

PROJECT REPORT

REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

PROJECT ID : PTN2022TMID30374

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INTRODUCTION

- 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.

- 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.

- LITERATURE SURVEY

- 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 suitability 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 fields,hence the parameters affecting the quality of river-water need to be analysed and to be used for water treatment purpose.

● References:

- 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).

- 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).

- Rushikesh Kshirsagar, R.Mudhalwadkar, Saish Kalaskar

Design and Development of IoT Based Water Quality Measurement System. The idea about low-cost IOT based portable approach for water quality measurements system. Because of its low-cost approach, everyone can afford to use it to determine quality of water(2019).

- N. Vijayakumar, R. Ramya

The real time monitoring of water quality in IoT environment. The parameters such as temperature, PH, turbidity, conductivity, dissolved oxygen of the water can be measured. The measured values from the sensors can be processed by the core controller. The raspberry PI B+ model can be used as a core controller (2015).

- M.Chitra, D. Sadhihskumar, R. Aravindh, M. Murali, R. Vaitilingame

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).

- 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).

- 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

- 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.

Reference:<https://app.mural.co/invitation/mural/ibm0082/1666797743994?sender=uf93f4fc8b3ed9d16cc620908&key=535a741b-def9-48d5-92b8-e0850fa6f1e6>

- 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

.

Reference:<https://app.mural.co/invitation/mural/ibmproject1215/1666848258091?sender=uf93f4fc8b3ed9d16cc620908&key=d4906cd4-138e-40f9-a546-ea061cc6c665>

- 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	<ul style="list-style-type: none"> ● To monitor the quality of water using sensors like temperature, potentiometer(pH), turbidity,salinity and so on.

- Collecting those data and storing it in cloudand perform analyse to check if the water is contaminated or not for drinking.
 - 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.

6. Scalability of the Solution Developing the product as both web and mobile application it is portable, and data can be accessed from anywhere anytime. provide a real-time monitoring and a feasible solution for remote or distant places where water quality laboratory is not present.

- PROBLEM SOLUTION:

4 REQUIREMENT ANALYSIS

- Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Arduino(control system)	Sensors are interfaced to Arduino and it collects measurements data periodically from sensors.
FR-2	WSN Sensor	Multiple sensor nodes installed for the detection of pH, temperature, dust particles, turbidity.
FR-3	Software Design Requirements	WSN requires IoT platform which requires Neural Network Model to classify water quality as Good OrBad. IoT integrated big data analytics to store data in cloud and analyze it constantly.
FR-4	LCD/PC/Mobile display	Displays the resulting sensed pH, temperature,turbidity. If ,acquired value > Threshold value, then comment=BAD.

If, acquired value < Threshold value, then comment=GOOD.

- Non-functional Requirements:

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

FR No. Non-Functional Requirement Description

NFR-1 Usability It is important to monitor water quality to ensure that, it is safe for humans to drink it as well as for wild life and marine life and to understand environmental impacts and to not harm sea life.

NFR-2 Security The IoT networks are incredibly safe and communication speed is also high. The technology comfortably resolves all the issues.

NFR-3 Reliability The water quality and monitoring system is reliable and its output can be assured. Since standardized hardware components and software designs are used.

NFR-4 Performance Real-time quality of water is executed and alerting the authorities if water quality is not good.

NFR-5 Availability The monitoring system is made available for use at any time with accuracy.

NFR-6 Scalability The system with high frequency, high mobility and low powered and cost-effective.

5 PROJECT DESIGN

- Data Flow Diagrams:

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 enters and leaves the system, what changes the information, and where data is stored.

● SOLUTION AND TECHNICAL ARCHITECTURE

Summary

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

Flow

- Feed the data received from the Sensor unit which are placed in the river sides.
- The collected data will be displayed in the Web page to the user.
- Then the collected data is sent to the data base, where the collected data and the predefined data are checked and monitored.
- If any data exceed the predefined data then the control signal will send to the Admin.
- The collected data will be stored in the IBM cloud storage. Later the data will be controlled by the admin via Web UI.

Components & Technologies:

S.No	Component	Description	Technology
1.	Sensor Data	The data is collected form the various sensor placed in the river sides.	ESP32Wifi module Raspberry Pie.
2.	Database for Storage	The data/info need to be stored for accessing it in future	MySQL-Oracle
3.	File Storage	File storage requirements	IBM Block Storage or Other Storage Service or Local Filesystem
4.	Cloud Database	Database	Serviceon Cloud IBM cloud
5.	Data Storage	File storage requirements	IBM Block Storage

Application Characteristics:

S.No	Characteristics	Description	Technology
1.	PH level Monitoring rivers. PH-sensor	The PH level of river water can be monitored via placing sensors in rivers.	
2.	Air Quality Monitoring Mount Sensor	The clarity and purity of river water can be monitored Surface Mount Sensor	
3.	Temperature Monitoring	The temperature of river water can be monitored Temperature sensor	
4.	Water Treatment	can be used as both a safety device in the water purification process as carbon dioxide, methane, and carbon monoxide are some of the key gases produced during the treatment process	NDIR gas sensors
4.	Soil Condition Monitoring	Soil condition monitoring sensors allow farmers to collect data about rainfall, temperature, and other metrics over time to track trends and predict irrigation needs.	Acoustic sensor

● User Stories

Use the below template to list all the user stories for the product.

User Type (Epic)	Functional Requirement (User Story)	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1 As a user, I can register for the application by entering my email, password, and confirming my password.	High	I can access my account /dashboard
	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
	USN-3 As a user, I can register for the application through Google	I can register & access the dashboard with Google Login	Low	Sprint-2
	USN-4 As a user, I can register for the application through G mail	I can access through Gmail	Medium	Sprint-1
Login	USN-5 As a user, I can log into the application by entering email & password	Login Details are received to me.	High	Sprint-1
Interface	USN-6 As a user, I can log into the application by entering email & password.	Easy Access application	High	Sprint-1
Customer (Web user)	Dashboard	WUSN-7 As a web User, I can get all information		

(data)(Temp etc..)	I can easily Understand how to use it.	High	Sprint-1
Customer Care Executive	View Perspective	CCE	As a Customer care, I can view the data in graph plots
	Easy Understanding of Graphs	High	Sprint-1
Administrator	Risk factor	ADMIN- 1	As a Admin, Update must be done at each step and take care of any errors
		Heavy Monitoing is Required.	High Sprint-2

- PROJECT PLANNING AND SCHEDULING

- SPRINT PLANNING & SCHEDULING:

TITLE DESCRIPTION DATE

Literature Survey & Information Gathering Literature survey on the selected project is done by gathering information about related details on technical papers and web browsing. 06 OCTOBER
2022

Empathy Map Prepared Empathy Map Canvas to combine thoughts and pains, gains of the project with all team members . 08 OCTOBER

2022

Ideation Brainstorming session is conducted with all team members to list out all the ideas and prioritise the top 3 ideas. 09 OCTOBER

2022

Proposed Solution Prepared the proposed solution document, which includes the novelty feasibility of idea business model, socia impact, scalability o solution, etc. 28 OCTOBER
2022

Problem Solution Fit Prepared problem - solution fit document. 30 OCTOBER
2022

- SPRINT DELIVERY SCHEDULE

Product Backlog, Sprint Schedule, and Estimation

Sprint	Functional Requirement (Epic)	User story Number	User Story / Task	Story Points	Priority	Team Member s
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	POONGUZHALI.M
		USN-2	Registration via Facebook	2	Low	
		USN-3	As a user, I can register for the application through Facebook	2		
		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 and Sprint 4						

SS 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 onCloud 2 High POOMATHI.B , SANTHIYA.S , RANJINI.R

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 RIZWANA

Create a Web UI USN-8 To create a Web UI, to access the data from the cloud And display all parameters. 2 Medium POONGUZHALI.M

To develop a Python code USN-9 Create a python code to sense the physical quantity And store data. 2 Medium POOMATHI.B RANJINI.R

Publish Data to cloud. USN-10 Publish Data that is sensed by the microcontroller to the Cloud 3 High SANTHIYA.S

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
POONGUZHALI.M, POOMATHI.B		
Testing	USN-12	Testing of project and final deliverables

Project Tracker, Velocity & Burndown Charts

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	
Story Points Completed (as on Planned End Date)					
Sprint-1	20	4 Days	24 Oct 2022	27 Oct 2022	20
Sprint-2	20	5 Days	28 Oct 2022	01 Nov 2022	20
Sprint-3	20	8 Days	2 Nov 2022	09 Nov 2022	20
Sprint-4	20	9 Days	10 Nov 2022	18 Nov 2022	20
				11 Nov 2022	19 Nov 2022

Velocity:

Burndown Chart:

- REPORT FROM JIRA

REFERENCE LINK (JIRA SOFTWARE):

<https://ibmprojectrealtimemonitoring.atlassian.net/jira/software/projects/RE/boards>

IMELINE CREATED USING JIRA SOFTWARE

<https://ibmprojectrealtimemonitoring.atlassian.net/jira/software/projects/RE/list?filter=statusCategory+%3D+Done+AND+statusCategoryChangedDate+%3E%3D+-1w&showDone=true&atOrigin=eyJpIjoiMmVlZjliNlA2ODIxNDg0MGlmOGZlMA2Y2M0Y2>

VjN2liLCJwljoiaiJ9

LISI'S IN JIRA:

ISSUES :

● CODING AND SOLUTIONING

● NODE RED SERVICE ASSOCIATED WITH IBM CLOUD:

Node red Dashboard:

● TESTING

● Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	15	0	0	15
Client Application	45	0	0	45
Security	1	0	0	1
Outsource Shipping	2	0	0	2
Exception Reporting	10	0	0	10
Final Report Output	4	0	0	4
Version Control	3	0	0	3

- USER ACCEPTANCE TESTING:

- Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEMS project at the time of the release to User Acceptance Testing (UAT).

- Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	9	5	4	3	21
Duplicate	2	0	2	0	4
External	3	4	1	2	10
Fixed	10	1	5	17	33
Not Reproduced	0	0	1	0	1

Skipped	0	0	1	2	3
Won't Fix	0	3	3	1	7
Totals 24	13	17	25	79	

- RESULT

- PERFORMANCE METRICS:

PERFORMANCE TABLE

PARAMETER	PERFORMANCE	DESCRIPTION
ADMIN TESTING	95%-100%	THE TESTING DONE BEFORE IT IS DEPLOYED AS AN APP
CUSTOMER SATISFACTION	75-85%	THE CUSTOMER NEED TO BE SATISFIED WITH THE MOBILE APPLICATION
USER INTERFACE	65-85%	THE APP CAN USED BY ANYONE.(EASE OF ACCESS)
SEVER RESPONSE	50-75%	url - response
DATA VALIDATION	60-80%	VALID DATA FROM THE WITH NO. OF TEST (15-30 APP CASE TESTCASE)
ERROR	3-5%	REAL-TIME DELAY MAY OCCUR

- ADVANTAGES AND DISADVANTAGES

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.

● CONCLUSION

Thus our project is used to Monitoring of Turbidity, PH & Temperature of Water makes use of water detection sensor with unique advantage and existing GSM network. The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters.

The operation is simple. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value. By keeping the embedded devices in the environment for monitoring enables self protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e. it can interact with other objects through the network.

Then the collected data and analysis results will be available to the end user through the Wi-Fi.

FUTURE SCOPE

We use water detection sensor has unique advantage. It consumes less time to monitor than a manual method for checking polluted levels, and notifies immediately to reduce affected rate of

pollution in water. People who are living in rural areas near to the river will be very satisfied with our idea. It will be useful to monitor water pollution in specific area. So this system prevent people from water pollution. It will be used for farming purpose to check quality water, temperature and PH level. Our Impact of this project is also create a social satisfaction for farmers too. The scalability of this project gives the addition of more different type of sensors. By interfacing the relay we can control the supply of water. We can also implement as a revenue model. This system could also be implemented in various industrial processes. The system can be modified according to the needs of the user and can be implemented along with lab view to monitor data on computers.

13.APPENDIX

- SOURCE CODE:
PYTHON CODE TO PUBLISH DATA

```
#program to publish data in ibm watson iot platform import time
import sys
import ibmiotf.application import ibmiotf.device import random
#Provide your IBM Watson Device Credentials

#Org_ID
organization = "84708c" #Device Type deviceType = "abcd" #device ID
deviceId = "12345" #Method of Authentication authMethod = "token" #Auth-token

authToken = "12345678"

# exception handling method #try block
try:

deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":authMethod, "auth-token":authToken}
```

```

deviceCli= ibmiotf.device.Client (deviceOptions)

#to handle the errors except Exception as e:
print ("Caught evention connecting device: %s" % str(e)) sys.exit()
#device connection deviceCli.connect()
#while Loop for getting the values while True:
Ph=random.randint (6,8)
WaterTurbidity=random.randint (15,100)
salinity=random.randint (500,1000)
DissolvedOxygen=random.randint (60,130)
conductivity=random.randint (100,1200) data = {'Ph' : Ph,
'WaterTurbidity':WaterTurbidity,'salinity':salinity,'DissolvedOxygen':
DissolvedOxygen,'conductivity':conductivity}
#define myonpublishcallback function def myonPublishCallback():
print ("Published Ph = %s" % Ph, "WaterTurbidity = %s %%" % WaterTurbidity,"salinity = %s" %
salinity,"DissolvedO2 = %s" % DissolvedOxygen,"conductivity = %s" % conductivity)
if(Ph<7.4 and salinity < 600 and DissolvedOxygen < 80 and conductivity < 200):
if(Ph>7.4 and salinity > 900 and DissolvedOxygen > 120 and conductivity > 1100):
print("UNSAFE, THE VALUES OF PARAMETERS ARE NOT IN THE RANGE")
else:
print("Quality of River water is measured and its correct")

success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish =
myonPublishCallback)
if not success:
print("Not connected to IOTF") #sleep time
time.sleep(10) #disconnect device deviceCli.disconnect()

```

OUTPUT

HTML CODE:

```
<!DOCTYPE html>
<html lang="en">
<head>
<style>
h1 {text-align: center;} p {text-align: center;} div {text-align: center;} body {
background-image: url("https://thumbs.dreamstime.com/b/clear-transparent-light-blue-water-
pool-texture-background-150961732.jpg");
background-color: #cccccc;
}
</style>
<meta charset="UTF-8">
<meta http-equiv="X-UA-Compatible" content="IE=edge">
<meta name="viewport" content="width=device-width, initial-scale=1.0">
<title>Login page in HTML</title>
</head>

<body>

<h1>Login Page</h1>
<form action="">
<!-- Headings for the form -->
<div class="headingsContainer">
<h3>Sign in</h3>
<p>Sign in with your username and password</p>
</div>

<!-- Main container for all inputs -->
<div class="mainContainer">
<!-- Username -->
<label for="username">Your username</label>
<input type="text" placeholder="Enter Username" name="username" required>

<br><br>
```

```
<!-- Password -->
<label for="pswrd">Your password</label>
<input type="password" placeholder="Enter Password" name="pswrd" required>

<!-- sub container for the checkbox and forgot password link -->
<div class="subcontainer">
<label>
<input type="checkbox" checked="checked" name="remember"> Remember me
</label>
<p class="forgotpsd"> <a href="#">Forgot Password?</a></p>
</div>
<button type="submit" onclick="window.location.href = 'https://node-red-qltdp-2022-
11-07.eu-gb.mybluemix.net/ui';">Login</button>

<!-- Sign up link -->
<p class="register">Not a member? <a href="#">Register here!</a></p>

</div>
</p>

</form>
</body>
</html>
```

MOBILE APP

MOBILE APP

- GIT-HUB LINK:

<https://github.com/IBM-EPBL/IBM-Project-4647-1658737002>