LAB REPORT

Submitted by

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Under the Guidance of
Ms. HEMA M
ASSISTANT PROFESSOR
COMPUTING TECHNOLOGIES DEPARTMENT

In partial satisfaction of the requirements for the degree of

BACHELOR OF TECHNOLOGY
in
COMPUTER SCIENCE ENGINEERING

SCHOOL OF COMPUTING

COLLEGE OF ENGINEERING AND TECHNOLOGY

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

KATTANKULATHUR - 603203

MAY 2023

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INSTITUTE OF SCIENCE & TECHNOLOGY
Deemed to be University u/s.3 of UGC Act, 1956

COLLEGE OF ENGINEERING & TECHNOLOGY
SRM INSTITUTE OF SCIENCE & TECHNOLOGY
S.R.M. NAGAR, KATTANKULATHUE – 603 203
Chengalpattu District

BONAFIDE CERTIFICATE

Register No. **RA2111003010318,RA2111003010321,RA2111003010325**

Certified to be the bonafide work done by **Ashish Sukumar, Rudra Garai, Vaishnavi** of II Year/IV Sem B.Tech Degree Course in the **Practical Software Software Engineering and Project Management 18CSC206J** in **SRM INSTITUTE OF SCIENCE AND TECHNOLOGY,** Kattankulathur during the academic year 2022 – 2023.

M. Hema (M. Hema)

LAB INCHARGE

M Hema

Assistant Professor

Department of Computing

Technologies SRMIST – KTR.

Department of Computing Technology * SRM IST * Kattankulathur 603 203

M. Pushpalatha

Head of the Department

Dr. Pushpalatha M

Professor & Head

Department of Computing

Technologies SRMIST –KTR.

Date :

ABSTRACT

The project "Air Quality Analyzer using Arduino" is aimed at developing an economical and efficient device for measuring and monitoring air quality parameters. The system is designed to measure particulate matter, carbon dioxide, carbon monoxide, and other harmful gases in the air. The proposed system is based on the Arduino platform, which is a low-cost microcontroller board that can interface with various sensors and modules. The device will be equipped with sensors such as the MQ-135 gas sensor, the SDS011 particulate matter sensor, and the DHT11 temperature and humidity sensor. The collected data will be displayed on an LCD screen, and the system will also have the capability to upload the data to the cloud for remote monitoring and analysis. The proposed system will provide an affordable and effective solution for air quality monitoring and will be useful in a variety of applications such as home, office, and industrial settings.

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LIST OF FIGURES

School of Computing

SRM IST, Kattankulathur – 603 203

Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	1
Title of Experiment	To identify the Software Project, Create Business Case, Arrive at a Problem Statement
Name of the candidate	Vaishnavi
Team Members	Vaishnavi , Ashish Sukumar , Rudra Garai
Register Number	RA2111003010325, RA2111003010318, RA2111003010321
Date of Experiment	23-01-2023

Mark Split Up

S.No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	5
	Total	**10**	10

1-2-2023

Staff Signature with date

Aim

To Frame a project team, analyze and identify a Software project. To create a business case and Arrive at a Problem Statement for the <title of the project>

Team Members:

S. No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Lead/Rep
2	RA2111003010318	Ashish Sukumar	Member
3	RA2111003010321	Rudra Garai	Member

Project Title: **Air Quality Analyser**

Project Description :

From contaminating our environment to damaging our health, poor air quality is a major global challenge. No one is immune to the negative effects of air pollution. In this project we are going to make an IoT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a webserver using internet and will trigger a alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2, smoke, alcohol, benzene and NH3.

BUSINESS CASE

DATE	24/01/2023
SUBMITTED BY	Vaishnavi
TITLE / ROLE	Team Leader

THE PROJECT

As urbanization causes the growth of suburban communities, the existing transportation infrastructure dependent on fossil fuels must expand. An increase in vehicle use gives rise to an increase in traffic-related pollutant emissions.

In this IOT project, you can monitor the pollution level from anywhere using your computer or mobile. We can install this system anywhere and can also trigger some device when pollution goes beyond some level,

THE HISTORY

Canaries in coal mines provided advanced warning of toxic gases. These living, mobile, handheld sensors saved countless lives of miners by detecting high concentrations of carbon dioxide, carbon monoxide, and methane.

Drager develops first portable tube for detecting carbon monoxide for the mining industry.

Preemptive Media created *AIR*- a portable air monitoring device that enabled people to find pollution hotspots in their neighborhood and urban environments.

LIMITATIONS

1) Often rely on low-cost sensors that may have limited accuracy or precision.

2) Some sensors have limited measurement range, which can lead to incorrect readings or missing data when air quality exceeds the sensors range

3) Other electronic devices and environmental factors can interfere with sensor readings

4) Arduino boards have limited processing power, so real-time data processing and analysis may be limited

5) Continuous operation of an air quality monitoring device using Arduino may require a large power source or frequent battery replacement

APPROACH

1) Arduino board -₹500 to ₹2500
2) Air quality sensor-₹150 to ₹500
3) OLED/LED display- ₹200 to ₹800
4) Breadboard and wires -₹100 to ₹500
5) Power source -₹50 to ₹200
6) Micro USb cable for connecting Arduino to computer -₹100 to ₹300

Optional components-

1) Fan or blower to increase air flow-₹100 to ₹500
2) Enclosure to protect components-₹200 to ₹1000

BENEFITS

1) The device can continuously monitor and display the air quality, allowing for real time monitoring and tracking of changes in air quality
2) It is cost effective making it accessible to wider range of individuals and organizations
3) The device can be customized to suit specific needs and requirements
4) The device is portable and can be easily transported to different locations for monitoring
5) It stores air quality data which can be used for research and analysis purposes

Result:

Thus, the project team formed, the project is described, the business case was prepared and the problem statement was arrived.

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	2
Title of Experiment	Identification of Process Methodology and Stakeholder Description
Name of the candidate	Vaishnavi
Team Members	Vaishnavi , Ashish Sukumar , Rudra Garai
Register Number	RA2111003010325, RA2111003010318 , RA2111003010321
Date of Experiment	10-2-2023

Mark Split Up

S.No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	5
	Total	**10**	10

14-2-2023

Staff Signature with date

Aim

To identify the appropriate Process Model for the project and prepare Stakeholder and User Description.

Team Members:

Sl No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep/Member
2	RA2111003010318	Ashish Sukumar	Member
3	RA2111003010321	Rudra Garai	Member

Project Title:

Selection of Methodology:

After evaluating the various process models available, we have decided to use the waterfall model for our air quality analyzer project.

This choice was made based on the following considerations:

1) Stable requirements: The requirements for our air quality analyzer are well defined and unlikely to change significantly during the course of the project. The waterfall model, with its linear and sequential approach, is well suited to projects with stable requirements.

2)Efficient delivery: The waterfall model focuses on completing each stage of the project before moving on to the next, which can help us to efficiently deliver the final product. This is particularly important given our tight budget and timeline constraints.

3)Clear milestones: The waterfall model provides clear milestones for each stage of the project, which will help us to monitor progress and ensure that we are on track to meet our goals.

4)Reduced risk: By completing each stage of the project before moving on to the next, the waterfall model can help us to identify and address any potential issues or risks before they become major problems.

Given these considerations, we believe that the waterfall model is the most appropriate process model for our air quality analyzer project, and we are confident that it will help us to successfully deliver a high-quality product.

Stakeholder Name	Activity/ Area /Phase	Interest	Influence	Priority (High/ Medium/ Low)
Customers	Usage	High	Low	High
Environmental Protection Agencies	Regulation	High	High	High
Manufacturers and Suppliers	Production and Supply	High	High	Medium
Scientists and Researchers	Development and Testing	High	Medium	High
Community Groups	Advocacy	Medium	Medium	Medium
Local residents and Businesses	Impacted by air quality	High	Low	High
Government Agencies	Monitoring and Management	High	High	High
Health care Providers	Public Health	High	Medium	High
Insurance companies and financial institutions	Coverage and Funding	Medium	High	Medium

Result

Thus the Project Methodology was identified and the stakeholders were described.

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SRM IST, Kattankulathur – 603 203

Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	3
Title of Experiment	System, Functional and Non-Functional Requirements of the Project
Name of the candidate	Vaishnavi
Team Members	Vaishnavi, Ashish Sukumar, Rudra Garai
Register Number	RA2111003010325, RA2111003010318, RA2111003010321
Date of Experiment	13-2-2023

Mark Split Up

S.No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	4
	Total	**10**	09

14-2-2023

Staff Signature with date

Aim

To identify the system, functional and non-functional requirements for the project.

Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep/Member
2	RA2111003010318	Ashish Sukumar	Member
3	RA2111003010321	Rudra Garai	Member

Project Title: Air Quality Analyzer

System Requirements:

1) Microcontroller unit (MCU), such as Arduino.
2) Sensors for measuring air quality parameters (particulate matter, temperature, humidity, air pressure, etc.)
3) A display unit or a mobile application for data visualization.
4) Memory storage for data logging.
5) Wireless communication module for data transfer (e.g. Wi-Fi, Bluetooth, etc.)
6) Power supply unit, such as a battery or AC adapter.

Functional Requirements:

1) Ability to measure the levels of particulate matter (PM) in the air.
2) Ability to measure levels of temperature, humidity, and air pressure.
3) Display of real-time air quality data on a screen or through a mobile application.
4) Ability to store and retrieve historical data for analysis and comparison.
5) Ability to set alarms and notifications for air quality levels exceeding a certain threshold.

6) Ability to provide a graphical representation of air quality data.

7) Ability to detect gas levels like CO2, CO, and other harmful gases.

8) Ability to perform data analysis and prediction using machine learning algorithms.

Non-Functional Requirements:

1) Accuracy of the data measured by the device.

2) The responsiveness of the device to changes in air quality.

3) Robustness of the device against environmental conditions like temperature and humidity.

4) Reliability of the device over an extended period.

5) Ease of use and ease of installation.

6) Security and privacy of the data collected by the device.

Result

Thus the requirements were identified and accordingly described.

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SRM IST, Kattankulathur – 603 203

Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	4
Title of Experiment	Prepare Project Plan based on scope, Calculate Project effort based on resources and Job roles and responsibilities
Name of the candidate	Vaishnavi
Team Members	Vaishnavi, Ashish Sukumar, Rudra Garai
Register Number	RA2111003010325, RA2111003010318, RA2111003010321
Date of Experiment	26-02-2023

Mark Split Up

S.No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	5
	Total	**10**	10

M. Flem 28-2-2023

Staff Signature with date

Aim

To Prepare Project Plan based on scope, Calculate Project effort based on resources, Find Job roles and responsibilities

Team Members:

Sl No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Team Leader
2	RA2111003010318	Ashish Sukumar	Project manager
3	RA2111003010321	Rudra Garai	Hardware designer

1. Project Management Plan

Focus Area	Details
Integration Management	1)Air quality analyzer is a project used to monitor the level of pollution in the air. 2)The team consists of three members Vaishnavi (Team leader), Ashish (Project manager), Rudra Garai (Hardware designer) 3) • Vaishnavi (Team leader): Set project goals, define scope of project, establish project plan and timeline • Ashish (Project manager): Ensure that the project is proceeding according to the plan, address any issues or risk. • Rudra Garai (Hardware designer): Design and develop the physical components of the project, including printed circuit boards, integrated circuits, and other electronic devices. 4) Based on our current design, we are not anticipating any changes but we are working to put a source control system in place. We would be maintaining all our software components as versions (version-controlled). 5) Final product developed is an air quality analyzer.
Scope Management	1)Project Title: Air Quality Analyzer Project Objectives: • To develop a low-cost air quality analyzer using Arduino that measures various pollutants scope Statement.

	• To provide real-time monitoring of air quality data using a graphical user interface. • To provide alerts when the air quality reaches hazardous levels. Project Deliverables: • An Arduino-based air quality analyzer prototype that measures PM2.5, PM10, CO, CO2, and NO2 • A GUI to display real-time air quality measurements 2) Change control: • Change Request Identification: The first step in the change control process is to identify any changes that are proposed for the project. • Change Request Assessment: Once a change request has been identified, it should be evaluated. • Change Request Approval: Analyze if the change request is assessed as feasible and acceptable. • Change Request Implementation: If the change request is approved implement the change.
Schedule Management	1) Project Planning: This milestone includes the completion of the project plan, including the scope statement, schedule, budget, and risk management plan. Estimated time: 2 weeks. 2)Project Design and refinement: This milestone includes the development of a High-Level Design (Flowchart) document. Estimated time: 1 week. 3)Product Development: This milestone includes the development of a working model of the air quality analyzer using Arduino, which includes sensors for measuring air quality, data processing and storage, and communication interfaces. Estimated time: 6 weeks. 4) Testing and Validation: This milestone includes the testing and validation of the prototype, to ensure that it meets the specified requirements and works correctly. Estimated time: 3 weeks. 5) Deployment and Maintenance: This milestone includes the deployment of the air quality analyzer in the intended environment, as well as ongoing maintenance and support.
Cost Management	1)Arduino board -₹500 to ₹2500 2)Air quality sensor-₹150 to ₹500 3)OLED/LED display- ₹200 to ₹800 4)Breadboard and wires -₹100 to ₹500 5)Power source -₹50 to ₹200 6)Micro USB cable for connecting Arduino to computer -₹100 to ₹300

	Optional components- Fan or blower to increase air flow-₹100 to ₹500 Enclosure to protect components-₹200 to ₹1000 Estimate. Total estimate- ₹6300 Cost control: Limit the spending to a maximum of 10,000 After all the testing and validation to produce the final product.
Quality Management	1)Develop Quality Standards: The first step in quality control is to develop a set of quality standards that define the expected level of quality for the project. These standards are based on the requirements of the project and the expectations of the stakeholders. 2) Document Quality Control Activities: Throughout the project, it's important to document all quality control activities, including testing results, inspection checklists, and quality assurance reviews.
Resource Management	1)Hardware Knowledge: Our team has a reasonable understanding of hardware components and circuits, as well as experience with microcontrollers, sensors, and other electronic components. 2)Software Development: The team is quite proficient in software development, including experience with programming languages such as C/C++, and knowledge of Arduino IDE and libraries. 3)Project Management: The team has experience in project management, including skills in task scheduling, resource allocation, and has a fair understanding of budget control. 4)Testing and Validation: The team has developed the required tests and hence has a good understanding on the testing and validation techniques.
Stakeholder	1)Customers 2)Environmental 3)Protection Agencies 4)Manufacturers and Suppliers 5)Scientists and Researchers 6)Community Groups 7)Local residents and Businesses 8)Government Agencies 9)Health care Providers

	10)Insurance companies and financial institutions
Communication Management	The team has decided to meet for an hour daily to discuss the progress, changes and upcoming tasks. Maintaining the minutes of the meeting with the relevant action points and task owners.
Risk Management	Some potential risks that could affect an air quality analyzer project using Arduino: 1)Technical Risks: Technical risks are related to the design and implementation of the system. These risks might include issues with hardware components or software development, difficulties in integrating components, or limitations in the accuracy of sensors. 2)Schedule Risks: Schedule risks are related to delays in the project timeline. These risks might include unexpected issues with components or manufacturing delays. 3)Cost Risks: Cost risks are related to the project budget. These risks might include unexpected costs related to component failures, additional resources required, or changes in regulatory requirements. The team has discussed and fully understands the above risks and has worked out the strategies to address these risks.

2. Estimation

2.1. Effort and Cost Estimation:

Activity Description	Sub Task	Sub Task Description	Effort (in hours)	Cost (in INR)
Design	System Design	Define system requirements, constraints, and specifications	3(members)*30hrs	27,000
	Hardware Design	Determine necessary components, design schematics, and layout board	1(member)*90	27,000
	Software Design	Develop code for data	2(members)*60	36,000

		acquisition, sensor calibration, and data visualization		
Production	Manufacturing	Build and test production units	3(members)*15	13,500
	Quality Assurance & Testing	Conduct quality control checks on units	3(members)*10	9,000
	Packaging and Shipping	Package units and ship to customers		
Project Management	Meetings	Hold team meetings and coordinate project timeline	3(members)*30	27,000
	Documentation	Create project documentation including user manual and technical specifications	3(members)*4	3600
	Risk Management	Identify and mitigate potential project risks	N/A(estimated s part of product design and development)	
Total			477	1,43,100

Effort (hr)	Cost (INR)
1	300

3. Infrastructure/Resource Cost [Cap Ex]:

The expenditure on this project will be on computer requirements with enough storage and capacity to run the Arduino IDE and handling data analytics task.

Infrastructure Requirement	Qty	Cost per qty	Cost per item
IR1	3	30,000	90,000

3.1. Maintenance and Support Cost [Op Ex]

Category	Details	Qty	Cost per qty per annum	Cost per item
People	Network, System, Middleware and DB admin Developer, Support Consultant	N/A		
License	Operating System Database Middleware IDE	N/A		
Infrastructures	Server, Storage and Network	N/a		

4. Project Team Formation

4.1. Identification Team members

Name	Role	Responsibilities
Customer	Key Business User (Product Owner)	Provide clear business and user requirements
Ashish Sukumar	Project Manager	Manage the project
Ashish Sukumar Vaishnavi Rudra Garai	Business Analyst	Discuss and Document Requirements
Vaishnavi	Technical Lead	Design the end-to-end architecture
N/A	UX Designer	Design the user experience
N/A	Frontend Developer	Develop user interface
Rudra Garai	Backend Developer	Design, Develop and Unit Test Services/API/DB
N/A	Cloud Architect	Design the cost effective, highly available and scalable architecture
N/A	Cloud Operations	Provision required Services
Vaishnavi Ashish Sukumar Rudra Garai	Tester	Define Test Cases and Perform Testing

4.2. Responsibility Assignment Matrix

RACI Matrix	Team Members			
Activity	**Name (BA)**	**Name (Developer)**	**Name (Project Manager)**	**Key Business User**
User Requirement Documentation	Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(A,R) Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(C,A)	Customer(A,R)
Hardware Design	Rudra Garai(A,R)	Rudra Garai(A,R)	Ashish Sukumar(C,I)	Team(R)
Software Design	Vaishnavi(A) Ashish Sukumar(A)	Vaishnavi(A,R) Ashish Sukumar(R)	Ashish Sukumar(C,I)	Team(R)
Software Development	Ashish Sukumar(R) Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(R) Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(C,I)	Customer(I)
Quality Control Design	Vaishnavi(A,R)	Ashish Sukumar(R) Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(C,I)	Customer(I)
Testing and Validation	Ashish Sukumar(R) Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(R) Vaishnavi(A,R) Rudra Garai(R)	Ashish Sukumar(C,I)	Customer(I)
Deployment	Vaishnavi (R) Ashish Sukumar(A,R)	Ashish Sukumar(A,R) Vaishnavi(R) Rudra Garai(R)	Ashish Sukumar(A)	Customer(R)

Legend:

A	Accountable
R	Responsible
C	Consult
I	Inform

Result:

Thus, the Project Plan was documented successfully.

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School of Computing

SRM IST, Kattankulathur – 603 203

Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	5
Title of Experiment	Prepare Work breakdown structure, Timeline chart, Risk identification table
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	1-03-2023

Mark Split Up

S.No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	4
2	Viva	5	4
	Total	**10**	08

25-4-2023

Staff Signature with date

Aim

To Prepare Work breakdown structure, Timeline chart and Risk identification table

Team Members:

Sl No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Air Quality Analyzer

WBS:

1. Planning Phase
   1.1. Define project objectives
   1.2. Identify project stakeholders
   1.3. Develop project scope statement
   1.4. Identify project risks
   1.5. Develop project schedule
   1.6. Develop project budget

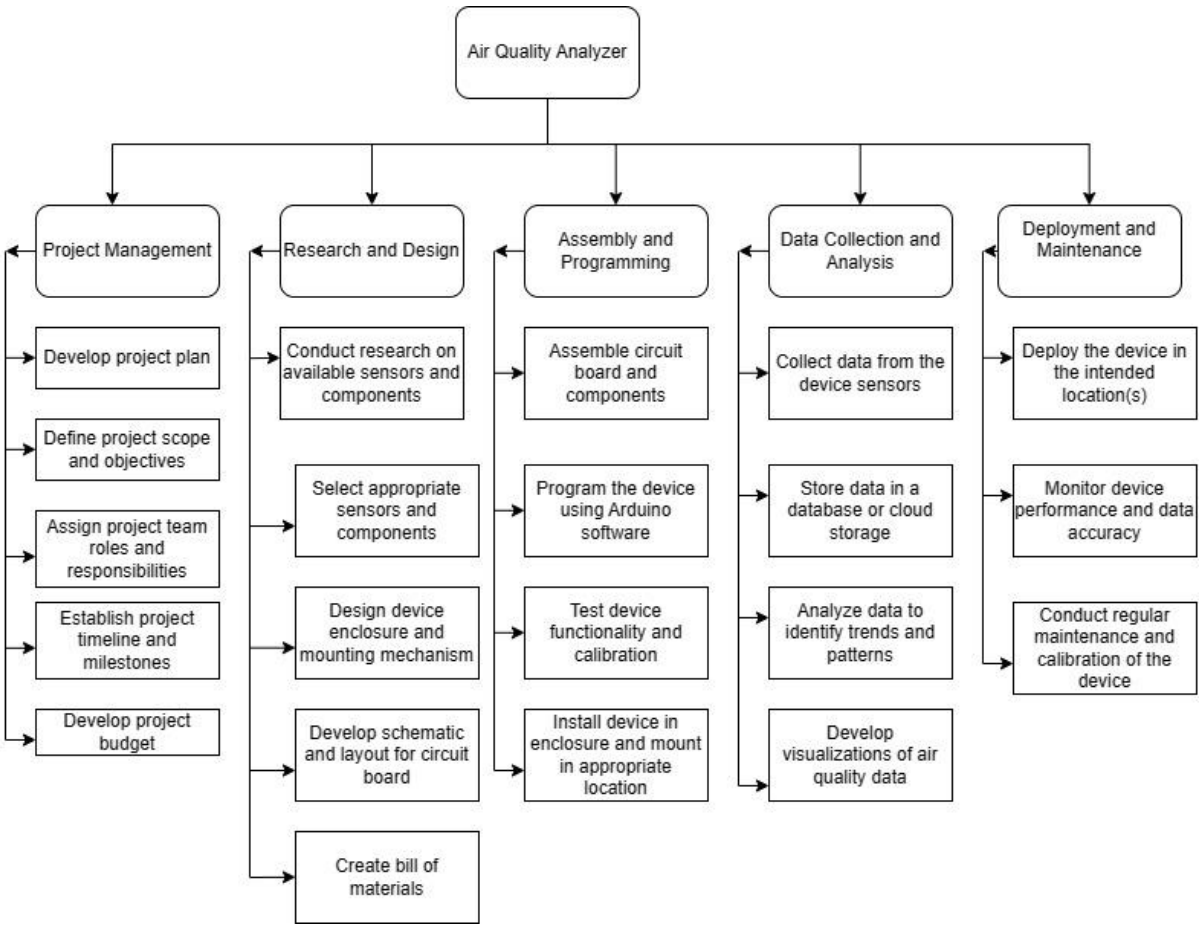
2. Design Phase
   2.1. Determine the components required for air quality analyzer
   2.2. Develop system architecture and schematic design
   2.3. Develop user interface
   2.4. Select sensors for air quality analyzer
   2.5. Design the power supply
   2.6. Develop software for data collection, analysis, and display

3.Construction Phase
   3.1. Assemble hardware components
   3.2. Install sensors
   3.3. Connect and test hardware components
   3.4. Load and test software

4.Testing Phase
   4.1. Conduct sensor calibration
   4.2. Conduct system testing
   4.3. Record test results
   4.4. Evaluate test results

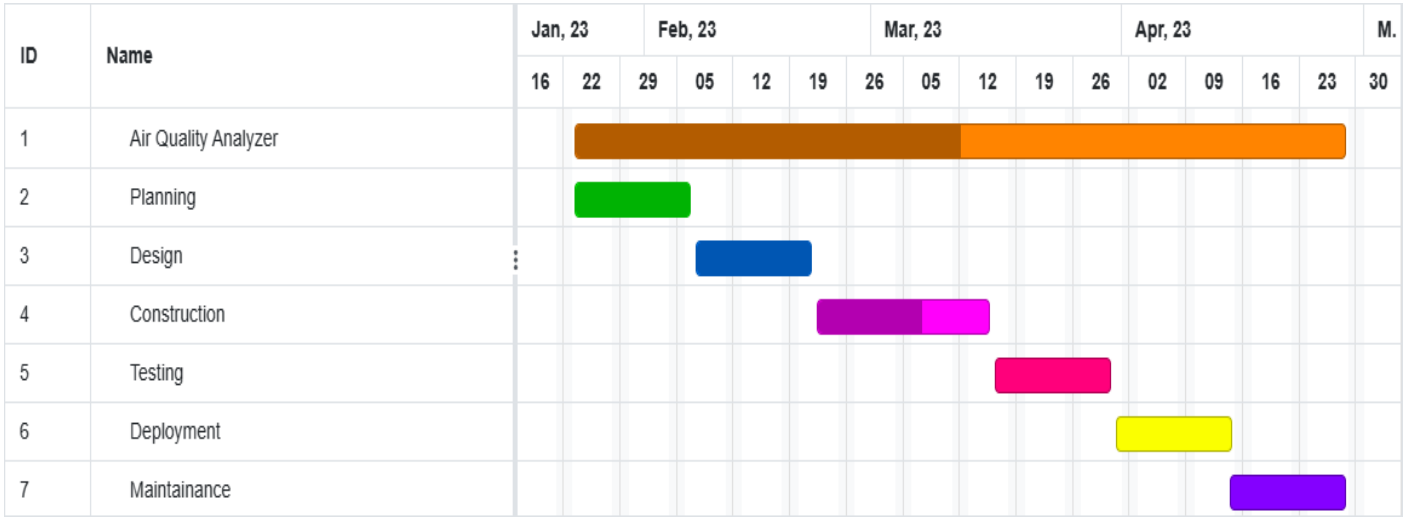
5.Deployment Phase
- 5.1. Develop user manual
- 5.2. Train users
- 5.3. Install the air quality analyzer in the desired location
- 5.4. Final testing and sign-off

6.Maintenance Phase
- 6.1. Develop maintenance plan
- 6.2. Conduct periodic maintenance
- 6.3. Troubleshoot and repair as necessary



TIMELINE – GANTT CHART:

Phase	Start Date	End Date	Duration
Planning	23/01/2023	06/02/2023	2 weeks
Design	07/02/2023	21/02/2023	2 weeks
Construction	22/02/2023	15/03/2023	3 weeks
Testing	16/03/2023	30/03/2023	2 weeks
Deployment	31/03/2023	14/04/2023	2 weeks
Maintenance	15/04/2023	29/04/2023	2 weeks



RISK ANALYSIS – SWOT & RMMM:

Strengths:

1) Low cost compared to commercial air quality analyzers
2) Can be customized to specific needs and requirements
3) Provides real-time data on air quality levels
4) Can help identify sources of air pollution in a specific area
5) Can be connected to the internet and share data

Weaknesses:

1) Requires technical expertise to assemble and program
2) Limited range of sensors available for certain air pollutants
3) Relies on stable power supply for reliable operation
4) May require regular calibration and maintenance

Opportunities:

1) Increasing public awareness of air pollution and its health effects
2) Growing demand for low-cost, portable air quality monitors
3) Potential for partnerships with local governments and environmental organizations
4) Potential for integration with smart home or smart city systems

Threats:

1) Competition from established commercial air quality monitoring companies
2) Potential legal or regulatory barriers to deployment in certain areas
3) Risk of inaccurate or unreliable data if not properly calibrated or maintained
4) Risk of damage or loss due to environmental factors or vandalism

Risk	Mitigation	Monitoring	Management
1) Technical difficulties with the assembly and programming of the device	Thoroughly research and plan the assembly and programming process, seek help from experienced individuals or resources, conduct thorough testing before deployment.	Regularly check for any technical issues during testing and operation, monitor for any unexpected behavior or errors.	If technical issues arise, troubleshoot and seek help as necessary, potentially delay deployment if necessary to address technical issues.
2) Limited range of sensors available for certain air pollutants	Research available sensor options and select the most appropriate ones for the project's goals, conduct research	Monitor the accuracy and reliability of the selected sensors	If necessary, consider updating or replacing sensors to improve

	and seek out alternatives if necessary.	during testing and operation.	accuracy and reliability.
3) Inaccurate or unreliable data due to lack of calibration or maintenance	Develop and implement a regular calibration and maintenance schedule, thoroughly document all calibration and maintenance activities.	Monitor data for any inconsistencies or unexpected patterns, check equipment regularly for signs of wear or damage.	If data is found to be inaccurate or unreliable, troubleshoot and seek help as necessary, potentially recalibrate or replace equipment if necessary.
4) Potential legal or regulatory barriers to deployment in certain areas	Thoroughly research local laws and regulations related to air quality monitoring and deploy only in areas where it is legally and ethically permissible.	Monitor for any changes in local laws or regulations that may impact the project.	If necessary, consult legal or regulatory experts for guidance on how to proceed.
5) Risk of damage or loss due to environmental factors or vandalism	Use sturdy, weather-resistant enclosures and install in secure locations, potentially use security cameras or other deterrents.	Regularly check equipment for any signs of damage or tampering, monitor security cameras or other security measures.	If damage or loss occurs, troubleshoot and seek help as necessary, potentially replace equipment if necessary.

Result:

Thus, the work breakdown structure with timeline chart and risk table were formulated successfully.

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School of Computing

SRM IST, Kattankulathur – 603 203

Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	6
Title of Experiment	Design a System Architecture, Use Case and Class Diagram
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	5-03-2023

Mark Split Up

S.No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	4
2	Viva	5	4
	Total	**10**	08

05-4-2023

Staff Signature with date

Aim

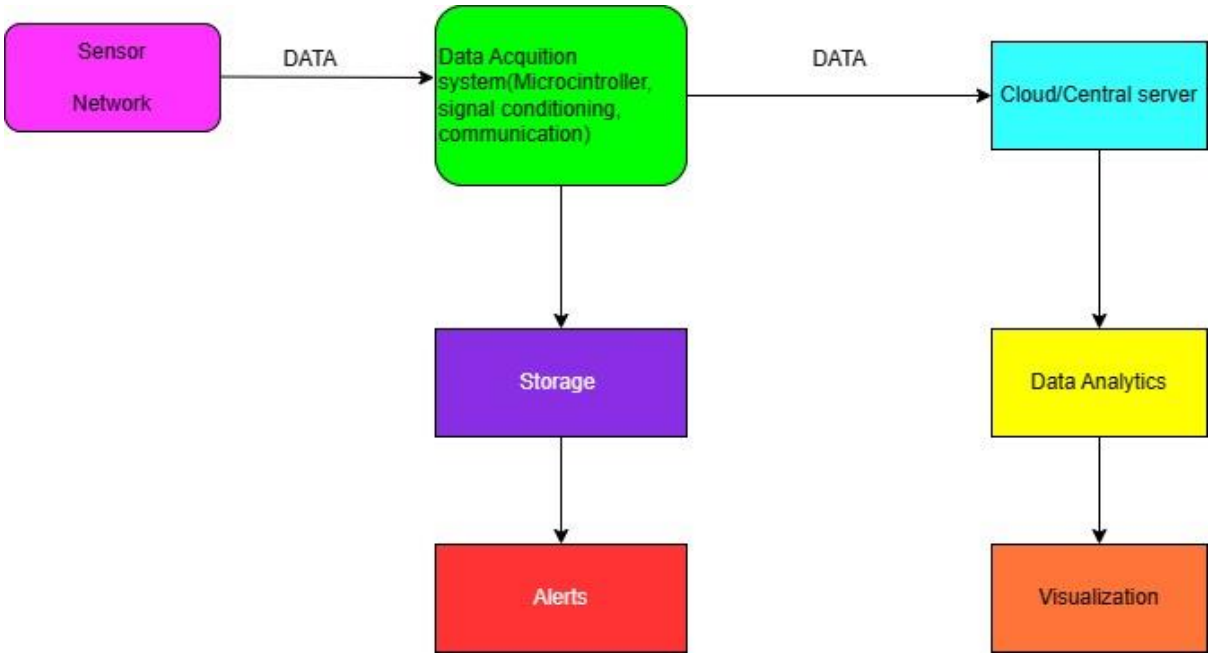
To Design a System Architecture, Use case and Class Diagram

Team Members:

Sl No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Team Lead
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Air Quality Analyzer

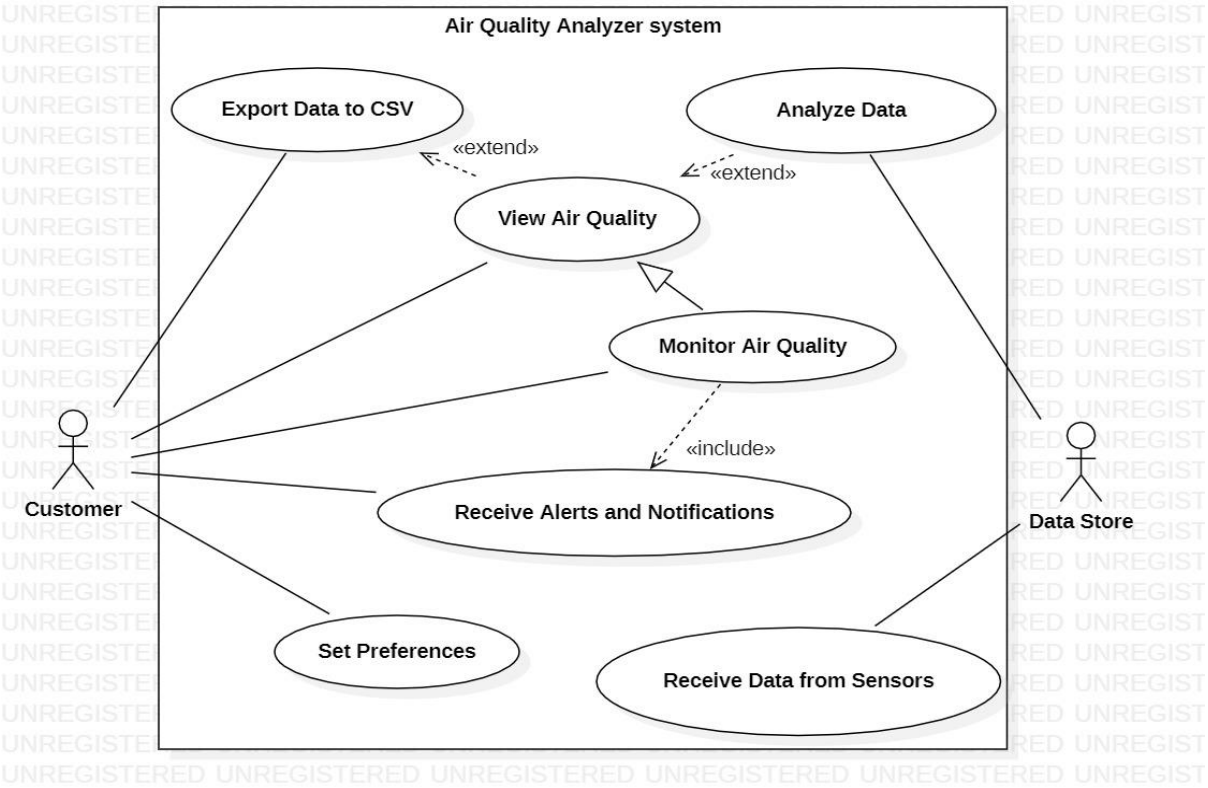
SYSTEM ARCHITECTURE:



1) **Sensors:** The first component of an air quality analyzer system is sensors that detect various pollutants.
2) **Data Acquisition System:** The second component of the system is a data acquisition system that collects the sensor data.
3) **Cloud or Central Server:** The third component of the system is a cloud or a central server that receives the sensor data.
4) **Data Storage:** The fourth component of the system is data storage, which stores the pre-processed data.
5) **Data Analytics:** The fifth component of the system is data analytics, which involves analyzing the data to extract insights and trends.

6) **Visualization:** The sixth component of the system is visualization, which involves presenting the data to end-users.
7) **Alerting and Notification:** The seventh component of the system is alerting and notification, which involves alerting the end-users when the air quality crosses a certain threshold.

USE CASE DIAGRAM:



The use cases are:

1) **Set Preferences:** Allows the customer to set their preferences for the system, such as the location they want to monitor.

2) **Monitor Air Quality:** Involves monitoring the air quality in real-time using sensors.

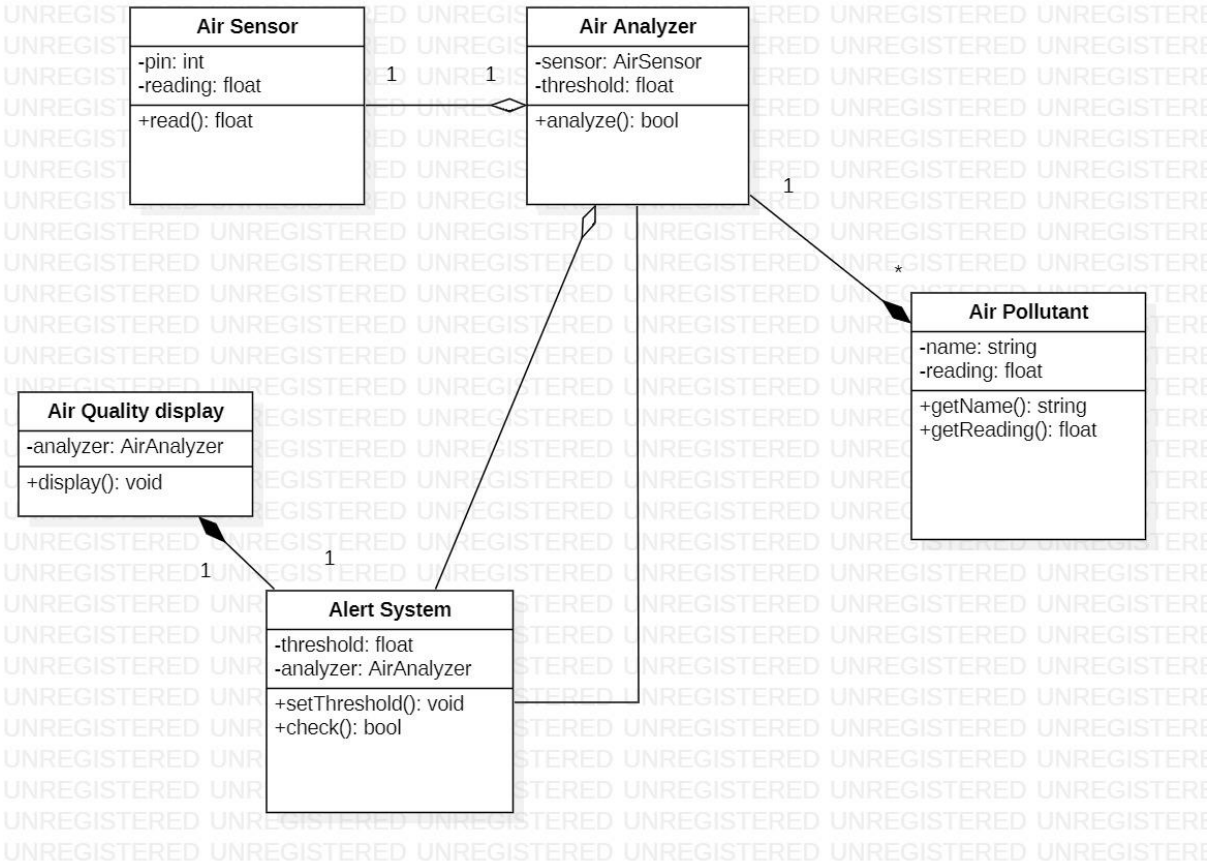
3) **Analyze Data for Insights:** Allows the customer to analyze air quality data to extract insights and trends.

4) **View Air Quality on Dashboard:** Displays real-time air quality data, such as pollutant concentrations and air quality indexes.
5) **Receive Alerts and Notifications:** Sends alerts and notifications to the customer when the air quality crosses a certain threshold.

6) **Receive Data from Sensors:** Involves receiving sensor data from the data acquisition system and storing it in a data store for processing and analysis.

7) **Export Data to CSV:** Allows the customer to export air quality data to a CSV file for further analysis.

CLASS DIAGRAM:



1) **AirSensor:** This class represents the sensor that measures the air quality. It has methods to read the sensor values and return them to the AirAnalyzer class.
2) **AirAnalyzer:** This class analyzes the sensor readings and determines the air quality. It has a reference to the AirSensor class, as well as a collection of AirPollutant objects.

3) **AirPollutant:** This class represents a specific type of pollutant in the air, such as carbon monoxide or ozone. It has attributes to store the pollutant concentration and a method to calculate the Air Quality Index (AQI) for that pollutant.
4) **AlertSystem:** This class represents a system for monitoring air quality and alerting the user if the air quality is poor. It has a reference to the AirAnalyzer class and the AirQualityDisplay class. It has methods to check the air quality and trigger an alert if necessary.
5) **AirQualityDisplay:** This class represents a display that shows the current air quality. It has a reference to the AlertSystem class and can only be used by that instance.

Result:

Thus, the system architecture, use case and class diagram created successfully.

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	7
Title of Experiment	Design a Entity relationship diagram
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	10-3-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	4
2	Viva	5	3
	Total	**10**	07

25-4-2023

Staff Signature with date

Aim

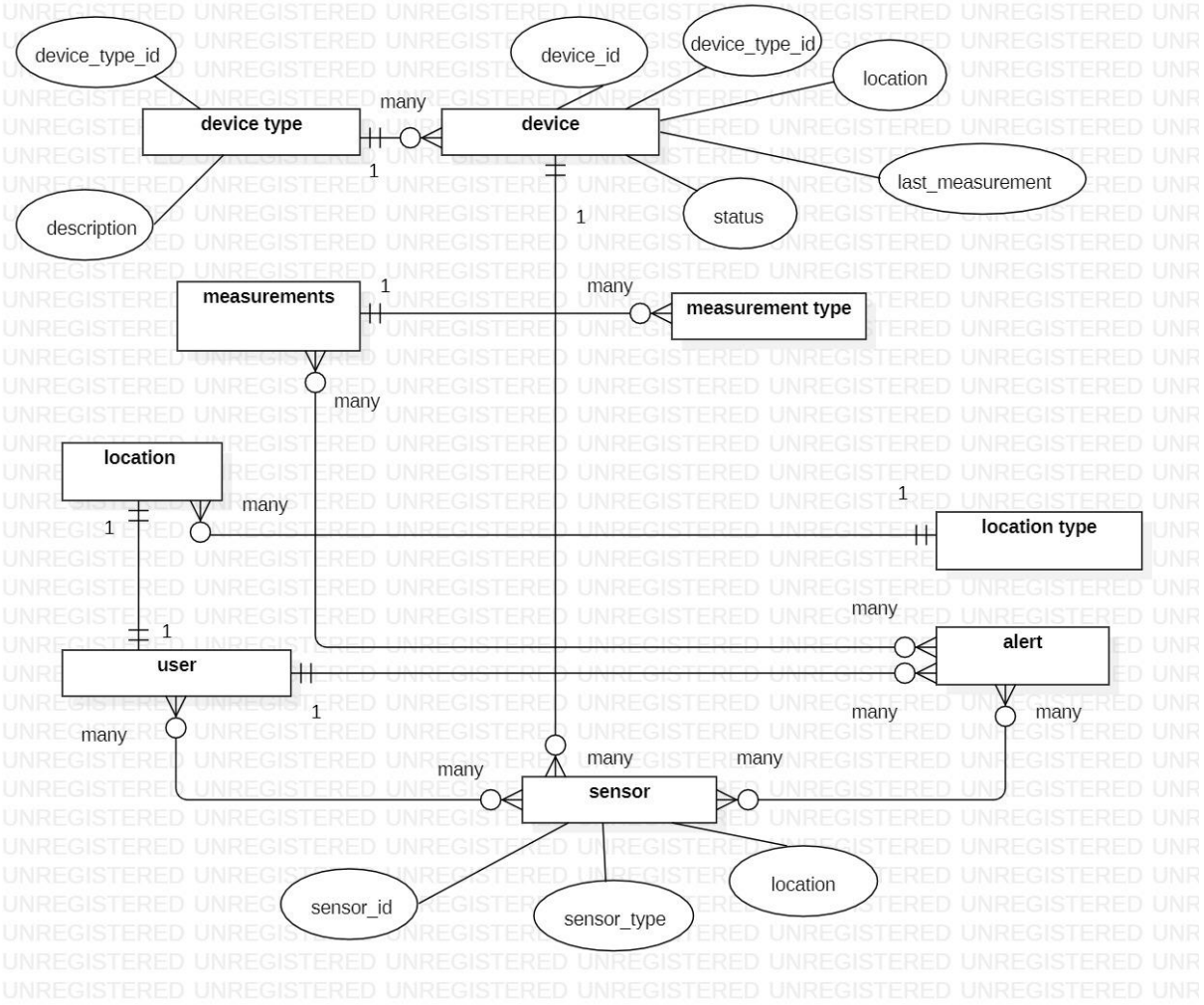
To create the Entity Relationship Diagram

Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Air Quality Analyzer

ER Diagram of Air Quality Analyzer:



1) Sensor: Represents the physical sensors that detect air quality parameters, such as CO2 or temperature, and provide measurements.

- sensor_id: unique identifier for each sensor
- sensor_type: type of sensor, e.g., CO2 sensor, temperature sensor, etc.
- location: physical location of the sensor, e.g., room number, building name, etc.

2) Measurement: Represents the individual measurements taken by the sensors at specific times, which include the measured value and a timestamp.
    - measurement_id: unique identifier for each measurement
    - sensor_id: foreign key referencing the sensor that produced the measurement
    - measured_value: value of the measurement, e.g., parts per million for CO2 measurement
    - timestamp: date and time when the measurement was taken

3) Device Type: Represents the different types of devices used to collect air quality measurements, such as Arduino-based devices, Raspberry Pi-based devices, or other custom devices.

    - device_type_id: unique identifier for each device type
    - description: description of the type of sensor

4) Device: Represents the physical devices that collect air quality measurements using sensors, which may include multiple sensors and store the measurements for analysis.

- device_id: unique identifier for each device
- device_type_id: foreign key referencing the device type that the device belongs to
- location: physical location of the device, e.g., room number, building name, etc.
- last_measurement: date and time of the last measurement taken by the device
- status: status of the device, e.g., working, malfunctioning, offline

5) Alert: Represents alerts generated when a measurement exceeds a predefined threshold value, indicating poor air quality that requires action to be taken.
   - alert_id: unique identifier for each alert
   - alert_type: type of alert, e.g., high CO2 levels, low oxygen levels, etc.
   - alert_message: description of the alert, e.g., "CO2 levels are above safe limits"

Result:

Thus, the entity relationship diagram was created successfully.

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	8
Title of Experiment	Develop a Data Flow Diagram (Process-Up to Level 1)
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	14-03-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	4
	Total	**10**	09

25-4-2023

Staff Signature with date

Aim

To develop the data flow diagram up to level 1 for the <project name>

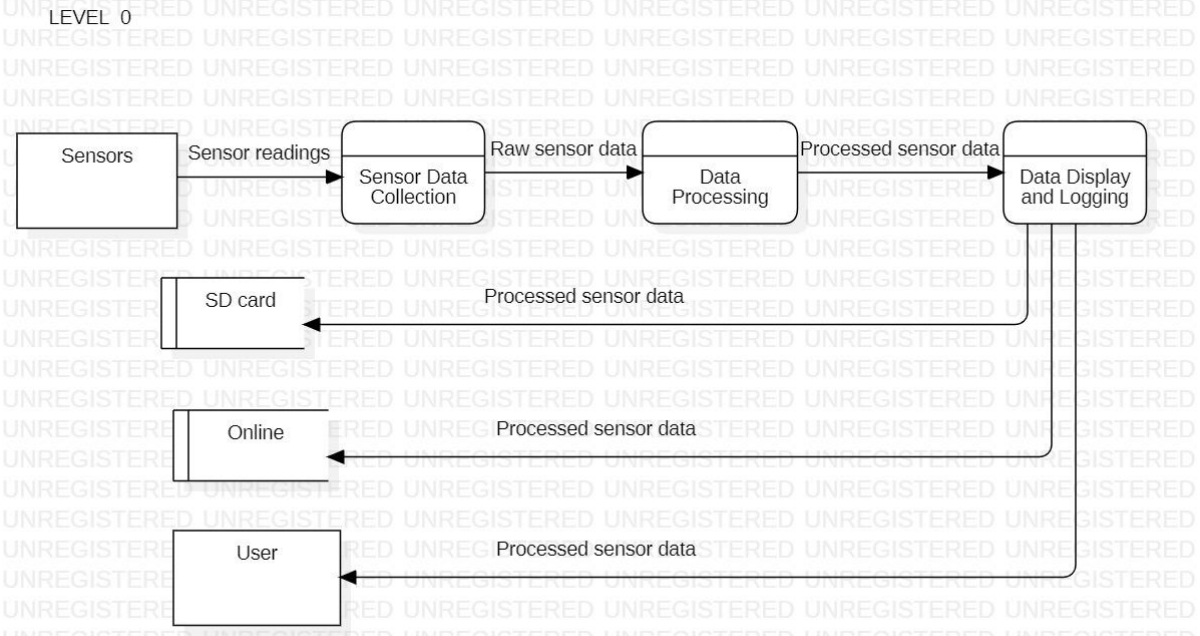
Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

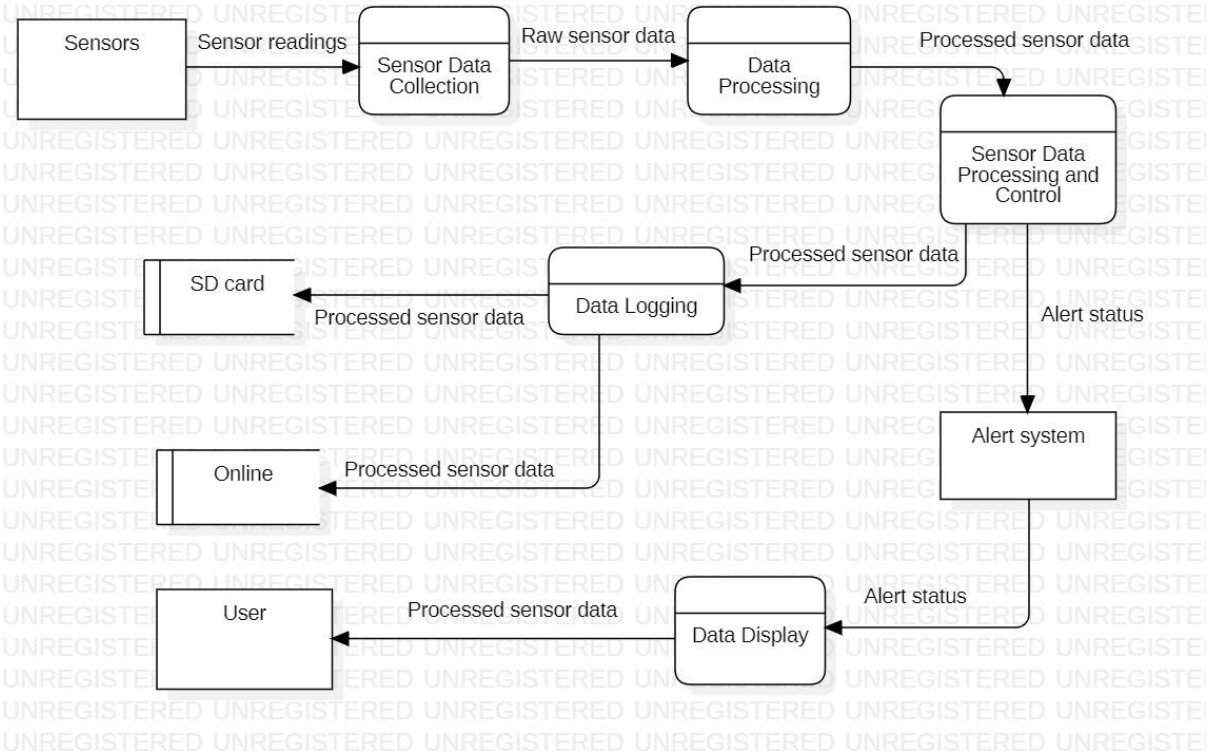
Air Quality Analyzer

Data Flow Diagram:

DFD Level 0



DFD Level 1



Result:

Thus, the data flow diagrams have been created for the Air Quality Analyzer.

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	9
Title of Experiment	Design a Sequence and Collaboration Diagram
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	15-04-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	3
	Total	**10**	08

25-4-2023

Staff Signature with date

Aim

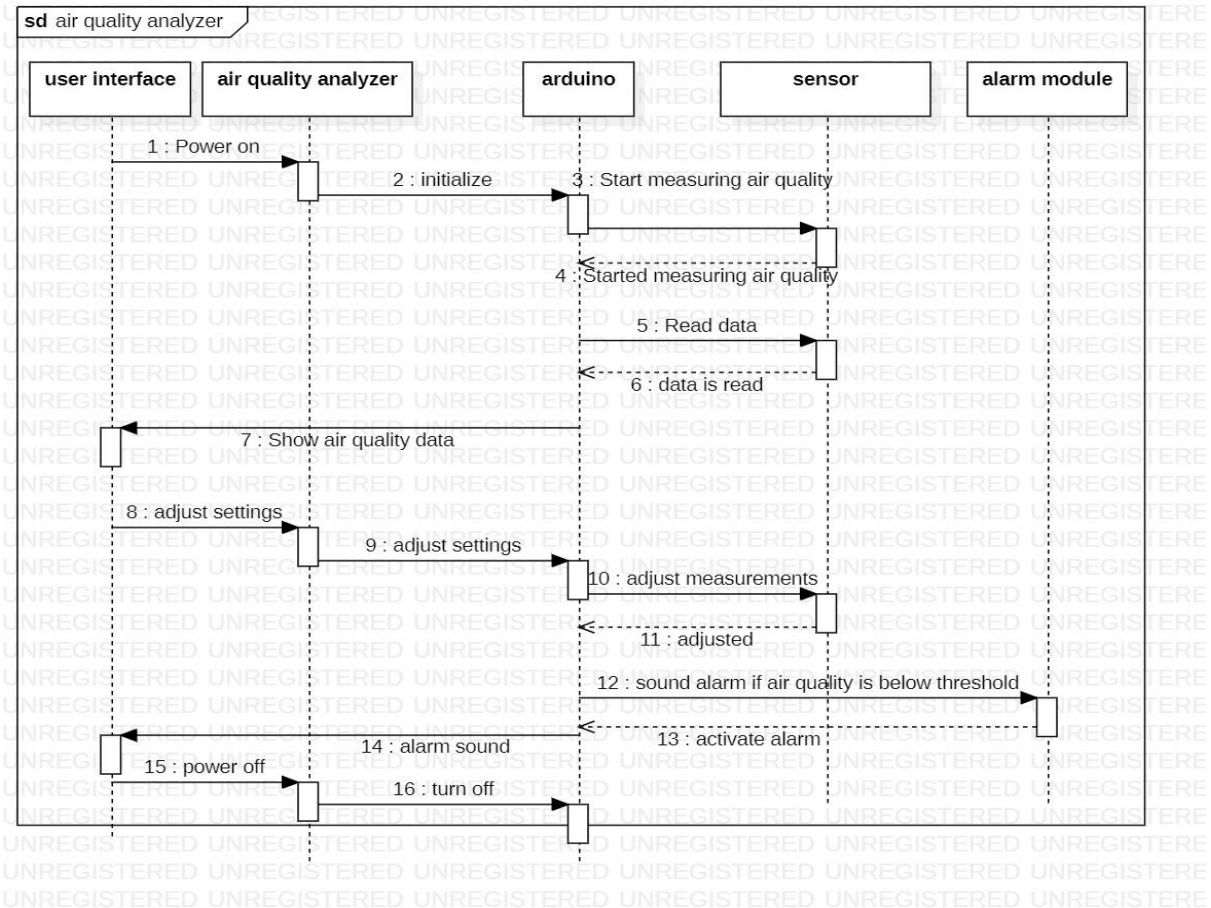
To create the sequence and collaboration diagram for the Air quality analyzer.

Team Members:

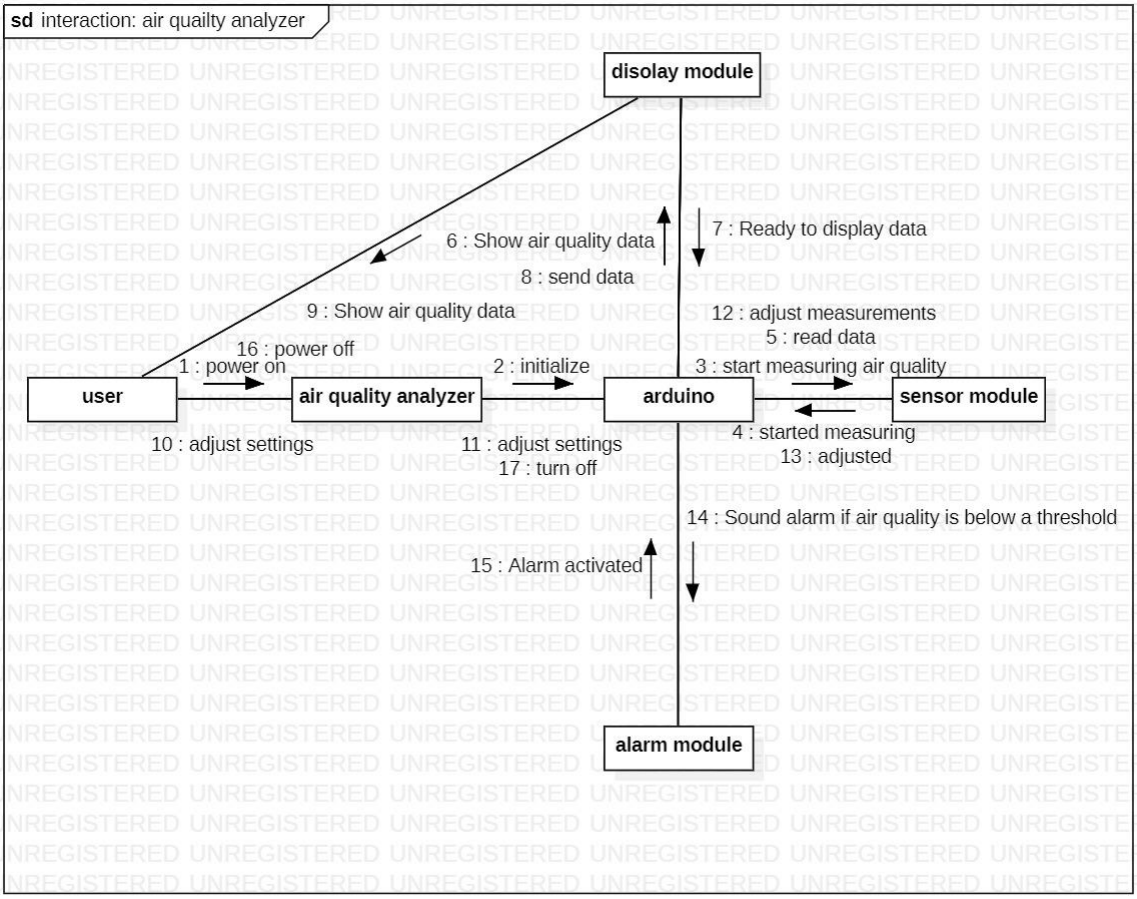
S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Air Quality Analyzer

Sequence Diagram:



Collaboration Diagram:



Result:

Thus, the sequence and collaboration diagrams were created for the Air quality analyzer

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	10
Title of Experiment	Develop a Testing Framework/User Interface
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	18-04-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	4
	Total	**10**	09

25-4-2023

Staff Signature with date

Aim

To develop the testing framework and/or user interface framework for the Air quality analyzer.

Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Executive Summary

Scope: The scope of this project is to develop an air quality analyzer using Arduino that can detect and measure various pollutants and environmental parameters, such as gas concentrations, particulate matter, temperature, humidity, carbon dioxide levels, and air pressure.

Objective: The objective of this project is to design and build a portable and low-cost air quality analyzer that can provide accurate and reliable readings of the air quality parameters in real-time, and also calculate the air quality index (AQI) based on the readings.

Approach: The approach for this project is to use various sensors and modules that are compatible with Arduino and can detect and measure the required parameters. The data from the sensors will be processed using an Arduino microcontroller and displayed on a TFT display or similar tool. The project will be tested by performing calibration and validation of the sensors, and by comparing the readings with those obtained from a professional air quality monitoring station.

Types of Testing, Methodology, Tools:

Types of Testing	Methodology	Tools Required
Functional Testing	Verify that the sensors accurately detect various pollutants and environmental parameters and send signals to the microcontroller.	Gas sensors, particulate matter sensor, temperature and humidity sensor, carbon dioxide sensor, air pressure sensor, Arduino board, breadboard, jumper wires
Performance Testing	Measure the response time of the sensors, accuracy, and precision of the readings.	Stopwatch, reference air quality monitoring station
Reliability Testing	Assess the sensors' durability and resistance to environmental factors such as temperature, humidity, and air exposure.	Test chamber, temperature and humidity meter
Usability Testing	Evaluate the user interface and ease of use of the system.	Prototype casing, user feedback surveys

Result:

Thus, the testing framework/user interface framework has been created for the Air quality analyzer .

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	11
Title of Experiment	Test Cases
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	22-04-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	5
	Total	**10**	10

25-4-2023

Staff Signature with date

Aim

To develop the test cases manual for the Air quality analyzer.

Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Air Quality Analyzer

Functional Test Cases

Test Scenario	Test Case	Execution Steps	Expected Outcome	Actual Outcome	Status	Remarks
Sensor Calibration	Calibration	1. Power on the air quality analyzer 2. Wait for the sensor to warm up 3. Press the	The air quality analyzer should display "Calibration successful"	"Calibration successful" is displayed	Pass	The sensor calibration test passed successfully.

		calibration button 4. Wait for the calibration process to complete				
Real-time Data Collection	Data Collection	1. Power on the air quality analyzer 2. Connect the analyzer to a computer 3. Open the serial monitor 4. Verify that the readings are displayed in real-time	The air quality analyzer should display the current readings for each pollutant	The readings for each pollutant are displayed in real-time	Pass	The real-time data collection test passed successfully.
Threshold Testing	Thresholds	1. Power on the air quality analyzer .	The air quality analyzer should sound an alarm and display a	The alarm sounds and a warning message is displayed	Pass	The threshold testing passed successfully.

		2. Set the threshold values for each pollutant 3. Wait for the readings to exceed the set thresholds	warning message			
Battery Life	Battery	1. Power on the air quality analyzer using battery 2. Record the start time 3. Allow the analyzer to run until the battery is depleted 4. Record the end time	The battery life should be at least 4 hours	The battery lasts for 5 hours before depletion	Pass	The battery life test passed successfully.

Non-Functional Test Cases

Test Scenario	Test Case	Execution Steps	Expected Outcome	Actual Outcome	Status	Remarks
Usability	Ease of Use	1. Provide the air quality analyzer to a new user who has no prior experience with the device 2. Ask the user to perform a sensor calibration and collect real-time data 3. Observe the user's interaction with the device and note any difficulties or confusion	The user should be able to calibrate the sensor and collect real-time data without any guidance or confusion	The user was able to perform the tasks without any guidance or confusion	Usability	Ease of Use

performance	Sensor Response Time	1. Expose the air quality analyzer to known levels of pollutants for a set duration 2. Record the time it takes for the sensors to respond to the changes in pollutant levels	The sensors should respond to changes in pollutant levels within a few seconds	The sensors respond to changes in pollutant levels within a few seconds	Pass	The air quality analyzer has a fast sensor response time.
Reliability	Sensor Accuracy	1. Collect real-time data using the air quality analyzer for a set duration 2. Compare the readings to those collected by a reference instrument	The readings collected by the air quality analyzer should match those collected by the reference instrument within an acceptable range of error	The readings collected by the air quality analyzer match those collected by the reference instrument within an acceptable range of error	Pass	The air quality analyzer has reliable sensor accuracy.
Security	Data Protection	1. Collect real-time data using the air quality analyzer 2. Store the data on an external	The data should not be accessible without proper authentication or authorization	The data is not accessible without proper authentication or authorization	Pass	The air quality analyzer has appropriate data protection measures.

		storage device 3. Attempt to access the data without proper authentication or authorization				

Result:

Thus, the test case manual has been created for the Air quality analyzer.

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	12
Title of Experiment	Manual Test Case Reporting
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	22-04-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	4
	Total	**10**	09

25-4-2023

Staff Signature with date

Aim

To prepare the manual test case report for the Air quality analyzer.

Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Manual Test Report: Air Quality Analyzer Project:

1) Current Status of Testing:

The testing of the Air Quality Analyzer Project is currently underway. We have completed the functional testing and the test coverage is at 95%. We have identified a few issues in the display screen and data logging functionality, which need to be addressed.

2) Present Obstacles:

The present obstacles we are facing in the testing of the Air Quality Analyzer Project are:

- Display Screen Issues: The display screen is sometimes displaying inaccurate readings. We have identified that this may be due to a loose connection between the display screen and the Arduino board.

- Data Logging Issues: The data logging functionality is not always reliable. We have identified that this may be due to a lack of memory in the Arduino board.

3) Request for Help from Stakeholders:

We are seeking help from stakeholders to remove the obstacles and proceed further with the testing of the Air Quality Analyzer Project. Specifically, we need:

- Assistance with the display screen: We would appreciate it if the hardware team could assist us in troubleshooting the display screen issues and ensure a secure connection between the display screen and the Arduino board.

- Additional memory for the Arduino board: We would appreciate it if the software team could provide us with additional memory for the Arduino board to ensure reliable data logging.

Category	Process Against Plan	Status
Hardware	Verify circuit board layout	Passed
Hardware	Test sensors for accuracy	Failed
Software	Upload code to Arduino	Passed
Software	Check sensor data in serial monitor	Passed
Calibration	Calibrate sensors for accurate readings	In progress
Integration	Connect Arduino to display screen	Passed

Integration	Test communication between Arduino and display screen	In progress
User Interface	Design user interface for display screen	Not started
User Interface	Test user interface for ease of use	Not started

Functional Area	**Test Coverage**	**Status**
Sensor Accuracy	100%	Failed
Data Logging	90%	Passed
Display Screen	80%	In progress
Communication	95%	Passed
Calibration	100%	In progress

Power Management	85%	Not started

Result:

Thus, the test case report has been created for the Air quality analyzer.

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Course Code: 18CSC206J

Course Name: Software Engineering and Project Management

Experiment No	13
Title of Experiment	Provide the details of Architecture Design/Framework/Implementation
Name of the candidate	Vaishnavi
Team Members	Ashish Sukumar, Vaishnavi, Rudra Garai
Register Number	RA2111003010318, RA2111003010325, RA2111003010321
Date of Experiment	22-04-2023

Mark Split Up

S. No	Description	Maximum Mark	Mark Obtained
1	Exercise	5	5
2	Viva	5	4
	Total	**10**	09

25-4-2023

Staff Signature with date

Aim

To provide the details of architectural design/framework/implementation

Team Members:

S No	Register No	Name	Role
1	RA2111003010325	Vaishnavi	Rep
2	RA2111003010318	Ashish Sukumar	Project Manager
3	RA2111003010321	Rudra Garai	Hardware Designer

Architectural Design:

The Air Quality Analyzer Project using Arduino follows a simple architectural design consisting of the following components:

Arduino Board: The Arduino board is the central component of the project. It is responsible for receiving input from various sensors, processing the data, and displaying the output on an LCD display.

Sensors: The project uses three sensors to measure air quality: a gas sensor to measure the concentration of harmful gases, a temperature and humidity sensor to measure ambient temperature and humidity, and a particulate matter sensor to measure the concentration of fine particulate matter in the air.

LCD Display: The project uses a standard 16x2 LCD display to display the readings from the sensors.

Data Logging Module: The project uses an SD card module to log the sensor readings and store them on an SD card.

Implementation Details:

The implementation of the Air Quality Analyzer Project using Arduino involves the following steps:

1. Sensor Connections: Connect the gas sensor, temperature and humidity sensor, and particulate matter sensor to the Arduino board.

2. Display Connection: Connect the LCD display to the Arduino board.

3. Data Logging Module Connection: Connect the SD card module to the Arduino board.

4. Sensor Calibration: Calibrate the sensors to ensure accurate readings.

5. Reading Collection: Collect readings from the sensors and store them in variables.

6. Processing: Process the sensor readings to obtain air quality data.

7. Display Output: Display the air quality data on the LCD display.

8. Data Logging: Log the sensor readings and store them on the SD card.

Power Management: Implement power management to ensure the longevity of the project.

Frameworks and Libraries Used

The Air Quality Analyzer Project using Arduino utilizes the following frameworks and libraries:

1. Arduino IDE: The project is developed using the Arduino Integrated
Development Environment (IDE).

2. Adafruit Sensor Library: The project uses the Adafruit Sensor Library to interface with the sensors.

3. Adafruit GFX Library: The project uses the Adafruit GFX Library to interface with the LCD display.

4. SD Library: The project uses the SD Library to interface with the SD card module.

C: > Users > Dell > AppData > Local > Microsoft > Windows > INetCache > IE > WZ1IGU6O > Main[1].cpp

```cpp
#include "MQ135.h"

#include <SoftwareSerial.h>

#define DEBUG true

SoftwareSerial esp8266(9,10); // This makes pin 9 of Arduino as RX pin and pin 10 of Arduino as the TX pin

const int sensorPin= 0;

int air_quality;

#include <LiquidCrystal.h>

LiquidCrystal lcd(12,11, 5, 4, 3, 2);

void setup() {

pinMode(8, OUTPUT);

lcd.begin(16,2);

lcd.setCursor (0,0);

lcd.print ("circuitdigest ");

lcd.setCursor (0,1);

```

```
void loop() {

MQ135 gasSensor = MQ135(A0);

float air_quality = gasSensor.getPPM();

if(esp8266.available()) // check if the esp is sending a message

 {

  if(esp8266.find("+IPD,"))

  {

   delay(1000);

   int connectionId = esp8266.read()-48; /* We are subtracting 48 from the output because the read() function returns the ASCII decimal v

   String webpage = "<h1>IOT Air Pollution Monitoring System</h1>";

     webpage += "<p><h2>";

     webpage+= " Air Quality is ";

     webpage+= air_quality;

     webpage+=" PPM";
```

```
String sendData(String command, const int timeout, boolean debug)

{

   String response = "";

   esp8266.print(command); // send the read character to the esp8266

   long int time = millis();

   while( (time+timeout) > millis())

   {

     while(esp8266.available())

     {

       // The esp has data so display its output to the serial window

       char c = esp8266.read(); // read the next character.

       response+=c;

     }
```

Result:

Thus, the details of architectural design/framework/implementation along with the screenshots were provided.

Conclusion:

Air pollution is a serious global issue that affects millions of people around the world. To combat this problem, an air quality analyzer using Arduino can be an effective solution. This project utilizes an Arduino microcontroller and an air quality sensor to measure the air quality parameters such as temperature, humidity, carbon monoxide, and nitrogen dioxide in the air.

The project uses MQ sensors to detect the presence of harmful gases in the air, and the collected data is displayed on a screen. The device is easy to build and is affordable. With the help of the Arduino microcontroller, the system can be programmed to trigger an alarm if the air quality falls below a certain threshold. The data can also be transmitted to the cloud using Wi-Fi or Bluetooth, allowing users to monitor air quality levels remotely.

Air quality analyzer using Arduino is a way to monitor the air quality in homes, workplaces, and public spaces. It can provide valuable insights into the quality of the air we breathe and help raise awareness about the importance of clean air.

References:

1) https://create.arduino.cc/projecthub/kayravat/air-quality-monitoring-system-using-arduino-and-mq135-sensor-eaebdd
2) https://www.hackster.io/ott
3) https://www.instructables.com/DIY-Air-Quality-Monitor-With-Arduino/https://www.instructables.com/DIY-Air-Quality-Monitor-With-Arduino/
4) https://circuitdigest.com/microcontroller-projects/air-quality-monitoring-with-mq135-sensor-and-arduino
5) https://www.hackster.io/mjrobot/arduino-air-quality-monitor-9d13c7