REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

A PROJECT REPORT

by

SHANJAY V

VARUN L

VASANTH R

VISHNU PRIYA

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

SRI SHAKTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

NOVEMBER 2022

ANNA UNIVERSITY : CHENNAI 641062

TABLE OF CONTENTS

CHAPTER TITLE NO

1 INTRODUCTION

1.1 Project Overview

1.2 Purpose

2 LITERATURE SURVEY

2.1 Existing problem

2.2 References

2.3 Problem Statement Definition

3 IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

3.2 Idea on & Brainstorming

3.3 Proposed Solu on

3.4 Problem Solu on fit

4 REQUIREMENT ANALYSIS

4.1 Functional requirement

4.2 Non-Functional requirement

5 PROJECT DESIGN

5.1 Data Flow Diagram

5.2 Solutions & Technical Architecture

5.3 User Stories

6 PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation
6.2 Sprint Delivery Schedule
6.3 Reports from JIRA

7 CODING & SOLUTIONING

7.1 Feature 1
7.2 Feature 2

8 TESTING

8.1 Test Cases
8.2 User Acceptance Testing

9 RESULTS

9.1 Performance Metrics

10 ADVANTAGES & DISADVANTAGES

11 CONCLUSION

12 FUTURE SCOPE 13

APPENDIX

Source Code

GitHub & Project Demo Link

ABSTRACT

Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. This paper proposes a sensor-based water quality monitoring system. The main components of Wireless Sensor Network (WSN) include a microcontroller for processing the system, communication system for inter and intra node communication and several sensors. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology. The environment consists of five key elements e.g., soil, water, climate, natural vegetation, and landforms. Among these water is the major need of human life. It is also vital for the persistence of other living habitats. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is the need for public health. So it is highly imperative for us to maintain water quality balance. Otherwise, it would severely damage the health of the humans and at the same time affect the ecological balance among other species. Internet of things (IoT) is an innovative technological phenomenon. It is shaping today's world and is used in different fields for collecting, monitoring and analysis of data from remote locations.

CHAPTER 1
INTRODUCTION

1.1 PROJECT OVERVIEW

River Water Quality Monitoring is the major tasks for upcoming generation as Water Pollution rates are increasing day by day. People who are not researchers are most likely to intersect environmental science in the context of protecting or restoring a place or species about which they are concerned, or in the context of pollution—trying to understand the sources and effects of contaminants, or trying to prevent or remediate environmental contamination. The works in this entry address pollutants affecting river ecosystems, including the people who live within or use resources from those ecosystems. Pollution is commonly subdivided based on the primary medium affected by contamination, creating categories such as air pollution, soil pollution, freshwater pollution, groundwater pollution, or marine pollution. In reality, of course, all of these media are intimately connected. Atmospheric deposition of contaminants pollutes soil and water bodies. Contaminated groundwater seeps into rivers, and contaminated rivers recharge groundwater aquifers. Fluxes of water, sediment, solutes, and even organisms carrying contaminants within their tissues create vectors to disperse pollutants. This is one of the great challenges to understanding and mitigating pollution: the contaminant is seldom an inert substance that stays in one place.

Another great challenge is that there are many different types of contaminants, including human and animal wastes such as sewage or intestinal bacteria, excess nutrients, heavy metals, petroleum products, radioactive isotopes, and an enormous array of synthetic chemicals such as pesticides and personal care products. Each type of contaminant can disperse through environmental media, combining with other chemical compounds to form metabolites that may have different levels of toxicity for organisms or different dispersal mechanisms than the original contaminant. Yet another challenge in understanding and managing pollutants is that a substance that is harmful to one type of organism may not cause harm to another

environmental standards set by government agencies for maximum permissible levels of contaminants are based on very limited knowledge and are likely to be inadequate. Most of the standards are also based on acute effects that show up very quickly. Contaminant levels below permissible standards can cause chronic effects—subtle but pervasive changes that eventually degrade the health of individual organisms and populations. Some chronic effects result from bioaccumulation, as an organism accumulates contaminants within its tissues over the course of its life, and bio-magnification, as organisms pass on their accumulated doses to predators or scavengers.

1.2 PURPOSE

Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. It is sensor-based water quality monitoring system. The main components of Wireless Sensor Network (WSN) include a microcontroller for processing the system, communication system for inter and intra node communication and several sensors. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology.

In this project, we have used IBM Watson IoT platform as our core platform for our project. The project starts with the Python Script, while running the code the description connects with the Cloud platform and generates the output.

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

New sensor capacities and executions are being created by remote correspondence. For natural applications, late advancements in sensor organizing are fundamental. The Things Web (IoT) permits joins between various gadgets to share and gather information. Notwithstanding mechanization, IoT grows its capacities by utilizing Industry to determine natural worries. Since water is one of the key prerequisites of human endurance and life submerged, some instrument is important to control water quality infrequently.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) allowsconnections 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. 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.

Water quality monitoring (WQM) system is widely being explored as it is needed to prevent the problem of water contamination worldwide. This paper proposed an independent robot busy with constant multisensory (pH, temperature, voltage and trash level) for better water quality.

The information were recorded utilizing sensors and communicated by means of Wi-Fi to a planned MIT creator versatile application and put away in the cloud to screen the water quality This paper presents the development and implementation of Water Quality Assessment and Monitoring (WQAM) system. The system development used WiFi enabled microcontroller to connect with the IoT environment and store the data in the IoT cloud server. The microcontroller used is Arduino UNO that interacts with three types of sensor probes which are pH, turbidity and temperature probe. All the data measurements is transferred using a WiFi module which is ESP8266. The IoT cloud used to utilize the data frame is ThingSpeak. This system was implemented on Bandar Perda Lake and Derhaka River in Pulau Pinang with two systems implemented at each location. The sensors were placed on the water surface for more accurate measurements. This system continuously measures the readings of pH, turbidity dan temperature on the lake/river for every 1 hour. Twenty readings were taken for every 1 hour within the first 20 minutes with 1 minute interval and the readings were stored in the IoT cloud server. The readings are accessible via ThingSpeak GUI. In conclusion, this system would benefit the authorities to take advantage of using the WQAM system with the aid of the IoT that is less time consuming, less cost and more reliable in real time.

Our main aim is to develop a system for continuous monitoring of river water quality at remote places using wireless sensor networks with low power consumption, low-cost and high detection accuracy. pH, conductivity, turbidity level, etc. are the limits that are analyzed to improve the water quality. Following are the aims of idea implementation: a. To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, temperature etc. using available sensors at remote place. b. To collect data from various sensor nodes and send it to base station by wireless channel. c. To simulate and analyze quality parameters for quality control. d. To send SMS to an authorized person automatically when water quality detected does not match the preset standards, so that, necessary actions can be taken.

2.2 REFERENCES

[1] B. Chen, Y. Song, T. Jiang, Z. Chen, B. Huang, and B. Xu, "Real-time estimation of population exposure to PM2.5 using mobile- and station-based big data," Int J Environ Res Public Health, vol. 15, Mar 23 2018.

[2] B. Paul, "Sensor based water quality monitoring system," BRAC University, 2018.

[3] S. Thombre, R. U. Islam, K. Andersson, and M. S. Hossain, "IP based Wireless Sensor Networks : performance Analysis using Simulations and Experiments", Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, vol. 7, no. 3, pp. 53–76, 2016.

[4] S. Thombre, R. U. Islam, K. Andersson, and M. S. Hossain, "Performance Analysis of an IP based Protocol Stack for WSNs", in Proceedings of the 2016 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2016, pp. 691–696.

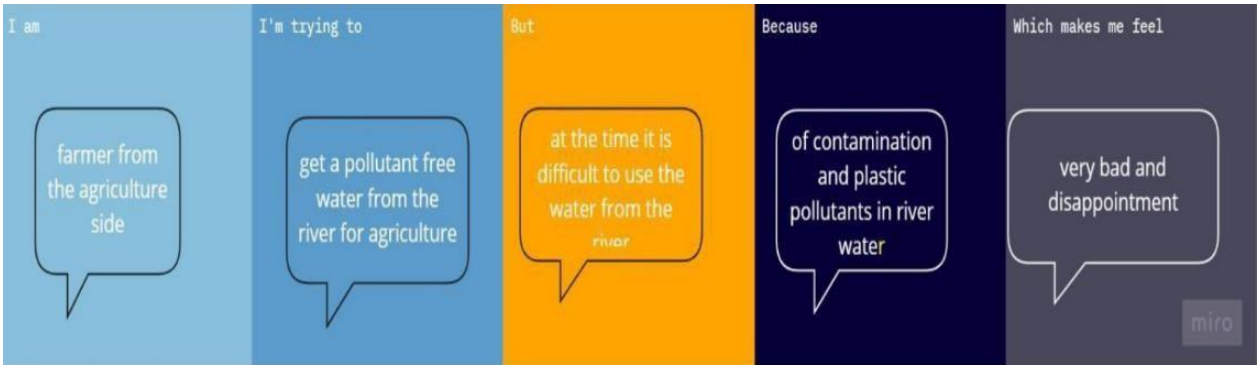
[5] M. Z. Abedin, A. S. Chowdhury, M. S. Hossain, K. Andersson, and R. Karim, "An Interoperable IP based WSN for Smart Irrigation Systems", presented at the 14th Annual IEEE Consumer Communications & Networking Conference, Las Vegas, 8-11 January 2017, 2017.

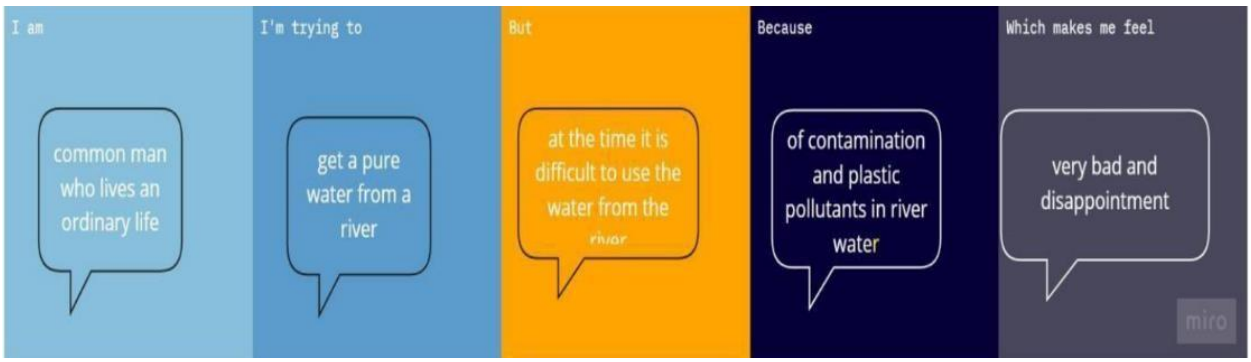
[6] K. S. Adu-Manu, C. Tapparello, W. Heinzelman, F. A. Katsriku, and J.-D. Abdulai, "Water quality monitoring using wireless sensor networks: Current trends and future research directions," ACM Transactions on Sensor Networks (TOSN), vol. 13, p. 4, 2017.

2.3 PROBLEM STATEMENT DEFINITION

A problem statement is important to a process improvement project because it helps clearly identify the goals of the project and outline the scope of a project. It also helps guide the activities and decisions of the people who are working on the project. The problem statement can help a business or organization gain support and buy-in for a process improvement project.

Creating a problem statement to understand customer's point of view. The below shown block diagram is a perfect example for our topic.

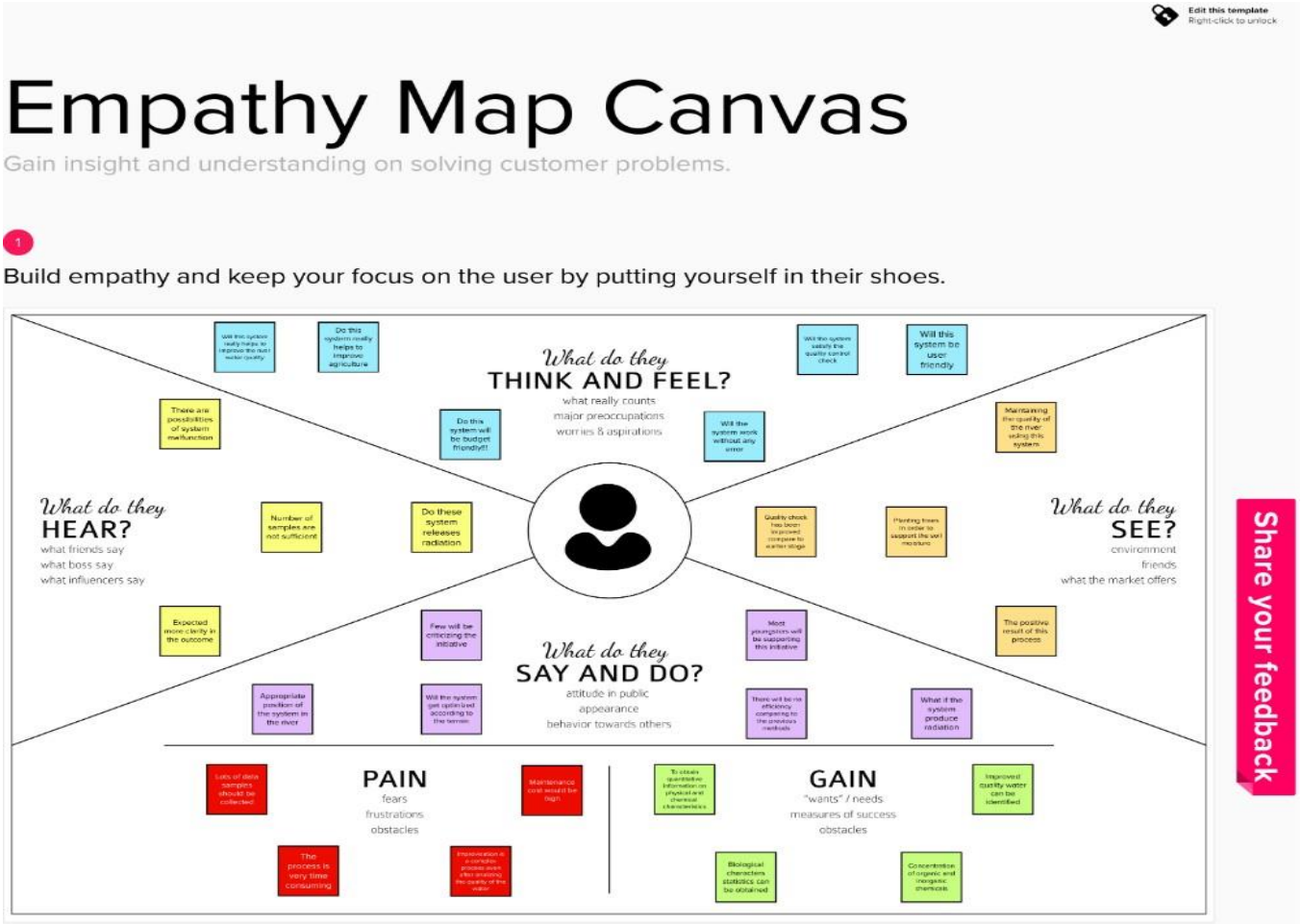




CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



Empathy maps are an efficient tool used by designers to not only understand user behaviour, but also visually communicate those findings to colleagues, uniting the team under one shared understanding of the user. Essentially, an empathy map is a square divided into four quadrants with the user or client in the middle. Each of the four quadrants comprises a category that helps us delve into the mind of the user. The four empathy map quadrants look at what the user **says**, **thinks**, **feels**, and **does**.

With the user at the centre and the categories in each of the four surrounding quadrants, an empathy map arranges all of your research about the user into an easyto-read visual.

3.2 IDEATION & BRAINSTORMING

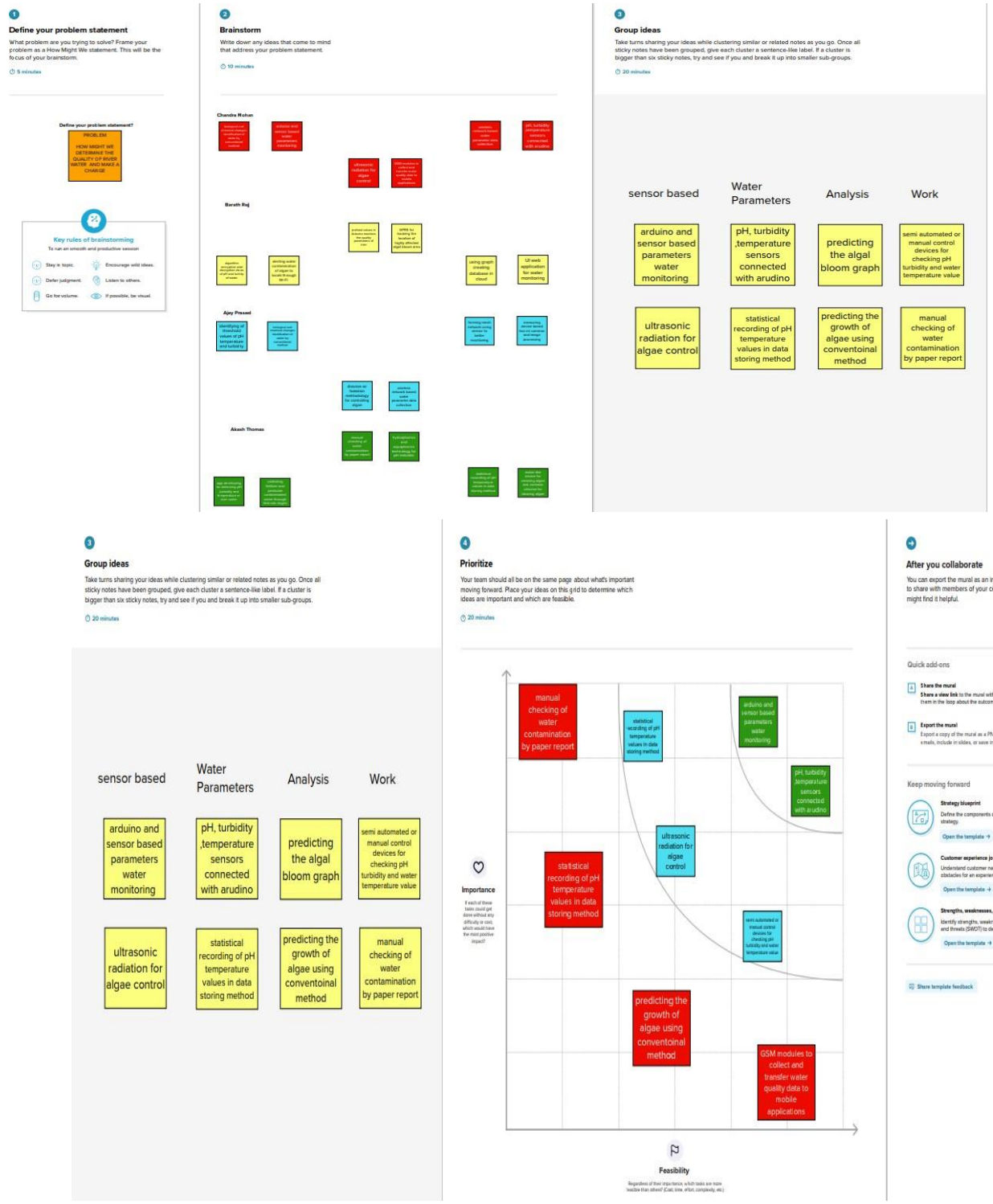


Fig3.Brainstorming

Brainstorming is a method design teams use to generate ideas to solve clearly defined design problems. Brainstorming is a method of generating ideas and sharing knowledge to solve a particular commercial or technical problem, in which participants are encouraged to think without interruption. Brainstorming is a group activity where each participant shares their ideas as soon as they come to mind. At the conclusion of the session, ideas are categorised and ranked for follow-on action.

When planning a brainstorming session it is important to define clearly the topic to be addressed. A topic which is too specific can constrict thinking, while an ill-defined topic will not generate enough directly applicable ideas. The composition of the brainstorming group is important too. It should include people linked directly with the subject as well as those who can contribute novel and unexpected ideas. It can comprise staff from inside or outside the organisation.

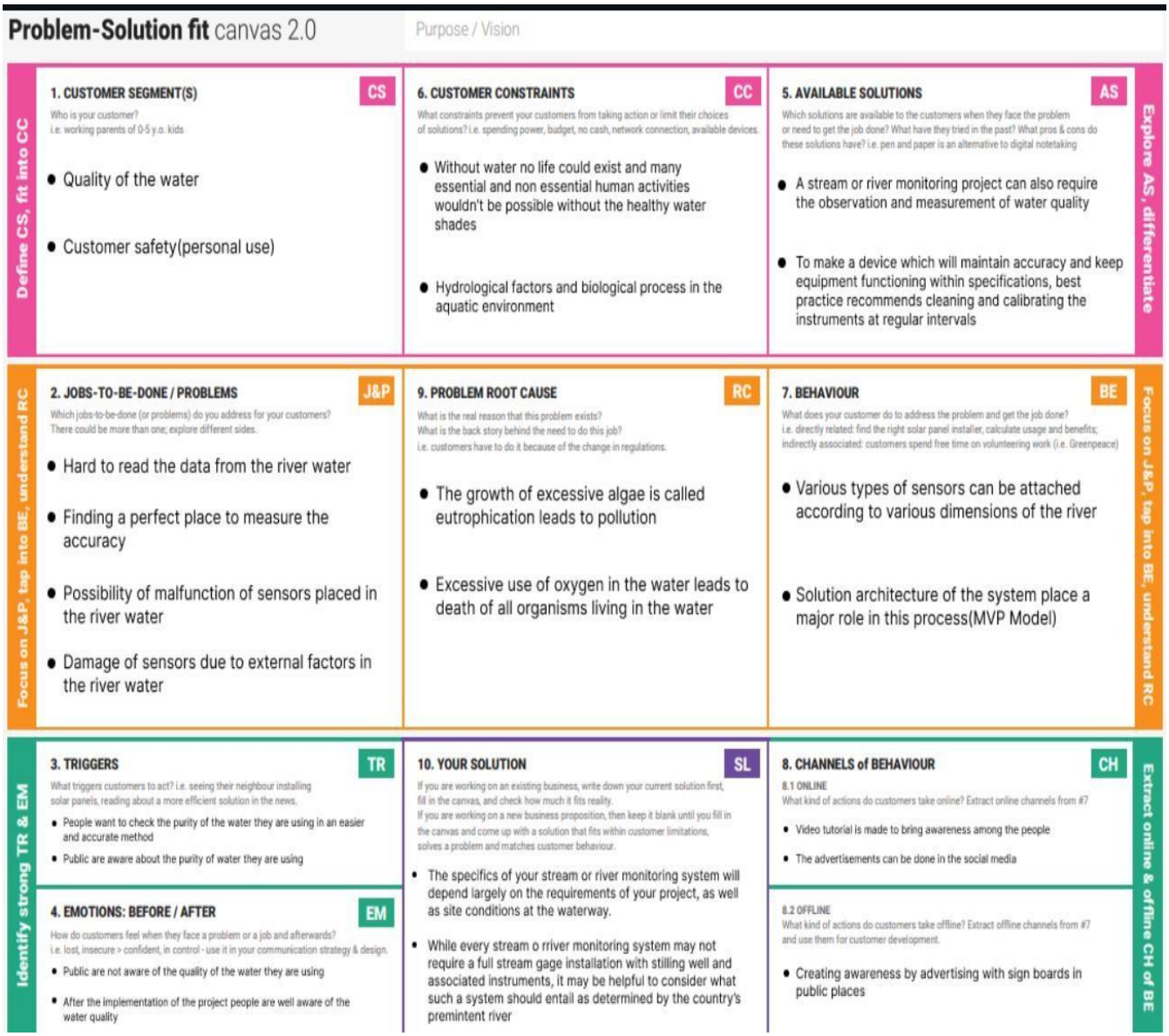
3.3 PROPOSED SOLUTION

Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.

To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc. using available sensors at a remote place. To assemble data from various sensor nodes and send it to the base station by the wireless channel. To simulate and evaluate quality parameters for quality control. To send SMS to an authorized person routinely when water quality detected does not match the preset standards, so that, necessary actions can be taken.

S.No	Parameter	Description
1.	Problem Statement (Problem to be solved)	To monitor the water parameters such as turbidity ,pH, dissolved solvents and to analyse the quality of river water.
2.	Idea / Solution description	Monitoring water parameters with sensors and control measures by ultrasonic frequencies.
3.	Novelty / Uniqueness	Arduino And Sensor Based Water Parameters Monitoring which identifies biological and chemical changes in water
4.	Social Impact / Customer Satisfaction	It provides the user with an idea about the quality of river water which might help them to base the usage of the water according to its quality.
5.	Business Model (Revenue Model)	The monitoring system could be sold in the market for the purpose of testing water quality.
6.	Scalability of the Solution	The model could be scaled according to size of the water body about to be tested.

3.4 PROBLEM SOLUTION FIT



CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Users Authorization levels	Complete mapping are given in a hierarchical manner in order to show only the specific Data.
FR-2	Historical Data	The Data are stored in the cloud from the beginning stage till the Updation .
FR-3	User Authentication	The credentials is accessible only to the authorized users to access the model.
FR-4	Users rules and laws	There is some specific guidelines which has to be followed by the users.

4.2 NON FUNCTIONAL REQUIREMENTS

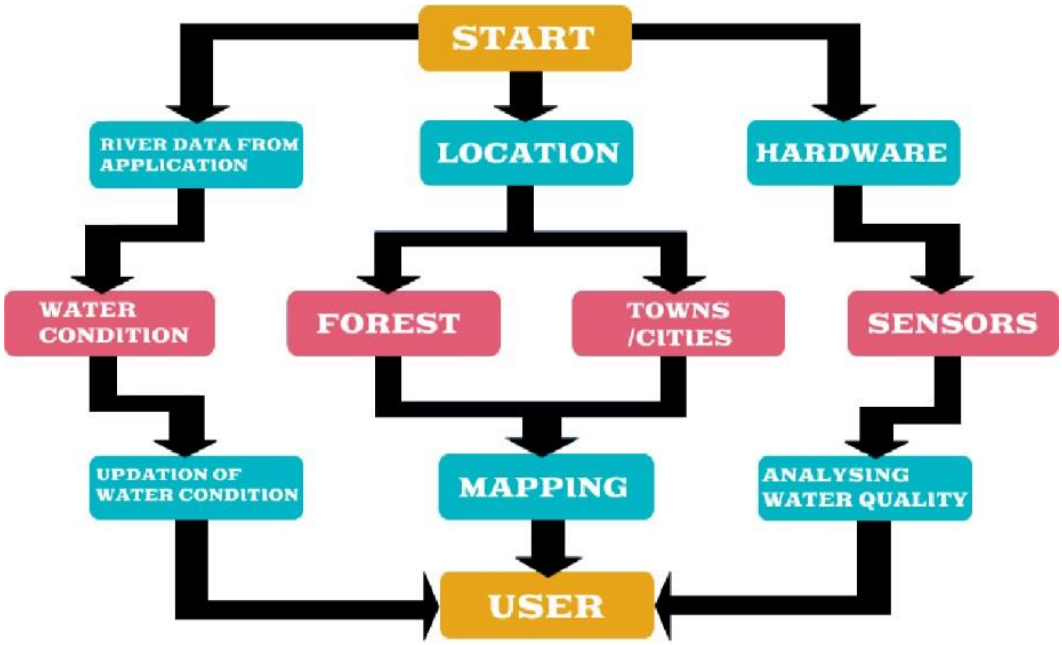
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The Final data should be easily understandable .
NFR-2	**Security**	The model are designed in a secured manner in order to maintain the privacy
NFR-3	**Reliability**	Even if there is a firmware issues (failures) the last updated Data's are stored in a Default manner.
NFR-4	**Performance**	High quality sensors are used to ease the customer's work.
NFR-5	**Availability**	The model are designed in such a way that are available ,usable and can be modified anytime.
NFR-6	**Scalability**	The System are Scaled according to the size of the water body (varies)

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

The Data Flow Graph of our proposed solution is shown below:



A data-flow graph is a collection of arcs and nodes in which the nodes are either places where variables are assigned or used, and the arcs show the relationship between the places where a variable is assigned and where the assigned value is subsequently used.

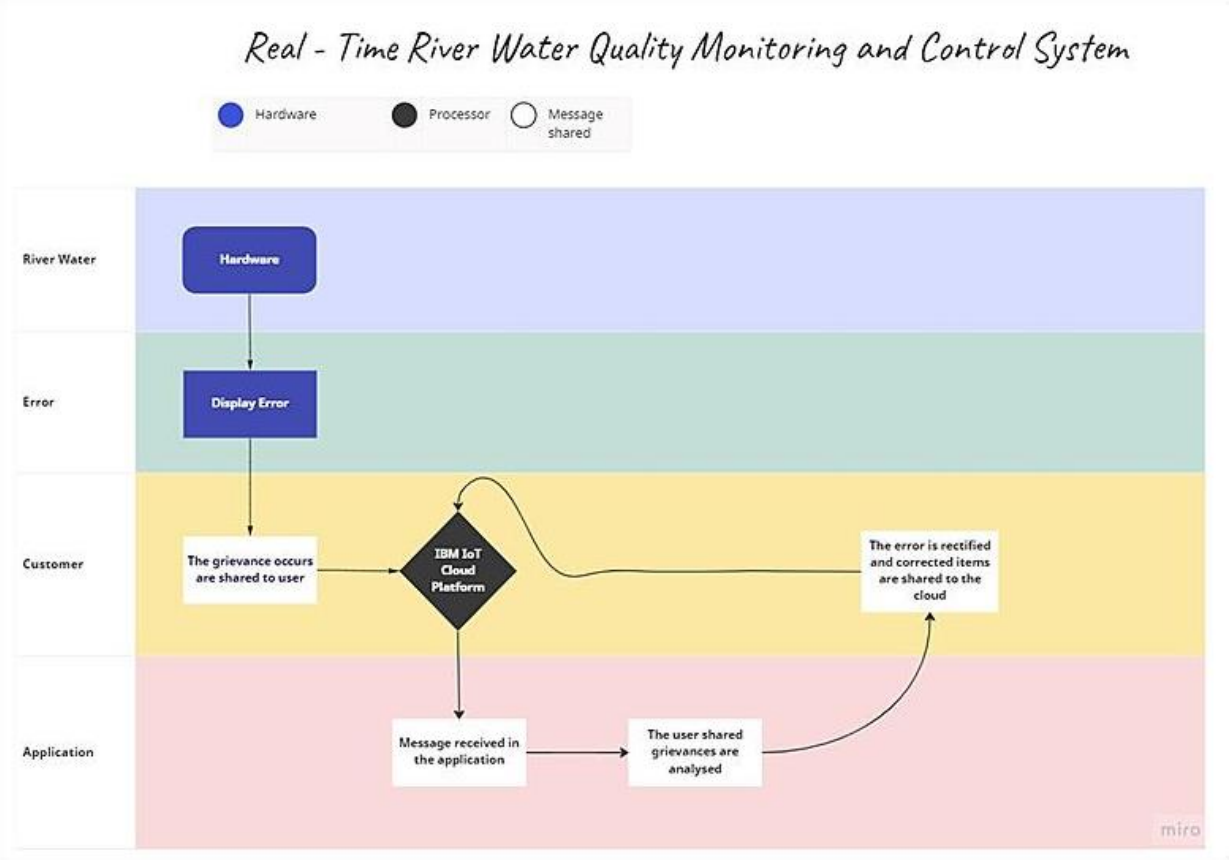
Our Data Flow Diagram shows the entire process from the entry of the Application to the exit which is controlled by the User. Here, after the user login the app moves on to the profile section where the user can see the materials to be selected then the measurement what he need to acquire is to be chosen.

5.2 SOLUTION & TECHNICAL ARCHITECTURE

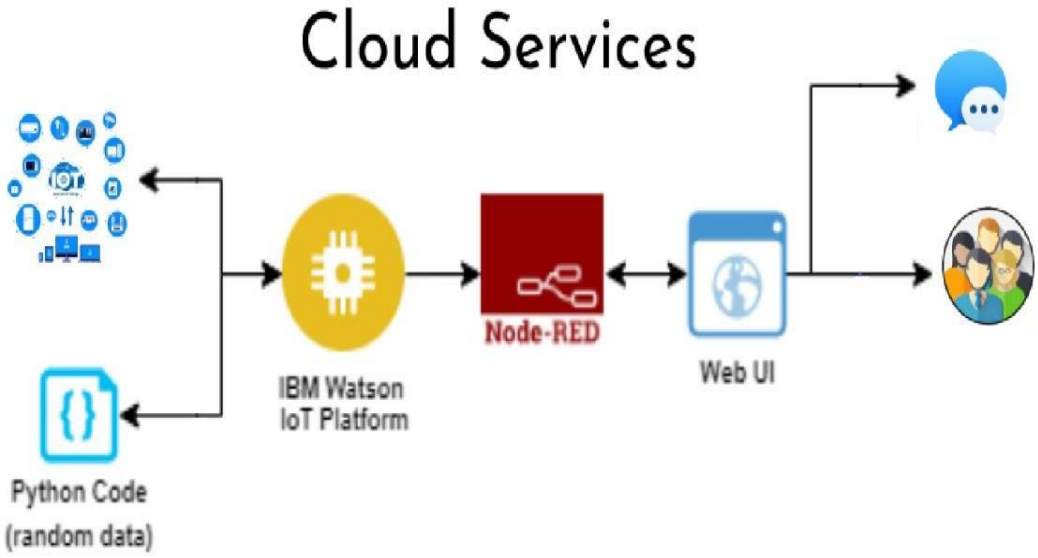
For Solution Architecture,

- The Quality of the Water will be determined by our IoT process.
- While consuming the impure water causing various diseases, this can be stopped by Controlling pollutants.
- We provide proper solution to overcome this disaster.

.



Technical Architecture:



Technical architecture—which is also often referred to as application architecture, IT architecture, business architecture, etc.—refers to creating a structured software solution that will meet the business needs and expectations while providing a strong technical plan for the growth of the software application through its lifetime. IT architecture is equally important to the business team and the information technology team.

Technical architecture includes the major components of the system, their relationships, and the contracts that define the interactions between the components. The goal of technical architects is to achieve all the business needs with an application that is optimized for both performance and security. IT architects plan for things they know are coming in the future and for things they don't yet envision or dream. Taking the time to design the architecture at the start will prevent major design changes, code refactoring, and expensive rework later in the project.

5.3 USER STORIES

A user story is an informal, general explanation of a software feature written from the perspective of the end user. Its purpose is to articulate how a software feature will provide value to the customer. It's tempting to think that user stories are, simply put, software system requirements. But they're not.

A key component of agile software development is putting people first, and a user story puts end users at the center of the conversation. These stories use nontechnical language to provide context for the development team and their efforts. After reading a user story, the team knows why they are building, what they're building, and what value it creates. User stories are one of the core components of an agile program. They help provide a user-focused framework for daily work — which drives collaboration, creativity, and a better product overall.

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering email , password, and confirming my password.	I can access my account/dashboard	High	Sprint-1
		USN-2	As a user, I will receive a confirmation email once I have registered for the application	I can receiva e confirmation email & click confirm	High	Sprint-2
		USN-3	As a user, I can register for the application through google	I can register & access the dashboard with google	High	Sprint-1
		USN-4	As a user, I can register for the application through Gmail	I can register througthe h mail	Medium	Sprint-2
	Login	USN-5	As a user, I can log into the application by entering email, password & captcha	I can receive login credentials.	High	Sprint-1
	Interface	USN-6	As a user, the interface should be user-friendly manner	I can able to access easily.	Medium	Sprint-1
Customer (Web user)	dashboard	USN-7	As a user, I can access the specific info(ph value, temp, humidity, quality).	I can able to know the quality of the water.	High	Sprint-1
Customer (input)	View manner	USN-8	As a user, I can view data in visual representation manner(graph)	I can easily understand by visuals.	High	Sprint-1
	Taste	USN-9	As a user , I can able to view the quality(salty) of the water	I can easily know whether it is salty or not	High	Sprint-1
	Colour visiblity	USN-10	As a user , I can able predict the water colour	I can easily know the condition by colour	High	Sprint-1
Administrator	Risk tollerent	USN-11	An administrator who Is handling the system should update and take care of the application.	Admin should monitor the records properly.	Medium	Sprint-2

CHAPTER 6

PROJECT PLANNING & SCHEDULING

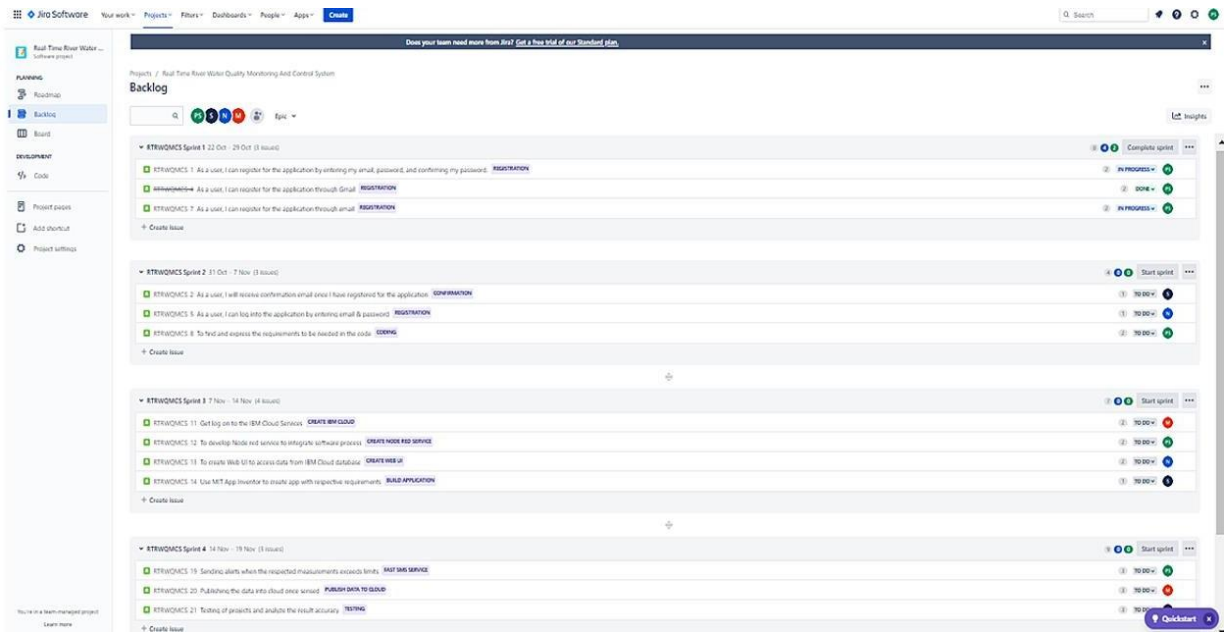
6.1 SPRINT PLANNING & ESTIMATION

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	CHANDRA MOHAN, AKASH THOMAS, AJAY PRASAD
	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	Medium	
	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	Medium	BARATH RAJ, AJAY PRASAD
	Create a node red service	USN-7	To create a node red service to integrate the IBM Watson along with the Web UI	2	low	AKASH THOMAS ,AJA\ PRASAD
	Create a Web UI	USN-8	To create a Web UI, to access the data from the cloud And display all parameters.	2	Medium	BARATH RAJ
	Publish Data to cloud.	USN-10	Publish Data that is sensed by the microcontroller to the Cloud	3	High	AKASH THOMAS
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	Medium	BARATH RAJ, CHANDRA MOHAN

6.2 SPRINT DELIVERY SCHEDULE

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	04 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	06 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	13 Nov2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 REPORTS FROM JIRA



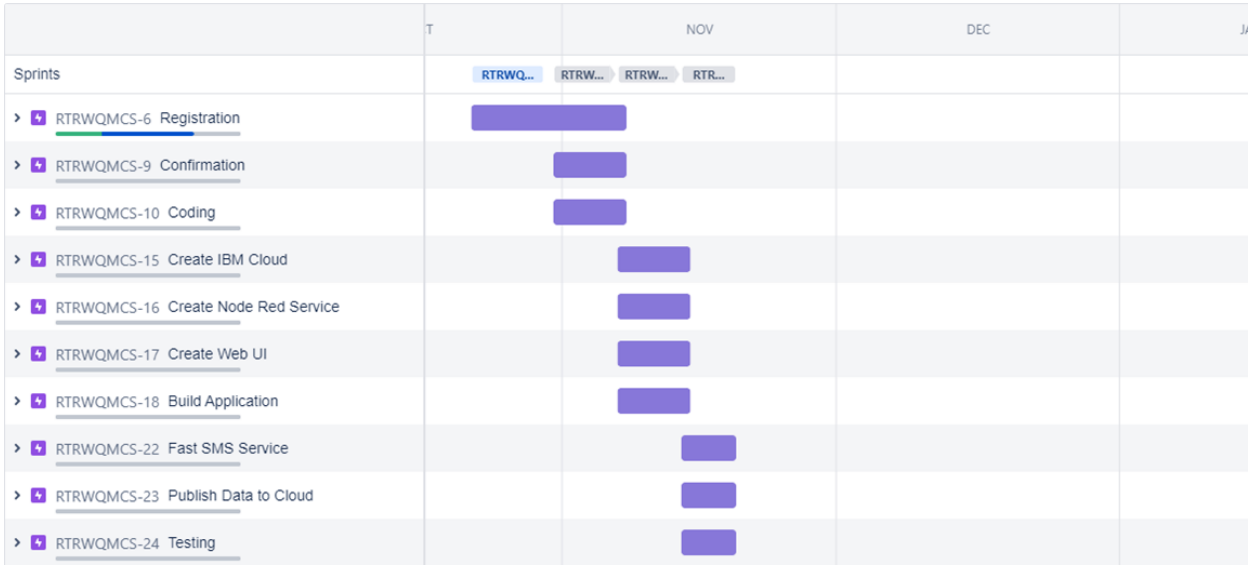
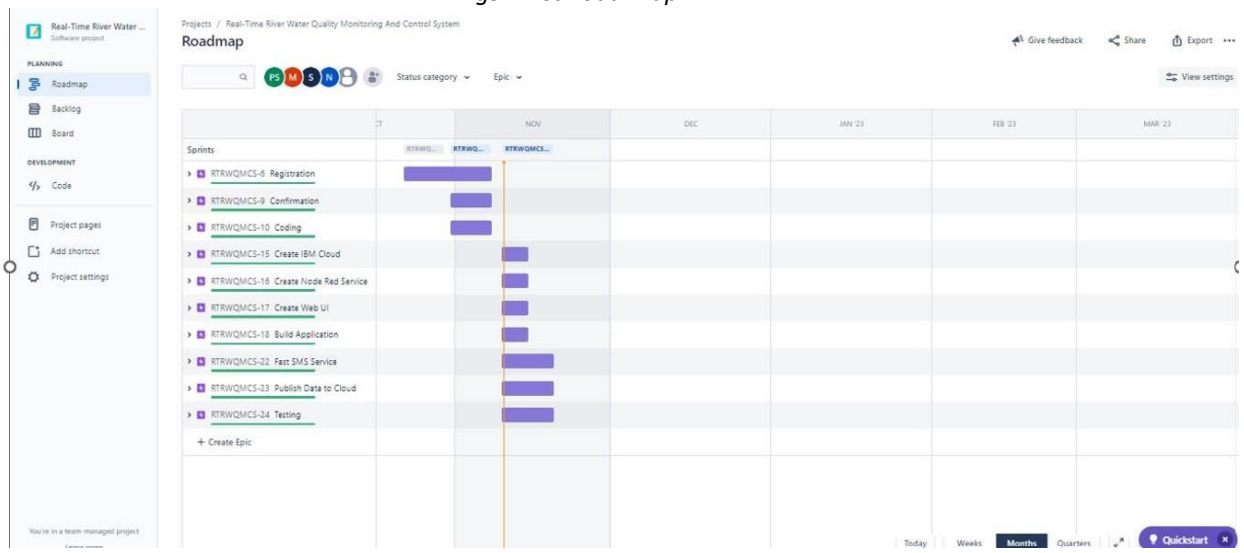


Fig9. First Road Map



CHAPTER 7 CODING & SOLUTIONING

7.1 FEATURE 1

IBM WATSON IoT PLATFORM

The very first process in this project section is to develop the IBM IoT Platform. This IoT platform is the core formula for all the connection process. As the only way of connecting several applications is the basic work of the cloud platform.

The process of signing in to the cloud process is the large process which carries verfication segments too. After creating the Cloud Profile, lets move to device creation part.

Device Creation

Now the next step is to create a device, we have created a device with following details

Device Type : 1234

Device Id : 1234567

With following details, we have created a device and the code for this device carries the requirements which satisfies the project specification. We used temperature, humidity and the pH value in the code.

1. temperature - 0 to 100
2. humidity - 0 to 100
3. ph value - 0 to 14

While, the device is made to run the results are appeared in the Recent Events tab near the Device part.

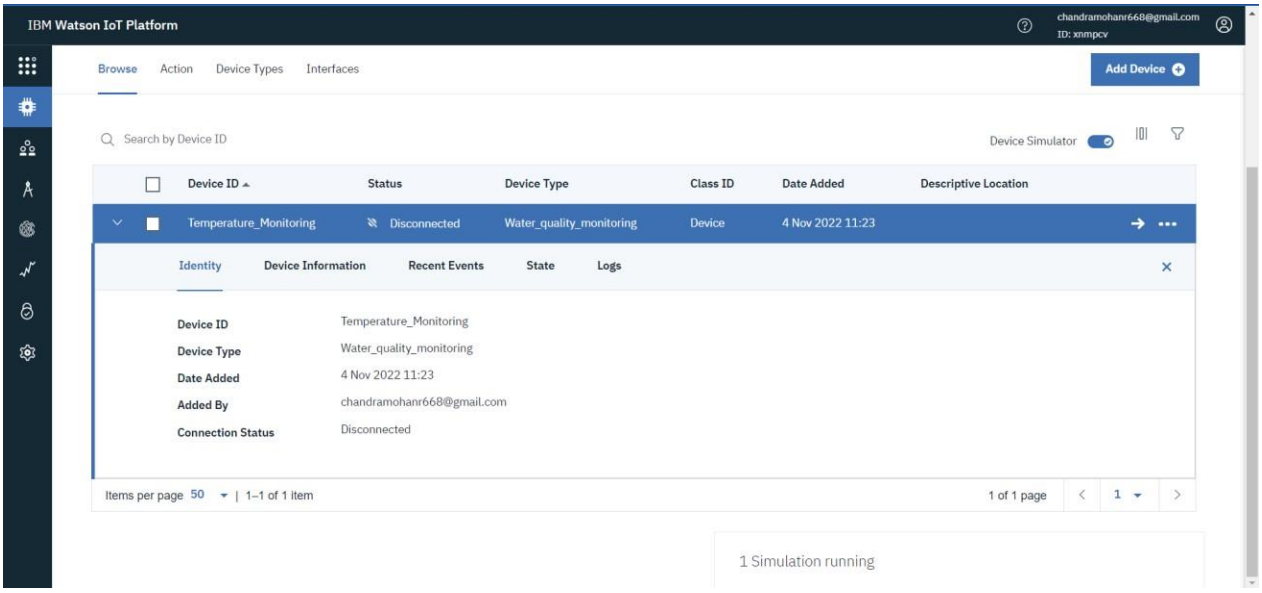


Fig11.Created Device

NODE-RED SERVICE

After registering to the IBM IoT Platform and created the device, now we move on to the Node-Red Service, in this here we can create the Web user interface and the Web Application by designing the circuit. Our Node-Red Circuit designing are as follows.

The first step is to install the IBM IoT block from the node-red service and we have set three functions namely, temp, hum, pH these three functions processess temperature, humidity and the pH value. And the three functions are connected to the msg.payload button. At seperately the functions are designed in the wave of chart, where temperature and humidity are designed in the Line Chart and pH value as Gauge chart.

After this, we set two buttons of the Switch board, Light ON and Light OFF. This button works as if it pressed to light ON, the python code displays "led is on", if light OFF, it shows " led is off".

Now for connecting to web we use "http" extention. And also, for connection to the Application we use MIT app application with get option function in Node-Red. The Node-Red website is copied and added "/sensor" to review the output.

For simulating the Node-Red Service, there appears "Deploy" button.

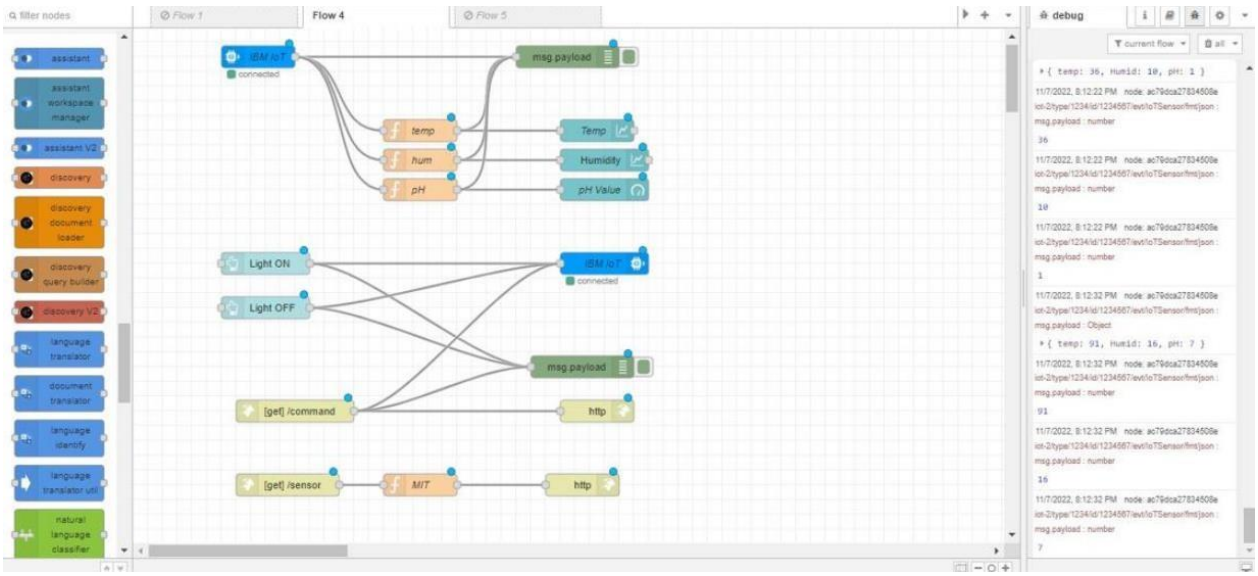


Fig12. Node-Red Circuit Design

USER INTERFACE

After the successful simulation of the Node-Red Service, User Interface is created. Our Web UI includes Temperature, Humidity, pH Value in accordance with Switch Board of Light ON and Light OFF. The Temperature and Humidity varies from 0 to 100. And the pH varies from 0 to 14.

Our Executed User Interface from the Node-Red is shown below.

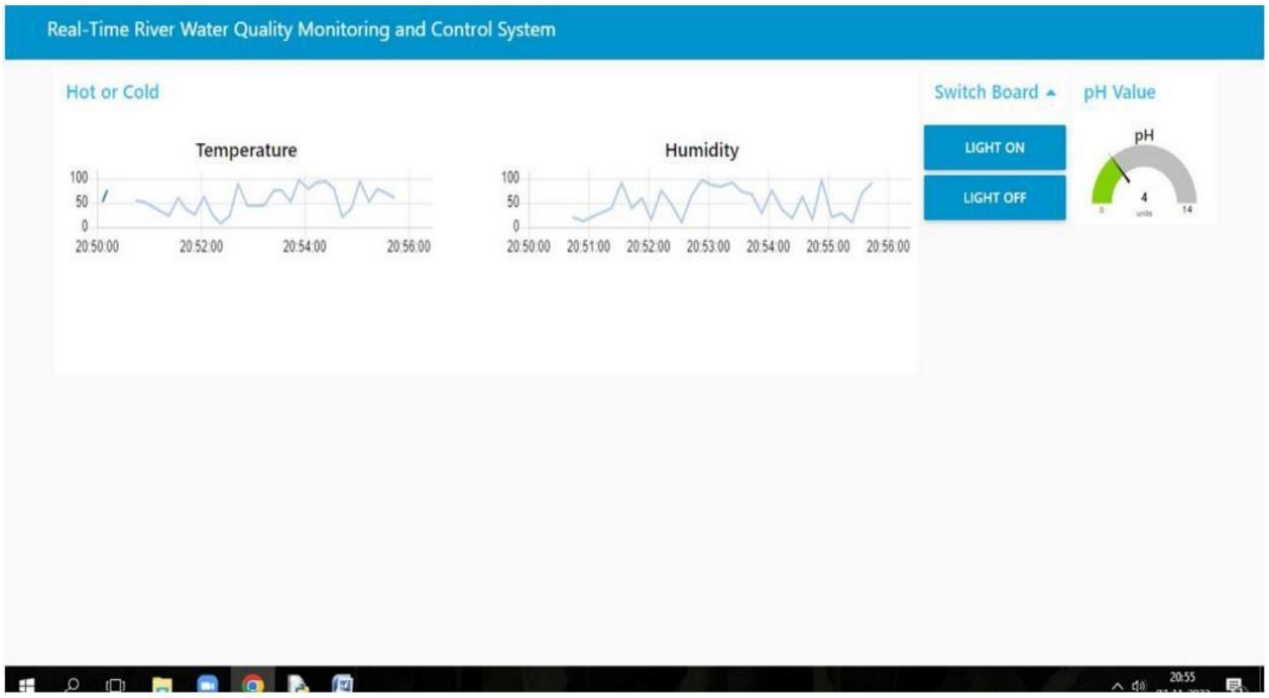


Fig13.Node-Red Page Web User Interface

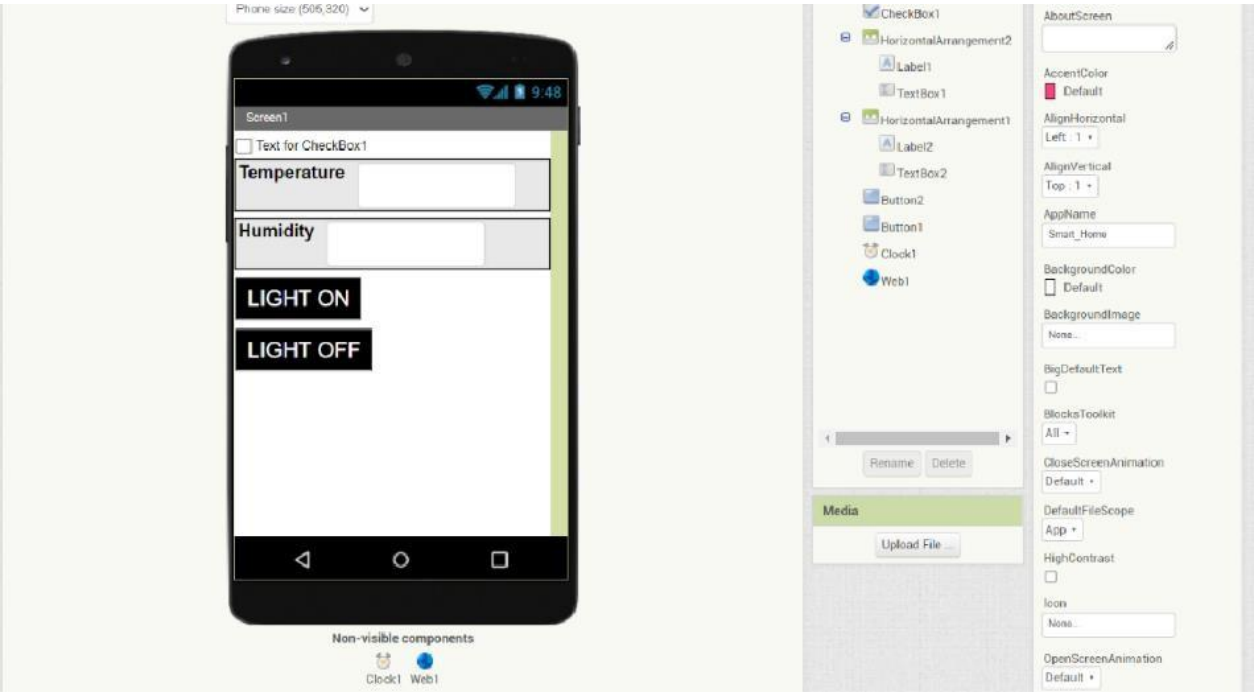
MIT APP INVENTOR

This phase is the most priority requirement of our project. Using an application helps users to monitor in easy way. MIT App inventor helps to desgin our application. We have created 6 Screens for our App.

Following the Login Page, Selection of process is shown with three categories such as Temperature, Humidity and pH value and atlast Logout button.

When the category is selected the page moves on to the Output Display Page where we can see all the three results as the python code is made simulated.

The last page contains Switch board of Light ON and Light OFF. As same as user interface, here also when we press these buttons the output of led on or off is displayed in the Python code



7.2 FEATURE 2

PYTHON CODE

Our Python Code is very Simple and easy to understand. The programs carries our device detalis and the requirements of the project are kept defined. All conditions are made properly and the output is done successfully.

CODE

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
```

```
#Provide your IBM Watson Device Credentials
organization = "udjkcs"
deviceType = "1234" deviceId
= "1234567" authMethod =
"token"
authToken = "123456789"

# Initialize GPIO


def myCommandCallback(cmd):
   print("Command received: %s" % cmd.data['command'])
   status=cmd.data['command']
   if status=="lighton":
      print ("led is on")
   elif status == "lightoff":
      print ("led is off")
   else :
      print ("please send proper command")

   #print(cmd)




try:
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":
authMethod, "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
        #.....................................

except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()
```

```
# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting"
10 times deviceCli.connect()

while True:
    #Get Sensor Data from DHT11

    temp=random.randint(0,100)
    Humid=random.randint(0,100)
    pH=random.randint(0,14)

    data = { 'temp' : temp, 'Humid': Humid ,'pH' : pH }
    #print data
    def myOnPublishCallback():
      print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % Humid, "pHValue =
%s" % pH,  "to IBM Watson")

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
      print("Not connected to IoTF")
    time.sleep(10)

    deviceCli.commandCallback = myCommandCallback

# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

CHAPTER 8 TESTING

8.1 TEST CASES

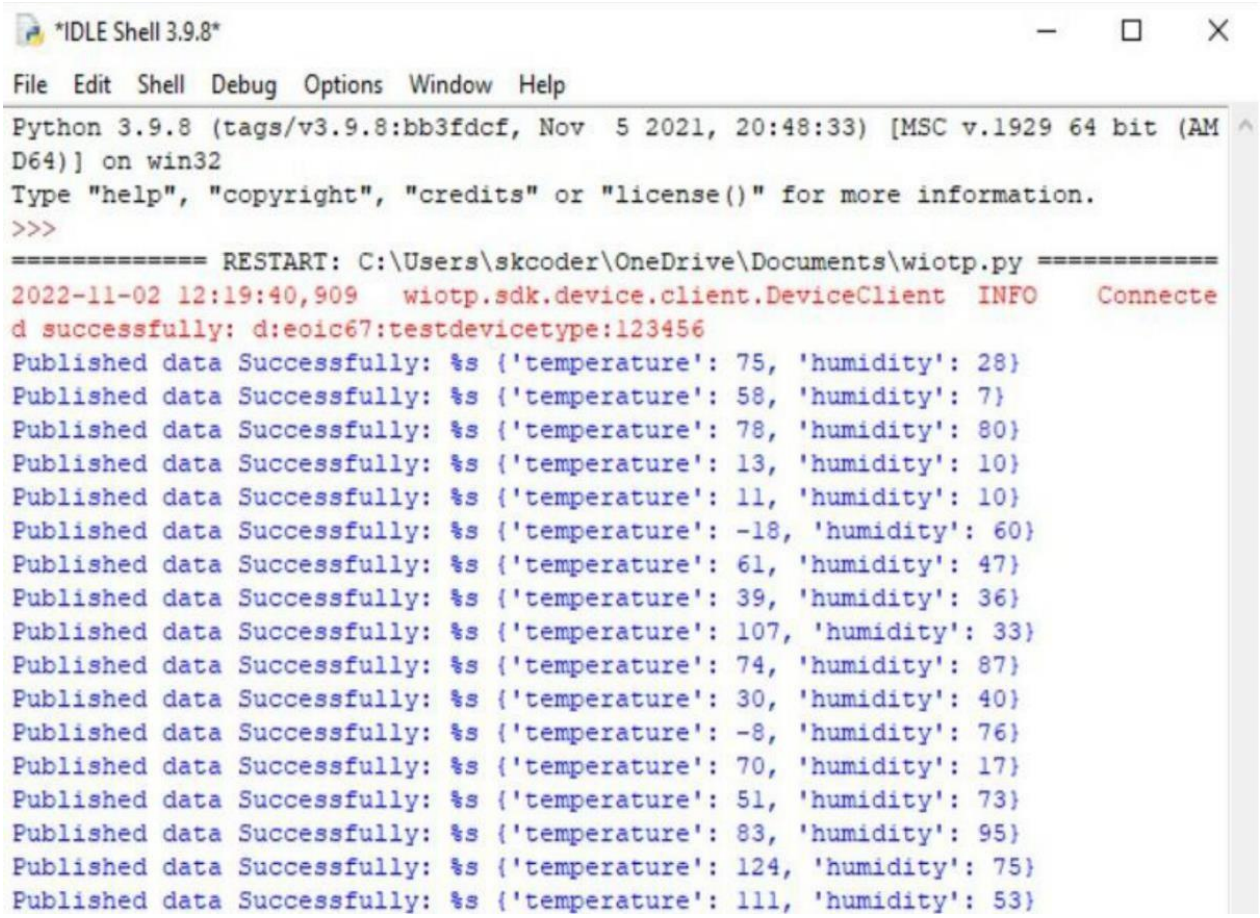
As the code is made to run, the system waits to connect with IoT platform. On account of coonection with the IBM Watson Platform, the code displays the output with relevant details. The output is shown in Cloud platform, the links to Node-Red also to the UI section. Finally when the Application is operated, the output is also displayed in it.

In our python code, we used temperature, humidity and pH value with the following conditions temp=random.randint(0,100)

Humid=random.randint(0,100)

pH=random.randint(0,14)

The output of our Code is shown below,



8.2 USER ACCEPTANCE TESTING

As the completion of the application development, the app should give as much support to the user. The developer must make sure of the avoidance of the disability in working of application by the user. All the appearance of the app should able to be configurable to the user. The usage of the application must satisfy the user at 100%. All the specifications must be simple and easy to use.

CHAPTER 9 RESULTS

9.1 PERFORMANCE METRICS

The performance and the working of the code is ver quick and the results appears in quick succession. Our code is linked with the most used IBM Watson IoT Platform which works with much perfection. This cloud platform is very secure to use and configure easily. As the code is simulated within seconds the result appears. We have done lot of works using this IoT platform which is very simple and good user friendly platform. Below we display our connected IoT platform which delivers the results as the code is run.

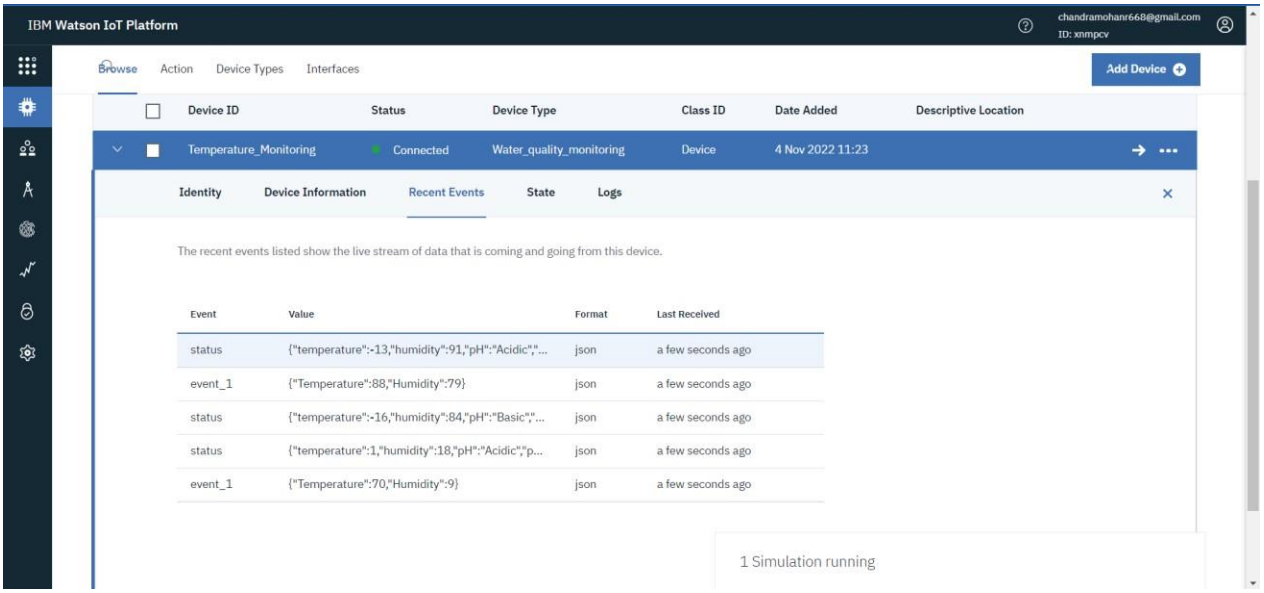


Fig18. IoT Platform Output

CHAPTER 10 ADVANTAGES & DISADVANTAGES

ADVANTAGES

Water quality standards also protect iconic, locally grown products such as wild rice and walleye. Protecting human health — Some pollutants pose risks to human health. Water quality standards protect human health and avoid the costs related to medical care, productivity loss, and even loss of life. This helps us to understand how the levels of nutrients, dissolved oxygen, temperature, salinity and phytoplankton change over time and how best to manage these conditions. Water quality is critical to environmental and ecosystem health. By monitoring water quality, researchers, scientists, and regulators can understand the impact of human activities, seasonal fluctuations, and weather events. Water quality data helps inform sustainable decision making and comprehensive regulatory policy.

DISADVANTAGES

It is difficult to collect the water samples from all the area of the water body. The cost of analysis is very high. The lab testing and analysis takes some time and hence the lab results does not reflect real time water quality measurement due to delay in measurement. Relationship and capacity challenges in water quality monitoring are discussed based on a rational approach to decision-making. Such an approach considers the costs and benefits of individuals and organisations in decision-making with regard to water quality monitoring. Both benefits and costs can be material (i.e. increase or decrease of financial resources) and immaterial (e.g. loss or gain of time, reputation).

CHAPTER 11

CONCLUSION

This way of monitoring the water quality made us very easy. Water monitoring is a crucial part of maintaining many environments including industrial buildings, commercial properties and healthcare establishments. Technology has advanced to the extent that there are now highly sophisticated, accurate and convenient water monitoring systems which offer a whole host of benefits. The major cause of water impurity by industrial wastes and also human acts. By analyzing the quality of water we can consume healthy state, but if we reduce the pollution causing acts we can gain more water ie.pure water even naturally. Stop polluting the river water and make environment clean and hygienic. Indicators are needed for monitoring the system from source to tap, including aesthetic changes, water quality indicators, suspicious activity, changes in water pressure and illness in the community. Action plans for management of both accidental and intentional pollution with biologicals and chemicals should include a base line understanding of the vulnerabilities and baseline quality. Triggers for action must be put in place: spill notification, rainfall, raw water turbidity, fecal indicators and public health indicators. The physical/chemical/biological and geological nature of the water system under study must be considered. Site assessment is an important component of the risk/management framework. Integration of inventory of risks to the watershed, along with climate prediction factors and the monitoring of the raw ambient water quality are critical. Monitoring recovery after contamination events is essential, this will require that baseline data sets are available. Climatic factors and meteorological data continue to show a pattern associated with water quality impacts (during floods but even droughts) and are often associated with treatment and management failures. Thus meteorological data, weather forecasting, and climate prediction scenarios should be integrated in the development of any assessment and management strategy.

CHAPTER 12

FUTURE SCOPE

Environmental water quality monitoring aims to provide the data required for safeguarding the environment against adverse biological effects from multiple chemical

contamination arising from anthropogenic diffuse emissions and point sources. Current monitoring approaches tend to emphasize either targeted exposure or effect detection. Here, we argue that irrespective of the specific purpose, assessment of monitoring results would bene substantially from obtaining and linking information on the occurrence of both chemicals and potentially adverse biological effects. As of now, water quality monitoring is just a wave of seeds. The development of this process must take advance at a quick rate. In the future, there will be a reduction in pollution as water quality monitoring grows.

CHAPTER 13

APPENDIX

SOURCE CODE

As we successfully developed and programmed our python code, lets this be the final code of execution.

```
import time
import sys
```

```
import ibmiotf.application
import ibmiotf.device
import random


#Provide your IBM Watson Device Credentials
organization = "udjkcs"
deviceType = "1234" deviceId
= "1234567" authMethod =
"token"
authToken = "123456789"

# Initialize GPIO


def myCommandCallback(cmd):
   print("Command received: %s" % cmd.data['command'])
   status=cmd.data['command']
   if status=="lighton":
      print ("led is on")
   elif status == "lightoff":
      print ("led is off")
   else :
      print ("please send proper command")

   #print(cmd)




try:
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":
authMethod, "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
        #.....................................................
```

```
except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting"
10 times deviceCli.connect()

while True:
    #Get Sensor Data from DHT11

    temp=random.randint(0,100)
    Humid=random.randint(0,100)
    pH=random.randint(0,14)

    data = { 'temp' : temp, 'Humid': Humid ,'pH' : pH }
    #print data
    def myOnPublishCallback():
      print ("Published Temperature = %s C" % temp, "Humidity = %s %%" % Humid, "pHValue =
%s" % pH,  "to IBM Watson")

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
      print("Not connected to IoTF")
    time.sleep(10)

    deviceCli.commandCallback = myCommandCallback

# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

PROJECT DEMONSTARTION VIDEO

GITHUB LINK : https://github.com/IBM-EPBL/IBM-Project-1883-1658419518

PROJECT DEMO LINK : https://youtu.be/CqL12GKSrTw