several advantages over traditional monitoring methods. Firstly, it provides real-time data, allowing for immediate awareness of changes inair and water quality. This empowers individuals to take precautions when pollution levels spike. Secondly, the system offers wider coverage by deploying sensor nodes in areas with limited existing infrastructure. This increases overall environmental data and public awareness. Finally, by presenting data through a user-friendly platform like a website or app, the system fosters transparency and accessibility. This allows both the public and policymakers to make informed decisions for environmental protection and pollution mitigation strategies.

EXISTING SYSTEM:

The passage doesn't explicitly mention a existing system for this project. It focuses on the limitations of current air and water quality monitoring practices. Here's how we can rephraseit:
Traditional Monitoring Methods:

The project acknowledges that there are existing methods for air and water quality monitoring. However, these methods likely suffer from limitations that the proposed IoT system aims to overcome. These limitations could include:

Limited Scope: Traditional methods might rely on manual sample collection and lab analysis, which can be time-consuming and geographically restricted.

Cost: Extensive monitoring networks using traditional methods can be expensive to set up and maintain.

Data Delays: Lab analysis can cause delays in obtaining results, hindering real-time awareness of environmental changes.

Limited Accessibility: Data from traditional methods might not be readily available to the public, hindering public awareness.

The proposed IoT system aims to address these shortcomings by offering a more cost-effective, real-time, and accessible solution for environmental monitoring.

DISADVANTAGES OF EXISTING SYSTEM:

Limited Coverage: Traditional methods often rely on fixed monitoring stations, leavinggaps in data collection, especially in remote or less developed areas.

Time Delays: These methods might involve manual sample collection and laboratory analysis, leading to delays in obtaining results. Real-time monitoring capabilities are often limited.

High Costs: Setting up and maintaining a network of traditional monitoring stations can be expensive due to equipment, personnel, and lab analysis costs.

Data Accessibility: Data from traditional methods might be stored in databases or reports, not readily accessible to the public in a user-friendly format. This limits public awareness of environmental conditions.

Human Error: Manual sample collection and analysis are prone to human error, potentially affecting data accuracy

CHAPTER – 4

SYSTEM REQUIREMENTS AND SPECIFICATION

System Requirement Specification (SRS) is a central report, which frames the establishment of the product advancement process. It records the necessities of a framework as well as has a depiction of its significant highlight. An SRS is essentially an association's seeing (in composing) of a client or potential customer's frame work necessities and conditions at a specific point in time (generally) before any genuine configuration or improvement work. It's a two- way protection approach that guarantees that both the customer and the association comprehend alternate's necessities from that viewpoint at a given point in time.

FUNCTIONAL REQUIREMENT

This section describes the functional requirements of the system for those requirements which are expressed in the natural language style.

1. Real-time Data Acquisition:

• The system must collect real-time data from water and air quality sensors deployed in different locations.

2. Comprehensive Parameter Measurements:

• The system should measure a comprehensive set of parameters for water quality (e.g., pH, turbidity, temperature, TDS) and air quality (e.g., CO, NO, O3, PM10, temperature, humidity).

3. Data Transmission:

• Sensor nodes must efficiently transmit data to a central server using appropriate IoT communication protocols (e.g., MQTT, HTTP).

4. Real-time Visualization:

• The system must provide real-time graphical representations of both water and air quality conditions for easy interpretation.

5. Automated Classification:

• Automated algorithms should classify water and air quality status based on established standards (e.g., ISPU for air quality, national water quality standards for water).

6. GIS Integration:

- The system should integrate with a Geographic Information System (GIS) for spatial analysis of pollution sources, enhancing the ability to pinpoint locations of environmental concern.

7. Alerting System:

- An alerting mechanism must notify relevant authorities and stakeholders in real-time in the event of water or air quality violations.

8. User Management:

- The system should have user authentication and authorization mechanisms to control access levels for different stakeholders.

9. Historical Data Storage:

- The system must store historical data for trend analysis and reporting purposes.

NON-FUNCTIONAL REQUIREMENT

These are requirements that are not functional in nature, that is, these are constraints within whichthe System must work.

1. Scalability:

- The system should be scalable to accommodate additional sensor nodes and users as monitoring requirements expand.

2. Reliability:

- The monitoring system must demonstrate high reliability, ensuring continuous data collection and minimal downtime.

3. Security:

- Robust security measures must be implemented to protect sensitive environmental data from unauthorized access or tampering.

4. Usability:

- The user interfaces (web and mobile) should be user-friendly, providing easy navigation and interpretation of environmental data.

5 Interoperability:

- The system should be compatible with various sensor models, allowing for flexibility in sensor deployment.

5. Response Time:

- The system must have low response times for data retrieval, ensuring timely access to information.

HARDWARE REQUIREMENT:

- **Processor:** Intel I3 2nd generation
- **Speed:** 2.1 Ghz
- **RAM:** 4GB
- **Hard Disk:** 500 GB
- **Keyboard:** Standard Windows Keyboard
- **Mouse:** Two or Three Button Mouse
- **Monitor:** SVGA

SOFTWARE REQUIREMENT:

- Operating System: Windows 7 / 10
- IDE Used: Arduino IDE
- Coding Language: Embedded c

SENSOR REQUIREMENT:

Water Quality Sensors:

1.Turbidity Sensor:

•Measures the cloudiness or haziness of a fluid caused by large particles that are visible to the naked eye.

2. PH Sensor:

•Measures the acidity or alkalinity of water.

3. DHT 11:

Measures temperature and humidity, useful for understanding environmental conditions.

4. TDS (Total Dissolved Solids) Sensor:

•Measures the total amount of mobile charged ions, including minerals, salts, or metals dissolved in agiven volume of water.

Air Quality Sensors:

1. MQ-7 Sensor:

•Measures the concentration of carbon monoxide (CO) in the air.

2. MQ-135 Sensor:

•Detects the concentration of gases such as ammonia, benzene, and smoke.

3. Analog Infrared CO2 Sensor:

•Measures the concentration of carbon dioxide (CO_2) in the air.

4. Dust Sensors (e.g., PM10 Sensor):

•Measures the concentration of particulate matter (PM) in the air.

5. DHT-11:

•Measures temperature and humidity, providing additional environmental data

CHAPTER – 5

SYSTEM DESIGN

SYSTEM ARCHITECTURE:

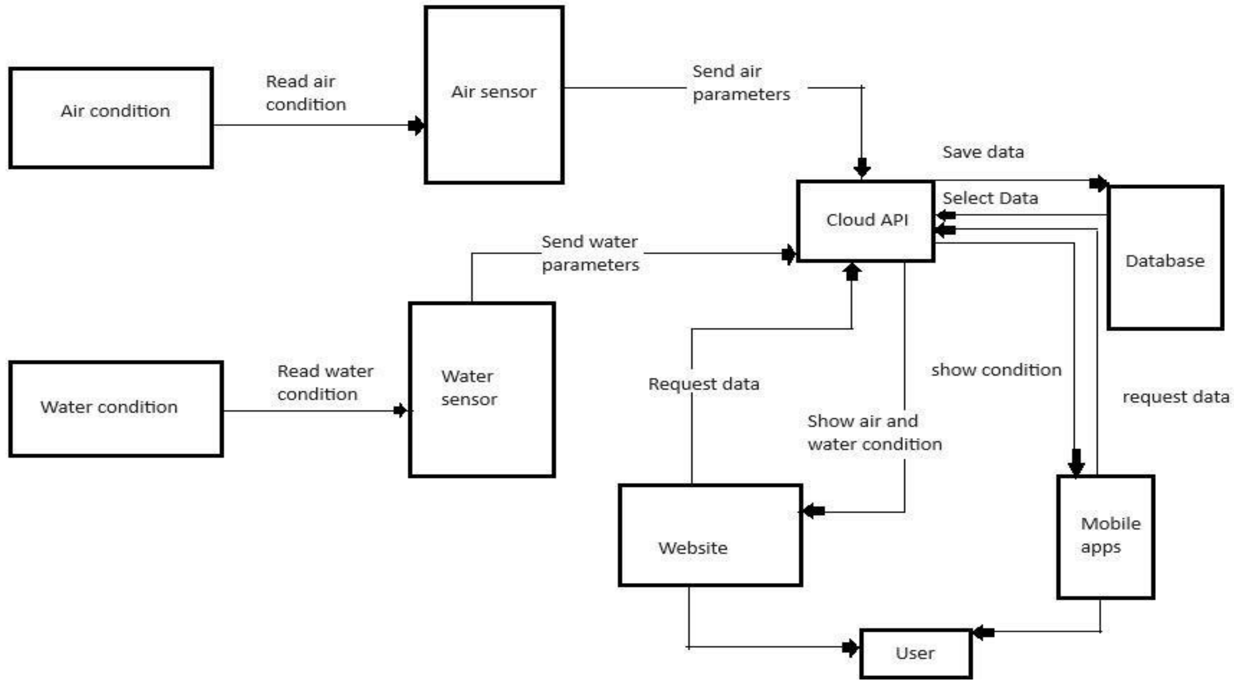

Fig 5.1 System architecture

An overview system is the system flow description starting from the required input. Then, the input is processed to become information that the user can access. In addition, the system overviewalso displays the components involved in the running of the system processes. An overview of

the Water and Air Quality Monitoring System based on the Internet of Things can see in figure 1. Figure 5.1. System Overview Fig 5.1 Shows an overview of the Internet of Things-based Water and Air Monitoring System.

The system works described in the general description are that devices connected to the internet can place in areas where water and air quality checks are carried out. When the tool can function stably, the data obtained by the water and air sensors will be sent to the server to be processed and stored in the database. Then the processed data is classified using ISPU standards, Water Quality Standards (Sanitation), and Drinking Water Quality Requirements. Further, water and air quality information will display via the web and mobile applications in real-time based on the nearest location or the location selected by the user.

HARDWARE OF WATER MODULE:

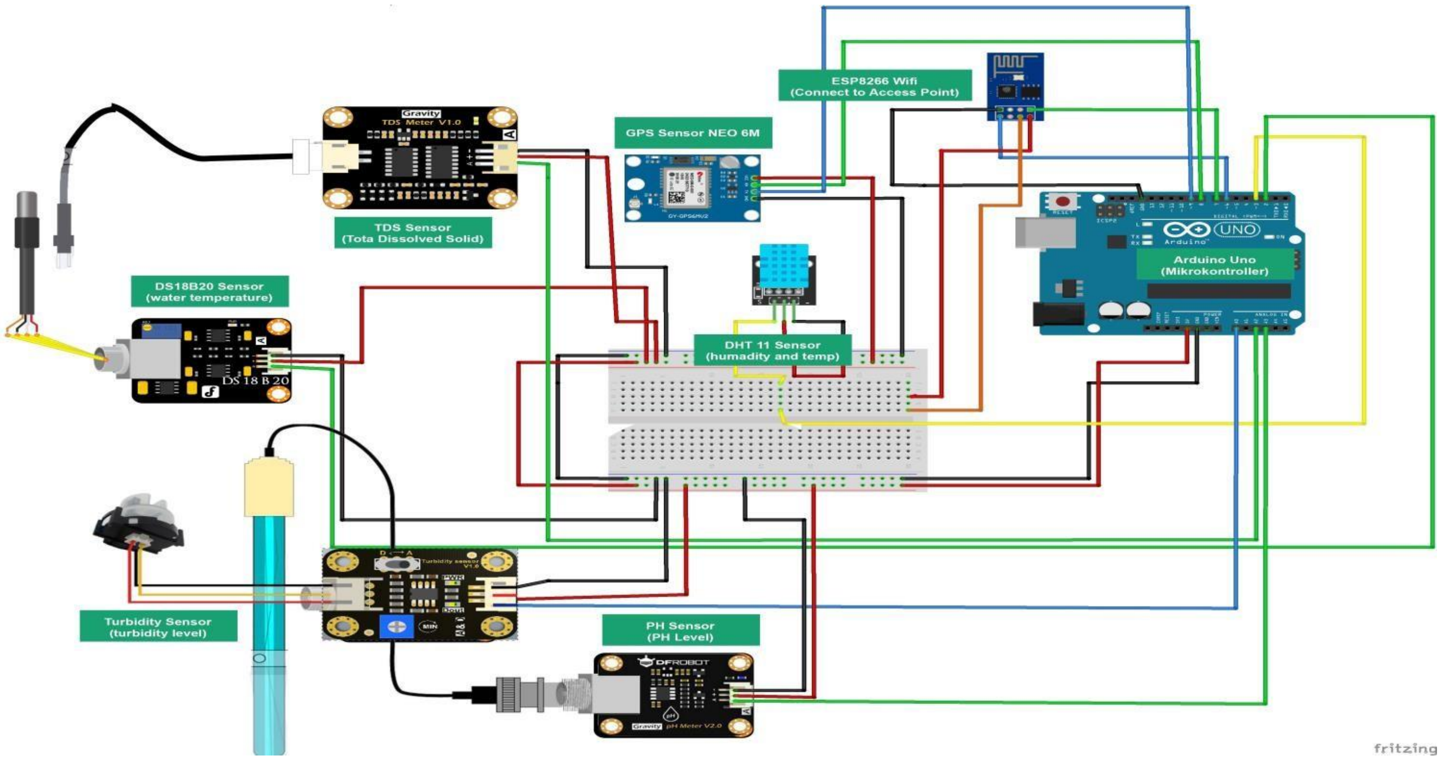

Figure 5.2.1: Hardware of water module

The water system is comprised of multiple sensor units tasked with gathering field data on the factors that determine the quality of both water and air in accordance with established standards in Indonesia. These sensors include a Turbidity Sensor for measuring turbidity levels a DS18B20 sensor to monitor water temperature a DHT 11sensor to measure air temperature a PH sensor for assessing acidity levels and a TDS(Total Dissolved Solid) sensor for tracking dissolved solids. All of these sensors are linked to an Arduino Uno microcontroller and an ESP-8266 serves as the means for connecting to the API and transmitting the data over the internet, this sensors connection and module you can see in figure 5.2.1.

HARDWARE OF AIR MODULE:

The air unit consists of various components including a DHT11 Sensor for assessing humidity and temperature an MQ-7 Sensor for detecting Carbon Monoxide levels an

MQ-135 Sensor for measuring Nitrogen Dioxide (NO2) levels and a GP2Y1010AU0F Dust Sensor for identifying particles (PM10). Apart from the sensor nodes each module is furnished with an Arduino Uno microcontroller and a NEO-6M GPS sensor for marking the location. All data gathered by the sensor nodes along with their corresponding locations will be transmitted to the server through internet connectivity facilitated by ESP-8266. This sensors connection and module we can seein figure 5.2.2.

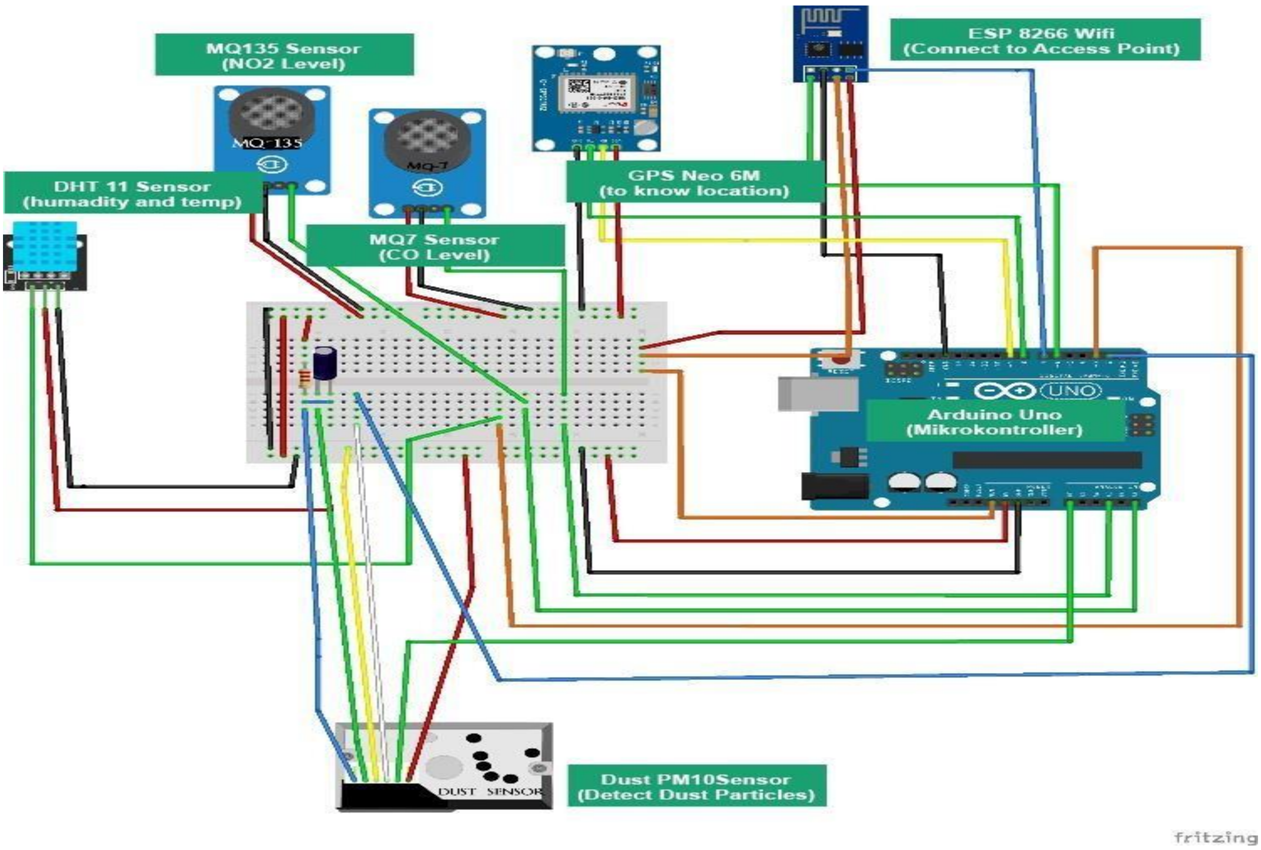

Figure 5.2.2: Hardware of air module

Chains of blocks: Each block in the ledger contains a hash generated by SHA-256referring to the preceding blocking the chain.

Digital signatures: Transactions use digital signatures to maintain integrity, the information used in the transaction is hashed using SHA-256, and then it is encrypted with the sender's private key to generate a signature. The miner then verifies this signature to validate the transaction.

Flow chart:

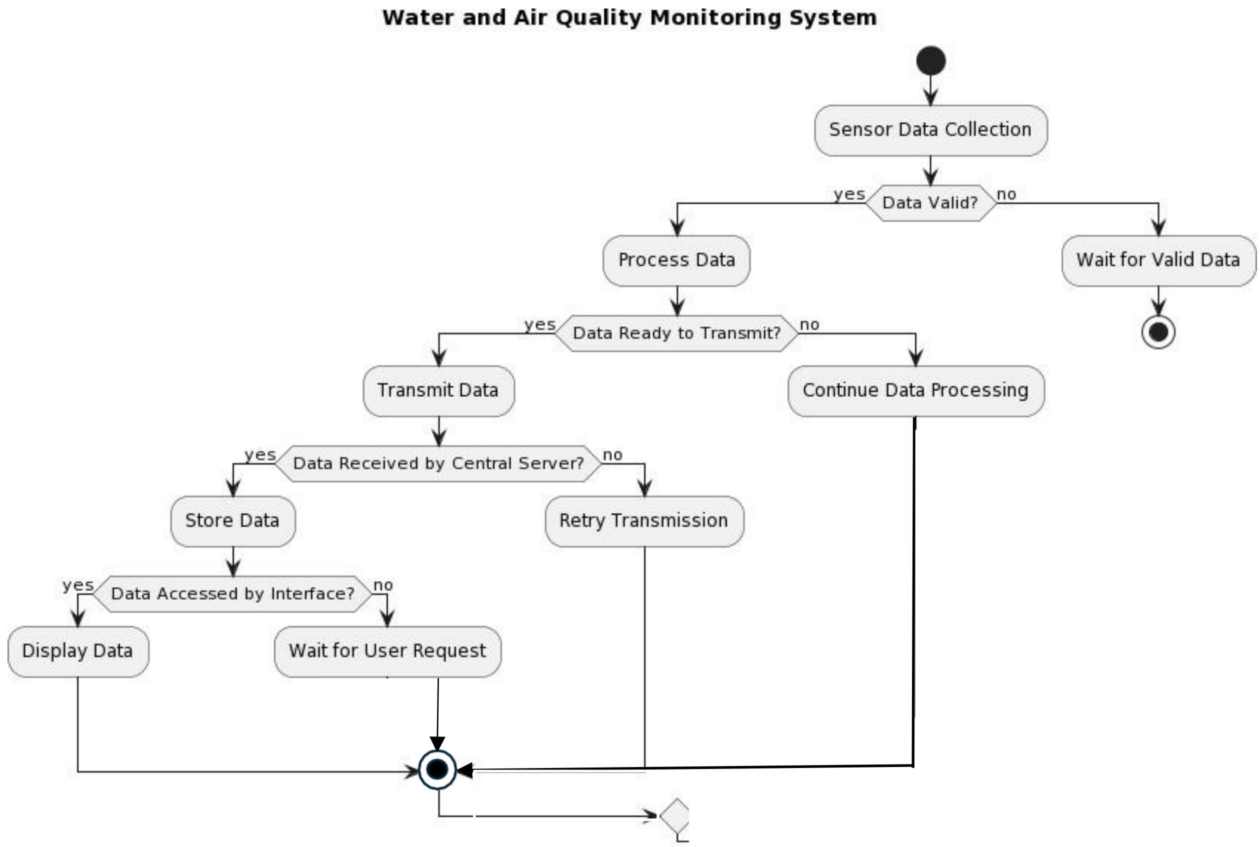

Fig 5.3: Flow Chart of air and water quality monitoring system

The data flow diagram shows how information about water quality travels from a sensor to a This flow chart figure5.4 shows that, when module collects sensor data if data is valid, the datawill be processed if not it waits ofr valid data. The processed Data checks if it is ready to transmit or not, if Yes it transmits data, if not it will retries the transmission. Then it will store the dataand display to the user.

Use Case Diagram:

A use case diagram in the Unified Modelling Language (UML) is a type of behavioural diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors inthe system can be depicted. In the use case diagram pathology lab admin creates the forensic report and sends to hospital, In hospital doctor will verify and send to the police, Police will verify and generate the final report.

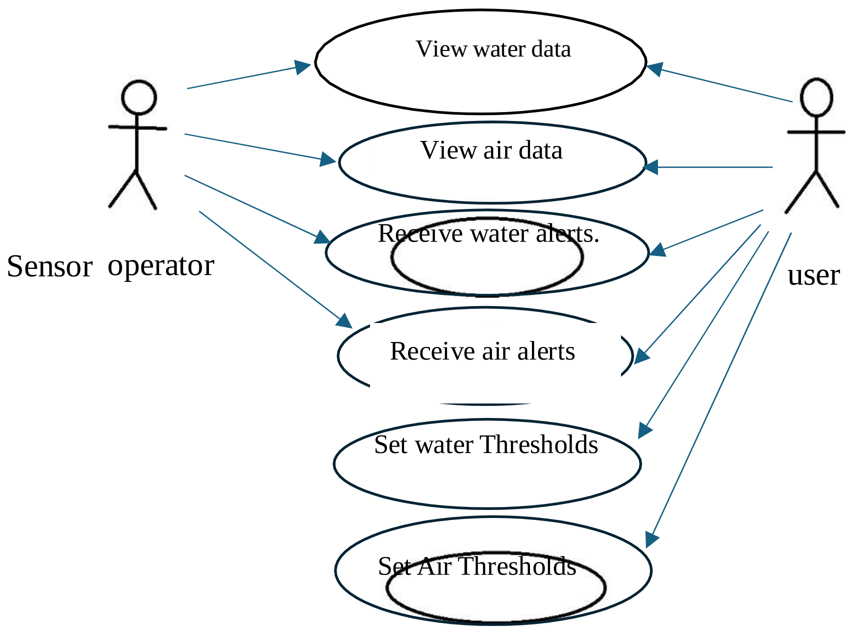

Fig 5.4: Use Case Diagram

A use case diagram for collaborative, secure, and efficient content validation and protection using,In this use case there are two peoples sensor operator and other one is user, sensor operator view water data ,air data and if limit exceeds he will be alerted. Similarly in user side user can access these data through application or website, they can view air data, water data and also can receivealerts . even user can set thresholds. This is interaction between module and users.

DATA FLOW DIAGRAM:

A data flow diagram (DFD) is a graphical representation of the "flow" of data through an information system, modelling its process aspects. A DFD is often used as a preliminary step tocreate an overview of the system without going into great detail, which can later

be elaborated

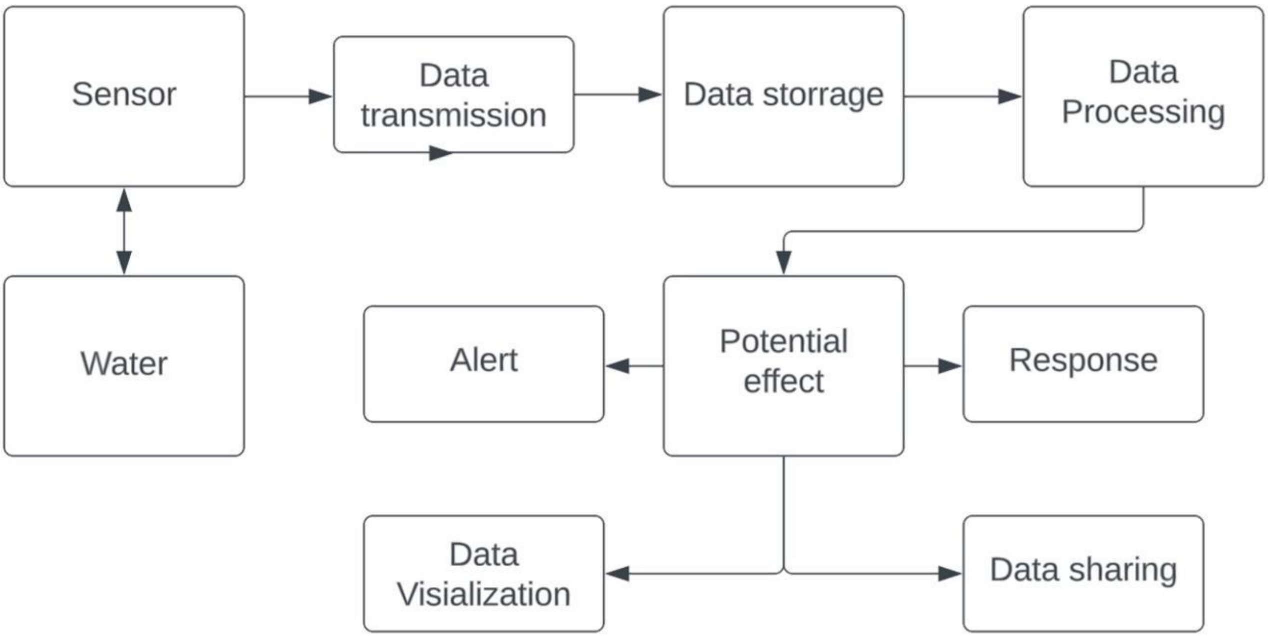

Fig 5.5.1: Data flow diagram of water quality travels from a sensor to a data storage system and ultimately to users

The data flow diagram shows how information about water quality travels from a sensor to a data storage system and ultimately to users. The sensor transmits data about water quality. This data is then stored in a data storage system. Here, the data is processed and analysed. Processed data is then split into two outputs: visual representations and alerts. Visualizations of the data can be viewed by users, while alerts are triggered based on potential water quality effects. Datasharing is also indicated, suggesting the system might transmit data to other systems or users. We can observe in figure 5.3.

CHAPTER 6

IMPLEMENTATION

The phase is initiated after the system has been nested and accepted by the user. In this phase, the system is installed to support the intended business functions. System performance is compared to performance objectives established during planning phase. Implementation includes user notification, user training, installation of hardware, installation of software onto production computers, and integration of the system into daily work processes. This phase continues until the system is operating in production in accordance with the defined user requirement Implementation in a project refers to the process of putting plans, designs, or strategies into actionto achieve project goals. It involves executing tasks, utilizing resources, and managing timelinesto complete project objectives. Implementation is a crucial stage in the project life cycle as it determines project success.

OVERVIEW OF PROJECT:

The Water and Air Quality Monitoring System based on the Internet of Things is a comprehensive solution designed to address the pressing issue of environmental pollution by leveraging cutting-edge technology. Deployed in Indonesia, the system comprises sensor nodes equipped with Turbidity, MQ-7, and MQ-135 sensors to monitor water and air quality parameters in real-time. These nodes communicate data to a central server or cloud platform, where it is processed and made accessible to users via web and mobile applications.

LIST OF MODULES:

1. Data collection Module,
2. Data processing Module,
3. Data Transmission Module,
4. Data Storage Module.

MODULAR DESCRIPTION:

Data collection module: This module is responsible for collecting sensor data fromthe sensor nodes. It involves reading data from sensors and validating it.

Pseudocode:

```
Procedure CollectData()
  For each senor in
    SensorNodesRead sensor
    data
    Validate
    data if
    data is
    valid
        Store
    dataElse
        Log
    errorEnd
    if
  End for
End Procedure
```

CODE:

```
#include <stdint.h> // For standard integer
types #include <stdbool.h> // For boolean
type

// Function prototypes for sensor data reading and validation (replace with your actual
functions)bool ReadSensorData(uint8_t sensorId, int16_t* data);
bool ValidateSensorData(uint8_t sensorId, int16_t data);

// Function prototypes for data storage and error logging (replace with your actual
functions)void StoreData(uint8_t sensorId, int16_t data);
void LogError(uint8_t sensorId, int16_t data, const char* errorMessage);

#define MAX_SENSORS 10 // Adjust this based on the actual number of sensors

bool CollectData(void) {
  bool allDataValid = true; // Flag to track overall data validity

  for (uint8_t sensorId = 0; sensorId < MAX_SENSORS;
    sensorId++) {int16_t sensorData;

    // Read sensor data
    if (!ReadSensorData(sensorId, &sensorData)) {
      LogError(sensorId, 0, "Failed to read sensor
      data");allDataValid = false;
      continue; // Skip to next sensor if read fails
    }

    // Validate sensor data
    if (!ValidateSensorData(sensorId, sensorData)) {
      LogError(sensorId, sensorData, "Sensor data validation
      failed");allDataValid = false;
    }
```

```
else
{
    // Store valid data
    StoreData(sensorId,
    sensorData);
  }
  }

  return allDataValid;  // Return true if all data was valid, false otherwise
    }
```

Data processing Module:

This moduel used to process the data based on the attributes after the sensors data collected Process the data that is, Air quality and water quality value in numerical

Pseudocode:

```
Procedure
    ProcessData()For
    each sensor data
      Analyze data
      Interpret data
      Update system
      state
    End For
End
Procedure
```

CODE:

```
#include

<stdint.h>

typedef struct {
  uint8_t sensorId;  // Sensor ID
  int16_t rawData;    // Raw sensor data
  float processedData; // Processed sensor data (example)
  bool alarmTriggered; // Flag indicating if an alarm needs to be raised
} SensorData;

bool ProcessData(SensorData* sensorDataArray, uint8_t
  numSensors) {for (uint8_t i = 0; i < numSensors; i++) {
    SensorData* currentSensor = &sensorDataArray[i];

    switch (currentSensor-
      >sensorId) {case
      SENSOR_ID_CO:
        // CO sensor processing logic
        currentSensor->processedData = (float)currentSensor->rawData / 100.0f; // Example
        conversioncurrentSensor->alarmTriggered = (currentSensor->processedData >
        CO_THRESHOLD);
        break;
      case SENSOR_ID_PM10:
        // PM10 sensor processing logic
        // ... (similar
        structure)break;
      // Add cases for other sensor
      typesdefault:
        // Handle unexpected
        sensor IDbreak;
    }
  }

  // Handle processed data and alarms
  (example)if
  (sensorDataArray[0].alarmTriggered) {
    // Take action for CO alarm
  }
  return true; // Assuming successful processing (adjust based on needs)
}
```

Data Transmission Module:

This Data transmission module will transmit the processed data to central server that System likely utilizes a data transmission module to send the collected air and water quality data from the sensor nodes to a centra server for Data formatting , communication , security , and error handling.

Pseudocode:

```
Procedure TransmitData(data)

  Establish connection with
  CentralServerIf connection
  successful
    Send data

    If data sent
      successfullyLog
      success
    Else

      Log transmission
    failureEnd If
  Else

    Log connection
  failureEnd If
End Procedure
```

CODE:

```
#include <stdint.h>
#include <stdbool.h>

// Function prototypes for establishing connection and sending data (replace with your actual
functions)
bool EstablishConnection(void);
bool SendData(const uint8_t* data, uint8_t dataLength);

void TransmitData(const uint8_t* data, uint8_t
  dataLength) {if (EstablishConnection()) {
    if (SendData(data, dataLength)) {   31
      // Log successful data transmission (optional)
    } else {
      // Log data transmission failure
    }
  } else {
    // Log connection establishment failure
    }
    }
```

Data Storage Module:

The provided code structure for StoreData outlines the basic idea of sending data to a central server database. However, embedded C code for data storage typically wouldn't directly interact with the server's database.

Pseudocode:

```
Procedure StoreData(data)
    Store data in CentralServer
    databaseIf data stored
    successfully
        Log
    success
    Else
        Log storage
    failureEnd If
End Procedure
```

CODE:

```
#include <stdint.h>

// Function prototypes for local storage (replace with your actual
functions)bool WriteDataToLocalStore(const uint8_t* data, uint8_t
dataLength);

void StoreData(const uint8_t* data, uint8_t dataLength) {
  // Transmit data to central server (assuming `TransmitData` is implemented)
  TransmitData(data, dataLength);

  // Optional local storage (if needed)
  if (WriteDataToLocalStore(data, dataLength)) {
    // Log successful local storage (optional)
  } else {
    // Log local storage failure (optional)
  }
```

CHAPTER 7

TESTING

SOFTWARE TESTING:

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the
Software system meets its requirements and user expectations and does not fail in an unacceptablemanner. There are various types of test. Each test type addresses a specific testing requirement.

TYPES OF TESTS

Unit testing:

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately tothe documented specifications and contains clearly defined inputs and expected results.

Integration testing:

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcomeof screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional test:

Functional tests provide systematic demonstrations that functions tested are available as specifiedby the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current testsis determined.

White Box Testing:

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, suchas specification or requirements document. It is a testing in which the software under test is treated, as a black box you cannot "see" into it. The test provides inputs and responds to outputs without considering how the software works.

Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

TEST CASES:

Table 7.7 Test case

TC No	Test Name	Test Description	Input	Expected Output	Actual Output	Test Result
1	Sensor Calibration	Verify that sensor readings are within calibrated range	Sensor readings from calibration	Calibrated sensor values	Calibrated sensor values	Pass
2	Data Acquisition	Check if Arduino can read data from all connected sensors	Reading from all connected sensors	Sensor readings in serial monitor	Sensor readings in serial monitor	Pass
3	Air Quality Monitoring	Test if Arduino calculates air quality index correctly	Sensor readings (PM, CO, NO2, etc.)	Air quality index value	Calculated air quality index	Pass
4	Water Quality Monitoring	Ensure Arduino computes water quality index accurately	Sensor readings (pH, DO, turbidity)	Water quality index value	Calculated water quality index	Pass
5	Threshold Alerting	Validate if Arduino triggers alerts when readings exceed limits	High sensor readings	Alert signal	Alert signal	Pass

CHAPTER 8

CONCLUSION

The development of the Water and Air Quality Monitoring System based on the Internet of Things (IoT) represents a significant step towards addressing environmental pollution challenges in Indonesia. The integration of advanced sensors for water and air quality parameters, coupled with real-time data acquisition and automated classification algorithms, provides a robust framework for continuous monitoring. The inclusion of a Geographic Information System (GIS) enhances spatial analysis, allowing for targeted interventions in areas of concern.

The system's mobile interfaces offer accessible and user-friendly platforms for stakeholders to stay informed about environmental conditions. The utilization of IoT technology ensures efficient data transmission and centralized storage, enabling quick responses to pollution incidents. The alerting system further enhances the system's utility by promptly notifying relevant authorities and users in the event of water or air quality violations.

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APPENDIX

APPENDIX: SNAPSHOTS

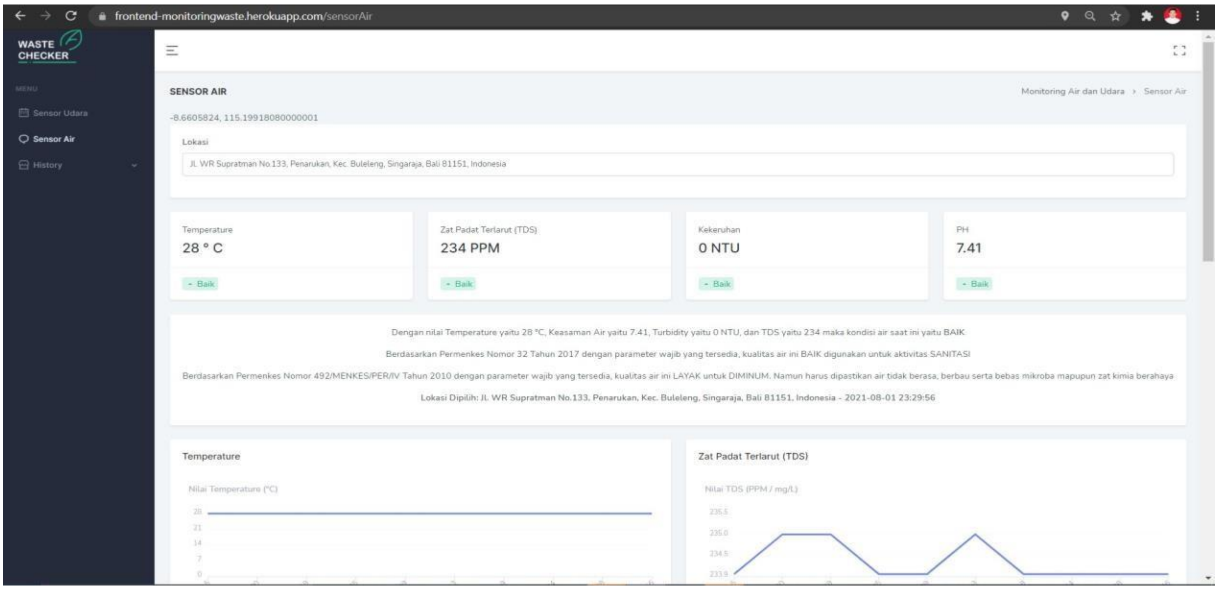


Fig A1: Dashboard Web for Water sensor

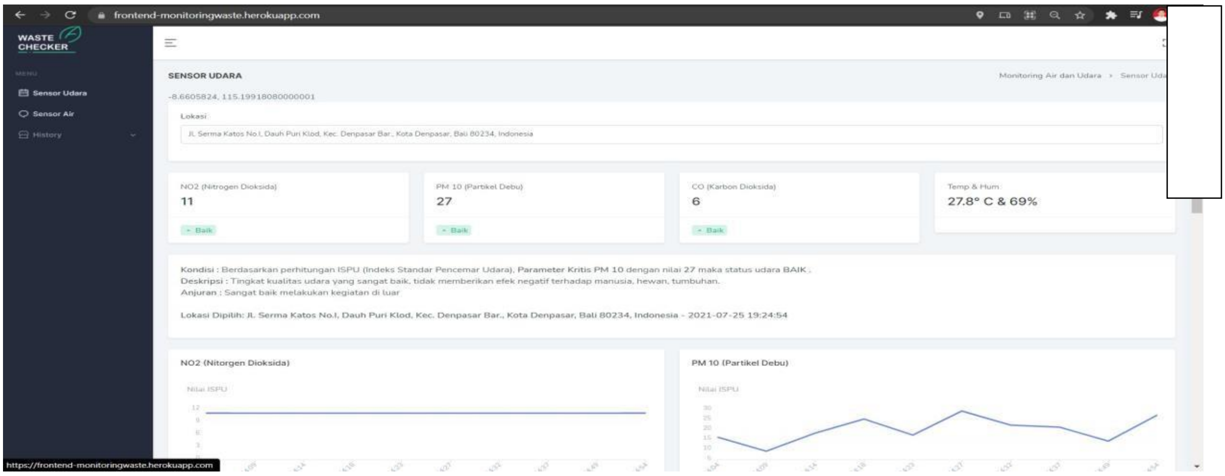
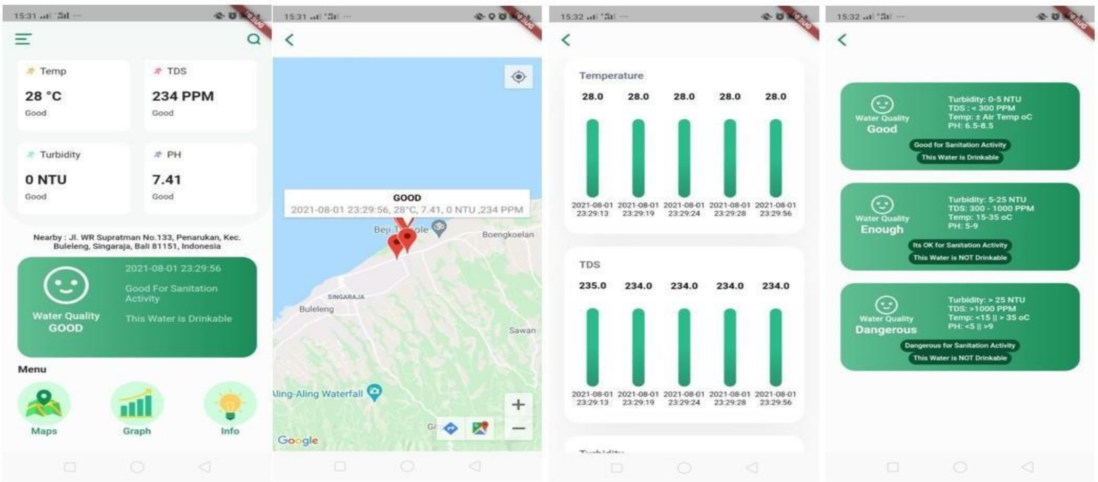
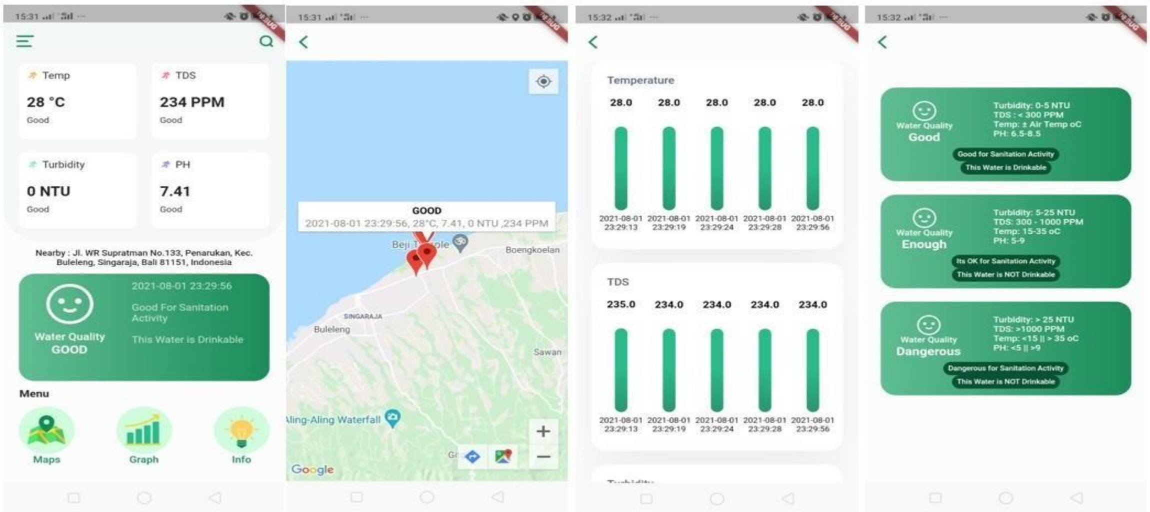


Fig A2: Dashboard web for Air Sensor



(a) (b) (c) (d)

Fig A3: Mobile App for Water sensor



(a) (b) (c) (d)

Fig A4: Mobile app for Air Sensor

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Air and Water Quality Indexing and EnvironmentMonitoring

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Abstract: *The current state of the environment continues to be a pressing global matter resulting from various human activities that release harmful substances posing a threat to living beings. To combat this issue advancements in technology have paved the way for the creation of an Internet of Things (IoT) based Water and Air Quality Monitoring System providing real-time data on environmental conditions. Through web and mobile applications individuals can easily access this system and view graphical representations of water and air quality readings. This innovative system involves sensor nodes strategically placed in different locations collecting field data and evaluating it against the set standards in India. For water monitoring sensors such as the Turbidity Sensor PH Sensor DHT 11 and TDS Sensor are utilized while for air quality the DHT11 sensor MQ-7 sensor and MQ-135 sensor play a crucial role. With this advanced monitoring system timely and accurate information on the state of the environment can be obtained aiding in taking necessary measures to combat pollution.*

Keywords: Real-time, sensor nodes, Internet of Things (IOT), Air and Water quality Detection, Central Server

I. INTRODUCTION

Environmental contamination is a widespread problem that currently plagues our planet. It is caused by various human actions that release pollutants commonly referred to as Man-made Contamination [1]. Pollution is defined as the introduction of harmful substances into the environment which can have adverse effects on humans and other living organisms [2]. The most prevalent forms of pollution particularly in industrial and densely populated areas are Water and Air contamination. Sadly, in India both the general public and the government are often unaware of the deteriorating quality of their surrounding water and air. This lack of awareness can lead to health issues exacerbated by the limited resources available for monitoring through Air Quality Monitoring Stations (AQMS) and water quality measurements conducted by Badan Lingkungan Hidup (BLH). However, with the utilization of modern technology such as the Internet of Things it is possible to address these problems. The Internet of Things is a novel concept that enables electronic devices and sensors to communicate through an internet connection with the aim of simplifying human life [3]. Through the development of a Water and Air Quality Monitoring System real-time monitoring of airand water quality in the surrounding environment can be achieved. Accessible through a website or mobile application this system can help the community and government take preventive measures to combat pollution and its detrimental effects. This monitoring system comprises multiple sensor nodes that provide data on various parameters used to determine water and air quality according to relevant standards in India. The classification of air quality is based on the Index Standard Pencemar Udara(ISPU)which is a numerical value that describes the ambient air quality in a specific location and its impact on human health aesthetic value and other living organisms [4]. Our research focuses on three primary pollutants to determine the ISPU value: Carbon Monoxide (CO) Nitrogen Dioxide (NO2) and Dust Particles (PM10). The classification of water quality in our study specifically looks into the suitability of drinking water and the necessity for Sanitary Hygiene. Drinking water is defined as processed water that meets health requirements and can be consumed directly [5]. Meanwhile Water for Sanitary Hygiene Purposes refers to water used in daily activities that maydiffer in quality from drinking water [6]. The parameters utilized to assess water quality include PH temperature turbidity and Total Dissolved Solids (TDS). To measure these parameters water quality sensor nodes are equipped with

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a Turbidity Sensor DS18B20 Sensor for temperature PH Sensor for acidity and TDS Sensor for dissolved solids. Additionally, air quality sensor nodes consist of a DHT11 Sensor for humidity and temperature MQ-7 Sensor for Carbon Monoxide levels MQ-135 Sensor for Nitrogen Dioxide levels and GP2Y1010AU0F Sensor for dust particles (PM10). Furthermore, this tool is equipped with an Arduino Uno microcontroller and a NEO-6M GPS sensor to determine the location of the sensor nodes. The data collected from the sensor nodes along with their location will be transmitted to the server through an internet connection accessed via ESP8266. This data will then be analysed and presented in a comprehensible format through the website or mobile application.

II. METHADOLOGY

The described functioning of the system involves connecting internet-enabled devices to areas designated for monitoring water and air quality. Once the tools are stable the data collected from the sensors will be transmitted to a server for processing and storage in a database. The processed data is then sorted according to ISPU standards Water Quality Standards (Sanitation) and Drinking Water Quality Requirements. This information can be viewed in real-time on a 16X2 LCD display and a mobile application. The Air and Water Quality Monitoring System utilizes two distinct modules specifically the water module and the air module. Each module is equipped with its own set of components allowing for mobility and the ability to measure water and air quality in varying locations. System overview is in figure1.

A. Water Module

The water system is comprised of multiple sensor units tasked with gathering field data on the factors that determine the quality of both water and air in accordance with established standards in Indonesia. These sensors include a Turbidity Sensor for measuring turbidity levels a DS18B20 sensor to monitor water temperature a DHT 11 sensor to measure air temperature a PH sensor for assessing acidity levels and a TDS (Total Dissolved Solid) sensor for tracking dissolved solids. All of these sensors are linked to an Arduino Uno microcontroller and an ESP-8266 serves as the means for connecting to the API and transmitting the data over the internet, this sensors connection and module you can see in figure 2.

B. Air Module

The air unit consists of various components including a DHT11 Sensor for assessing humidity and temperature an MQ-7 Sensor for detecting Carbon Monoxide levels an MQ-135 Sensor for measuring Nitrogen Dioxide (NO2) levels and a GP2Y1010AU0F Dust Sensor for identifying particles (PM10). Apart from the sensor nodes each module is furnished with an Arduino Uno microcontroller and a NEO-6M GPS sensor for marking the location. All data gathered by the sensor nodes along with their corresponding locations will be transmitted to the server through internet connectivity facilitated by ESP-8266. This sensors connection and module we can see in figure 3.

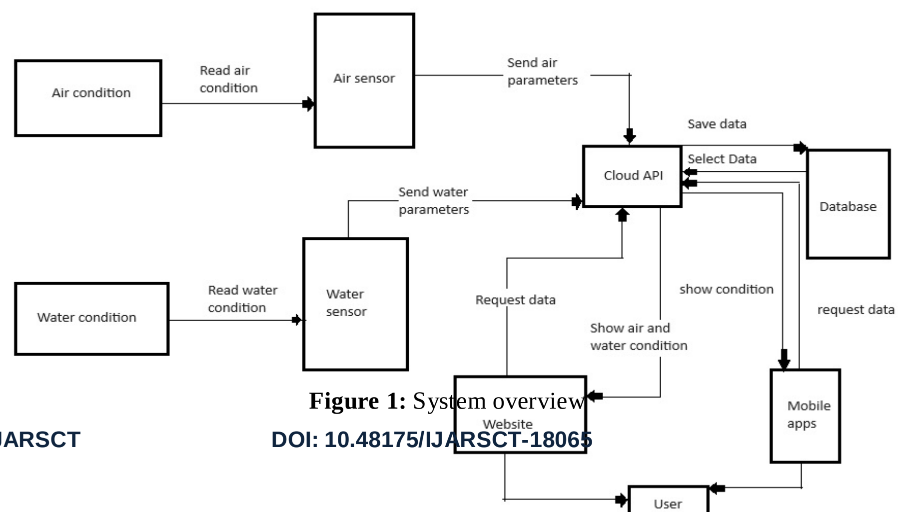

Figure 1: System overview

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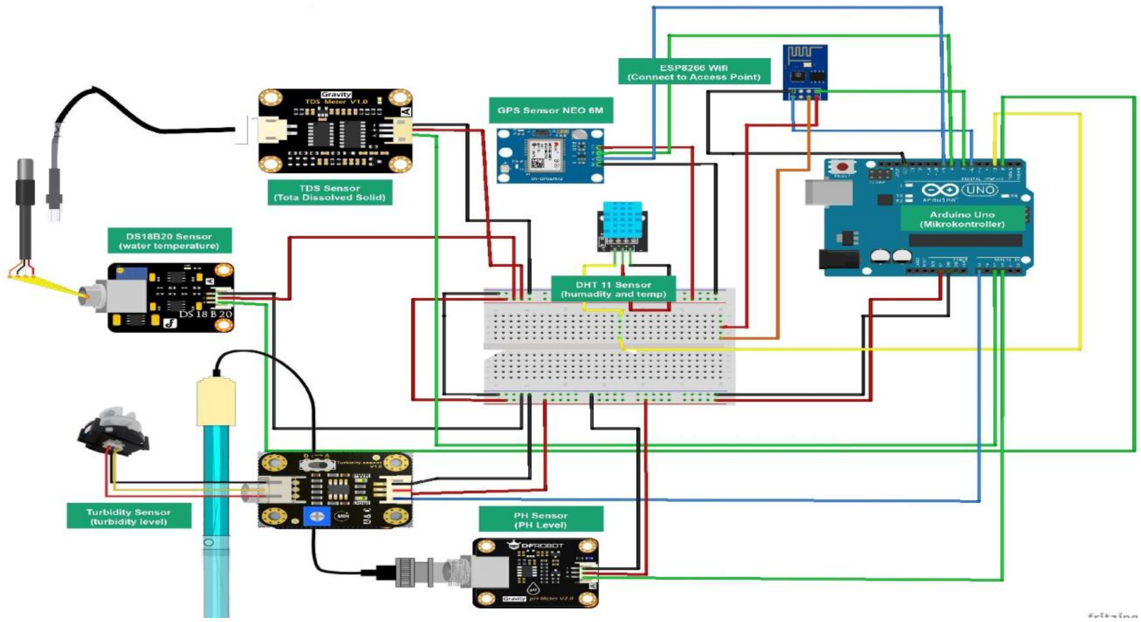

Figure 2: Design Hardware for water module

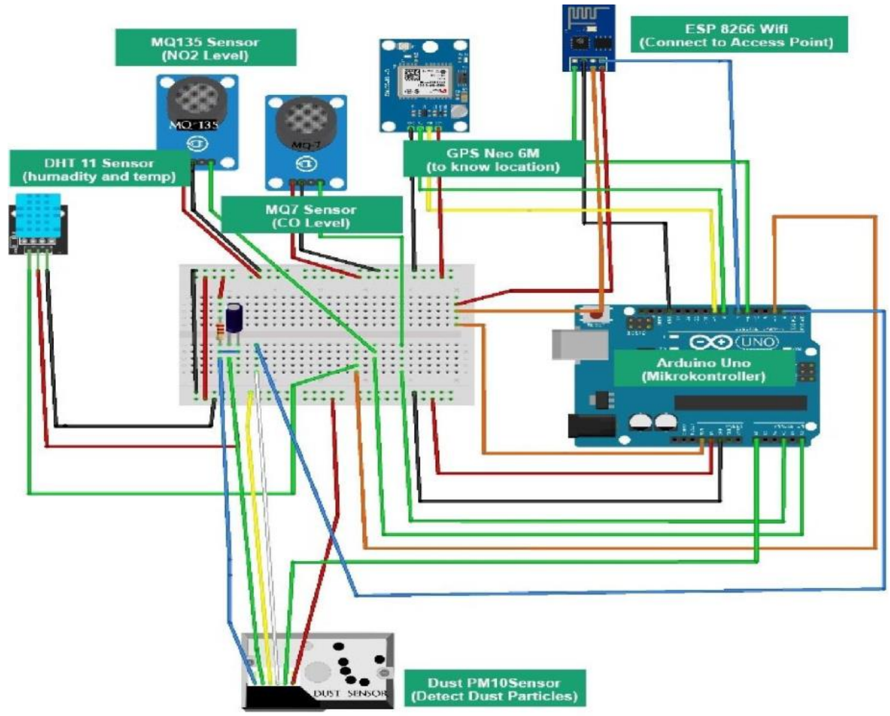

Figure 3: Design Hardware for Air module

III. PROBLEM IDENTIFICATION AND DEFINITION

Background: Environmental pollution, stemming from various human activities, poses significant threats to ecosystems and human health. The adverse impacts of pollutants on air and water quality necessitate effective monitoring systems for timely detection and mitigation.

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Problem Statement: Current environmental monitoring systems often face limitations in terms of real-time data acquisition, comprehensive parameter measurements, and automated classification. There is a need for an integrated approach to monitor both air and water quality, utilizing IoT technology, to address the following key challenges:

Water Quality Monitoring Challenges:

Inadequate Monitoring of Industrial Pollution:

- Problem: Existing water quality monitoring systems may not effectively track pollution from industrialactivities in real-time.
- Consequence: Delayed detection of pollutants may lead to prolonged environmental damage and potentialhealth risks for communities relying on water sources.
- Limited Parameter Measurements:
- Problem: Some monitoring systems may lack a comprehensive set of parameters, leading to an incompleteunderstanding of water quality.
- Consequence: Incomplete data may hinder accurate assessments of water quality, making it challenging toenforce relevant standards and regulations.

Manual Data Classification and Analysis:

- Problem: Systems relying on manual classification and analysis may be time-consuming and prone to errors.
- Consequence: Delayed response to water quality issues and potential inaccuracies in classification, impactingthe reliability of information provided to stakeholders.
- Air Quality Monitoring Challenges:
- Inadequate Coverage in Unmonitored Areas:
- Problem: Certain regions may lack official air quality monitoring, leaving inhabitants unaware of potentialhealth risks.
- Consequence: Lack of real-time air quality data can impede decision-making for both authorities and thepublic, leading to unaddressed pollution concerns.

Manual Classification of Air Quality:

- Problem: Systems requiring manual classification of air quality may be subject to delays and subjectivity.
- Consequence: Delayed response to deteriorating air quality conditions and potential discrepancies inclassification, impacting public health and regulatory measures.
- Limited Spatial Analysis of Pollution Sources:
- Problem: Existing systems may lack spatial analysis capabilities, hindering the identification of specificsources of air pollution.
- Consequence: Inability to pinpoint pollution sources may impede targeted intervention strategies, leading toinefficient pollution management.

IV. RESULT AND DISCUSSION

This section discusses the implementation results of hardware, web, mobile applications you can observe in figure 4,5,6,7.

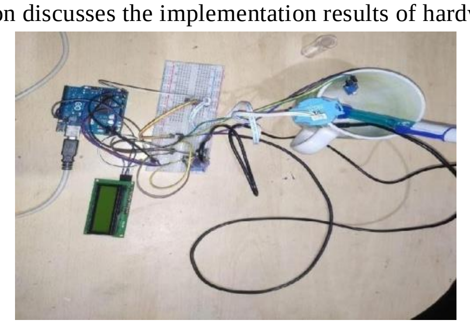

Figure 2: Overall view of the research work

Figure 3: Working Module

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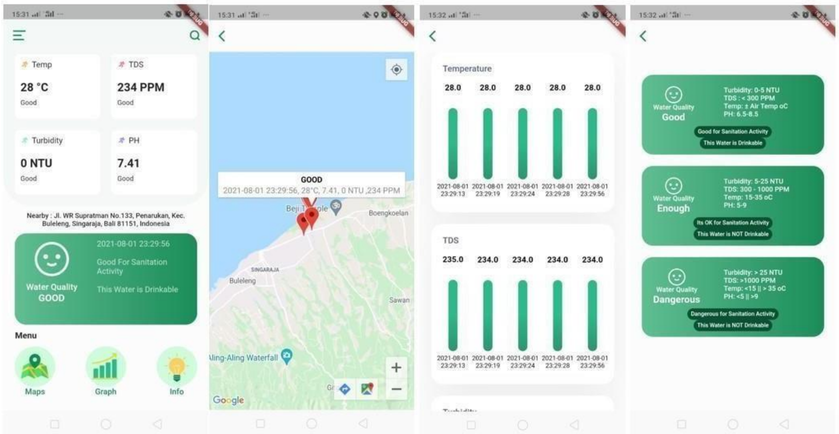
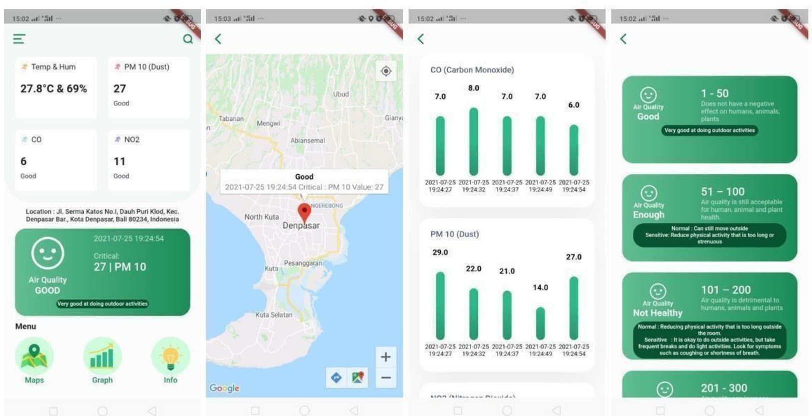


(a) (b) (c) (d)

Figure 4: Mobile App for Water sensor



(a) (b) (c) (d)

Figure 5: Mobile App for Air sensor

V. CONCLUSION

The creation of the Water and Atmosphere Quality Tracking Solution based on the Internet of Things (IoT) marks a substantial stride towards resolving issues of ecological contamination in Indonesia. The merging of cutting-edge detectors for water and air quality parameters coupled with instantaneous data collection and automated classification algorithms establishes a strong framework for uninterrupted monitoring. The incorporation of a Geographic Information System (GIS) enhances spatial interpretation allowing for strategic interventions in areas of concern. The platform's mobile interface offers easy-to-use and accessible channels for stakeholders to remain updated on environmental conditions. By leveraging IoT technology the system guarantees efficient data transmission and centralized storage facilitating prompt responses to instances of pollution. Moreover, the alerting system adds to the system's efficacy by promptly notifying relevant authorities and users in the event of any water or air quality violations.

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