

# **REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM**

Category: INTERNET OF THINGS

## **A PROJECT REPORT**

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# INDEX

## 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 Ideation & Brainstorming

3.3 Proposed Solution

3.4 Problem Solution fit

## 4.REQUIREMENT ANALYSIS

4.1 Functional requirement

4.2 Non-Functional requirements

## 5.PROJECT DESIGN

5.1 Data Flow Diagrams

5.2 Solution & 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

13.1 Source Code

13.2 GitHub & Project Demo Link

# 1.INTRODUCTION

## 1.1 Project Overview:

### River Water quality monitoring System

River water which is used as drinking water is a very precious commodity for all human beings. The system consists of several sensors which are used for measuring physical and chemical parameters of water. The parameters such as temperature, pH, and dissolved oxygen of the water can be measured. Using this system a person can detect pollutants from a water body from anywhere in the world. 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 micro-controller 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. Data collected at the IBM cloud Server and verify them to trigger the actions to be performed.

## 1.2 Purpose:

Water quality refers to chemical, physical biological and radio logical characteristics of water. It is a measure of the condition of water relative to the necessities of one or more bio-tic species and or to any human need or purposes. Water quality monitoring is defined as a sampling and analysis of the water in lake, stream, ocean and river and conditions of the water body. Smart water quality monitoring is a process of real-time monitoring and the analysis of water to identify changes in parameters based on the physical, chemical and biological characteristics. Monitoring water quality is clearly important: in our seas, our rivers, on the surface and in our ports, for both companies and the public. It enables us to assess how they are changing, analyze trends and to inform plans and strategies that improve water quality and ensures that water meets its designated use. There are several indicators determining water quality. These include dissolved oxygen, turbidity, bio indicators, nitrates, pH scale and water temperature. Monitoring water quality helps to identify specific pollutants, a certain chemical, and the source of the pollution. There are many sources of water pollution: wastewater from sewage seeping into the water supply; agricultural practices (e.g., the use of pesticides and fertilizer); oil pollution, river and marine dumping, port, shipping and industrial activity.

Monitoring water quality and a water quality assessment regularly provides a source of data identify immediate issues – and their source.

- Identifying trends, short and long-term, in water quality.
- Data collected over a period of time will show trends, for example identifying increasing concentrations of nitrogen pollution in a river or an inland waterway. The total data will then help to identify key water quality parameters
- Environmental planning methods: water pollution prevention and management.
- Collecting, interpreting and using data is essential for the development of a sound and effective water quality strategy. The absence of real-time data will however hamper the development of strategies and limit the impact on pollution control. Using digital systems and programs for data collection and management is a solution to this challenge.
- Monitoring water quality is a global issue and concern: on land and at sea. Within the European Union, the European Green Deal sets out goals for restoring biological biodiversity and reducing water pollution, as well as publishing various directives to ensure standards of water quality. Individual nation states, for example France, have also clear regulatory frameworks requiring the effective monitoring of water quality. In the United States, the Environmental Protection Agency (EPA) enforces regulations to address water pollution in each state. Across the world, countries increasingly understand the importance of effective water quality monitoring parameters and methods

## **2.LITERATURE SURVEY**

## **2.1 Existing Problem:**

Due to population growth, urbanization ,and climatic change ,competition for water resources is expected to increase, with a particular impact on agriculture, river water. Water will be suitable to potable water monitoring compound spillage identification done rivers, remote estimation for swimming pools. It holds self-sufficient hubs that unite with the cloud to ongoing water control .The River water needed to be treated before it is used in agriculture feilds,hence the parameters affecting the quality of river-water need to be analysed and to be used for water treatment purpose.

## **2.2 References:**

1. K.S. Adu-Manu, C. Tapparello, W. Heinzelman, F.A. Katsriku, J.-D. Abdulai Water quality monitoring using wireless sensor networks: Current trends and future research directions ACM Transactions on Sensor Networks (TOSN) (2017).
2. S. Thombre, R.U. Islam, K. Andersson, M.S. Hossain IP based Wireless Sensor Networks : performance Analysis using Simulations and Experiments.Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 7 (2016).

5. M.Chitra, D. Sadhihskumar, R. Aravindh, M. Murali, R. Vaithilingame IoT based Water Flood Detection and Early Warning System. The collected information (data) from the water level sensor and temperature and humidity sensor passed to Thingview Android application in order to find the flow graph level of the water level in the river and temperature, humidity values and sends SMS to the registered contact mobile numbers (2020).

6. Dr. Geetha IoT based real time water quality monitoring system using smart sensor WQM is a cost effective and efficient system designed to monitor drinking water quality with the help of IOT (2020).

### **2.3 Problem Statement:**

The reduce the river water pollution and to monitor the parameters of river water and control measures can impact vegetation, health. The Real time analysis of Indicators of River water (Ph, salinity, nutrients, etc.,)

## **IDEATION & 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 help 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 & Brainstorming:**

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions. Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.



## Brainstorm & Idea prioritization

Use this template in your own brainstorming sessions. As our team can unleash their imagination and generate ideas, we'll be able to use not a single idea, but a whole room.

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### Before you collaborate

Brainstorming is a process that can be used to generate ideas. It's a process that can be used to generate ideas. It's a process that can be used to generate ideas.

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### Define your problem statement

Define your problem statement. Define your problem statement. Define your problem statement.

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### Brainstorm

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## Group ideas

Use this template in your own brainstorming sessions. As our team can unleash their imagination and generate ideas, we'll be able to use not a single idea, but a whole room.

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### Prioritize

Prioritizing is a process that can be used to generate ideas. It's a process that can be used to generate ideas. It's a process that can be used to generate ideas.

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### After you collaborate

After you collaborate, you'll be able to use not a single idea, but a whole room.

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### 3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Eutrophication, or the massive development of algae, causes pollution (monitoring and managing the quality of river water
2.	Idea / Solution description	Detecting dust particles, monitoring water PH, dissolved oxygen, and temperature, and changing authorities if water quality is poor
3.	Social Impact / Customer Satisfaction	Localities will not suffer as a result of poor water quality since they will be notified when the water quality is not good
4.	Business Model (Revenue Model)	Aeron systems provides water quality monitoring systems for industrial water treatment plants, river bodies, aqua forming, and digital recorders
5.	Scalability of the Solution	The assessment of realtime readings and continual monitoring helps in the preservation of water quality.
6.	Novelty / Uniqueness	A web application may be used to monitor the quality of river water. The quality parameter will be tracked in real time with standard measurements.

### 3.3 Proposed Solution:

Define CS, fit into CC	<p><b>1. CUSTOMER SEGMENT(S)</b></p> <p>Who is your customer?</p> <p>According to our problem statement, people living in rural areas and so, who uses river water.</p>	<p><b>6. CUSTOMER CONSTRAINTS</b></p> <p>What constraints prevent your customers from taking action or limit their choices of solutions?</p> <p>Only one system is used for specific area and so people may find it hard to recover if any fault occurs, as we used sensors to detect temperature and pH.</p>	<p><b>5. AVAILABLE SOLUTIONS</b></p> <p>Which solutions are available to the customers when they face the problem need to get the job done? What have they tried in the past? What pros &amp; cons do these solutions have?</p> <p>Eventhough the individual notifications to each people could not be sent, the system will still notify the corporation and they can further notify the people.</p>	Explore AS, differentiate
on J&P, tap into	<p><b>2. JOBS-TO-BE-DONE / PROBLEMS</b></p> <p>Which jobs-to-be-done (or problems) do you address for your customers?</p> <p>The river water quality monitoring system checks the temperature and pH of the water periodically and notifies the public when the quality of the water varies.</p>	<p><b>9. PROBLEM ROOT CAUSE</b></p> <p>What is the real reason that this problem exists? What is the back story behind the need to do this job?</p> <p>As we know sensors are bit costly and our system needs more than one sensors to work. The sensors are used periodically to check the quality of the water and might need to be replaced frequently.</p>	<p><b>7. BEHAVIOUR</b></p> <p>What does your customer do to address the problem and get the job done?</p> <p>The customer could use the user guide provided to overcome the problem or else they can report and contact the corporation. They will take care of the problem.</p>	Focus on J&P, tap int C

## 4 REQUIREMENT ANALYSIS

### 4.1 Functional Requirements:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR 1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
FR 2	User Confirmation	Confirmation via Email Confirmation via OTP
FR 3	Ultrasonic generator	Periodically the waves are generated to destroy algae in the range of 25%,50%,100%
FR 4	Ph level detection	To observe the water quality, Ph sensor is used and the signals are conveyed to the Arduino
FR 5	Turbidity detection	Turbidity sensor measures the purity of element or marshy water in the water and the signals are delivered to Arduino

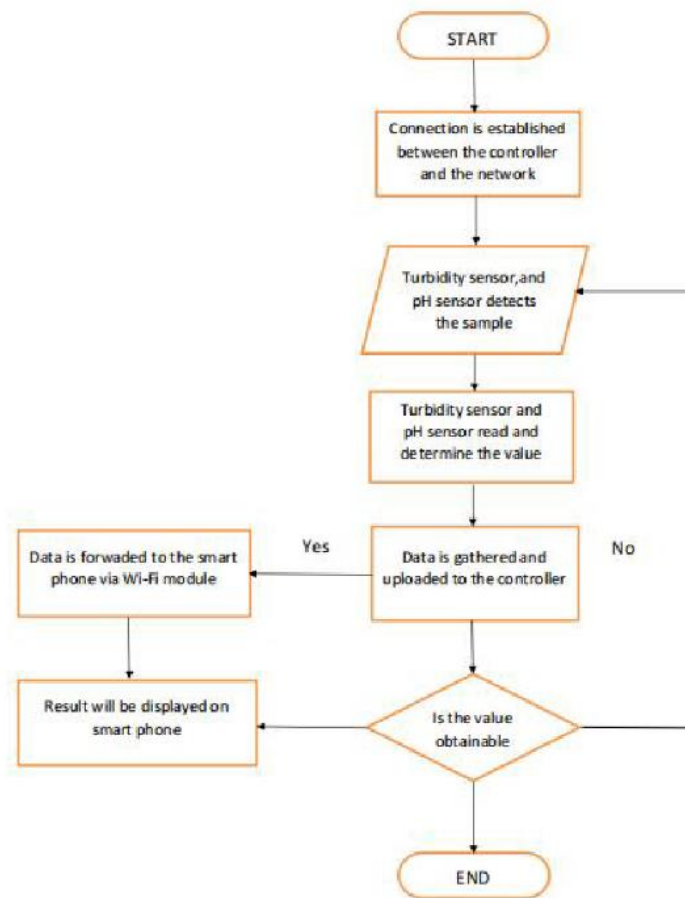
## 4.2 Non-functional Requirements:

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Monitors the flow and quality of ground water, and investigates surface- and ground-water interactions.
NFR-2	Security	The data and information are secured in the application by using the application firewall.
NFR-3	Reliability	The Real time sensor output values with future predicted data storage with output efficiency of 98%. It also gives certainty for aquaculture safety
NFR-4	Performance	The performance of system has higher efficiency and environmental friendly.
NFR-5	Availability	It is available in the form of mobile UI 24 x 7 monitoring system.
NFR-6	Scalability	The system has high scalability. Able to be changed in size or scale to give the best output.
NFR-7	Stability	The ability of the system to bring itself back to its stable configuration. The stability is high.
NFR-8	Efficiency	The monitoring system is highly efficient,high mobility with consumption of power.

## **5 PROJECT DESIGN**

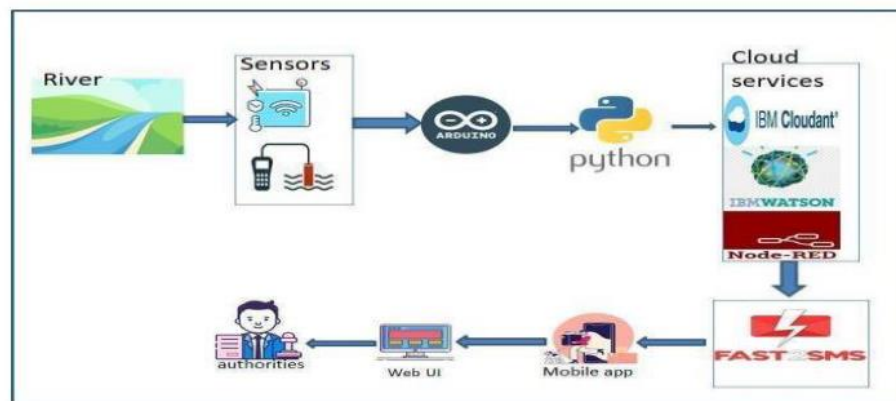
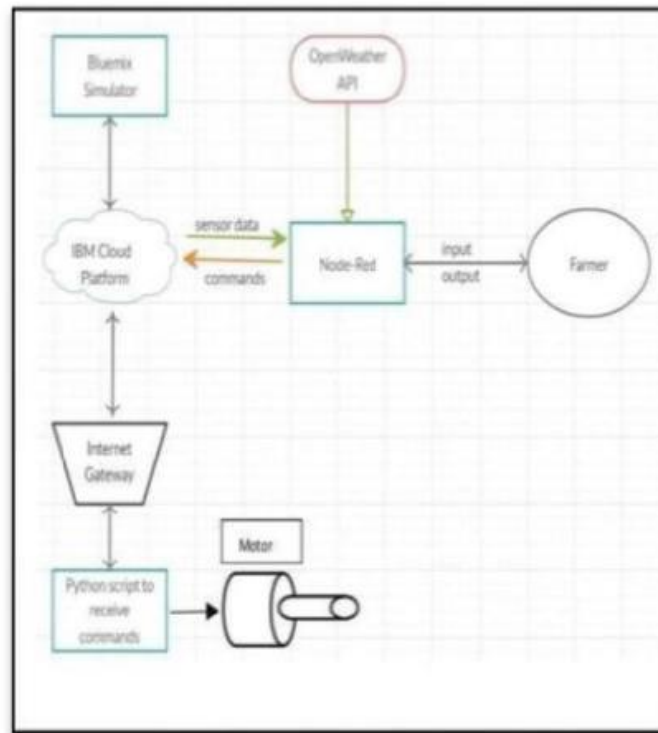
### **5.1 Data Flow Diagrams:**

Summary This code pattern explains how to build an IOT based river water monitoring and controlling system with some predefined values.



## 5.2 SOLUTION AND TECHNICAL ARCHITECTURE

## TECHNICAL ARCHITECTURE





**Table-1 : Components & Technologies:**

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application	HTML, CSS, Node-Red ,Cloud,etc
2.	Application Logic-1	Logic for a process in the application	JAVA/PYTHON
3.	Application Logic-2	Logic for a process in the application	IBM WATSON STT services
4.	Application Logic-3	Logic for a process in the application	BM WATSON Assistant
5.	Database	Data Type, Configurations etc	MySQL,PostgresSQL
6.	Cloud Database	Database Service on Cloud	IBM DB2,IBM Cloudant etc
7.	File Storage	File storage requirements	IBM Block Storage or Other Storage Service or Local Filesystem
8.	External API-1	Purpose of External API used in the application	IBM Weather API, etc
9.	External API-2	Purpose of External API used in the application	Aadhar API, etc
10.	Machine Learning Model	Purpose of External API used in the application	Object Recognition Model, etc..
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration: Cloud Server Configuration :	Local, Cloud Foundry, Kubernetes, etc.

**Table-2: Application Characteristics:**

S.No	Characteristics	Description	Technology
	Open-Source Frameworks	List the open-source frameworks used	Technology of Opensource framework
2.	Security Implementations	List all the security / access controls implemented, use of firewalls etc	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	Technology used
4.	Availability	Justify the availability of application	Technology used
5.	Performance	Design consideration for the performance of the application	Technology used

## 6.PROJECT PLANNING AND SCHEDULING

### 6.2 SPRINT DELIVERY 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	VENMATHI SHALINI YOGALAKSHMI VISHNU PRIYA
	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	VENMATHI SHALINI
	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	YOGALAKSHMI VISHNU PRIYA SHALINI
	Create a node red service	USN-7	To create a node red service to	2	MEDIUM	

			integrate the IBM Watson along with the Web UI			VISHNU PRIYA VENMATHI
	Create a Web UI	USN-8	To create a Web UI, to access the data from the cloud and display all parameters.	2	MEDIUM	SHALINI
	To develop a Python code	USN-9	Create a python code to sense the physical quantity and store data	2	MEDIUM	
Sprint-4	Publish Data to cloud.	USN-10	Publish Data that is sensed by the microcontroller to the Cloud	3	HIGH	VENMATHI
	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	SHALINI
	Testing	USN-12	Testing of project and final deliverables	3	MEDIUM	VISHNU PRIYA

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	4 Days	24 Oct 2022	27 Oct 2022	20	29 Oct 2022
Sprint-2	20	5 Days	28 Oct 2022	01 Nov 2022	20	04 Nov 2022
Sprint-3	20	8 Days	02 Nov 2022	09 Nov 2022	20	11 Nov 2022
Sprint-4	20	9 Days	10 Nov 2022	18 Nov 2022	20	19 Nov 2022

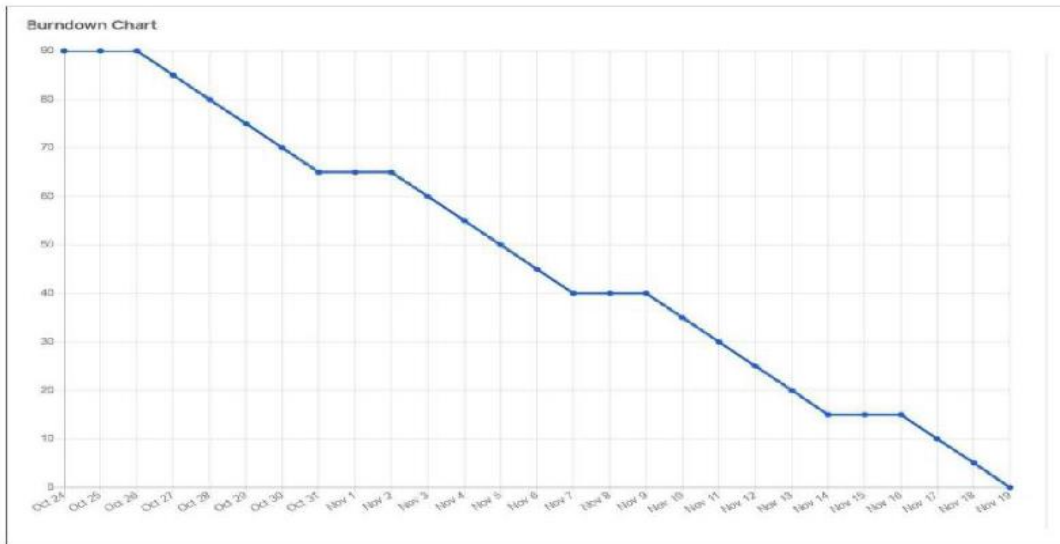
**Velocity:**

Imagine we have 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{\text{sprint duration}}{\text{velocity}} = \frac{20}{10} = 2$$

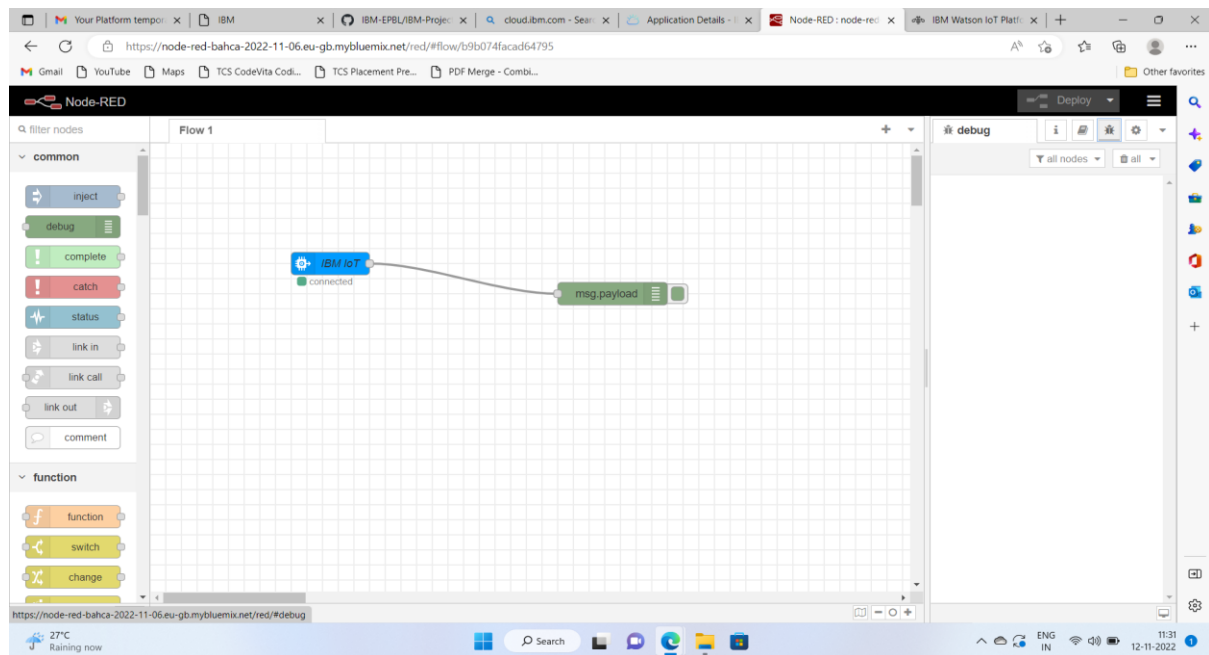
**Burndown Chart:**

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

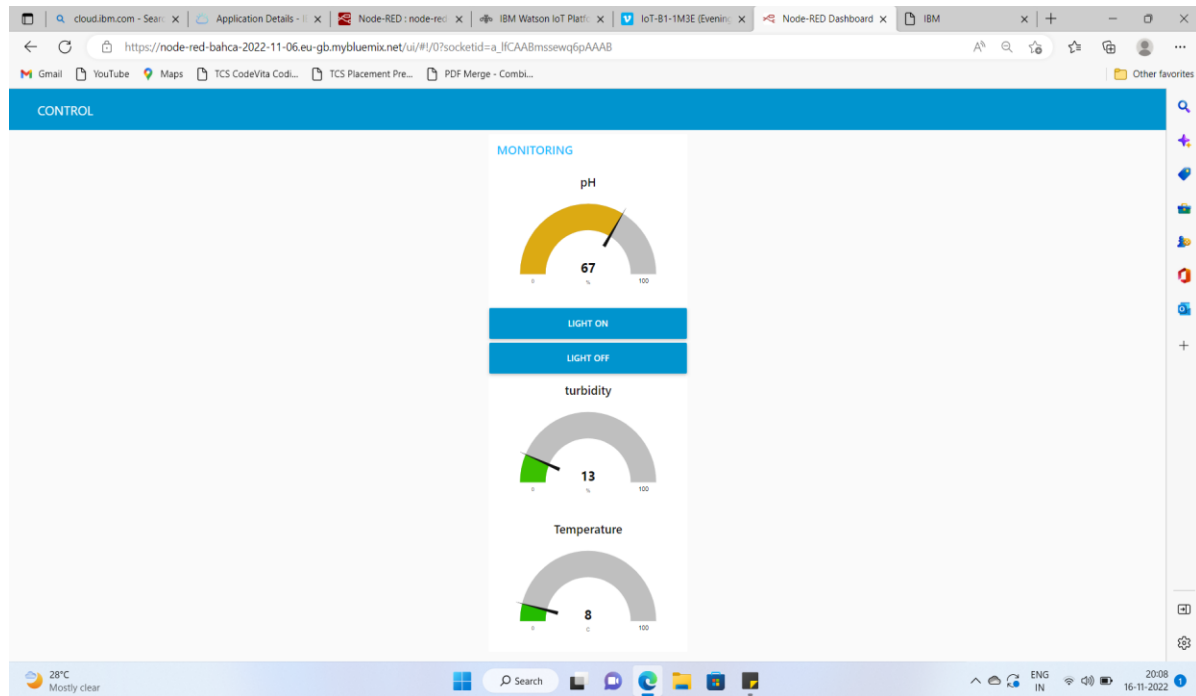


## 7.CODING AND SOLUTIONING

### 7.1 NODE RED SERVICE ASSOCIATED WITH IBM CLOUD:



**NODE-RED TO CREATE UI**



## ADVANTAGES:

- The prototype developed for water quality maintenance is very beneficial for safeguarding public health and also adds to the clean environment.
- The automation of this water monitoring, cleaning and control process removes the need of manual labor and thus saves time and money.
- The automation of the system makes the control and monitoring process more efficient and effective. Real time monitoring on mobile phone which is possible through the interface of plc with Arduino and Bluetooth module allows remote controlling of the system

## 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.
- The process is time consuming due to slow process of manual data collection from different locations of the water body.
- The method is prone to human errors of various forms.

## PROJECT CODE OUTOUT:

The image displays a Python IDE on the left and the IBM Watson IoT Platform interface on the right.

**Python IDE (Left):** The code in `Test_python_3.7.4.py` generates random data for pH, turbidity, and temperature, and publishes it to the IoT platform. The console output shows a stream of published data points.

```

pH = random.r
turbidity = random.randint(1,
temperature = random.randint(
data = {'pH': pH, 'turbid': tur
print(data)
def myOnPublishCallback():
while True

```

**Run Console Output:**

```

Published pH= 12 Turbidity:564 Temperature:54
Published pH= 2 Turbidity:571 Temperature:98
Published pH= 7 Turbidity:677 Temperature:65
Published pH= 8 Turbidity:352 Temperature:13
Published pH= 1 Turbidity:862 Temperature:88
Published pH= 1 Turbidity:834 Temperature:7
Published pH= 9 Turbidity:213 Temperature:89
Published pH= 14 Turbidity:677 Temperature:22
Published pH= 11 Turbidity:292 Temperature:368
Published pH= 2 Turbidity:53 Temperature:21
Published pH= 6 Turbidity:499 Temperature:69
Published pH= 11 Turbidity:238 Temperature:26
Published pH= 2 Turbidity:463 Temperature:43
Published pH= 6 Turbidity:966 Temperature:91
Published pH= 5 Turbidity:593 Temperature:85
Published pH= 14 Turbidity:368 Temperature:86
Published pH= 4 Turbidity:532 Temperature:8

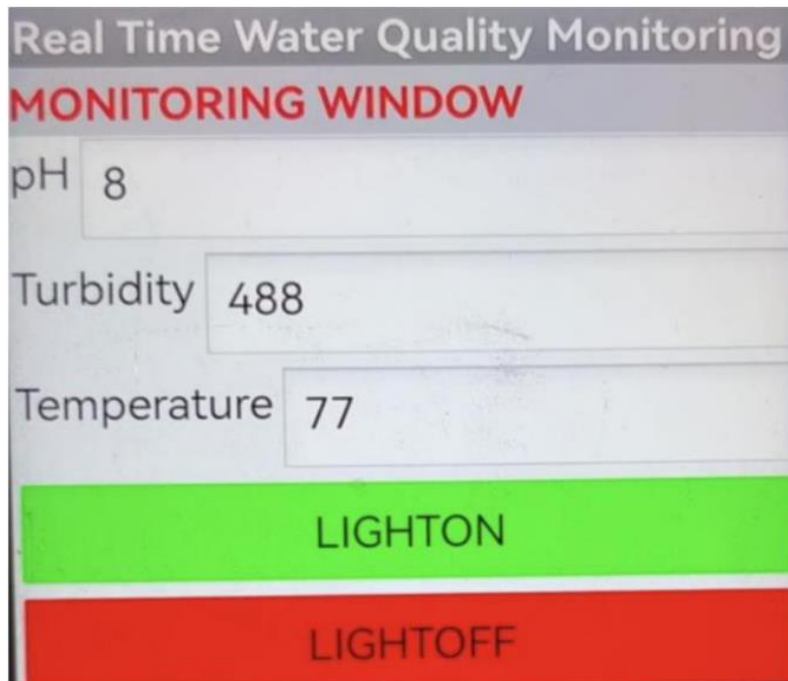
```

**IBM Watson IoT Platform (Right):** The 'Events' tab shows a live stream of data events. The table below represents the data shown in the interface.

Event	Value
demo	["pH":12,"turbid":93,"temp":87]
demo	["pH":7,"turbid":873,"temp":94]
demo	["pH":3,"turbid":204,"temp":19]
demo	["pH":11,"turbid":304,"temp":77]
demo	["pH":13,"turbid":16,"temp":50]

At the bottom, a device card for '00003' (Micro\_controller\_2) is shown as 'Disconnected'.

MOBLIE APP TO RECEIVE DATA FROM CLOUDE



**13.2 GIT-HUB LINK:**

<https://github.com/IBM-EPBL/IBM-Project-39756-1660497707>

**DEMO VIDEO LINK**

[Real time river water quality monitoring and control system.](#)

