Project Report

Real Time Water Quality Monitoring And Control System

Submitted by
PNT2022TMID07826
Karthick -713519CEIT013
Pooja Rani-713519CEIT025
Akshaya-713519CEIT002
Subramani-713519CEIT040

1:

Intoduction:

Wireless communication developments are creating new sensor capabilities. The current developments in the field of sensor networks are critical for environmental applications. Internet of Things (IoT) allows connections among various devices with the ability to exchange and gather data. IoT also extends its capability to environmental issues in addition to automation industry by using industry 4.0. As water is one of the basic needs of human survival, it is required to incorporate some mechanism to monitor water quality time to time. Around 40% of deaths are caused due to contaminated water in the world. Hence, there is a necessity to ensure supply of purified drinking water for the people both in cities and villages. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology. In this paper, the proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature and humidity of the surrounding atmosphere. And also, the Microcontroller Unit (MCU) interfaced with these sensors and further processing is performed at Personal Computer (PC). The obtained data is sent to the cloud by using IoT based ThinkSpeak application to monitor the quality of the water.

1.1:

Project Overview :

- River water quality can be monitored by the web application.
- Can be able to know if there are any dust particles present in the water.

- The PH level of the water can be monitored.
- Water temperature can be monitored.
- Alerting the authorities if the water quality is not good so that they can go and announce the localities not to drink that water.

1.2:
Purpose:

- Results are used to pinpoint any changes or trends that appear in water bodies over a period of time. These can be short of long term developments.
- Regularly monitoring water quality is a crucial part of identifying any existing problems, or any issues that could emerge in the future. For example, data has been used to reveal that over the past few years, increases in fertilisers used for food production had increased global nitrogen pollution in rivers by up to 20%.
- When designing and developing pollution prevention and management strategies data collected from water quality monitoring efforts is hugely helpful. With 70% of untreated industrial waste dumped straight into water systems, pollution management is a must.
- Today governments, communities and businesses are required to meet a range of water quality goals. Monitoring data is used to determine whether or not pollution regulations are being complied with.
- From oil spills and radiation leaks to floods and mass erosion, water quality monitoring data is a must when developing emergency strategies.

2:

Literature Survey:

S.NO	Paper	Author	Year	Method and algorithm
1	IoT Based Real-time River Water QualityMonitoring	Mohammad Salah Uddin Chowdurya, Talha Bin	2019	Spark MLlib, Deep learning neural network models, Belief Rule Based (BRB) system
2	Real Time Water Quality Monitoring System	Mithila Barabde1, Shruti Danve	2015	MATLAB
3	Cost-Effective River Water Quality Management using Integrated Real-Time Control Technology	Fanlin Meng, Guangtao Fu, and David Butler	2017	UWWS modeling, Non-Dominated Sorting Genetic Algorithm II
4	Water quality monitoring in smart city	Yiheng Chen*, Dawei Han	2018	Big Data and Internet of Things (IoT)
5	Water Quality Monitoring System Using Wireless Sensor Network	Shruti,Sridharan	2014	Wireless Sensor Network,ZigBee technology

2.1 Existing Problem

Water quality serves as the foundation for almost all development. Contaminated, unsafe water threatens human health, diminishes food production, reduces ecosystem functions, and limits economic growth. Unfortunately, new water quality challenges due to emerging pollutants like pharmaceuticals, pesticides, and industrial and household chemicals exacerbate historical water

quality threats, particularly in light of changing climate patterns and their impacts on human health and ecosystems.

A UNESCO fact sheet notes that lack of safely managed sanitation, including sewage treatment (for piped sewers) and fecal sludge management (for on-site sanitation like latrines and septic systems), contributes significantly to water pollution. A reduction of about one-third of the world's biodiversity is estimated to be a consequence of the degradation of freshwater ecosystems due to pollution of water resources.

2.2 References

1. Chowdury, M.S.U., Emran, T.B., Ghosh, S., Pathak, A., Alam, M.M., Absar, N., Andersson, K. and Hossain, M.S., 2019. IoT based real-time river water quality monitoring system. Procedia Computer Science, 155, pp.161-168.
2. Barabde, M. and Danve, S., 2015. Real time water quality monitoring system. International Journal of Innovative Research in Computer and Communication Engineering, 3(6), pp.5064-5069.
3. Meng, F., Fu, G. and Butler, D., 2017. Cost-effective river water quality management using integrated real-time control technology. Environmental science & technology, 51(17), pp.9876-9886.
4. Chen, Y. and Han, D., 2018. Water quality monitoring in smart city: A pilot project. Automation in Construction, 89, pp.307-316.
5. Sridharan, S., 2014. Water quality monitoring system using wireless sensor network. International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), 3(4), pp.399-402.

2.3 Problem Statement Definition

I am	Common people living a normal life on Earth	Common people living on Earth who consume water in their day-to-day life for different purpose
I'm trying to	Monitor the quality of the water	Wants to monitor the water consumed everyday whether the water is contaminated or pure, pH, temperature, salinity in it
but	Do not know to monitor the quality of water	Time consuming process for manual testing
because	Lack of required knowledge	Common people lack knowledge of this type of testing, sensors etc.

Which makes me feel	Doubted and fearful of the consumed water	Decline of pure water, increasing viral diseases

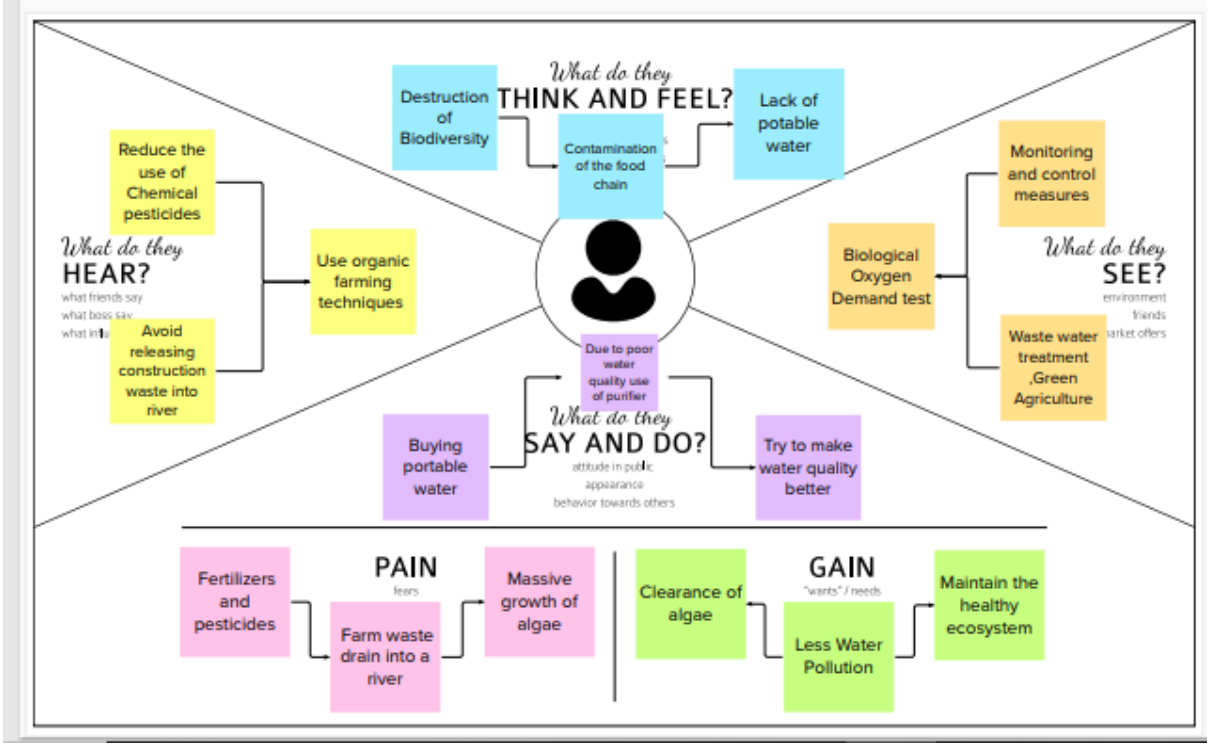
3. Ideation and Proposed Solution

3.1 Empathy Map Canvas

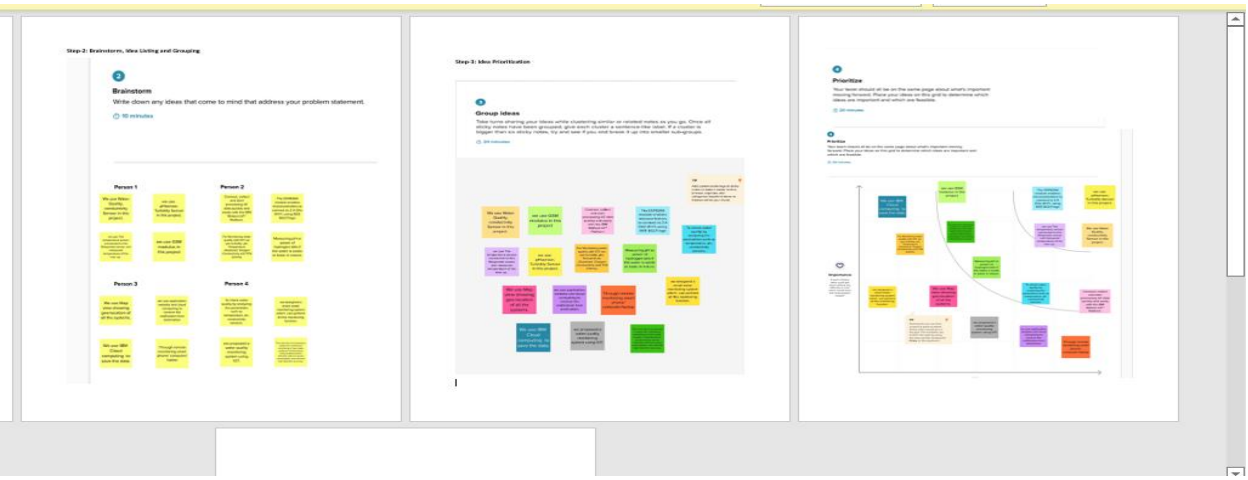
An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's Behaviours and attitudes.

It is a useful tool to helps teams better understand their users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



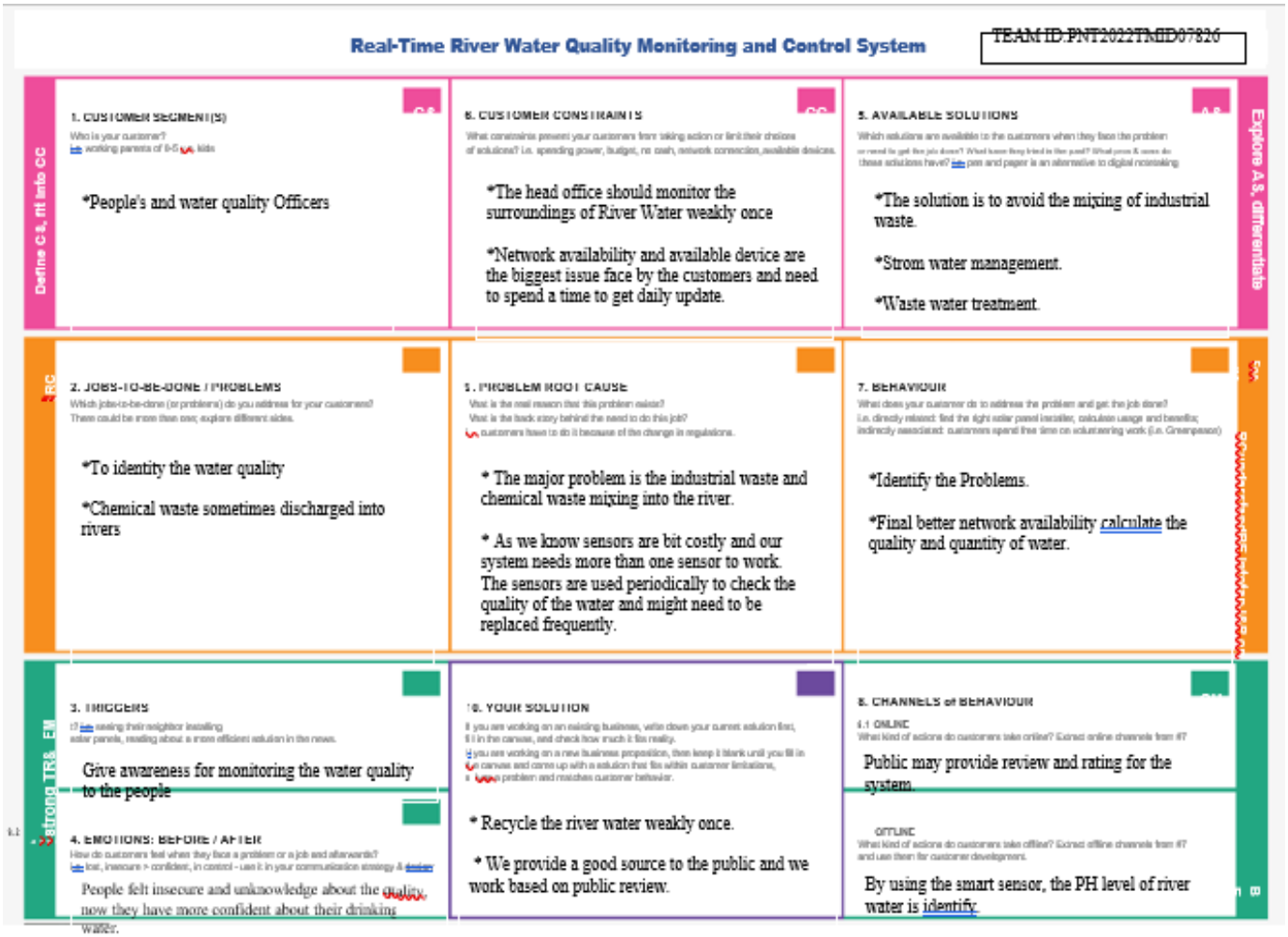
3.2 Ideation and Brainstorming



3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	IOT Based Real Time River Water Quality Monitoring and Control System
2.	Idea / Solution description	1. To monitor the quality of water using sensors like temperature, potentiometer(pH), turbidity, salinity and so on. 2. Collecting those data and storing it in cloud and perform analyse to check if the water is contaminated or not for drinking. 3. If the water is contaminated an alert is made to the user/ local authority through SMS or can be viewed through web application anytime.
3.	Novelty / Uniqueness	1. Based on the collected data prediction is made whether the water can be used for cultivation of specific crops and suitable for the aquatic animals.
4.	Social Impact / Customer Satisfaction	Algal growth, fertilizers, pesticides cause river pollution which can impact all living beings. Better monitoring and control measures can impact health and vegetation massively.
5.	Business Model (Revenue Model)	Service based product is developed to serve the local people to know the quality of water before consuming it or using it for any purpose. This prevents health issues or at most loss of living being.

3.4 Problem Solution Fit



4. Requirement Analysis

4.1 Functional Requirements

Following are the functional requirements of the proposedsolution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story/ Sub-Task)

FR-1	**User Registration**	Registration through registered credentials register confirmation e-mails
FR-2	**User Confirmation**	Confirmation via Email Confirmation via OTP/SMS
FR-3	**Log in to the System**	Enter the OTP Check the Credentials Checkthe Access/Server
FR-4	**Manage the Modules**	Manage the system Admins of userManage and Monitor Details of SystemUser Manage the User Roles Manage the User Accessibility and UserPermission Manage User DetailsPrivacy
FR-5	**Check Process Details**	Temperature Turbidity Details dissolved oxygenlevel in water presence of chemical substances in water
FR-6	**Log out**	Save the existing measurements Exit

4.2 Non-Functional Requirements

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Make Easierto Use ,More Efficiency to Use,Reduction of Errors While Using thisTechniques

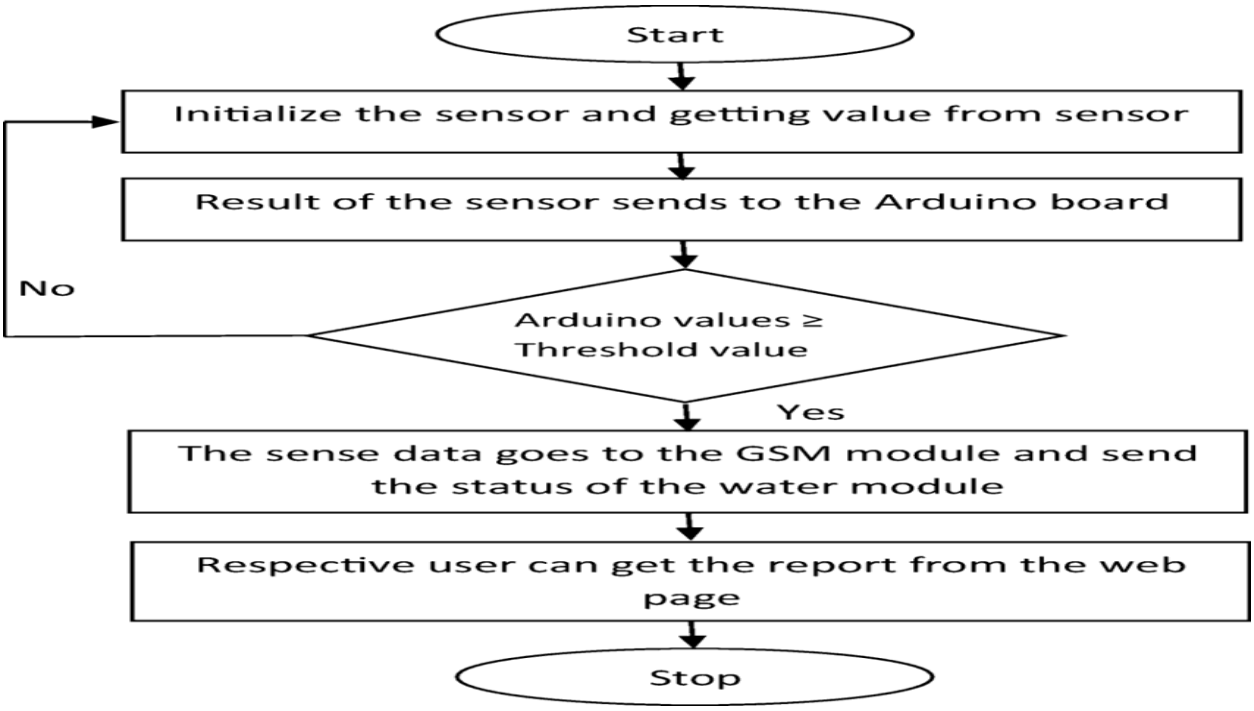
NFR-2	**Security**	end by end encrypted protocol in Data Authentication, Sensitive data protected personallyidentifiable information(PII) other information details of users and networks

NFR-3	**Reliability**	Provides the objective evidence necessary to makedecisions on managing water quality today and in future also. This techniques make good communication betweenthe user and the networks and it also achieves a better trade-off between costsand reliability
NFR-4	**Performance**	Implementing Monitoring River Water, by using sensing sensor to monitor the river water parametersmaking moreuseful for various environmental Usage.
NFR-5	**Availability**	PH Monitoring,Conductivity Analysis,CDOM(Dissolved Organic Matter),Measure of Carbonate and bicarbonate levels in water,this techniques made possible bylinking information in water
NFR-6	**Scalability**	Automatic Water Sampler, PH testing, Recording the water temperature,chlorophyll fluorescence analysismeasuring the dissolved oxygen levels.

5. Project Design

5.1 Data Flow Diagram

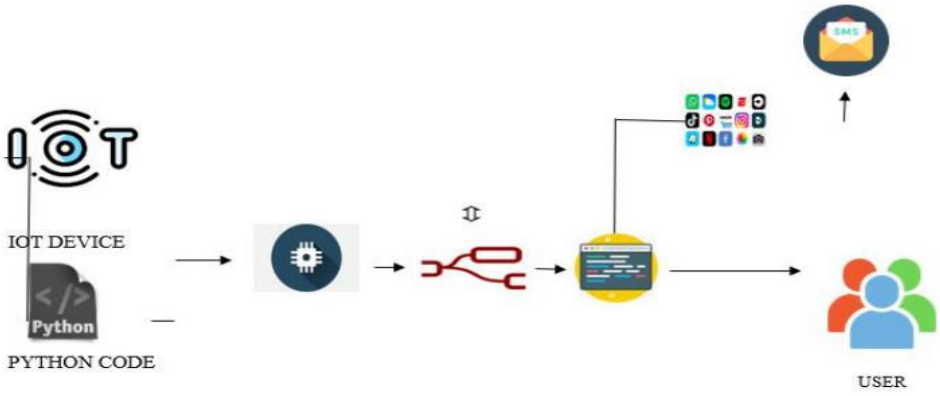
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data entersand leaves the system, what changes the information, and where data is stored.



5.2 Solution & Technical Architecture

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

1. Find the best tech solution to solve existing business problems.
2. Describe the structure, characteristics, behaviour, and other aspectsof the software toprojectstakeholders.
3. Define features,development phases, and solution requirements.
4. Provide specifications according to which the solution is defined, managed,anddelivered.



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user/remote user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
	Notification	USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
	Signup through third parties	USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register and access the dashboard with Google credentials	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password	I can register and access the dashboard through the application cred	High	Sprint-1
	Dashboard					
Customer (Web user)		USN-6	As I am a customer I need a proper support and service	Each and every process was under firewall /security protocol	High	Each sprint
Customer Care Executive		USN-7	24/7 service can provided by company			Sprint 3
Administrator		USB-8	Who will have the entire access of this project	All the access was with encrypted	High	Each sprint

6 Project Planning and Scheduling

6.1 Sprint Planning and Estimation

MILESTONES	TASKS	NAME OF THE STUDENTS WHO DONETHETASK
Prerequisite ProjectObjective	1. IBM Cloud services 2. Software	
Create And Configure IBM Cloud Services	1. Create IBM Watson IOT Platform and Device 2. Create Node-RED Service	Karthick, pooja Rani
Develop the python Scrip	1. Develop a python Scrip 2. Publish Data to the IBMCloud	Akshaya,Subramani
Develop A web Application Using Node-RED Service	1. Develop the Web Application Using Node-RED 2. Use Dashboard Nodes for Creating UI(Web App) 3. Create an HTTP requests toCommunicate with Mobile App	Karthick, pooja Rani

Building Mobile App	1. Design Your UI To Display the Water Turbidity Values 2. Configure the Application To Receive the Data FromCloud 3. Configure theMobile AppFor Controlling Motor using Buttons	Akshaya,Subramani
Ideation Phase	1. Literature Survey on the Selected Project & Information Gathering 2. Prepare Empathy Map 3. Ideation	Karthick, pooja Rani,Subramani
Project Desi gn Phas e-I	1. Proposed Solution 2. Prepare Solution Fit 3. Solution Architecture	Akshaya,Subramani,Karthick

Project Design Phase-II	1. Customer Journey 2. Functional Requirement 3. Data Flow Diagram 4. Technology Architecture	Karthick, pooja Rani ,Akshaya

Project Planning Phase	1. Prepare Milestone & 2. Activity List 3. Sprint Delivery Time	Subramani,Akshaya
Project Development Phase	1. Project Development Delivery of Sprint1 2. Project Development Delivery of Sprint2 3. Project Development Delivery of Sprint3 4. Project Development Delivery of Sprint4	Subramani,Akshaya, Karthick, pooja Rani

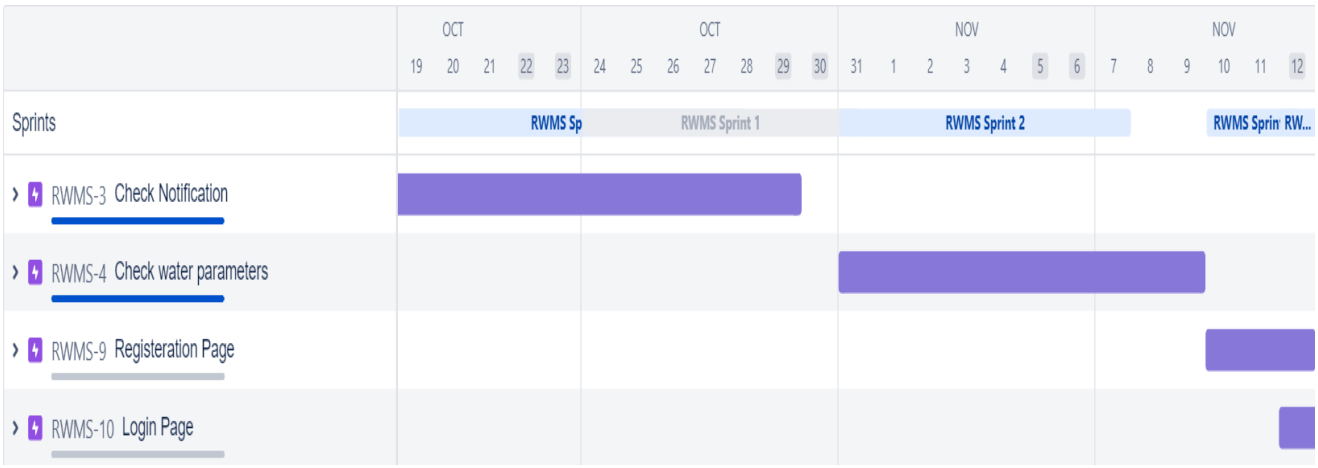
6.2 Sprint Delivery Schedule

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	Karthick, Pooja Rani, Akshaya, Subramani.
	Registration via facebook	USN-3	As a user, I can register for the application through Facebook	2	Low	
	Registration via Mail ID	USN-4	As a user, I can register for the application through Gmail	2	Medium	
Sprint-2	Confirmation	USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	
	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	
	IBM Cloud service access		Get access to IBM cloud services.	2	High	
Sprint-3	Create the IBM Watson IoT and device Settings	USN-6	To create the IBM Watson IoT Platform and integrate the microcontroller with it, to send the sensed data on cloud	2	High	Karthick, Pooja Rani.
	Create a node red service	USN-7	To create a node red service to integrate the IBM Watson along with the Web UI	2	Medium	Akshaya, Subramani Pooja Rani.
	Create a Web UI	USN-8	To create a Web UI, to access the data from the cloud and display all parameters.	2	Medium	Akshaya, Subramani.
	To develop a Python code	USN-9	Create a python code to sense the physical quantity and store data.	2	Medium	Akshaya, Subramani. Karthick
	Publish Data to cloud.	USN-10	Publish Data that is sensed by the microcontroller to the Cloud	3	High	Karthick, Pooja Rani, Akshaya, Subramani.
Sprint-4	Fast-SMS Service	USN-11	Use Fast SMS to send alert messages once the parameters like pH, Turbidity and temperature goes beyond the threshold	3	High	Karthick, Pooja Rani, Akshaya, Subramani.
	Testing	USN-12	Testing of project and final deliverables	3	Medium	

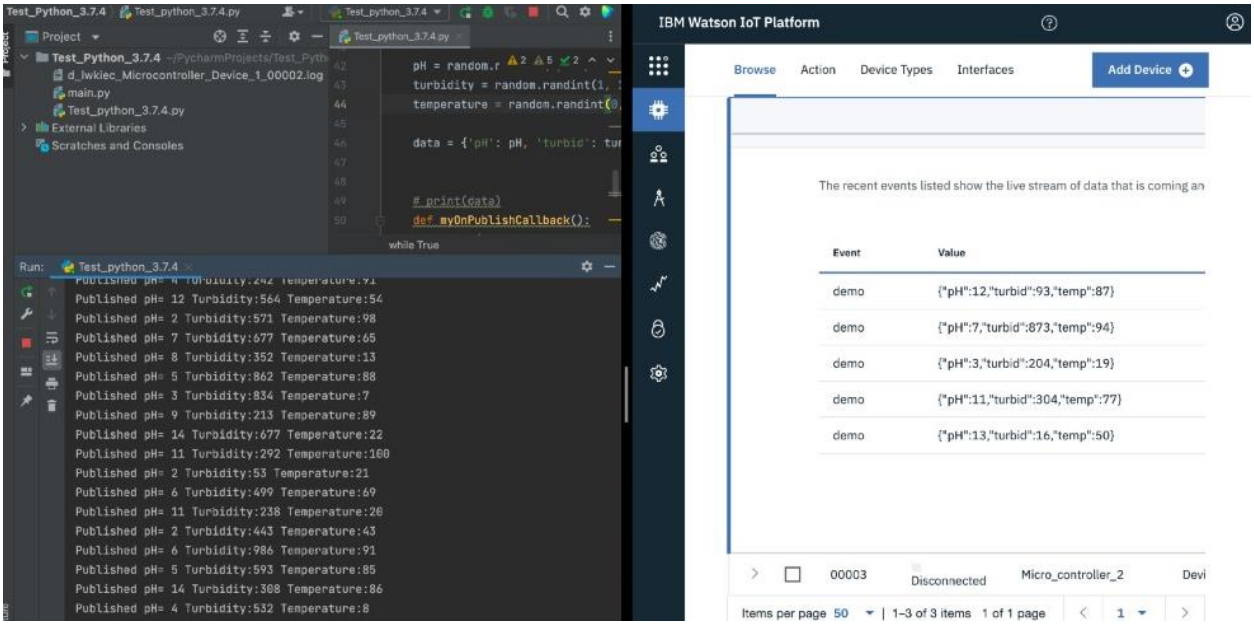
6.3 Reports from JIRA

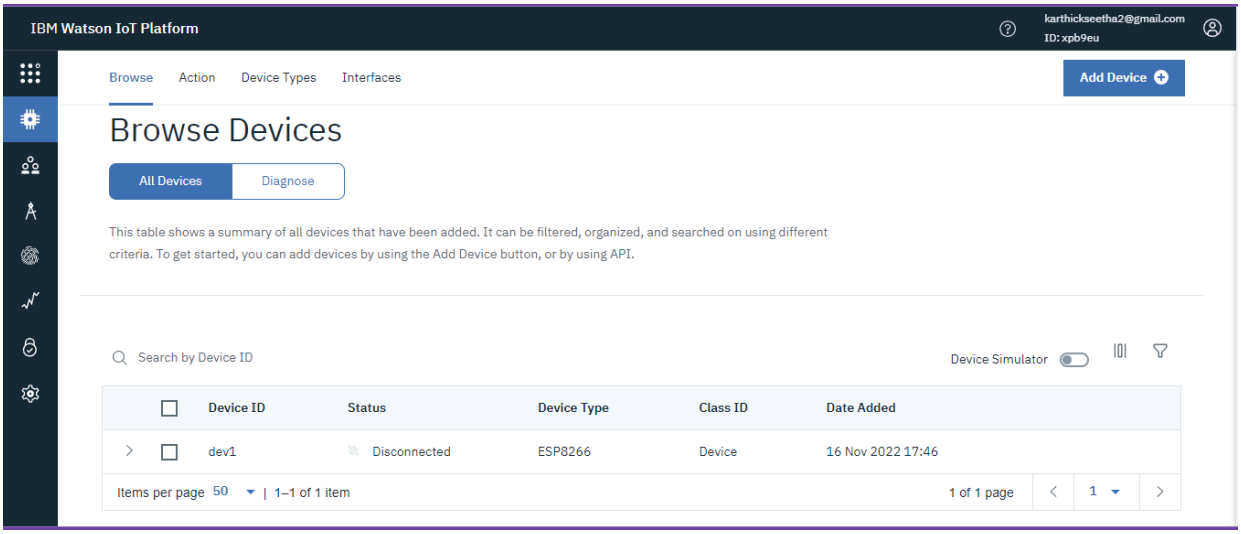


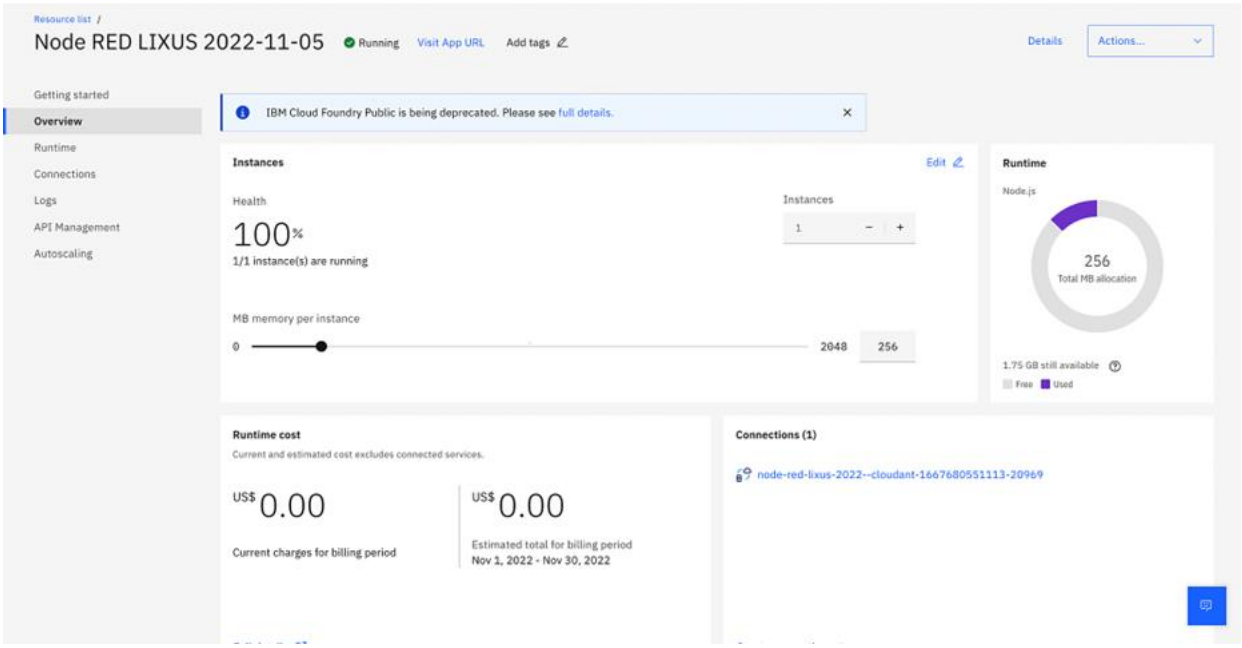
7. Coding & Solution

7.1 Feature 1

The Aim of our project is to determine the water quality by measuring the pH, temperature and Turbidity of river water. For this purpose, we have created an IBM cloud account, Developed a Web Application using NODE Red service and we have also built a mobile application

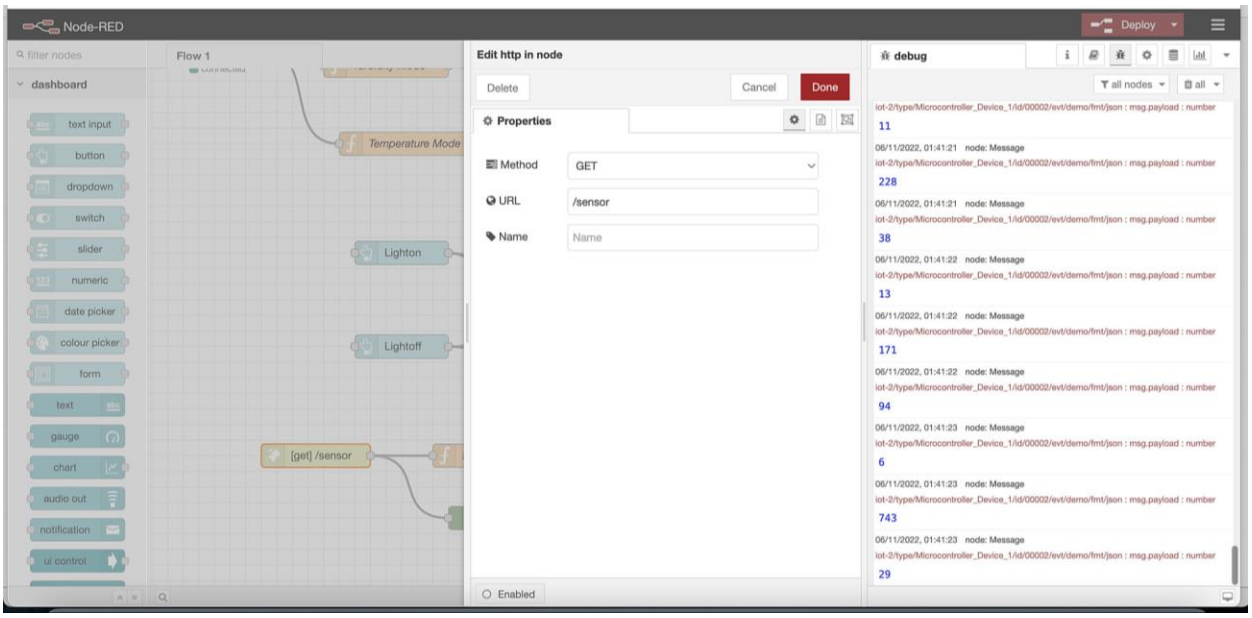


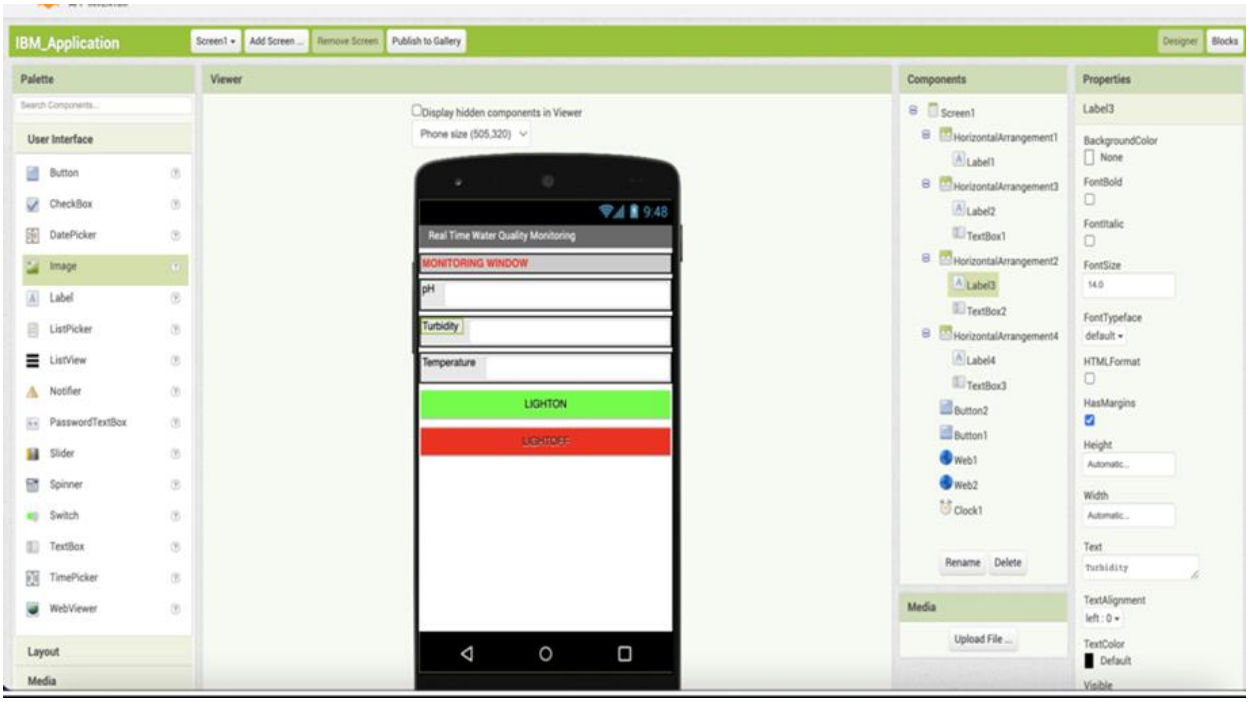




7.2 Feature 2

Once the water quality level has become unfit to use text message wil be sent to the client and they can also monitor the water quality level using the web application or mobile application





8.Testing

8.1 Test Cases

Login:

- Verify user is able to see login page
- Verify user is able to loginto application or not?
- Verify login page elements

Signup:

- Whether the user can signup or not
- The username and password entered are saved in database or not.

View the water quality measures:

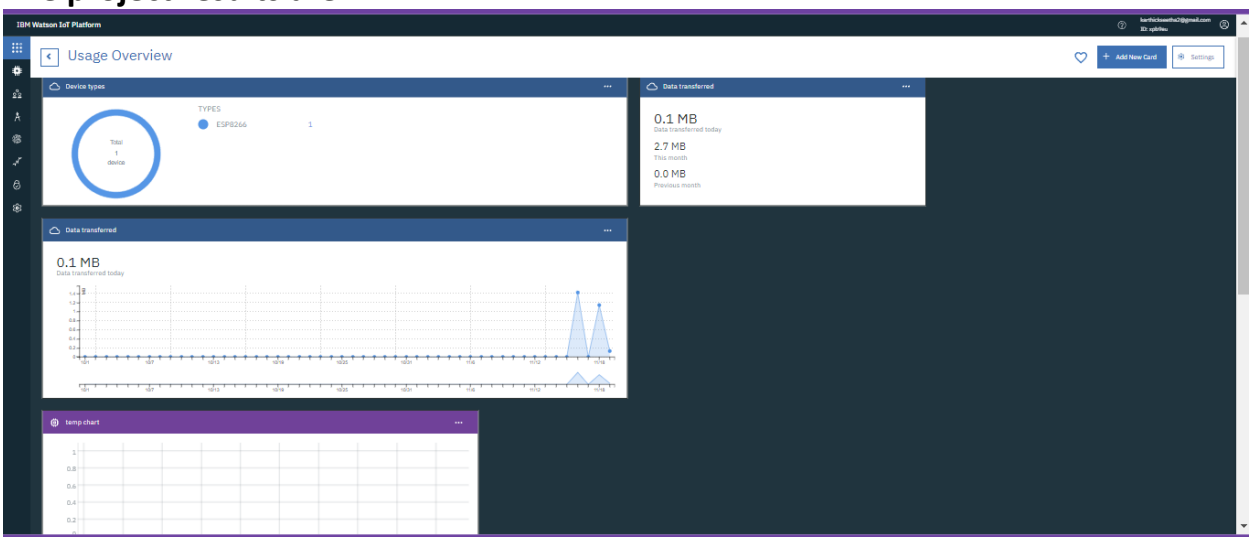
- Whether the user is able to see the pH,temperature and turbidity values.
- Wthether these values are periodically updated.

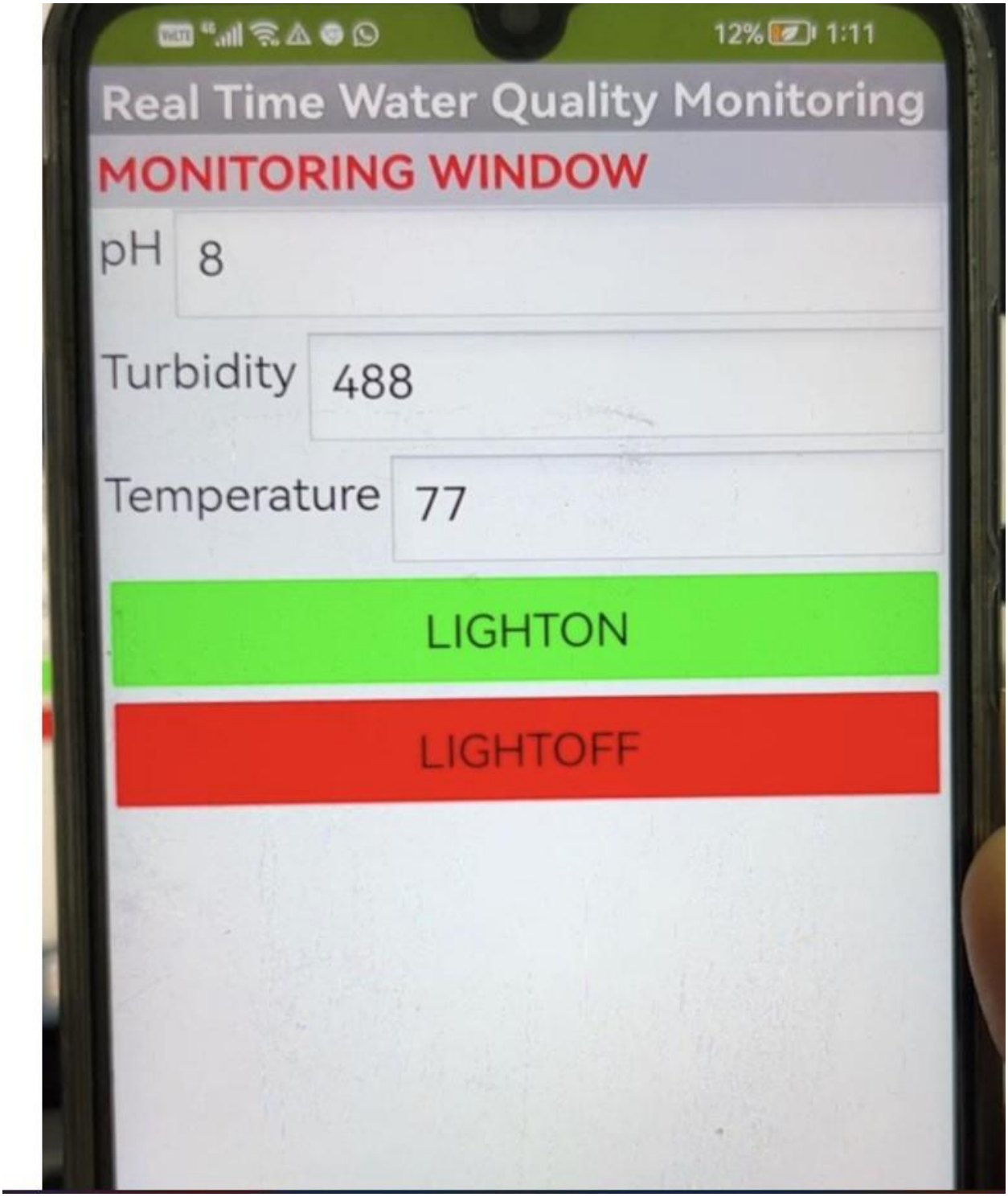
SMS:

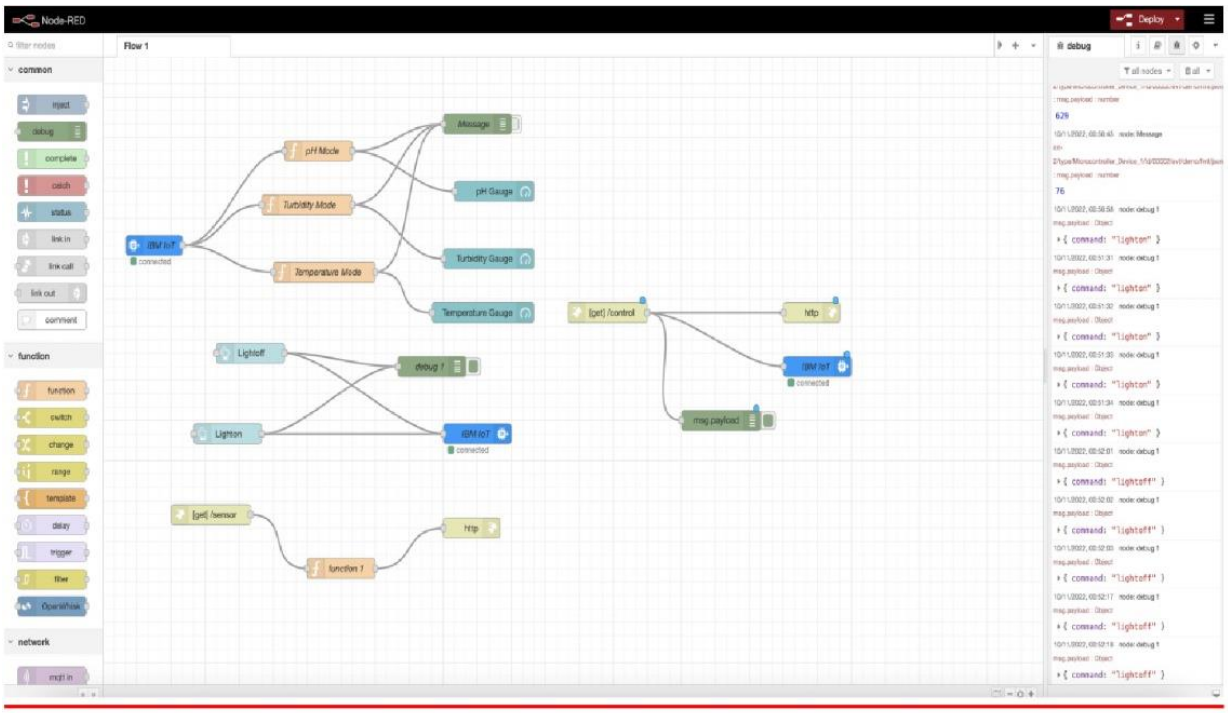
- Whether the user receives sms if water quality goes below a certain level

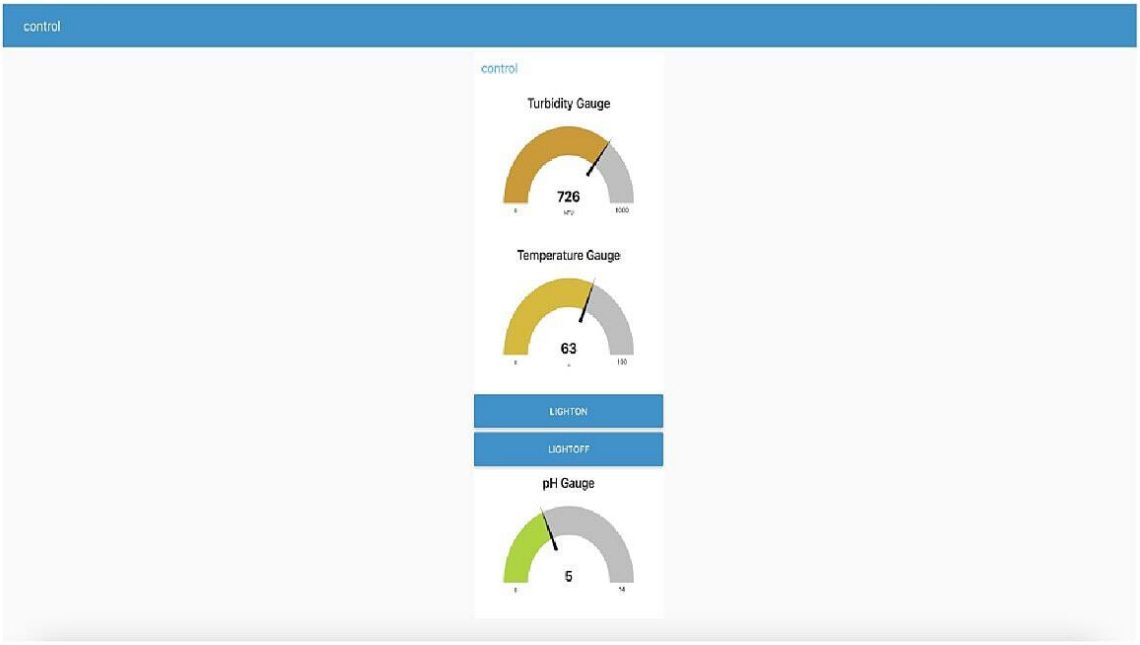
9.Results:

The project results are:




12% 1:11
Real Time Water Quality Monitoring
MONITORING WINDOW
pH
8
Turbidity
488
Temperature
77
LIGHTON
LIGHTOFF





10.Advantages & Disadvantages

10.1 Advantages:

Ease and convenience of usage

Modern smart water monitoring systems analyse data continually and instantly alert users to changes in the system, giving peace of mind and reducing the need for unreliable and expensive sampling. Smart systems are also designed to be easy-to-use, allowing easy access of all the data in one place, accessible via any internet enabled device.

Instantaneous data

Without a smart water monitoring system, sampling is the main way water quality checks take place. The problem with sampling Is that results can take weeks to come back, by which time conditions may have changed. Using real-time monitoring, instant data allows pre-cursors to potential issues (such as corrosion) to be flagged up and immediately be addressed before major issues occur. The ability to make real-time decisions during critical moments can be vital in preventing expensive repairs and breakdown.

Improved accuracy of measurements

If sampling is the sole way that water quality Is checked, there is unfortunately always the prospect of human error. Results are open to interpretation and represent a snap shot in time, rather than a full picture of a number of days or weeks. With advanced water monitoring technology, highly accurate measurements allow building managers, FMs and maintenance teams to detect and gather more data, including dissolved oxygen – a pre-cursor to all types of corrosion.

10.2 DISADVANTAGES:

➤The system is less effective as sensors are installed very deep inside the water and their positions are fixed.

➤The sensors are very expensive. Moreover their maintenance cost is also very high. This leads

to higher cost on the regulatory body.

➤The sensors which work on power source may often required to be replaced in case of malfunctioning.

➤Mounted Sensors may get damage during natural disasters and often by aquatic animals.

11. CONCLUSION

Thus, the project using IBM CLOUD is tested,verified and executed successfully.

12. FUTURE SCOPE

In the future, we have planned to implement this project in large scale which will be helpful and used by all people.

13. APPENDIX

13.1 Source Code:

```
#include <ESP8266WiFi.h>

#include "DHT.h"

#include <ArduinoJson.h>

#include <PubSubClient.h>



// Watson IoT connection details
```

```
   #define MQTT_HOST
"xpb9eu.messaging.internetofthings.ibmcloud.com"
//Organization
ID.messaging.internetofthings.ibmcloud.com
   //change  3xr4l4
   #define MQTT_PORT 1883
   #define MQTT_DEVICEID "d:xpb9eu:ESP8266:dev1"
//d:Organization ID:Device Type:Device ID
   //change  3xr4l4
   #define MQTT_USER "use-token-auth"
   #define MQTT_TOKEN "karthikproject" // change your
auth_id :
   #define MQTT_TOPIC "iot-2/evt/status/fmt/json"
   #define MQTT_TOPIC_DISPLAY "iot-
2/cmd/display/fmt/json"


   // Add GPIO pins used to connect devices
```

```
#define DHT_PIN 2 // GPIO pin the data line of the DHT
sensor is connected to

// Specify DHT11 (Blue) or DHT22 (White) sensor
#define DHTTYPE DHT11



// Add WiFi connection information
char ssid[] = "karthick";     //  your network SSID (name)
char pass[] = "87654321";  // your network password



DHT dht(DHT_PIN, DHTTYPE);



// MQTT objects
void callback(char* topic, byte* payload, unsigned int
length);
WiFiClient wifiClient;
```

```
    PubSubClient mqtt(MQTT_HOST, MQTT_PORT,
callback, wifiClient);


    // variables to hold data
    StaticJsonDocument<100> jsonDoc;
    JsonObject payload = jsonDoc.to<JsonObject>();
    JsonObject status = payload.createNestedObject("d");
    static char msg[50];


    float h = 0.0;
    float t = 0.0;




    void callback(char* topic, byte* payload, unsigned int
length) {
      // handle message arrived
      Serial.print("Message arrived [");
      Serial.print(topic);
```

```
    Serial.print("] : ");


    payload[length] = 0; // ensure valid content is zero
terminated so can treat as c-string
    Serial.println((char *)payload);
  }
  void sendSMS(String msg)
  {
    Serial.print("AT");  //Start Configuring GSM Module
    delay(1000);        //One second delay
    Serial.println();
    Serial.println("AT+CMGF=1");
    delay(1000);
    Serial.println("AT+CMGS=\"+916385808140\"\r");
    delay(1000);
    Serial.println(msg);
    delay(100);
    Serial.println((char)26);
    delay(1000);
```

```
}

void setup() {

 // Start serial console

  Serial.begin(115200);

  Serial.setTimeout(2000);

  while (!Serial) { }

  Serial.println();

  Serial.println("ESP8266 IBM Cloud Application");



  // Start WiFi connection

  WiFi.mode(WIFI_STA);

  WiFi.begin(ssid, pass);

  while (WiFi.status() != WL_CONNECTED) {

    delay(500);

    Serial.print(".");

  }

  Serial.println("");

  Serial.println("WiFi Connected");
```

```
    // Start connected devices
    dht.begin();

    // Connect to MQTT - IBM Watson IoT Platform
    if (mqtt.connect(MQTT_DEVICEID, MQTT_USER,
MQTT_TOKEN)) {
      Serial.println("MQTT Connected");
      mqtt.subscribe(MQTT_TOPIC_DISPLAY);

    } else {
      Serial.println("MQTT Failed to connect!");
      ESP.reset();
    }
  }

  void loop() {
    mqtt.loop();
    while (!mqtt.connected()) {
      Serial.print("Attempting MQTT connection...");
```

```
      // Attempt to connect
      if (mqtt.connect(MQTT_DEVICEID, MQTT_USER,
MQTT_TOKEN)) {
        Serial.println("MQTT Connected");
        mqtt.subscribe(MQTT_TOPIC_DISPLAY);
        mqtt.loop();
      } else {
        Serial.println("MQTT Failed to connect!");
        delay(5000);
      }
    }
    int sensorValue = analogRead(A0);
    Serial.println(sensorValue);
    delay(1000);
    h = dht.readHumidity();
    t = dht.readTemperature(); // uncomment this line for
centigrade
    Serial.print("Current humidity = ");
     Serial.print(h);
```

```
      Serial.print("%  ");
      Serial.print("temperature = ");
      Serial.print(t);
      Serial.println("C  ");
      // t = dht.readTemperature(true); // uncomment
this line for Fahrenheit

    // Check if any reads failed and exit early (to try
again).
    if (sensorValue<50) {
      Serial.println("WATER POLLUTED");
      sendSMS("WATER POLLUTED");
        delay(3000);
    }
    if (isnan(h) || isnan(t)) {
      Serial.println("Failed to read from DHT sensor!");
    } else {
      // Send data to Watson IoT Platform
      status["temp"] = t;
```

```
      status["humidity"] = h;
      status["TURBIDITY"] = sensorValue;
      serializeJson(jsonDoc, msg, 50);
      Serial.println(msg);
      if (!mqtt.publish(MQTT_TOPIC, msg)) {
        Serial.println("MQTT Publish failed");
      }
    }

    // Pause - but keep polling MQTT for incoming
messages
    for (int i = 0; i < 10; i++) {
      mqtt.loop();
      delay(1000);
    }
  }
```

13.2 Github and project demo link:

Project demo link:
https://drive.google.com/drive/folders/1D8C4jDT-6-9U33q8FRQTAwXPrTOmOiqb

Github Link:

https://github.com/IBM-EPBL/IBM-Project-30634-1660151373