REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

A PROJECT REPORT

Submitted by

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NOVEMBER, 2022

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CHAPTER 1

INTRODUCTION

The limited water supplies brought on by global warming, the expanding population, the advancements in industry, etc. make monitoring water quality difficult nowadays. Therefore, it is necessary to create the finest approaches for real-time monitoring of the water quality indicators. Pollution from both point and non-point sources generally has an impact on water quality. As a result of industrialization, globalization, urbanization, agriculture, etc., hazardous materials of many categories have been combined with drinking water. In essence, poor water quality causes disease transmission and death. Waterborne illnesses cause up to 5 million deaths worldwide. The limited water supplies brought on by global warming, the expanding population, the advancements in industry, etc. make monitoring water quality difficult nowadays. The primary goal of water quality monitoring is to gather data at predetermined places and regular intervals that can be utilized to identify current trends. Pollution needs to be reduced, and monitoring water quality is the final step in making sure that pollution management in water is effective. Our proposed system is made up of a number of sensors that accurately calculate the standard values of water in real-time while requiring less labor overall.

The concentration of hydrogen ions is usually measured by water quality metrics like pH. It indicates whether the water is alkaline or acidic at the moment. A pH of 7 indicates that the water is pure; a pH of less than 7 indicates that the water is acidic, and a pH of more than 7 indicates that the water is alkaline. The pH values vary from 0 to 14. The pH level should be between 6.5 and 8.5 for drinking purposes. The second beneficial characteristic Turbidity is a measurement of the abundance of invisible suspended particles in water. The risk of diarrhea increases with increasing turbidity, cholera. Contrarily, if turbidity is low, the water is pure. Water temperature is determined via a temperature sensor. Manually collecting water samples from various sites is one of the classic methods of monitoring water quality. If the values generated by the sensors are exceeded, an alert is sent to the system user, who will then take the appropriate action. As we get the solutions of the water samples, we can measure the various quality attributes of the water and compare them with the given threshold values or standard values.

1.1 PROJECT OVERVIEW

Water is one of the main elements that significantly affect ecosystems. However, due to increasing industrialization, human waste, and the careless use of pesticides and chemical fertilizers in agriculture, which poison the water, it is now heavily exploited. In order to monitor the water quality across a large area, such as a lake, river, or aquaculture, a water monitoring system is necessary. According to the state of the world today, Internet of Things (IoT) and remote sensing techniques are utilized in a variety of study fields to monitor, collect, and analyze data from distant locations. In this research, a real-time, low-cost water quality monitoring system in an IoT environment is suggested. Several sensors make up this system, which evaluates physical and chemical parameters. These sensors can be used to measure pH, turbidity, conductivity, and dissolved oxygen in water. This method allows for the analysis of data provided online and the real-time assessment of water body quality.

1.2 PURPOSE

Water is necessary for all life, and without good watersheds, many necessary and optional human activities would be impossible. The same actions have a wide range of potential effects on watersheds. Watersheds frequently cross national, state, and local boundaries, thus even though two neighbors who live far from one another may not adhere to the same legal and cultural norms, they may still be considered members of the same watershed. By this standard, maintaining a watershed's or its lakes, streams, and rivers' health is your obligation as much as it is that of the local, state, or federal regulatory body. For the same reason, rather than being determined by governmental boundaries, water quality laws are increasingly centered on the watershed level. Streams and rivers serve as a crucial resource for human activities as well as a habitat for a variety of non-human creatures and plants. They provide an above-ground look at the hydrology and health of a watershed. Over 3.5 million miles of streams and rivers traverse various topographies in the United States alone.

The U.S. Environmental Protection Agency has discovered that, in spite of this extensive reliance on waterways, more than half of the country's streams and rivers are in poor biological condition. If your project could have an influence on a stream or river, it is essential to set up an effective monitoring system to ensure that the hydrology and water quality of the waterway are not adversely affected, and so that any impact can be remedied if it is discovered. The development of a reliable, affordable system for tracking the water quality in real time, using a wireless sensor network and the internet of things, was the overarching goal of all the initiatives.

Monitoring water quality is a problem and a concern that affects both land and sea. The European Green Deal outlines objectives for preserving biological variety and minimizing water pollution inside the European Union. It also publishes a number of directives to guarantee standards of water quality. Additionally, distinct legal frameworks for each nation state, such as France, mandate the efficient monitoring of water quality. The Environmental Protection Agency (EPA) of the United States carries out measures to manage water contamination in each state. Countries all around the world are becoming more aware of the significance of efficient monitoring techniques and metrics for water quality.

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING PROBLEMS

Competition for water resources is predicted to increase as a result of population expansion, urbanization, and climate change, with an impact on agriculture and river water in particular. Water quality will be ideal for potable water monitoring, spillage identification through rivers, and remote assessment for swimming pools. It contains autonomous hubs that connect to the cloud to maintain water control. Before being utilized in agricultural areas, river water must be treated, thus it is necessary to analyses and employ for water treatment the factors that affect the river's water quality.

2.2 REFERENCES

[1] An IOT Based Smart Water Quality Monitoring System using Cloud
IEEE – April 2020
Ajith Jerom B.; R. Manimegalai; R. Manimegalai

Other sources of pollution include agricultural runoff and unregulated small scale industry that results in polluting, most of the rivers, lakes and surface water in India. In this paper, An IoT Based Smart Water Quality Monitoring System using Cloud and Deep Learning is proposed to monitor the quality of the water in water-bodies. In conventional systems, the monitoring process involves the manual collection of sample water from various regions, followed by laboratory testing and analysis. This process is ineffective, as this process is arduous and time-consuming and it does not provide real-time results. The quality of water should be monitored continuously, to ensure the safe supply of water from any water bodies and water resources. Hence, the design and development of a low-cost system for real-time monitoring of water quality using the Internet of Things (IoT) is essential. Monitoring water quality in water bodies using Internet of Things (IoT) helps in combating environmental issues and improving the health and living standards of all living things.

[2] IOT-based System for Real-time Water Pollution Monitoring of Rivers
IEEE - September 2021
Mohammad Ariful Islam Khan; Mohammad Akidul Hoque; Sabbir Ahmed

The research proposes a system to remotely monitor the water quality of a river so that the authorities can gather better insights about the condition of that particular river and predict the critical future phenomena. Consequently, they will be able to take auspicious steps in order to protect the rivers and save the environment. The proposed framework can observe the real-time value of pH, conductivity, turbidity, temperature and flow of the water by utilizing various sensors. Furthermore, through our device, effective predictions about imminent floods can be made. Thus, authorities can commence early warning for floods and ensure prompt evacuation. Thus, our technique can significantly minimize the casualties caused by this disaster. In this context, real-time feeds are obtained through Internet of Things (IoT). For wireless data transmission Message Queuing Telemetry Transport (MQTT) is used.

[3] **Design and Implementation of Real Time Approach for The Monitoring of Water Quality Parameters**

IEEE - June 2022

Access to safe drinking water is essential to nurturing human life on earth. Polluted air and unsanitary water can cause health problems. Unhygienic water can cause stomach and health-related problems. A specific range of water quality parameters, mainly temperature, pH, total dissolved solids (TDS) and turbidity, can degrade the growth of these bacteria. This presented paperwork is to develop a smart water quality monitoring system using four sensors and an IoT platform to help determine water quality. It is to analyses the parameters of water samples such as tap water, co way water, river water, pond water, and lake water whether these water samples are in the threshold range for drinking or not. The device is initially used to measure pH, turbidity, total dissolved solids (TDS) and temperature, and then sent the information to the microcontroller Arduino Uno.

[4] A Development and Implementation of Water Quality Assessment Monitoring (WQAM) System using the Internet of Things (IoT) in Water Environment

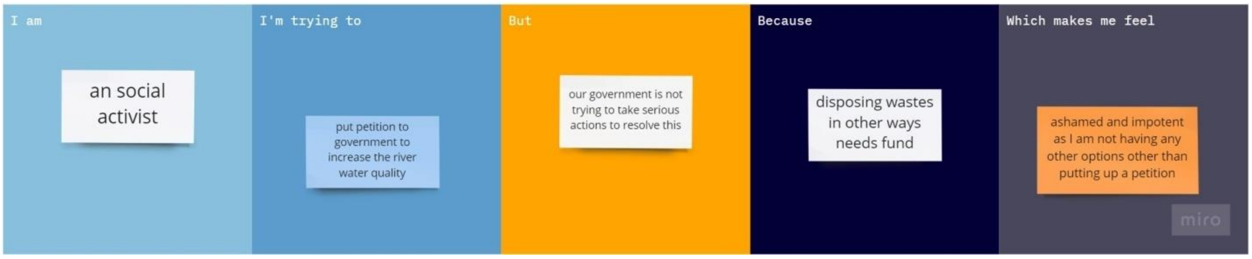
JEVA - 23 November 2021

Muhammad Farhan Johan, S. Abdullah, A. Zanal Saurabh S. Soman, Hamidreza Zareipour, Om Malik

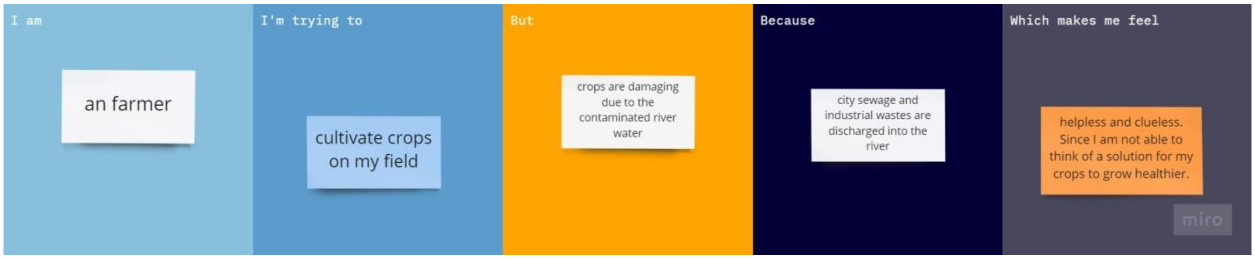
This paper presents the development and implementation of Water Quality Assessment and Monitoring (WQAM) system. The system development used Wi-Fi enabled microcontroller to connect with the IoT environment and store the data in the IoT cloud server. The microcontroller used is Arduino UNO that interacts with three types of sensor probes which are pH, turbidity and temperature probe. All the data measurements is transferred using a Wi-Fi module which is ESP8266. The IoT cloud used to utilize the data frame is Thing Speak. This system was implemented on Bandar Pereda Lake and Deraa River in Pulao 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.

2.3 PROBLEM STATEMENT DEFINITION

All living things need water to survive, and it is not possible to live without it. Environmental pollution has grown to be a big issue as a result of technological development and industrialization. One of the most significant types of this environmental contamination is water pollution. The quality of water that we drink - whether directly or through commercially made juices - is essential to our survival. Any disparity in water quality would have a negative impact on human health as well as the ecological balance among all animals. The parameters of the water's chemical, biological, radiological, and biological composition are referred to as its quality.



I am	I'm trying to	But	Because	Which makes me feel
an social activist	put petition to government to increase the river water quality	our government is not trying to take serious actions to resolve this	disposing wastes in other ways needs fund	ashamed and impotent as I am not having any other options other than putting up a petition



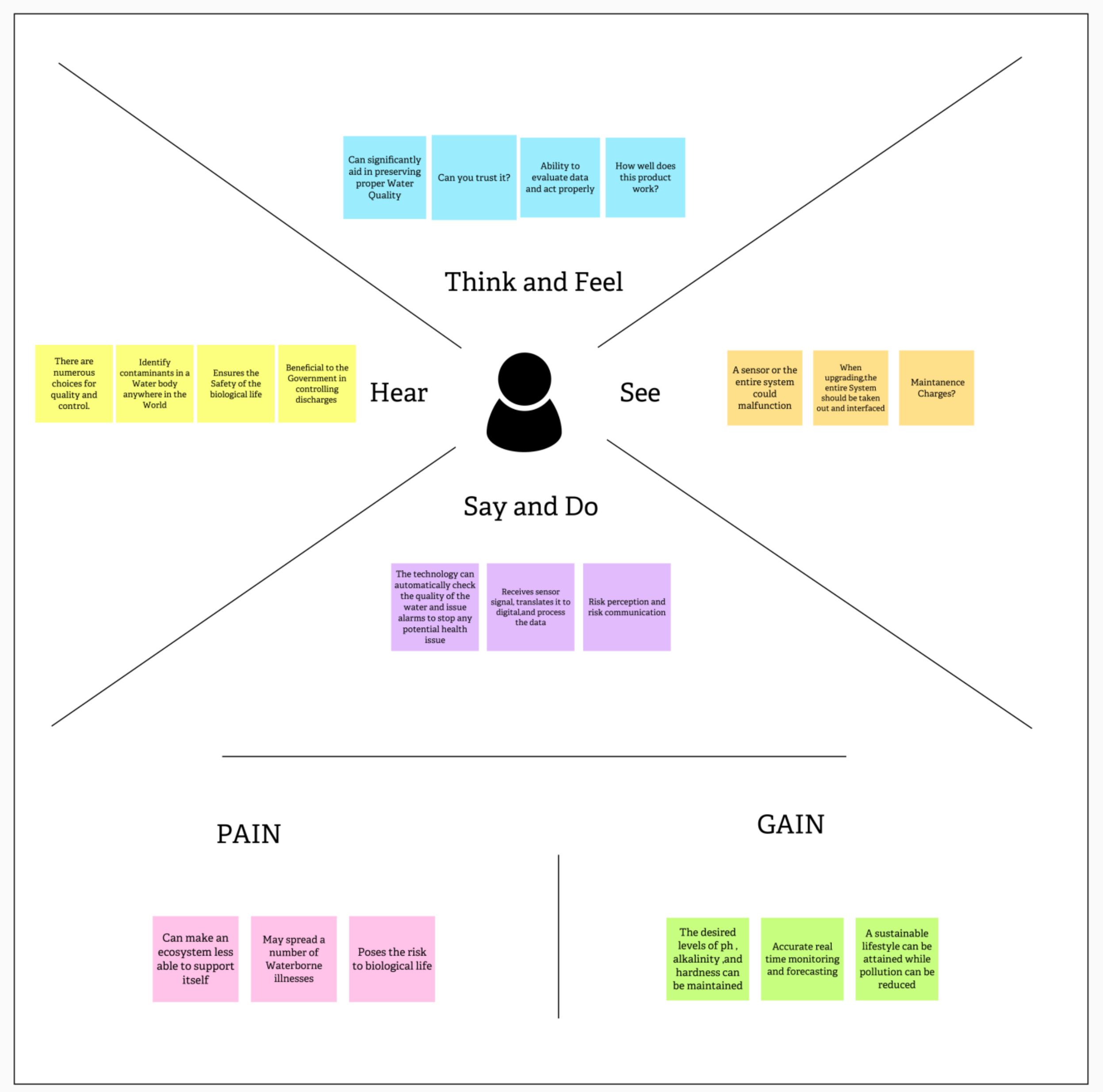
I am	I'm trying to	But	Because	Which makes me feel
an farmer	cultivate crops on my field	crops are damaging due to the contaminated river water	city sewage and industrial wastes are discharged into the river	helpless and clueless. Since I am not able to think of a solution for my crops to grow healthier.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a straightforward, simple-to-understand picture that summarizes information about a user's actions and views. It is a helpful tool that enables teams to comprehend their users more fully. It's important to comprehend both the actual issue and the individual who is experiencing it in order to develop a workable solution. Participants learn to think about situations from the user's perspective, including goals and problems, through the exercise of constructing the map.



Think and Feel

Can significantly aid in preserving proper Water Quality

Can you trust it?

Ability to evaluate data and act properly

How well does this product work?

Hear

There are numerous choices for quality and control.

Identify contaminants in a Water body anywhere in the World

Ensures the Safety of the biological life

Beneficial to the Government in controlling discharges

See

A sensor or the entire system could malfunction

When upgrading,the entire System should be taken out and interfaced

Maintanenence Charges?

Say and Do

The technology can automatically check the quality of the water and issue alarms to stop any potential health issue

Receives sensor signal, translates it to digital,and process the data

Risk perception and risk communication

PAIN

Can make an ecosystem less able to support itself

May spread a number of Waterborne illnesses

Poses the risk to biological life

GAIN

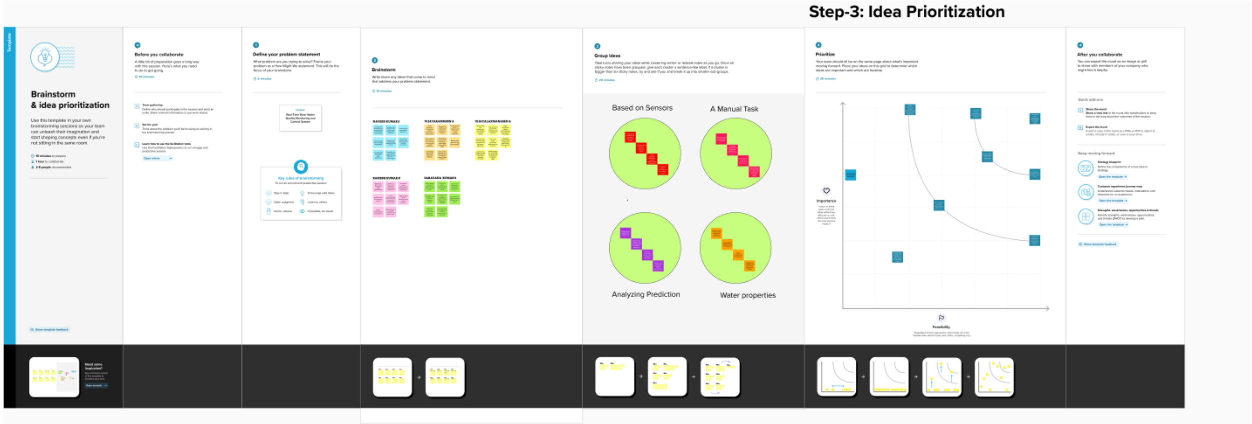
The desired levels of ph , alkalinity ,and hardness can be maintained

Accurate real time monitoring and forecasting

A sustainable lifestyle can be attained while pollution can be reduced

3.2 IDEATION & BRAINSTROMING

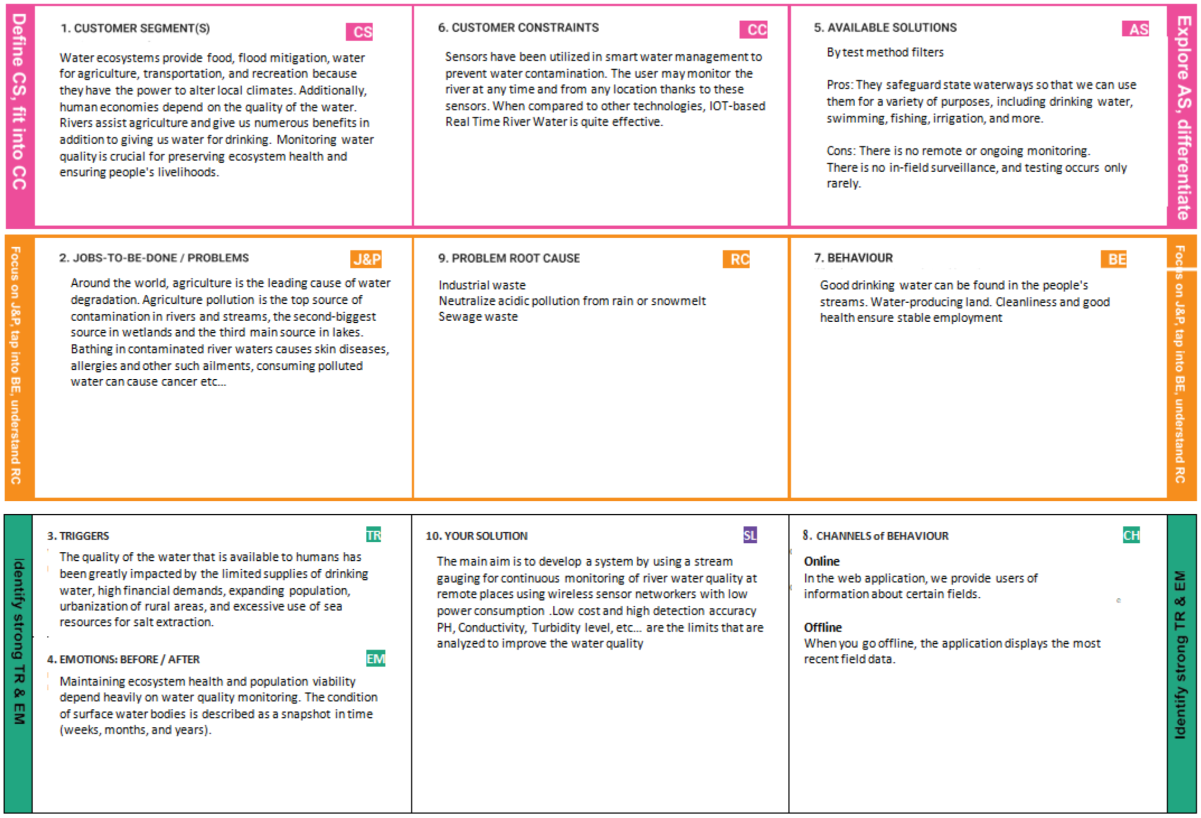
Each member of a team is encouraged to participate in the creative problem-solving process by participating in a free-flowing, open environment during a brainstorming session. A focus on quantity over quality, the acceptance and development of unconventional ideas, and the encouragement of all participants to work together in order to produce a wealth of original solutions are all priorities.


Step-3: Idea Prioritization
Template
Brainstorm & idea prioritization
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.
Before you collaborate
Define your problem statement
Key rules of brainstorming
Brainstorm
Group ideas
Based on Sensors
A Manual Task
Analyzing Prediction
Water properties
Prioritize
Importance
Feasibility
After you collaborate

3.3 PROPOSED SOLUTION

S.No.	Parameter	Description
1	Problem Statement (Problem to be solved)	• In order to manage the algal bloom and keep an eye on water quality indicators like ph, turbidity and dissolved solvents using available sensors.
2	Idea / Solution description	• Utilizing Sensors and Arduino to monitor water parameters and ultrasonic frequency to control those parameters. • To collect data from numerous sensor nodes and wirelessly transmit it to the base station. • To send a SMS to the authorized person.
3	Novelty / Uniqueness	• The sensor will transmit an alert message to the neighboring control room if the water is contaminated. • When an employee isn't present, alert message is delivered to his mobile phone.
4	Social Impact / Customer Satisfaction	• Poor drinking water quality is the root cause of more than 50 different diseases, accounting for 80% of illnesses and 50% of child fatalities. • People come to know about the quality of water.
5	Business Model (Revenue Model)	• We can sell our project to the public sector through advertising. • Through social media, we can spread advertising.
6	Scalability of the Solution	• Operating this Model is a pretty simple process. • Both farming and drinking can be done with it.

3.4 PROBLEM SOLUTION FIT



Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Water ecosystems provide food, flood mitigation, water for agriculture, transportation, and recreation because they have the power to alter local climates. Additionally, human economies depend on the quality of the water. Rivers assist agriculture and give us numerous benefits in addition to giving us water for drinking. Monitoring water quality is crucial for preserving ecosystem health and ensuring people's livelihoods.

6. CUSTOMER CONSTRAINTS CC

Sensors have been utilized in smart water management to prevent water contamination. The user may monitor the river at any time and from any location thanks to these sensors. When compared to other technologies, IOT-based Real Time River Water is quite effective.

5. AVAILABLE SOLUTIONS AS

By test method filters

Pros: They safeguard state waterways so that we can use them for a variety of purposes, including drinking water, swimming, fishing, irrigation, and more.

Cons: There is no remote or ongoing monitoring.
There is no in-field surveillance, and testing occurs only rarely.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

Around the world, agriculture is the leading cause of water degradation. Agriculture pollution is the top source of contamination in rivers and streams, the second-biggest source in wetlands and the third main source in lakes. Bathing in contaminated river waters causes skin diseases, allergies and other such ailments, consuming polluted water can cause cancer etc...

9. PROBLEM ROOT CAUSE RC

Industrial waste
Neutralize acidic pollution from rain or snowmelt
Sewage waste

7. BEHAVIOUR BE

Good drinking water can be found in the people's streams. Water-producing land. Cleanliness and good health ensure stable employment

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

The quality of the water that is available to humans has been greatly impacted by the limited supplies of drinking water, high financial demands, expanding population, urbanization of rural areas, and excessive use of sea resources for salt extraction.

4. EMOTIONS: BEFORE / AFTER EM

Maintaining ecosystem health and population viability depend heavily on water quality monitoring. The condition of surface water bodies is described as a snapshot in time (weeks, months, and years).

10. YOUR SOLUTION SL

The main aim is to develop a system by using a stream gauging for continuous monitoring of river water quality at remote places using wireless sensor networkers 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

8. CHANNELS of BEHAVIOUR CH

Online
In the web application, we provide users of information about certain fields.

Offline
When you go offline, the application displays the most recent field data.

Identify strong TR & EM

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Registration of users to track the river water quality	Fill out a form to register with your Gmail or mobile phone.
FR-2	User Confirmation	Gmail confirmation or an OTP
FR-3	User Sign-Up	Type a strong password to log in. Numbers and special characters are required in the password. Ideally, a password would have more than 8 characters.
FR-4	Details About the Water	View current water strategy details in website show in percentage to understand easy as well as faster and notification from regular interval of time to monitor the water from the website or login.
FR-5	Sign out	For security reasons, you should log out after seeing the information. However, since the site won't send you any notifications after you log out, so receive send an SMS to let you know about any changes.

4.2 NON-FUNCTIONAL REQUIREMENTS

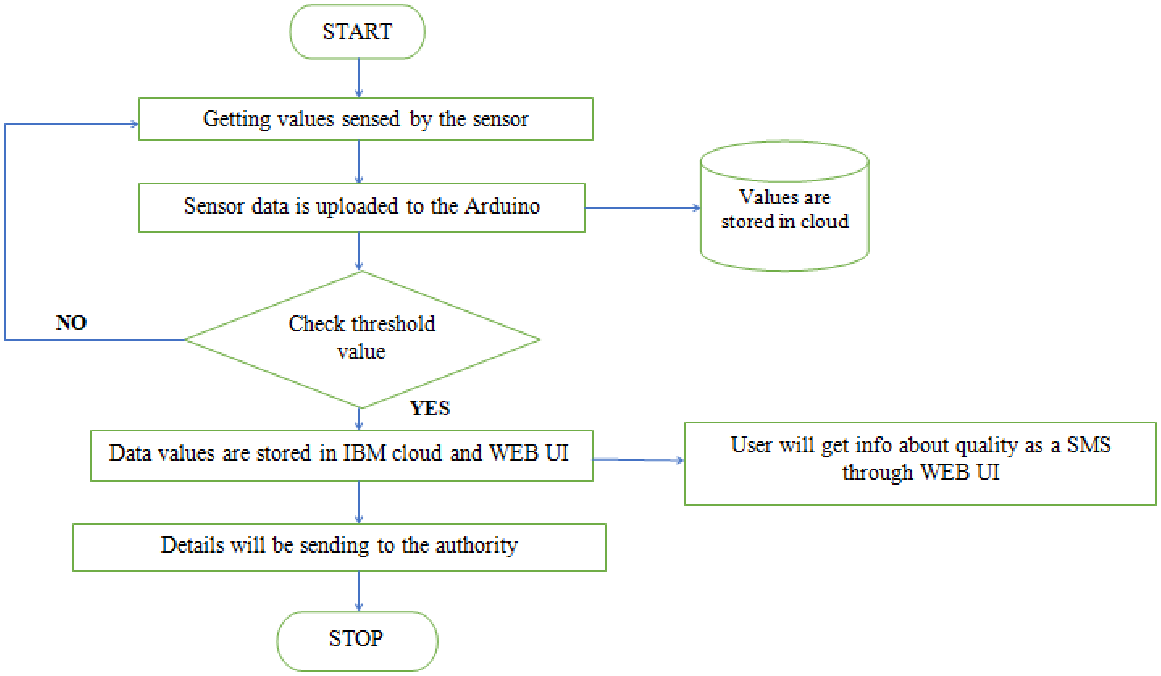
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	User interface screen loads cannot take more than two seconds. User friendly monitoring.
NFR-2	Security	Password protection for the user account. Only after email verification is account creation completed If your password is forgotten, you can reset it by selecting the Forgot Password option, and a confirmation email will be sent to your registered email address.
NFR-3	Reliability	Users can successfully access their accounts 99.99% of the time. If issue found solve within 1 hour
NFR-4	Performance	The whole monitoring data should be accessible after logging in, with time and statistics charts for easier understanding.
NFR-5	Availability	It is accessible online at all times, from any location, using only internet-based methods.
NFR-6	Scalability	The system can support more users concurrently without experiencing delays. Operating system is easy to use.

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAMS

A data flow diagram (DFD) is a common visual representation of how information moves through a system. A clean and understandable DFD can graphically represent the appropriate quantity of the system need. It displays how information enters and exits the system, what modifies the data, and where information is kept.


START
Getting values sensed by the sensor
Sensor data is uploaded to the Arduino
Values are stored in cloud
NO
Check threshold value
YES
Data values are stored in IBM cloud and WEB UI
User will get info about quality as a SMS through WEB UI
Details will be sending to the authority
STOP

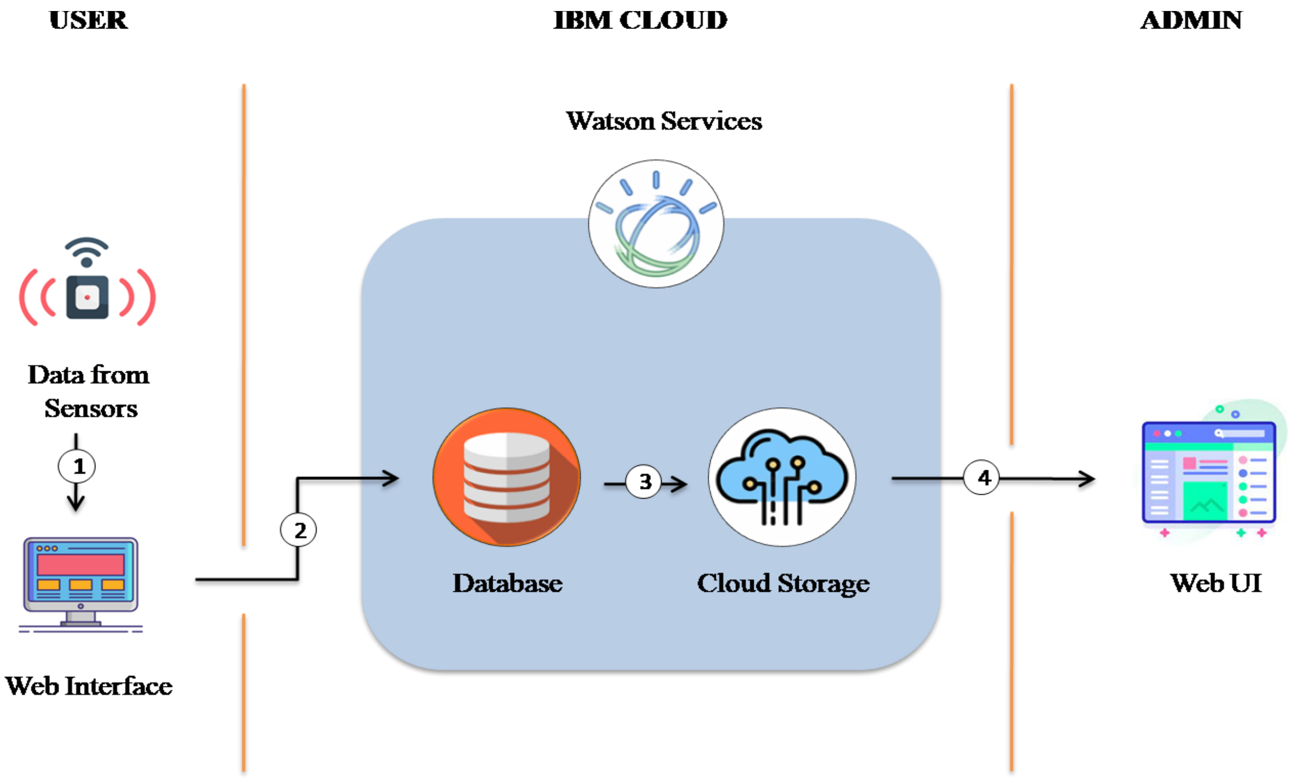
5.2 SOLUTION AND TECHNICAL ARCHITECTURE

An IOT-based river water monitoring and controlling system with some predefined values can be built using the instructions in this code pattern.

Flow:

- Feed the information obtained from the sensor unit situated along the riverside.
- The user will see the gathered information on the web page.
- The acquired data is then transferred to the database, where it is validated and kept track of along with the predetermined data.
- The acquired data will be saved in the IBM cloud storage if any data exceeds the predetermined data, at which point the control signal will be sent to the administrator.
- Later, the administrator will have UI control over the data.

Technical Architecture:



Components & Technologies:

S.No.	Component	Description	Technology
1.	User Interface	User interacts with application through Web UI and Mobile App	HTML, CSS, JavaScript
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 service
4.	Application Logic-3	Logic for a process in the application	IBM Watson Assistant
5.	Database	Data Type, Configurations	MySQL,/NoSQL
6.	Cloud Database	Database Service on Cloud	IBM Cloudant
7.	File Storage	File storage requirements	IBM Block Storage/ Local File system
8.	External API-1	Purpose of External API used in the application	IBM Weather API
9.	External API-2	Purpose of External API used in the application	Aadhar API
10.	Machine Learning Model	Purpose of Machine Learning Model	Object Recognition Model
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / CloudLocal Server Configuration: Cloud Server Configuration :	Local, Cloud Foundry, Kubernetes

Application Characteristics:

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

5.3 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 byentering my email address, password, and password confirmation.	Can gain access to my account/ Dashboard.	High	Sprint-1
		USN-2	Once I have registered for the application, Iwill receive a confirmation email.	I can receive an email confirmation and click/confirm.	High	Sprint-2
		USN-3	As a user, I can sign up for the app using Google.	I can use Google to register and access the dashboard.	High	Sprint-1
		USN-4	As a user, I can sign up for the applicationusing Gmail.	I can sign up through themail.	Medium	Sprint-2
	Login	USN-5	I can access the application as a user by entering my email address, password, and captcha.	I can obtain login information.	High	Sprint-1
	Interface	USN-6	As a user, the interface should be easy touse.	I can easily gain access.	Medium	Sprint-1
Customer (Webuser)	Dashboard	USN-7	As a user, I have access to specific information (pH value, temperature, humidity,and quality).	I can determine thewater's quality.	High	Sprint-1
Customer	View manner	USN-8	As a user, I can view data in a graphical format (graph).	Visuals help me understand better.	High	Sprint-1
	Taste	USN-9	As a user, I can see the water's quality (saltiness).	I can easily tell if it's salty or not.	High	Sprint-1

	Color visibility	USN-10	As a user, I can predict the colour of thewater.	I can quickly determine the condition based on the color.	High	Sprint-1
Administrator	Risk tolerant	USN-11	The application should be updated and maintained by the system administrator.	The records should be properly monitored by the administrator.	Medium	Sprint-2

CHAPTER 6

PROJECT DESIGN & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

S.NO	MILESTONE	DESCRIPTION	STATUS
1	Prerequisites	Prerequisites are all the requirements at the requirement level necessary for carrying out thevarious project phases.	Completed
2	Create & Configure IBM cloud services	Higher levels of compliance, security, and management are made possible by IBM Cloud's solutions, which also feature tried-and-true architecture patterns and strategies for quick delivery of mission-critical workloads.	Completed
3	Ideation phase	Ideation is the process through which you come up with ideas and solutions using exercises like sketching, prototyping, brain-storming, writing in the head, coming up with the worst-casescenario, and a variety of other ideation approaches.	Completed
4	Project design phases	Project design is the initial stage of a project where the main characteristics, organization, success factors, and primary deliverables are planned out. The objective is to create one or more designs that can be applied to realize the intended project objectives.	Completed
5	Project planning phase	The project manager collaborates with the team to develop the technical design, task list, resource plan, communications plan, budget, and initial schedule for the project during the planning phase. The project manager also establishes the roles and responsibilities of the	Completed

		project team andits stakeholders.	
6	Develop the python script	A Python script is a collection of instructions found in a file and designed to be executed similarly to a programme. It is intended thatthe file will be executed from the command line or from a Python interactive shell to carry out a specific task. Of course, the file imports several modules and includes methods.	Completed
7	Develop web application	Instead of running locally and natively on the device's operating system (OS), web applications (or web apps) are application programmers that operate ina web browser.	Completed
8	Project development phase	Project development is the process of organizing and distributing resources to fully develop a project or product from concept to go-live.	Completed

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 enteringmy email, password, and confirming my password.	2	High	Naveenkumar, Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
Sprint-1	User Confirmation	USN-2	As a user, I will receive confirmation email once I haveregistered for the application	1	Medium	Naveenkumar, Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar

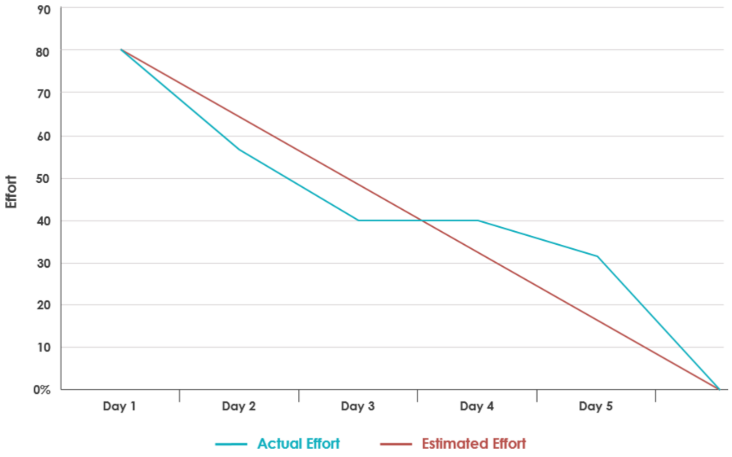
Sprint-1	Login	USN-3	As a user, I can log into the application by enteringemail & password	2	High	Naveenkumar, Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
Sprint-2	Interface Sensor	USN-1	A sensor interface is a bridge between a device and anyattached sensor. The interface takes data collected by the sensor and outputs it to the attached device.	2	High	Naveenkumar, Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
Sprint-3	Coding(Accessing datasets)	USN-1	Coding is a set of instructions used to manipulate information so that a certain input results in a particularoutput.	2	High	Naveenkumar, Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
Sprint-4	Web Application	USN-1	As a user, I will show the current information of theRiver Water.	1	Medium	Naveenkumar, Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar

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).

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

Burndown Chart

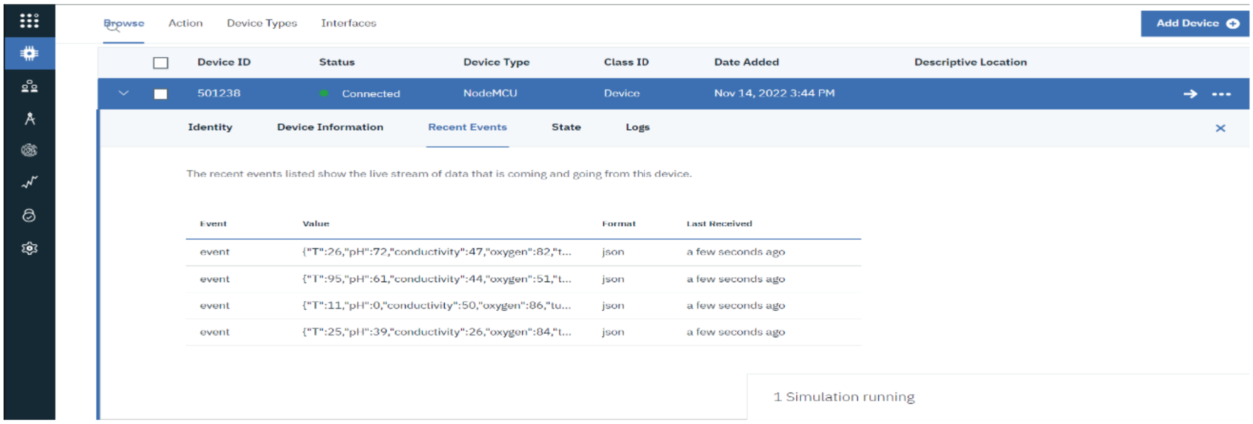


CHAPTER 7

CODING & SOLUTIONING

7.1 FEATURE 1

IBM Watson

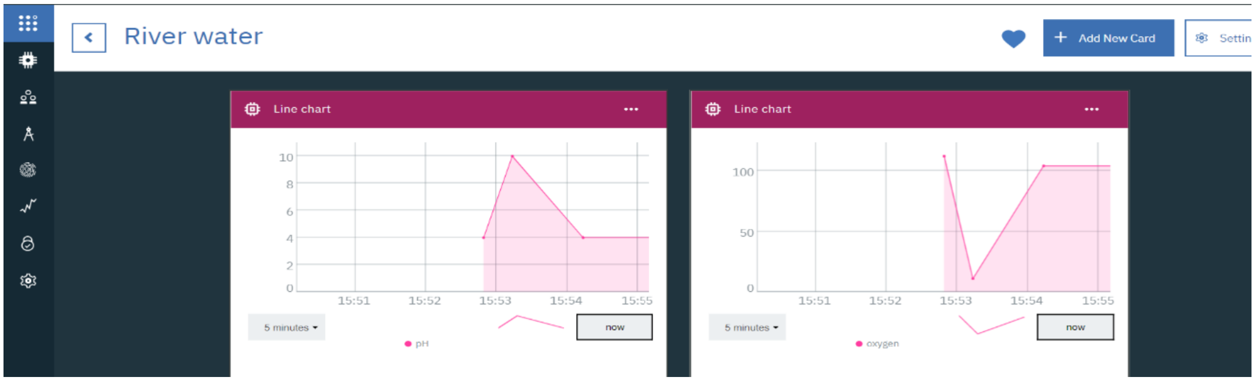


	Device ID	Status	Device Type	Class ID	Date Added	Descriptive Location
□	501238	● Connected	NodeMCU	Device	Nov 14, 2022 3:44 PM	

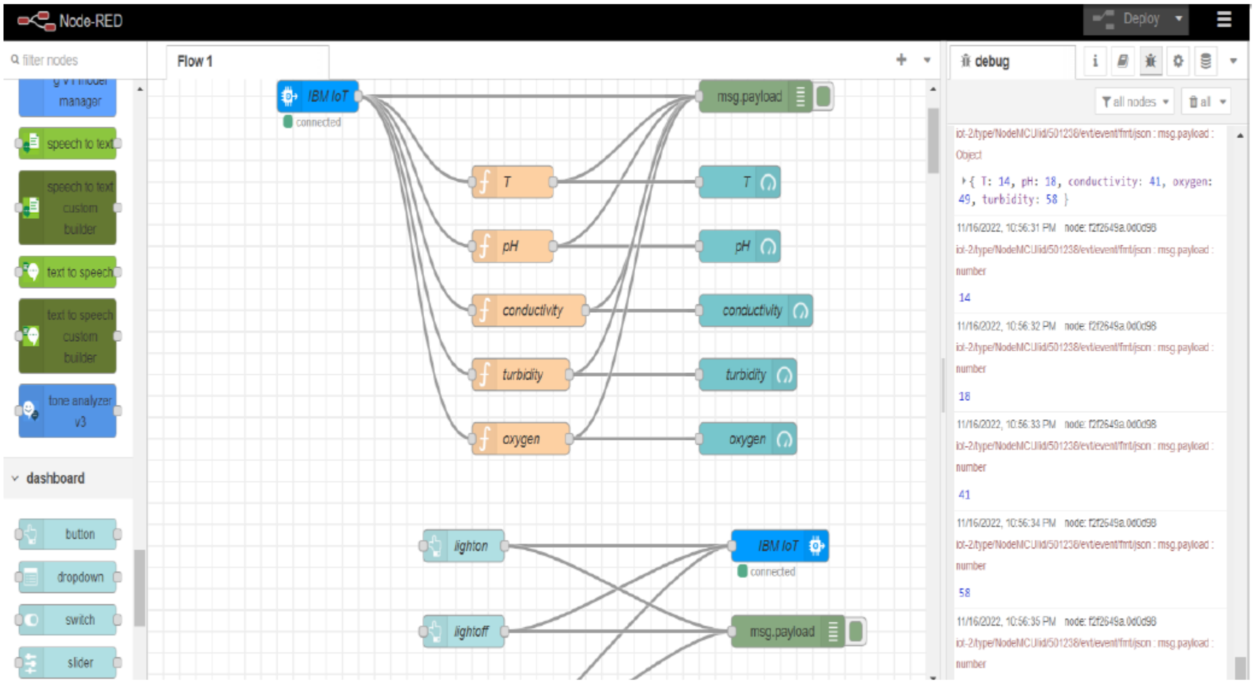
The recent events listed show the live stream of data that is coming and going from this device.

Event	Value	Format	Last Received
event	{"T":26,"pH":72,"conductivity":47,"oxygen":82,"t...	json	a few seconds ago
event	{"T":95,"pH":61,"conductivity":44,"oxygen":51,"t...	json	a few seconds ago
event	{"T":11,"pH":0,"conductivity":50,"oxygen":86,"tu...	json	a few seconds ago
event	{"T":25,"pH":39,"conductivity":26,"oxygen":84,"t...	json	a few seconds ago

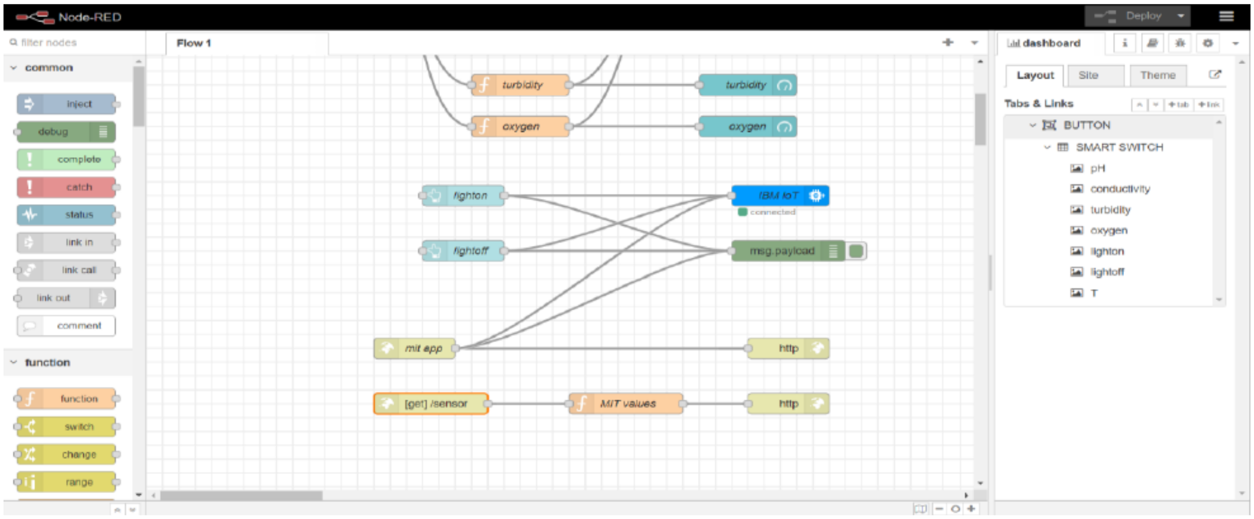
1 Simulation running



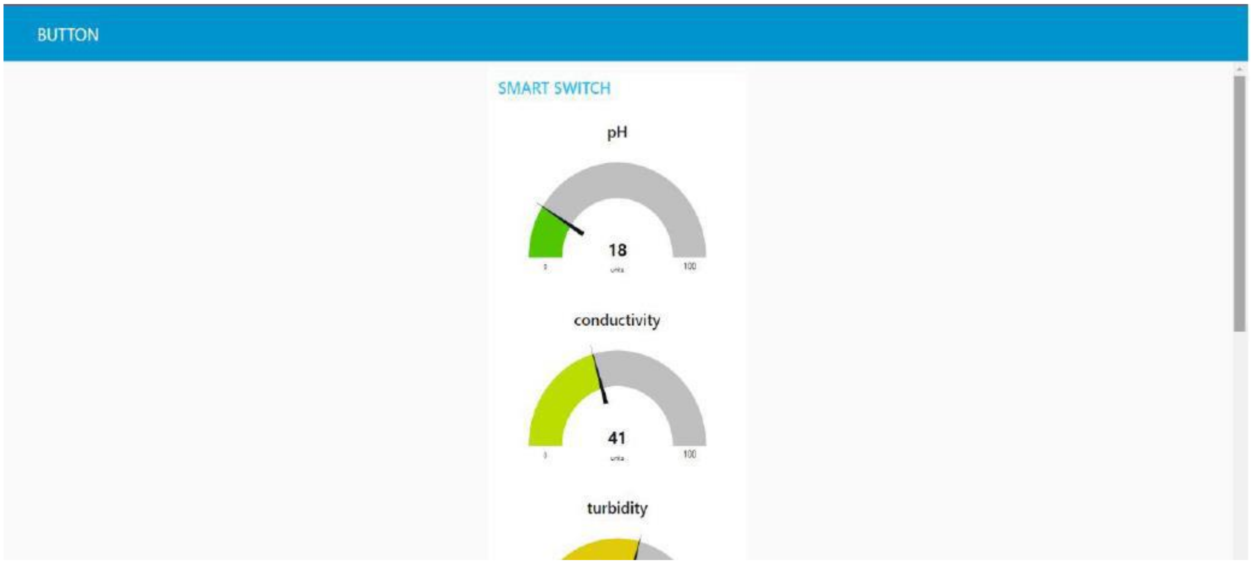
Node Red Service associated with IBM Cloud

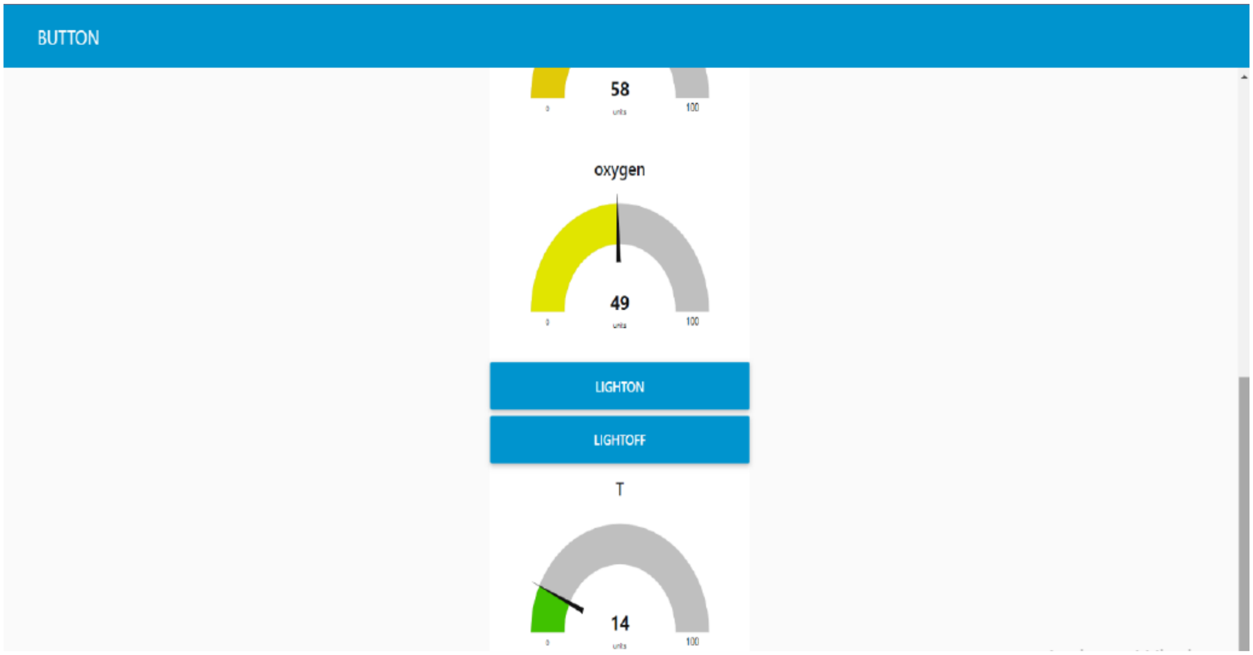


```
iot-2/type/NodeMCU/id/501238/evt/event/fmt/json : msg.payload :
Object
▸{ T: 14, pH: 18, conductivity: 41, oxygen:
49, turbidity: 58 }
11/16/2022, 10:56:31 PM   node: f2f2649a.0d0d98
iot-2/type/NodeMCU/id/501238/evt/event/fmt/json : msg.payload :
number
14
11/16/2022, 10:56:32 PM   node: f2f2649a.0d0d98
iot-2/type/NodeMCU/id/501238/evt/event/fmt/json : msg.payload :
number
18
11/16/2022, 10:56:33 PM   node: f2f2649a.0d0d98
iot-2/type/NodeMCU/id/501238/evt/event/fmt/json : msg.payload :
number
41
11/16/2022, 10:56:34 PM   node: f2f2649a.0d0d98
iot-2/type/NodeMCU/id/501238/evt/event/fmt/json : msg.payload :
number
58
11/16/2022, 10:56:35 PM   node: f2f2649a.0d0d98
iot-2/type/NodeMCU/id/501238/evt/event/fmt/json : msg.payload :
number
```



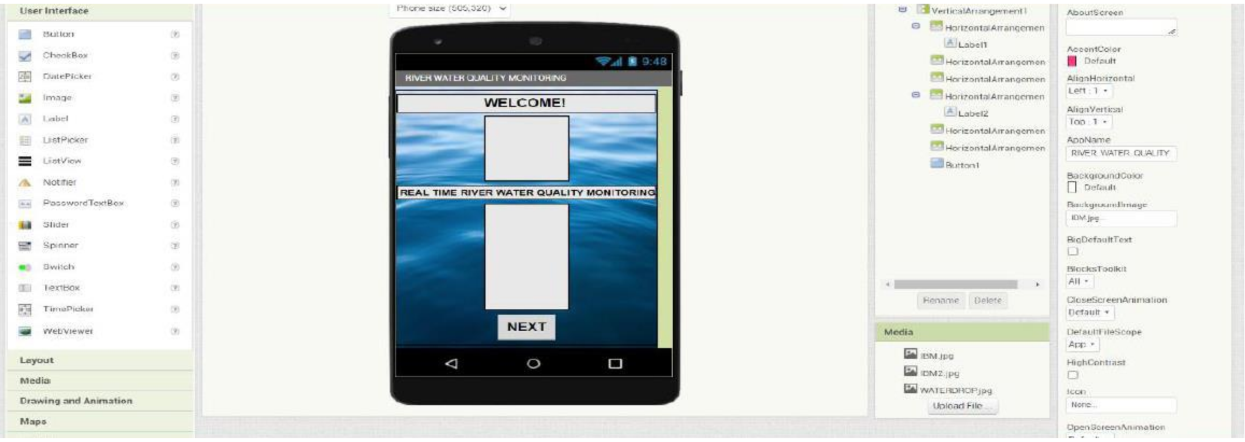
Node Red Dashboard



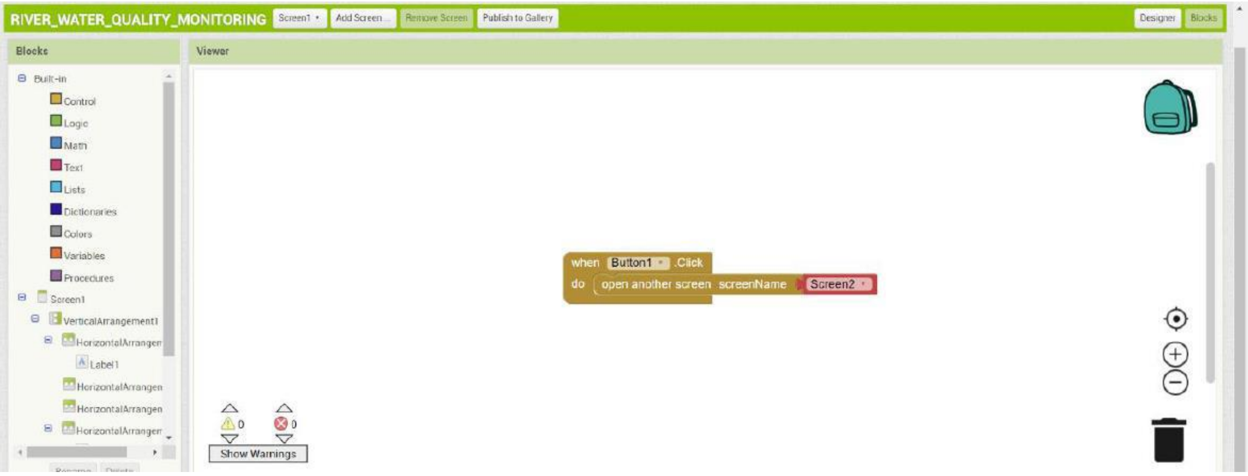


7.2 FEATURE 2

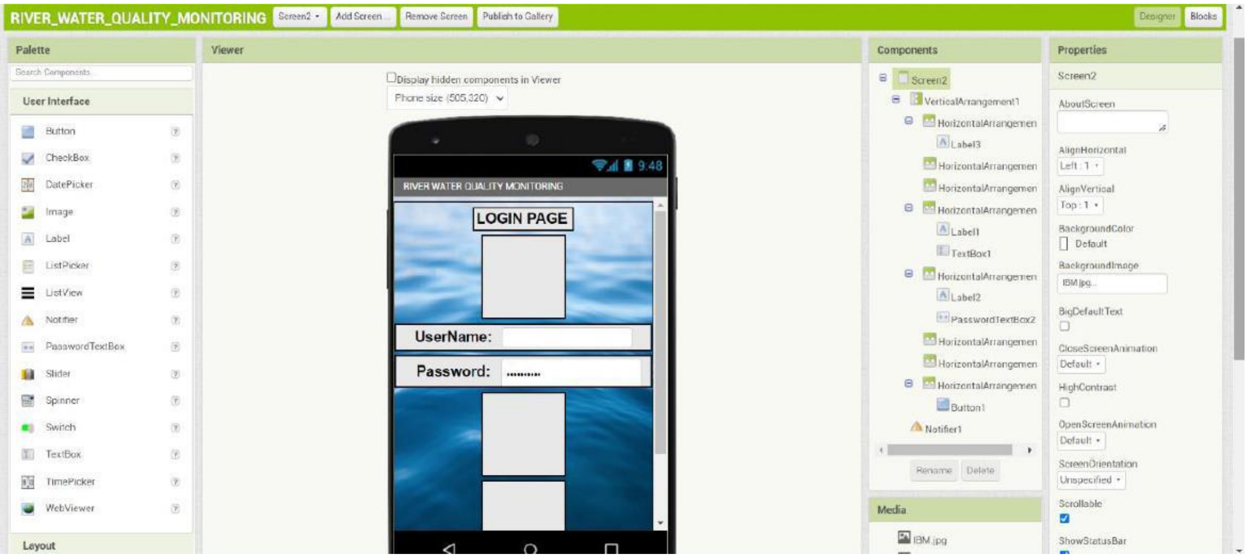
MIT APP Inventor



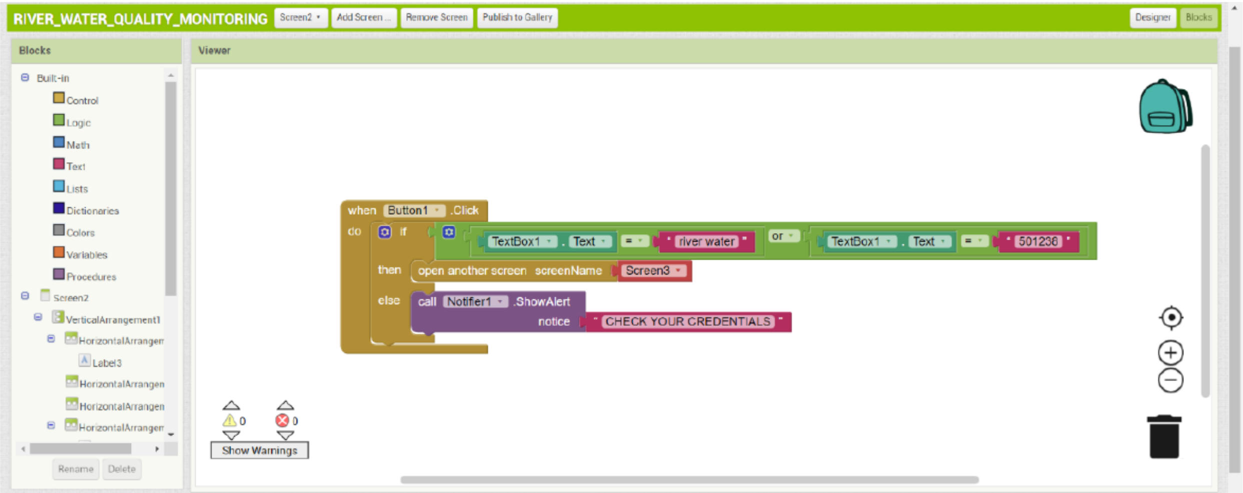
AccentColor: Default
AlignHorizontal: Left : 1
AlignVertical: Top : 1
AppName: RIVER_WATER_QUALITY
BackgroundColor: Default
BackgroundImage: IBM.jpg...
BlocksToolkit: All
CloseScreenAnimation: Default
DefaultFileScope: App
Icon: None...



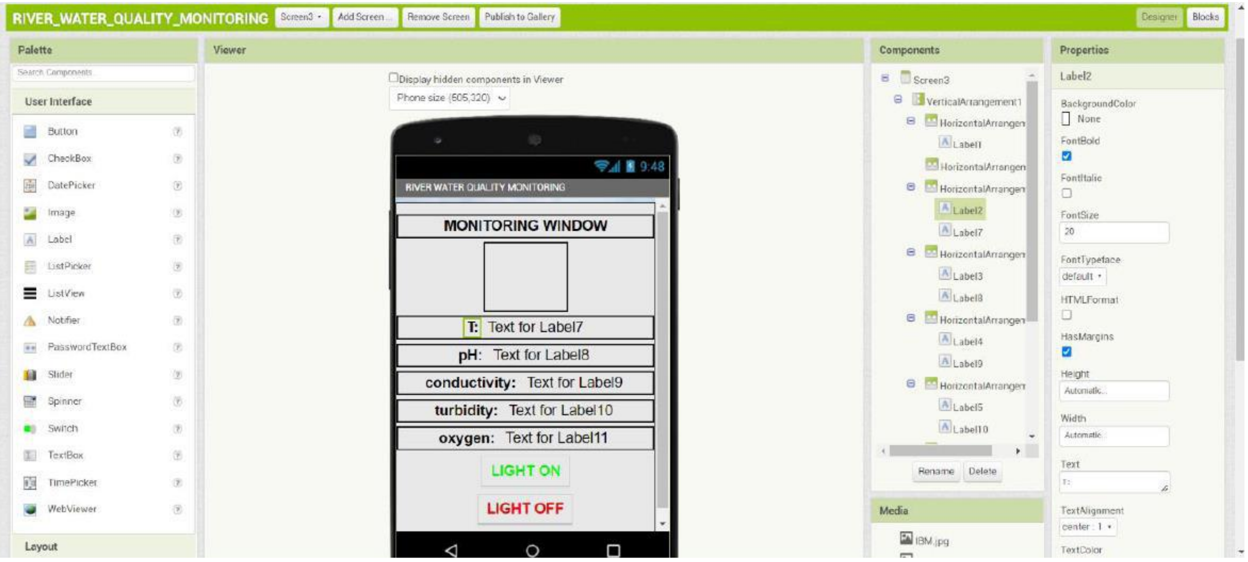
```
when Button1 .Click
do  open another screen  screenName  Screen2
```



AlignHorizontal: Left : 1
AlignVertical: Top : 1
BackgroundColor: Default
BackgroundImage: IBM.jpg...
CloseScreenAnimation: Default
OpenScreenAnimation: Default
ScreenOrientation: Unspecified
Scrollable: ☑



```
when Button1 .Click
do  if    TextBox1 . Text = "river water"  or  TextBox1 . Text = "501236"
    then  open another screen  screenName  "Screen3"
    else  call Notifier1 .ShowAlert
                         notice  "CHECK YOUR CREDENTIALS"
```



MONITORING WINDOW

T: Text for Label7

pH: Text for Label8

conductivity: Text for Label9

turbidity: Text for Label10

oxygen: Text for Label11

LIGHT ON

LIGHT OFF

Label2

BackgroundColor: None

FontBold: ☑

FontItalic: □

FontSize: 20

FontTypeface: default

HTMLFormat: □

HasMargins: ☑

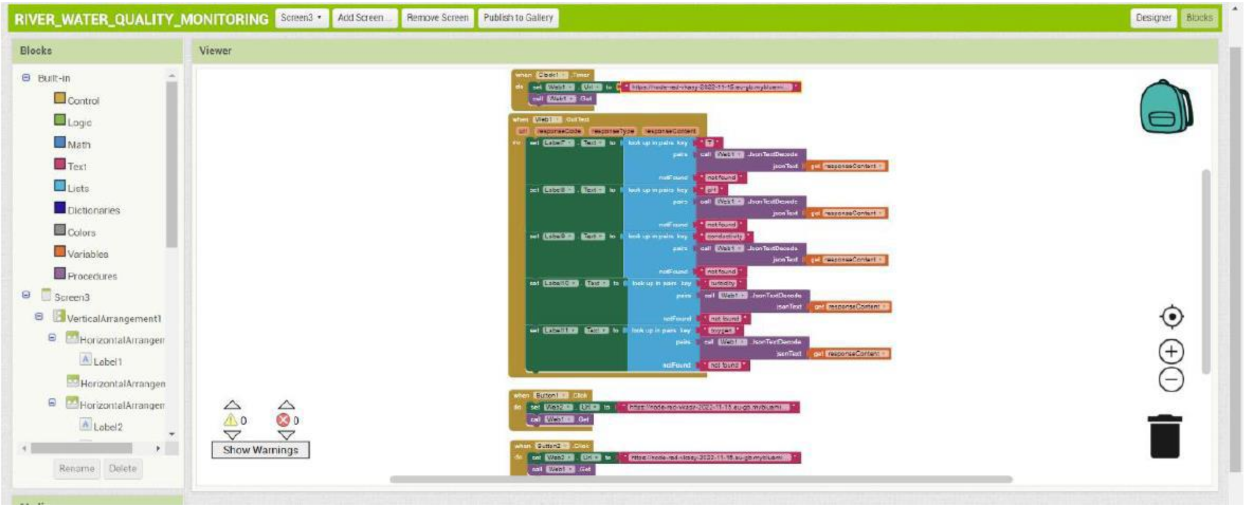
Height: Automatic...

Width: Automatic...

Text: T:

TextAlignment: center : 1

TextColor



```
when Clock1 .Timer
do  set Web1 . Url to "https://node-red-vkasy-2022-11-15.eu-gb.mybluemi..."
    call Web1 .Get

when Web1 .GotText
  url  responseCode  responseType  responseContent
do  set Label7 . Text to  look up in pairs  key "T"
                                            pairs  call Web1 .JsonTextDecode
                                                        jsonText  get responseContent
                                            notFound "not found"
    set Label8 . Text to  look up in pairs  key "pH"
                                            pairs  call Web1 .JsonTextDecode
                                                        jsonText  get responseContent
                                            notFound "not found"
    set Label9 . Text to  look up in pairs  key "conductivity"
                                            pairs  call Web1 .JsonTextDecode
                                                        jsonText  get responseContent
                                            notFound "not found"
    set Label10 . Text to  look up in pairs  key "turbidity"
                                             pairs  call Web1 .JsonTextDecode
                                                         jsonText  get responseContent
                                             notFound "not found"
    set Label11 . Text to  look up in pairs  key "oxygen"
                                             pairs  call Web1 .JsonTextDecode
                                                         jsonText  get responseContent
                                             notFound "not found"

when Button1 .Click
do  set Web2 . Url to "https://node-red-vkasy-2022-11-15.eu-gb.mybluemi..."
    call Web1 .Get

when Button2 .Click
do  set Web2 . Url to "https://node-red-vkasy-2022-11-15.eu-gb.mybluemi..."
    call Web1 .Get
```

Code Layout, Readability, Reusability Key Ideas

KEY IDEA 1: Code must be simple to comprehend.

KEY IDEA 2: When writing code, try to think of as many applications as you can.

KEY IDEA 3:

Choosing specific terms

- Avoiding general names (or knowing when to use them)
- Using concrete names instead of abstract names
- Adding further information to names using suffixes or prefixes
- Determining how long names should be
- Using name formatting to add extra information.

Select Particular Words

You must avoid using "empty" terms and pick words that are very detailed. For instance, the word "obtain" is quite general, as shown in the example: def GetPage(url):

Searching for more colourful words

Don't be scared to consult a thesaurus or ask a buddy for ideas for better names. There are many terms to choose from in English because it is a rich language.

Example:

send ~ deliver, dispatch, announce, distribute, route find ~ search, extract, locate, recover start ~ launch, create, begin, open make ~ create, set up, build, generate, compose, add, new

KEY IDEA 4: It's preferable to be accurate and straightforward rather than cute.

- Avoid tmp and retval as generic names.
- Instead of using a name that is meaningless, such as this, choose a name that expresses the entity's values or goals.
- Sometimes using a generic name will help you find a bug. temp or tmp

Use concrete names instead of abstract names

Consider that your internal method ServerCanStart() checks the server's ability to listen on a specific TCP/IP port. However, ServerCanStart() is a bit of an ambiguous moniker. CanListenOnPort() would be a more specific moniker (). This name specifically states what the method does. Don't try to combine two concepts that are orthogonal to one another. Follow the Single Responsibility Rule to make naming methods easy.

Other Important Attributes Coding

Knowing that part of the data your application gets is not yet secure leads to many security attacks. You may want to utilise variables with names like unsafeMessageBody or untrustedUrl for this. The variables that are produced after running functions that clean up the dangerous input could be trustedUrl or safeMessageBody. Before further processing, a password should be encrypted because it is currently in "plaintext." Better name for the password: plaintext password.

The ideal length for a name

How do you choose between the names d and days for a variable? The precise application of the variable will determine the response.

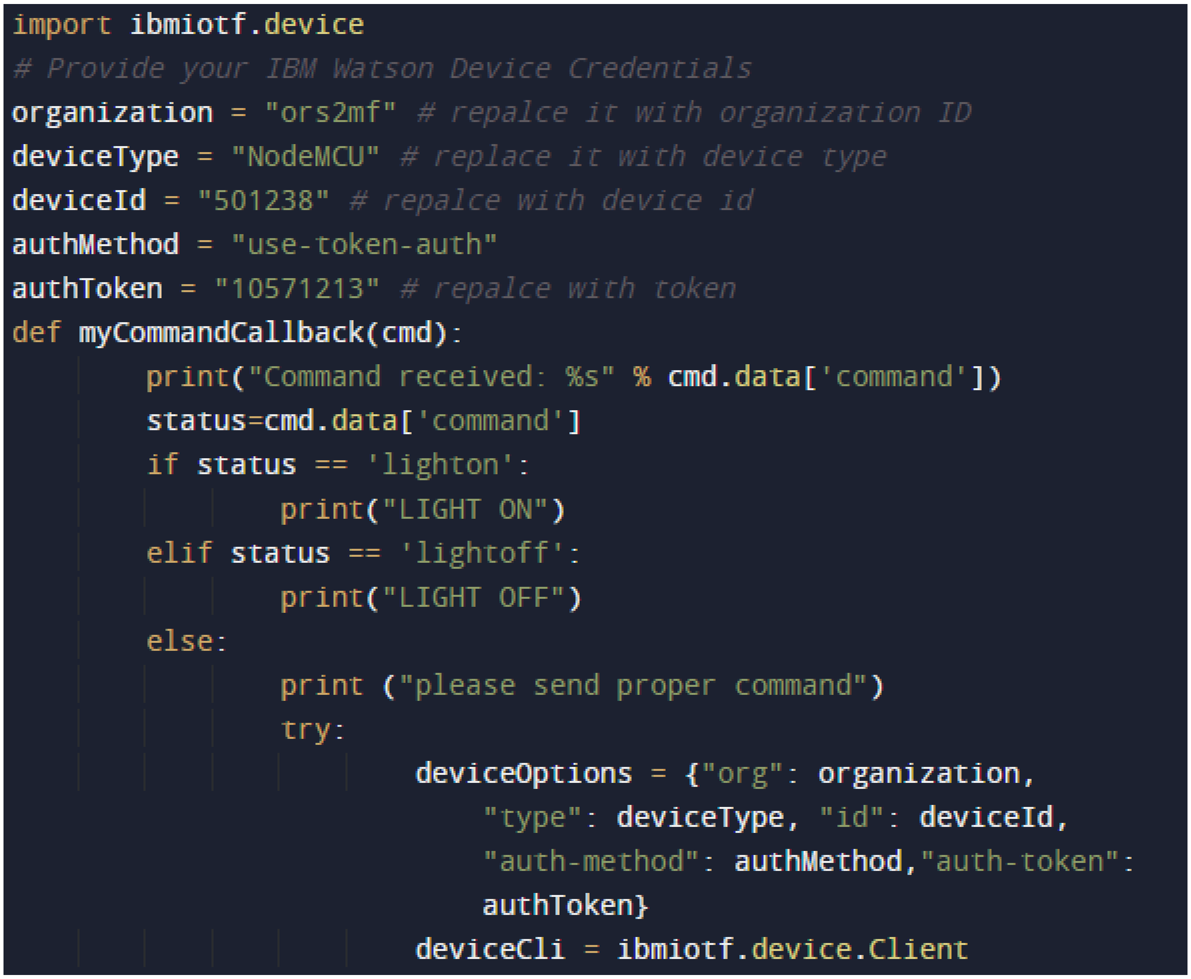
For a Limited Scope, Shorter Names Are Acceptable

The amount of information that identifiers need to contain depends on how many other lines of code

```
if (debug) { map<string,int> m; LookUpNamesNumbers(& m);

Print(m);

}
```

Despite the fact that m is devoid of any information, this is not an issue because the reader already has all the knowledge necessary to comprehend this code.

Code Layout



```
import ibmiotf.device
# Provide your IBM Watson Device Credentials
organization = "ors2mf" # repalce it with organization ID
deviceType = "NodeMCU" # replace it with device type
deviceId = "501238" # repalce with device id
authMethod = "use-token-auth"
authToken = "10571213" # repalce with token
def myCommandCallback(cmd):
        print("Command received: %s" % cmd.data['command'])
        status=cmd.data['command']
        if status == 'lighton':
                print("LIGHT ON")
        elif status == 'lightoff':
                print("LIGHT OFF")
        else:
                print ("please send proper command")
                try:
                        deviceOptions = {"org": organization,
                            "type": deviceType, "id": deviceId,
                            "auth-method": authMethod,"auth-token":
                            authToken}
                        deviceCli = ibmiotf.device.Client
```

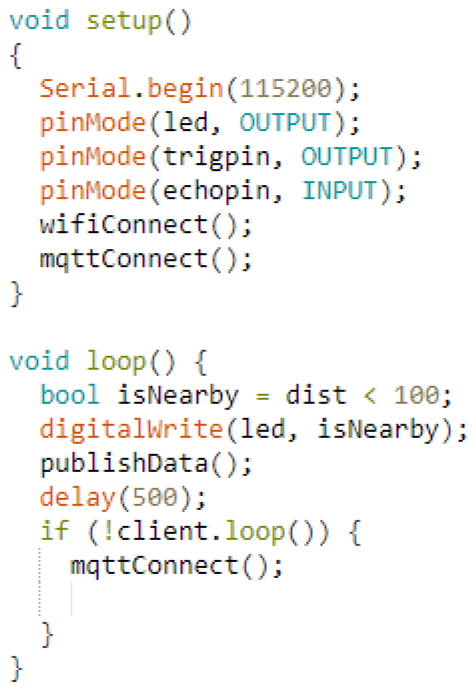
Readability & Reusability

- Readable code is code that clearly communicates its intention to the reader.
- This code is easy to read and understand everything faster.
- Pre-existing code can be recycled to perform the same function or repurposed to perform a similar but slightly different function. Code reusability **increases productivity reduces costs, and improves overall quality**.
- We can reuse every part of the code.

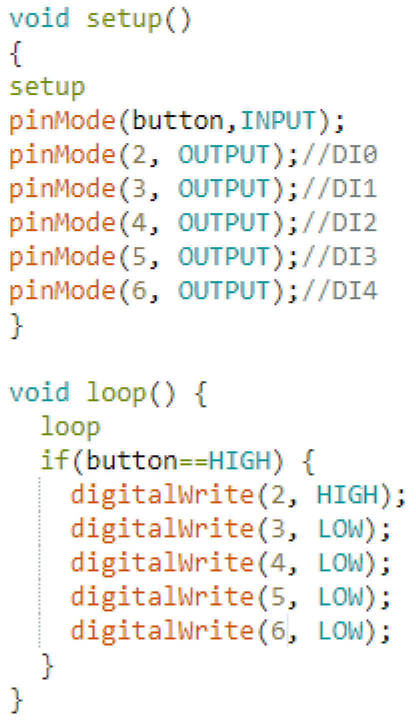
Utilization of Algorithms

1. Data from the sensor nodes are being gathered by us.
2. The Node-RED platform's IBM cloud connection configuration needs to be set up.
3. Next, it can link the Node-RED platform with IBM Watson IoT.
4. The information is then sent to the IBM Watson IoT platform.
5. The app that we need must be designed and developed.
6. Also link the app to Node-RED.
7. As a result, our mobile app can simply display the water's pH and turbidity levels in real time.
8. A motor controller was required if we wanted to close the specific dam.
9. As a result, we developed a motor controller for a mobile app.
10. Results from the controller are displayed in app.

Dynamic Programming

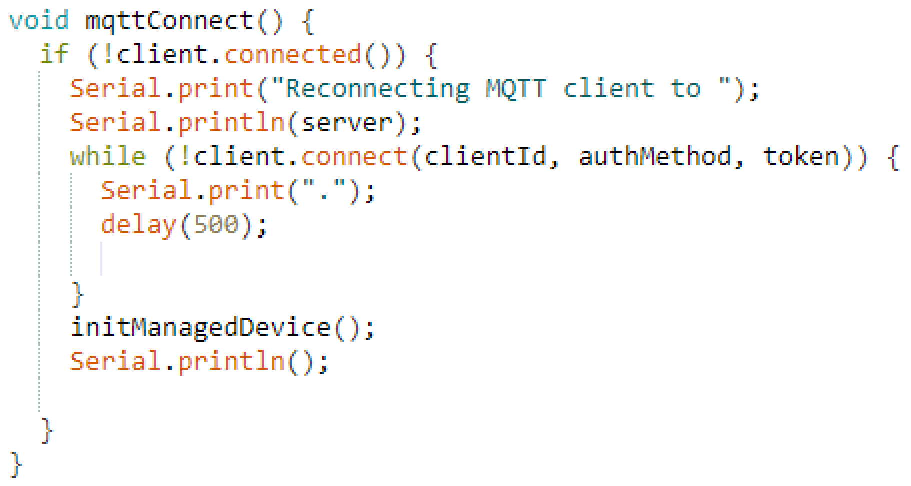


```
void setup()
{
  Serial.begin(115200);
  pinMode(led, OUTPUT);
  pinMode(trigpin, OUTPUT);
  pinMode(echopin, INPUT);
  wifiConnect();
  mqttConnect();
}

void loop() {
  bool isNearby = dist < 100;
  digitalWrite(led, isNearby);
  publishData();
  delay(500);
  if (!client.loop()) {
    mqttConnect();

  }
}
```

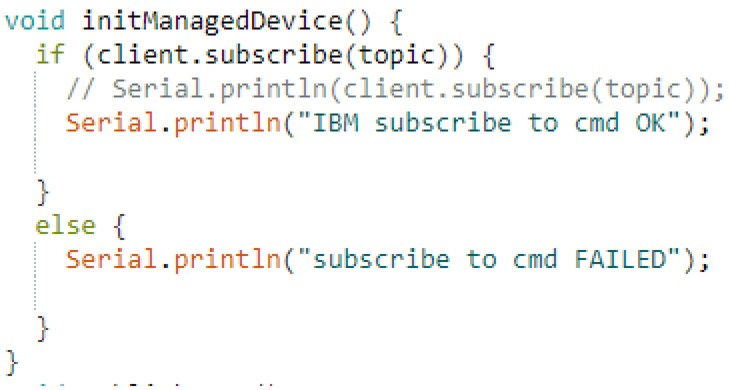


```
void setup()
{
setup
pinMode(button,INPUT);
pinMode(2, OUTPUT);//DI0
pinMode(3, OUTPUT);//DI1
pinMode(4, OUTPUT);//DI2
pinMode(5, OUTPUT);//DI3
pinMode(6, OUTPUT);//DI4
}

void loop() {
  loop
  if(button==HIGH) {
    digitalWrite(2, HIGH);
    digitalWrite(3, LOW);
    digitalWrite(4, LOW);
    digitalWrite(5, LOW);
    digitalWrite(6, LOW);
  }
}
```

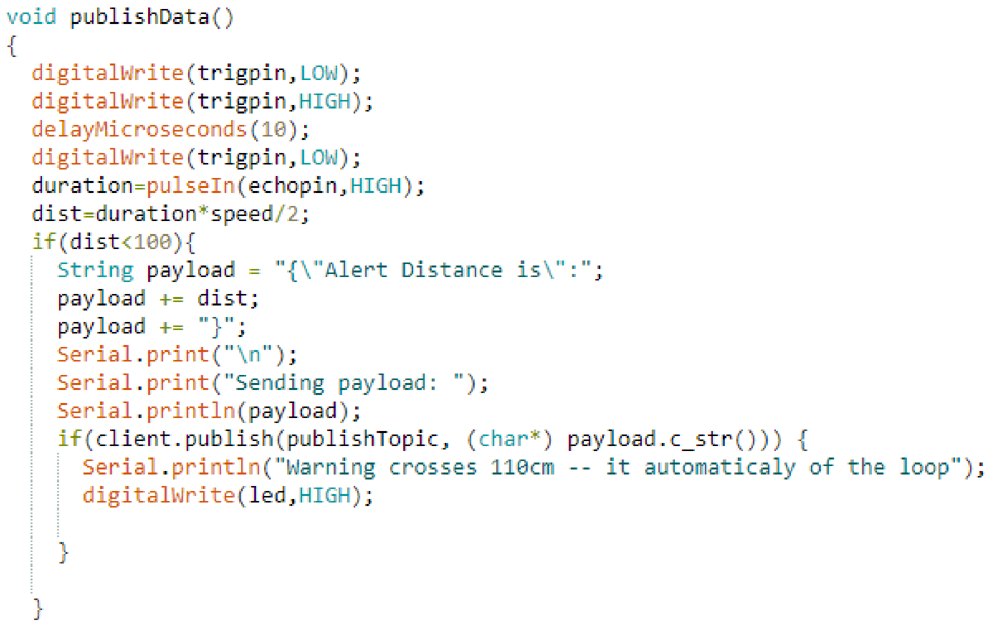
Optimization



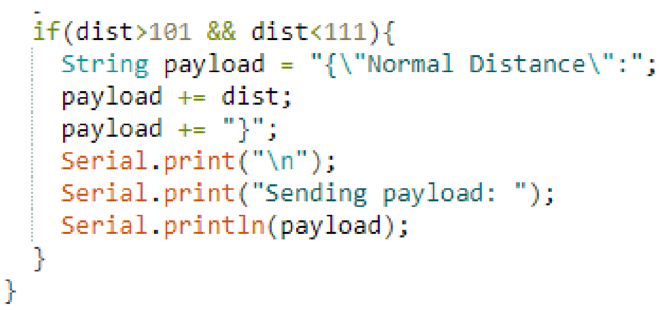
```
void mqttConnect() {
  if (!client.connected()) {
    Serial.print("Reconnecting MQTT client to ");
    Serial.println(server);
    while (!client.connect(clientId, authMethod, token)) {
      Serial.print(".");
      delay(500);

    }
    initManagedDevice();
    Serial.println();

  }
}
```



```
void initManagedDevice() {
  if (client.subscribe(topic)) {
    // Serial.println(client.subscribe(topic));
    Serial.println("IBM subscribe to cmd OK");

  }
  else {
    Serial.println("subscribe to cmd FAILED");

  }
}
```

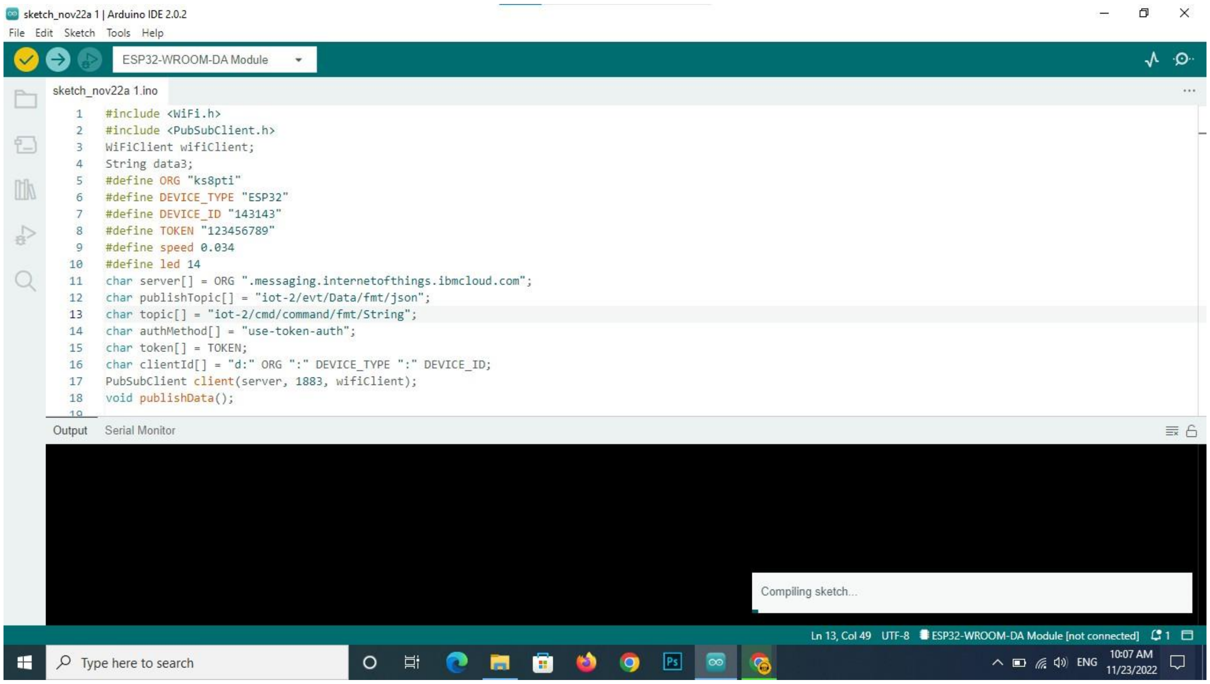


```
void publishData()
{
  digitalWrite(trigpin,LOW);
  digitalWrite(trigpin,HIGH);
  delayMicroseconds(10);
  digitalWrite(trigpin,LOW);
  duration=pulseIn(echopin,HIGH);
  dist=duration*speed/2;
  if(dist<100){
    String payload = "{\"Alert Distance is\":";
    payload += dist;
    payload += "}";
    Serial.print("\n");
    Serial.print("Sending payload: ");
    Serial.println(payload);
    if(client.publish(publishTopic, (char*) payload.c_str())) {
      Serial.println("Warning crosses 110cm -- it automaticaly of the loop");
      digitalWrite(led,HIGH);

    }

  }
```



```
  if(dist>101 && dist<111){
    String payload = "{\"Normal Distance\":";
    payload += dist;
    payload += "}";
    Serial.print("\n");
    Serial.print("Sending payload: ");
    Serial.println(payload);
  }
}
```

Debugging & Traceability


sketch_nov22a 1 | Arduino IDE 2.0.2
File Edit Sketch Tools Help
ESP32-WROOM-DA Module
sketch_nov22a 1.ino
Output
Serial Monitor
Ln 13, Col 49 UTF-8 ESP32-WROOM-DA Module [not connected]
Type here to search
ENG
10:07 AM
11/23/2022

```
#include <WiFi.h>
#include <PubSubClient.h>
WiFiClient wifiClient;
String data3;
#define ORG "ks8pti"
#define DEVICE_TYPE "ESP32"
#define DEVICE_ID "143143"
#define TOKEN "123456789"
#define speed 0.034
#define led 14
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/Data/fmt/json";
char topic[] = "iot-2/cmd/command/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
```

```
Compiling sketch...
```

- We are debugging everything through the Arduino IDE.
- Traceability refers to how easily code or documentation can be traced back to its source.
- Traceability is used both in software development and in testing to improve software quality and consistency.

Exception Handling

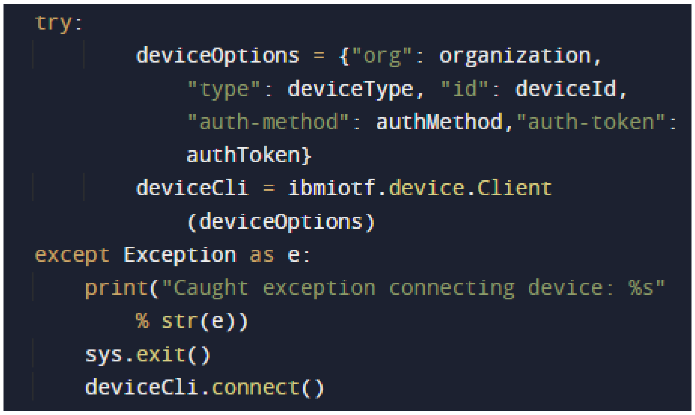
- Many built-in exceptions in Python are thrown when a problem is encountered by your programme (something in the programme goes wrong).
- The Python interpreter stops the running process and passes control to the calling process until these exceptions are addressed. The software will crash if it is not addressed.

Let's take a software where function A calls function B, which then calls function C as an example. An exception that occurs in function C but isn't handled there is passed to B before being handled by A. If the mistake is never addressed, a notification is shown and our software abruptly and unexpectedly stops.

Catching Exceptions

A try statement in Python can be used to manage exceptions. The try clause contains the crucial operation that can cause an exception. The except clause contains the code that manages exceptions. Thus, once we have identified the exception, we may decide what actions to take.

Here is an easy illustration.



```
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()
    deviceCli.connect()
```

CHAPTER 8

TESTING

8.1 TEST CASES

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
Cloud 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

8.2 USER ACCEPTANCE TESTING

Purpose of the document

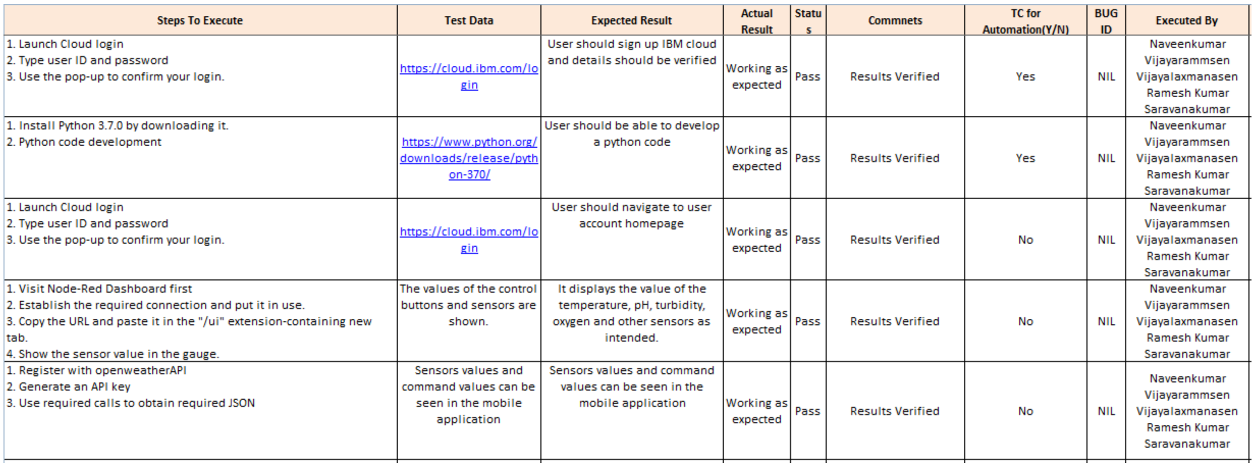
This document's goal is to provide a concise explanation of the test coverage and open issues for the REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEMS project at the time of the release to User Acceptance Testing (UAT).

Result Analysis

This report lists the number of bugs that have been fixed or closed at each severity level, along with how they were fixed.

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Sub Total
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

Testcases Report

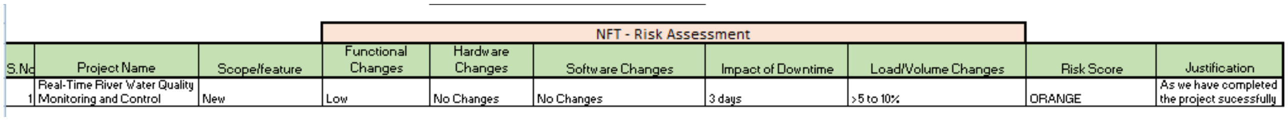


Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets	TC for Automation(Y/N)	BUG ID	Executed By
1. Launch Cloud login 2. Type user ID and password 3. Use the pop-up to confirm your login.	https://cloud.ibm.com/login	User should sign up IBM cloud and details should be verified	Working as expected	Pass	Results Verified	Yes	NIL	Naveenkumar Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
1. Install Python 3.7.0 by downloading it. 2. Python code development	https://www.python.org/downloads/release/python-370/	User should be able to develop a python code	Working as expected	Pass	Results Verified	Yes	NIL	Naveenkumar Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
1. Launch Cloud login 2. Type user ID and password 3. Use the pop-up to confirm your login.	https://cloud.ibm.com/login	User should navigate to user account homepage	Working as expected	Pass	Results Verified	No	NIL	Naveenkumar Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
1. Visit Node-Red Dashboard first 2. Establish the required connection and put it in use. 3. Copy the URL and paste it in the "/ui" extension-containing new tab. 4. Show the sensor value in the gauge.	The values of the control buttons and sensors are shown.	It displays the value of the temperature, pH, turbidity, oxygen and other sensors as intended.	Working as expected	Pass	Results Verified	No	NIL	Naveenkumar Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar
1. Register with openweatherAPI 2. Generate an API key 3. Use required calls to obtain required JSON	Sensors values and command values can be seen in the mobile application	Sensors values and command values can be seen in the mobile application	Working as expected	Pass	Results Verified	No	NIL	Naveenkumar Vijayarammsen Vijayalaxmanasen Ramesh Kumar Saravanakumar

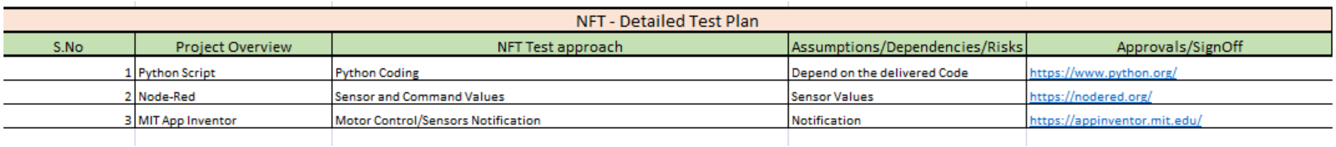
CHAPTER 9

RESULTS

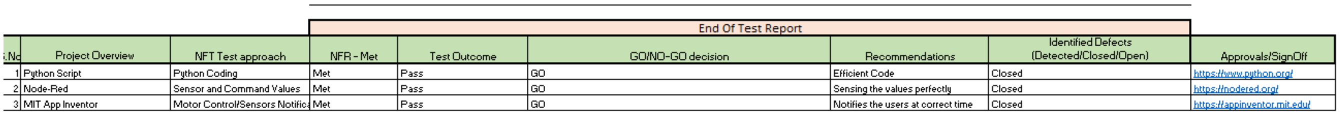
9.1 PERFORMANCE METRICS



			NFT - Risk Assessment						
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Volume Changes	Risk Score	Justification
1	Real-Time River Water Quality Monitoring and Control	New	Low	No Changes	No Changes	3 days	>5 to 10%	ORANGE	As we have completed the project sucessfully



NFT - Detailed Test Plan				
S.No	Project Overview	NFT Test approach	Assumptions/Dependencies/Risks	Approvals/SignOff
1	Python Script	Python Coding	Depend on the delivered Code	https://www.python.org/
2	Node-Red	Sensor and Command Values	Sensor Values	https://nodered.org/
3	MIT App Inventor	Motor Control/Sensors Notification	Notification	https://appinventor.mit.edu/



			End Of Test Report					
.No	Project Overview	NFT Test approach	NFR - Met	Test Outcome	GO/NO-GO decision	Recommendations	Identified Defects (Detected/Closed/Open)	Approvals/SignOff
1	Python Script	Python Coding	Met	Pass	GO	Efficient Code	Closed	https://www.python.org/
2	Node-Red	Sensor and Command Values	Met	Pass	GO	Sensing the values perfectly	Closed	https://nodered.org/
3	MIT App Inventor	Motor Control/Sensors Notifica	Met	Pass	GO	Notifies the users at correct time	Closed	https://appinventor.mit.edu/

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 with no. Of test case	60-80% (15-30 Testcase)	Valid data from the app
Error	3-5%	Real-time delay may occur

CHAPTER 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

- The prototype created for maintaining water quality is excellent for preserving public health and also contributes to a clean environment.
- This water monitoring, cleaning, and control procedure is automated, which eliminates the need for manual work and saves time and money.
- The system's automation improves the effectiveness and efficiency of the control and monitoring processes. Remote control of the system is possible thanks to real-time mobile monitoring made possible by the Bluetooth module and Arduino interface on the PLC.
- Automation will speed up the process of checking the parameters.
- It is economically accessible to the average person.
- Offers protection against infections brought on by water.
- Measurement accuracy
- The user receives an SMS notice.

DISADVANTAGES

- The cost of analysis is very high
- It is challenging to collect water samples from every area of the water body.
- It takes time for lab testing and analysis.
- As a result, the results do not reflect real-time water quality measurements.
- The method is time-consuming and subject to a variety of human errors because manual data collection is done slowly from various locations around the water body.

CHAPTER 11

CONCULSION

This article provides a thorough analysis of the methods and technologies used by current smart water quality monitoring systems. A low-cost, simpler approach for monitoring water quality is also suggested. The implementation makes it possible for sensors to give customers online data. Algorithms for water quality anomaly detection can be added to the suggested setup to improve it. Therefore, the suggested system will undoubtedly benefit society's access to a reliable water supply. People will be greatly assisted in becoming aware of the dangers of using contaminated water and in stopping water pollution by real-time monitoring of water quality utilizing IoT integrated big data analytics.

Real-time river water quality monitoring is the main focus of the research. Because IoT integrated big data analytics can offer dependability, scalability, speed, and permanence, it appears to be a better solution. Real-time analytics tools including Spark streaming analysis through Spark ML lib, Deep learning neural network models, and the Belief Rule Based (BRB) system will all be thoroughly compared during the project development period.

This study suggests systematic testing of the suggested technologies in Bangladeshi rivers with various water quality characteristics. We only measure the characteristics that affect the quality of river water due to budgetary constraints. This project could be expanded into a productive local water management system. Additionally, other characteristics that were outside the purview of this experiment can also be quantified, including total dissolved solids, chemical oxygen demand, and dissolved oxygen. Therefore, greater funding is needed to continue to enhance the system as a whole.

CHAPTER 12

FUTURE SCOPE

Our usage of water detecting sensors provides a special benefit. Compared to a manual technique, it takes less time to check for contaminated levels and notifies the affected rate of water pollution instantly. Rural residents who live close to the river will be delighted with our suggestion. Monitoring water pollution in a certain location will be helpful. Consequently, this mechanism shields users from water pollution. It will be used to check the PH level, temperature, and water quality for agricultural purposes. This project will have a positive social impact on farmers as well.

This project can be scaled up to include more diverse types of sensors. The relay can be interfaced to allow us to regulate the water supply. We can use it as a revenue model as well. Additionally, this technology might be used in a number of industrial procedures. To monitor data on computers, the system can be adjusted to suit the needs of the user.

CHAPTER 13

APPENDIX

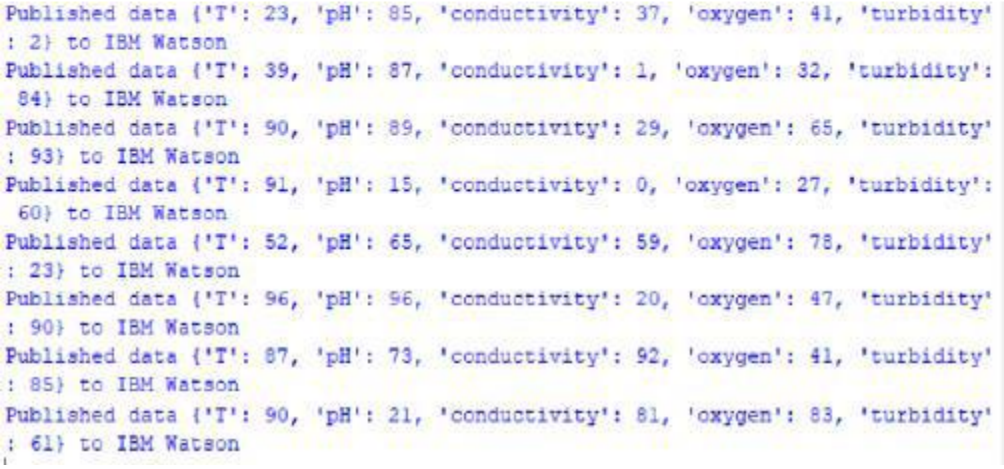
SOURCE CODE

Python Code to Publish Data

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

# Provide your IBM Watson Device Credentials
organization = "nqat1y" # repalce it with organization ID
deviceType = "NodeMCU" # replace it with device type
deviceId = "501238" # repalce with device id
authMethod = "token"
authToken = "10571213" # repalce with token
def myCommandCallback(cmd):
print("Command received: %s" % cmd.data['command'])
status=cmd.data['command']
if status == 'lighton':
print("LIGHT ON")
elif status == 'lightoff':
print("LIGHT OFF")
else:
print ("please send proper command")
try:
deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod,
"auth-token": authToken}
```

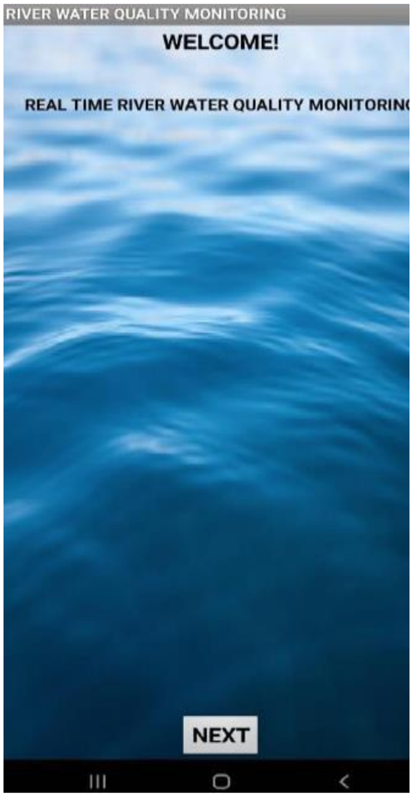
```
deviceCli = ibmiotf.device.Client(deviceOptions)


# ...........................................
except Exception as e:
print("Caught exception connecting device: %s" % str(e))
sys.exit()
deviceCli.connect()
while True:
pH = random.randint(0,100)
conductivity = random.randint(0,100)
T = random.randint(0,100)
oxygen = random.randint(0,100)
turbidity = random.randint(0,100)


# Send Temperature & Humidity to IBM Watson
data = {'T': T,'pH':pH,'conductivity':conductivity,'oxygen':oxygen,"turbidity":turbidity}


# print data
def myOnPublishCallback():
print("Published data",data, "to IBM Watson")
success = deviceCli.publishEvent("event", "json", data, 0, myOnPublishCallback)
if not success:
print("Not connected to IoTF")
time.sleep(5)
deviceCli.commandCallback = myCommandCallback


# Disconnect the device and application from the cloud
```

Output

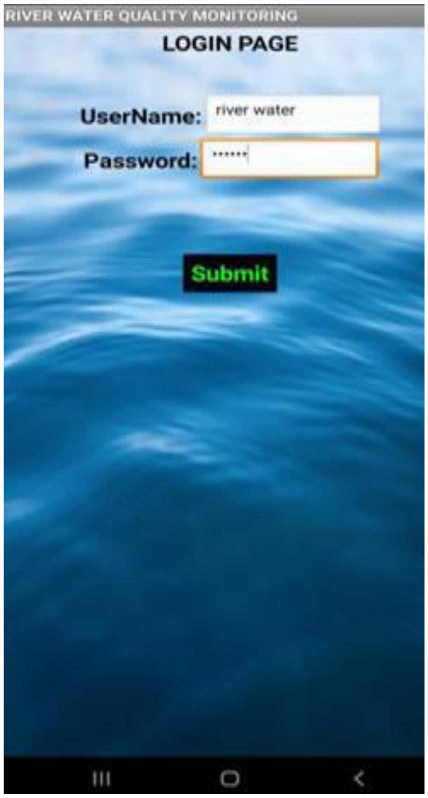


```
Published data {'T': 23, 'pH': 85, 'conductivity': 37, 'oxygen': 41, 'turbidity'
: 2} to IBM Watson
Published data {'T': 39, 'pH': 87, 'conductivity': 1, 'oxygen': 32, 'turbidity':
 84} to IBM Watson
Published data {'T': 90, 'pH': 89, 'conductivity': 29, 'oxygen': 65, 'turbidity'
: 93} to IBM Watson
Published data {'T': 91, 'pH': 15, 'conductivity': 0, 'oxygen': 27, 'turbidity':
 60} to IBM Watson
Published data {'T': 52, 'pH': 65, 'conductivity': 59, 'oxygen': 78, 'turbidity'
: 23} to IBM Watson
Published data {'T': 96, 'pH': 96, 'conductivity': 20, 'oxygen': 47, 'turbidity'
: 90} to IBM Watson
Published data {'T': 87, 'pH': 73, 'conductivity': 92, 'oxygen': 41, 'turbidity'
: 85} to IBM Watson
Published data {'T': 90, 'pH': 21, 'conductivity': 81, 'oxygen': 83, 'turbidity'
: 61} to IBM Watson
```

Output in Mobile App

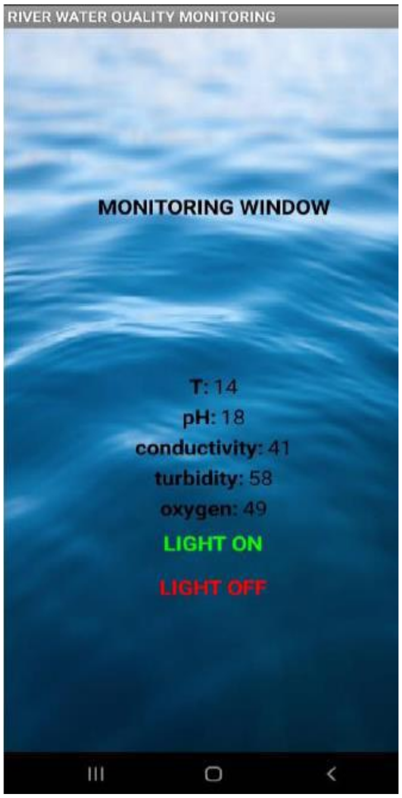


RIVER WATER QUALITY MONITORING
WELCOME!
REAL TIME RIVER WATER QUALITY MONITORING
NEXT



UserName: river water

Password: ******



T: 14
pH: 18
conductivity: 41
turbidity: 58
oxygen: 49

GITHUB LINK

https://github.com/IBM-EPBL/IBM-Project-41463-1660642315