PROJECT REPORT

REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

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CHAPTER 1
INTRODUCTION

1.1 Project Overview

The major goal is to create a system that uses wireless sensor networks to continuously monitor river water quality at remote locations with low power consume option, low cost and high detection accuracy. The main aim is to assure low cast efficient water quality monitoring and control over river. To operated battery is safer and low rate of electrical shocks. Project predict hardness, turbidity, humidity and make river water to safe drinking water with better consistency for house hold purpose. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology. Data collected at the apart site can be displayed in a visual format on a server PC with the help of Spark streaming analysis through Spark MLlib, Deep learning neural network models, Belief Rule Based (BRB) system and is also compared with standard values. Also, it assures low cost efficient water quality monitoring and control over river water. Since its battery operated, it is much safer for the locality and people to use the river water that has low rate of electrical shocks as the battery is completely insulated and rechargeable so that the system is continuous.

By using this product people can predict, analyze the hardness of water and also the factors like temperature and turbidity of water for having a safe drinking and water with better consistency for house hold purposes. Since water is an essential compound in our daily basis intake of it in healthy manner is provided by our cost-efficient quality monitoring and control system which is market affordable and greatly lifesaving factor for people using river water. The environment around consists of five key elements e.g., soil, water, climate, natural vegetation, and landforms. Among this water is the utmost crucial element for human life. It is also vital for the persistence of other living habitats. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is the need for public health.

1.2 Purpose

In an healthy manner controlling of turbidity, hardness, pH value of normal river water using IoT. The system collects various parameters from water, such as pH, dissolved oxygen, turbidity, conductivity, temperature and so on.

The remote sensing technology is the cornerstone of IoT based water quality monitoring. This implements the approach by using the pH sensor, turbidity sensor to obtain analog readings for water contaminates. The clients can get ongoing water quality information from far away. Now a day' s Internet of things (IoT) is an innovative technological phenomenon. It is shaping today' s world and is used in different fields for collecting, monitoring and analysis of data from remote locations. IoT integrated network if everywhere starting from smart cities, smart power grids, and smart supply chain to smart wearable.

Though IoT is still under applied in the field of environment it has huge potential. It can be applied to detect forest fire and early earthquake, reduce air population, monitor snow level, prevent landslide, and avalanche etc. Moreover, it can be implemented in the field of water quality monitoring and controlling system. Water quality monitoring has gained more interest among researchers in this twenty-first century. Numerous works are either done or ongoing in this topic focusing on various aspects of it. The key theme of all the projects was to develop an efficient, cost-effective, real-time water quality monitoring system which will integrate wireless sensor network and internet of things. In this research, we monitor the physical and chemical parameters of water bodies inside Chittagong city by using an IoT based sensor network.

CHAPTER 2

LITERATURE SURVEY

2.1 Existing Problems

Nowadays, water quality monitoring faces challenges because of global warming limited water resources, growing population, industrial improvements etc. So there is need to develop a best methodologies to monitor the water quality is generally affected due to both point and non-point sources of pollution. Generally poor water quality spreads diseases. There is need for effective monitoring, evaluation and control of water quality in different areas. Ensuring safe water supply of drinking water is big challenge for today's generation. The excessive use of fertilizers in farms and also in other sectors such as mining and construction have contributed in overall reduction of water quality. To ensure the safe supply of the drinking water the quality needs to be monitor.

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So we can give a design and development of a low cost system for real time monitoring of the water quality using IoT(Internet of Things) and machine learning. The system include of different sensors is used for measuring physical and chemical parameters of the water. Turbidity measures the large number of suspended particles in water that are invisible. If the turbidity is higher then there is higher risk of diarrhea, cholera [1]. On the other hand, if turbidity is lower then the water is clean. Temperature sensor measures whether water is hot or cold. The traditional methods of water quality monitoring involve the manual collection of water samples from different locations. As we will get the solutions of water samples then we can measure the different quality attributes of water and compare them with the given threshold values or standard values, if the values generated from the sensors are exceeded then alert is sent to the user of system and necessary actions will be taken by users.

2.2 References

[1] Kengnal P, Megeri MN, Giriyappanavar BS, Patil RR (2015) Multivariate analysis for the water quality assessment in rural and urban vicinity of Krishna River (India). Asian J Water Environ Pollut 12:73–80

[2] Kumar M, Singh Y, Al MKET (2010) Interpretation of water quality parameters for villages of Sanganer Tehsil by using multivariate statistical analysis. J Water Resour 2:860–863. H

[3] Loganathan K, Ahamed AJ (2017) Multivariate statistical techniques for the evaluation of groundwater quality of Amaravathi River Basin: South India. Appl Water Sci 7:4633–4649.
[4] Nagar EA (2007) Guidelines for Water Quality Monitoring Central Pollution Control Board Parivesh Bhawan Foreword. Water 1–35

2.3 Problem Statement Definition

Water is one of the major compounds that profoundly influence ecosystem. But, nowadays it is been exploited heavily due to rapid industrialization, human waste and random use of pesticides and chemical fertilizers in agriculture, which leads to waste contamination. Thus, a water monitoring system is necessary to observe the water quality in a large area such as lake, river, and aquaculture. As per the current world situation, Internet of Things (IoT) and remote sensing techniques are used in heterogeneous areas of research for supervising, congregate and analyzing data from the remote locations.

In this paper, the suggested system is a minimal price real time water quality monitoring system in IoT environment. This system comprises of numerous sensors for assessing the physical and chemical parameter. The factors of water that can be assessed using these sensors are pH, turbidity, conductivity, dissolved oxygen. Using this system, the real time quality of water bodies can be determined and the data uploaded over the Internet are analyzed.

India is facing a major issue of natural resource exiguity, especially in case of water due to population growth and economic development. Most of the water bodies are contaminated due to the superfluous pollutants, which are mostly human-made. Thus certify the cleanliness of water is a major challenge. Rapid industrialization and greater emphasis on agriculture growth with latest technology, usage of more fertilizers and pesticides caused large impurity in aquatic surroundings directing to debasement of water quality and depletion of aquatic life. Water bodies are contaminated due to point and non-point sources of pollution, which include sewage discharge, discharge from industries, run-off from agricultural fields, urban run-off and even due to floods, droughts and lack of education and awareness amid users.

The involvement of users in looking at the aspects like hygiene, environment sanitation, storage and disposal are exceptive elements to uphold the quality of water bodies. The tonicity of lakes, rivers and other water bodies and their biological diversification are directly linked with the health of nearly every element of the ecosystem. Due to the use of befouled water by

ecosystem components, the waterborne diseases are spreading over surroundings causing death and slowing down socio-economic progress. About 5 million people have died because of waterborne diseases all over the world (Water Resource Information System of India, 2017). Fertilizers and pesticides used for agriculture purpose can be washed by rain through soil, which ends up in water bodies. Industrial effluents are also washed into water bodies.

These pollutants go into the food chain and gather till they reach noxious levels, ultimately killing birds, fish quality whereas for agriculture and industries the quality can be flexible. Industries use water from rivers to power machinery and for Increment in water temperature diminishes the broke down oxygen level in water which influences the biotic life. The large portion of the above variables makes water quality. checking more paramount in our biological system Water quality observing is the gathering of data from the suggested framework dispatched at the set areas at a standard interim of time, with a precise goal to give the constant information which will be utilized to characterize the ebb and flow conditions. The primary point of constant water quality observing framework incorporates the valuation of water quality parameters, for example, physical, substance properties, with a definite goal to recognize the varieties in water parameters and to give an early cautioning of the dangers.

The framework additionally gives a constant examination of the gathered information recommends reasonable medicinal measures to slacken the water pollution. The aim of this paper is to deliver survey of functions held in smart water quality monitoring system with respect to application, communication technology used, sensors used etc. and to portrayal minimal price periodic smart water quality monitoring system using Arduino microcontroller with Wi-Fi module to examine parameters like pH, turbidity, temperature, water level, conductivity. The system also takes account facility to inform the user and the concerned authorities on variation of parameters in water bodies.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 Empathy solution

- The empathy map includes what do you think and what do you? they think about the human health affect, increase the chlorine concentration, affect the environment also.
- What do they and what do? present unwanted component and clean water.
- Pain of the problems are polluted water and shortage of water, disease.
- Gain of the empathy map is pure water and detect the temperature of the river water.

Fig 3.1: Empathy map

3.2 IDEATION & BRAINSTORMING

The ideation phase detects the main purpose of the project to work in the germs and bacteria present in the water and affect the eco system

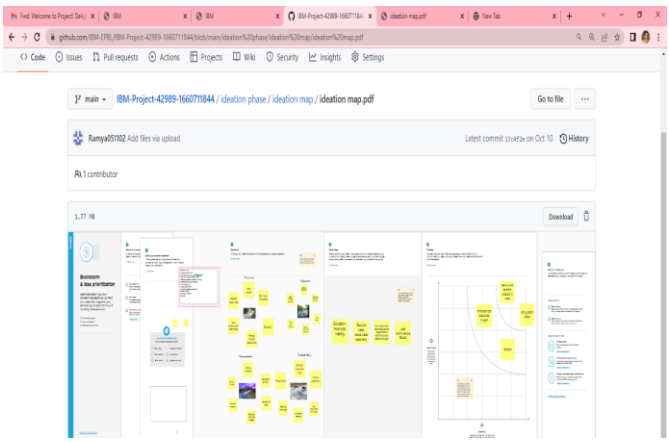


Fig 3.2: Ideation map

3.3 PROPOSED SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Water is a finite resource that is necessary for agriculture, industry and the survival of all living things on the planet, including humans. Many people are unaware of the need of drinking adequate amounts of water on a daily basis. Many unregulated methods waste more water. Poor water allocation, inefficient consumption, lack of competent and integrated water management are all factors that contribute to this problem. Therefore, efficient use and water monitoring are potential constraint for home or office water management system.
2.	Idea / Solution description	The solution to this problem is, to monitor the river water quality for the need of safe drinking water.
3.	Novelty / Uniqueness	The uniqueness is to obtain the water monitoring system with high frequency, high mobility, and low powered. Therefore, our proposed system will immensely help Bangladeshi populations to become conscious against contaminated water as well as to stop polluting the water.
4.	Social Impact / Customer Satisfaction	Using this application, we can track the contents in river water to make sure that the water is in safe limit for utilizing for general purpose on living things.
5.	Business Model (Revenue Model)	Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. The system consists of

3.4 PROBLEM SOLUTION FIT

PROBLEM SOLUTION FIT DOCUMENT Purpose/Vision

1.CUSTOMER SEGMENT(S) Farmers, Government authorities and Drinking Water supplier	**6.CUSTOMER CONSTRAINTS** River water quality analysis replaces the need for using laboratory checking and reduces the time of delay required for result. The give instant solutions and suggestions like what it is and what can be done to change.	**5.AVAILABLE SOLUTIONS** This work presents the architecture of river water monitoring systems based on contemporary IoT communication technology, AI, and Wireless Networks. AI-based IoT applications to boost and save time for results and suggestions to the problems.
2.JOBS-TO-BE-DONE / PROBLEMS • Check the water quality • Check the level of chlorine in water. • Check type of water • Find if the water is suitable for aquaculture	**9.PROBLEM ROOT CAUSE** Root Cause Analysis supported by input from the problems-sufferers, instruction manual studies, comparing design and actual operating data, gathering know how from relevant literature, tech journals articles and advertisements especially on new products.	**7.BEHAVIOUR** Understand this decision-making process, the study attempts to assess river water monitoring technology model based on available resources, prevailing social and economic conditions and personal aspects of users India.
3.TRIGGERS River water quality analysis work by providing essential nutrients for the development of farming and other industries. It is a best replacement for checking water quality in laboratories. The best quality is that it is user friendly. **4.EMOTIONS: BEFORE /AFTER** Without river water quality analysis it was difficult for farmers, industrialists and many more to analyze the quality of water for their purpose. After river water quality analysis, the process is made much simpler and easy to use.	**10. YOUR SOLUTION** • Implement IOT based river quality monitoring system to get instant results. • Suggestions can be made to solve if any problem araises.	**8.CHANNELS of BEHAVIOURS** Online portal for making recommendations for problems based on PH parameters using Machine Learning.

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / SubTask)
FR-1	User Registration	Registration through Form Registration through Email Registration through product mobile **UI**
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Ph level detection	To monitor the water quality Ph sensor is used and the signals are sent to Arduino.
FR-4	Turbidity detection	Turbidity sensor measures the clarity of element or muddiness utter in the water and the signals are send to Arduino.
FR-5	Ultrasonic generator	At regular interval times the waves are generated to clear algae 25%,50%,100%

4.2 Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	It has simple monitoring system and efficient to use
NFR-1	**Security**	Mobile application is secured with firewalls protection.
NFR-1	**Reliability**	Real time sensor output values with future predicted data storage. 98% efficient monitoring output. It also gives assurance for aquaculture safety.
NFR-1	**Performance**	It has greater performance and environmentally safe model.
NFR-1	**Availability**	In the form of mobile UI 24 x 7 monitoring system.
NFR-1	**Scalability**	Highly Scalable. It is capable to produce a best final output.
NFR-1	**Stability**	The stability is very high
NFR-1	**Efficiency**	It is highly efficient, high mobility and low powered

CHAPTER 5

PROJECT DESIGN

5.1 Data flow diagram

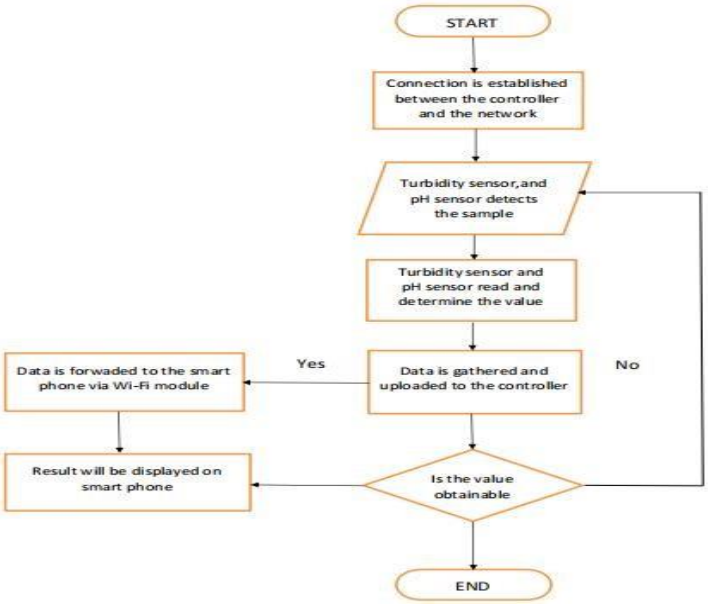


Fig 5.1: Data Flow Diagram

5.2 SOLUTION &TECHNICAL ARCHITECTURE

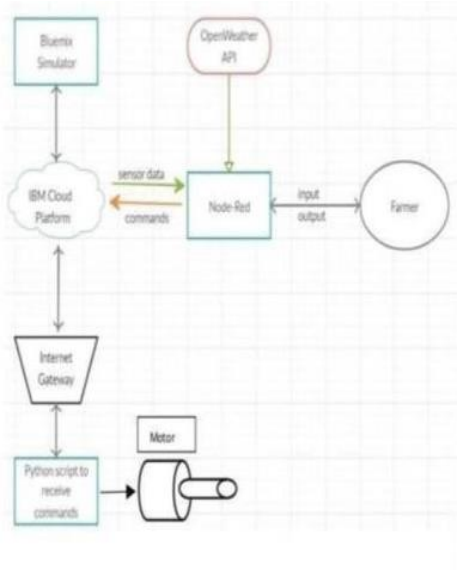


Fig 5.2 Solution &Technical Architecture

5.3 USER STORIES

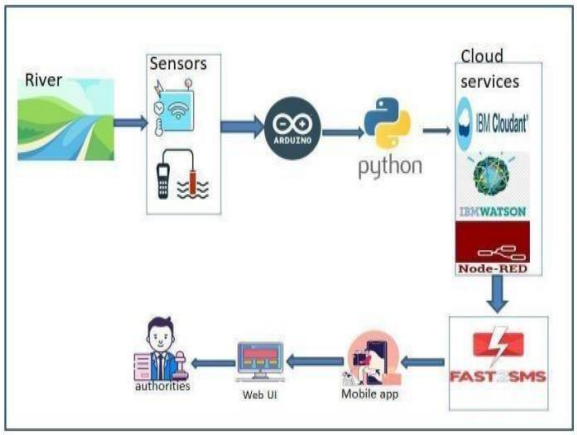


Fig 5.3 :User stories

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 Sprint planning and estimation

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.

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	Anushiya k
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	Iswarya M.
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	Jeyamary R
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	Ramya Lakshmi T
Sprint-1	Login	USN-5	As a user, I can log into the application by Enterin	1	High	Anushiya k

			g email & passwo rd			

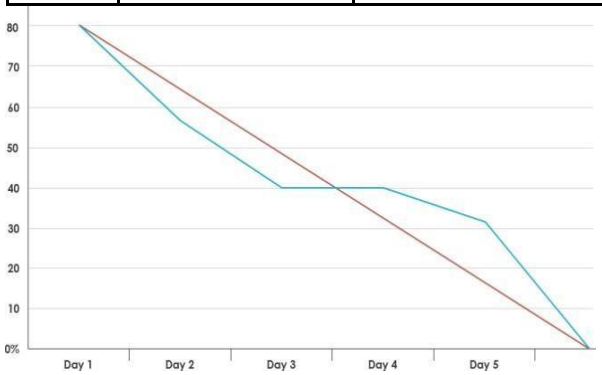
6.2 sprint delivery schedule

Sprint	**Total Story Points**	**Duration**	**Sprint Start Date**	**Sprint End Date (Planned)**	**Story Points Completed (as on Planned End Date)**	**Sprint Release Date (Actual)**
Sprint-1	20	6 Days	31 Oct 2022	5 nov 2022	20	4Nov 2022
Sprint-2	20	6 Days	1 Oct 2022	6 Nov 2022	30	7 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	49	13Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	50	18 Nov 2022

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

6.3 Reports from JIRA

1	Understanding the project requirement	The Aim is team members are assigned with tasks for each to be executed as a responsible team lead.Also create repository in the Github, Assign members and teach how to use and open the Github and IBM career education portals .	1 WEEK
2	Starting of project	Advisory of team lead to his team members based on regularly attending training sessions for installing and use of prerequiste . Also necessarily attending the training sessions based on python code,development of android app in mobile app invtr.com and working along NodeRed is ensured by the team lead and acknowledged by team members simultaneously.	1 WEEK



3	Attend class	Team members and team lead must watch and learn from classes provided by IBM and NALAYATHIRAN and must gain access of MIT license for their project.	4 WEEK
4	Budget and scope of project	Budgetary planning process taken up on whole as a team to detect the user compatible price to the buy the product based on budgetary on IOT and component level.	1 WEEK

CHAPTER 7

TESTING

Testing is more important in every project because we need to know the performance such that the value of product is depend up on the performance

7.1 Test Cases

1.Controlling of app from the phone

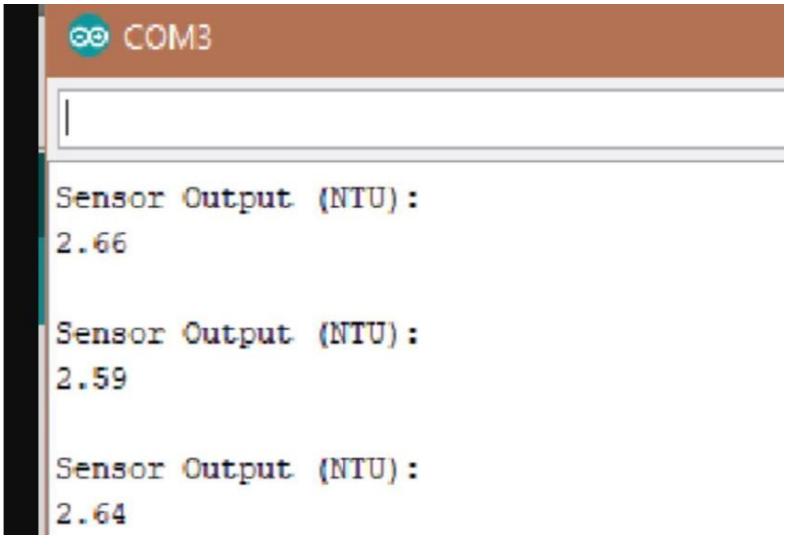
2.Time complexity of data flow.

3.Peformance

4.Data from node to UI and to user.

7.2 User Acceptance Testing

Most of our development is done through the IBM platforms so that the sensors suggested that no need of particular testing. But user performance is well and good.



CHAPTER 8

RESULTS

We are displaying the resulting sensed pH, temp, turbidity, and ORP values. It continuously senses the values of pH, temp, turbidity, and ORP and the resulting values are displayed to the LCD, PC or mobile in real-time. If the acquired value is above the threshold value comments will be displayed as ‘BAD’. If the acquired value is lower than the threshold value comments will be displayed as ‘GOOD’. A bar/line graph will also be shown for perfect understanding. The time series representation of sensor data with decision the resulting sensed pH, temp, turbidity, and ORP values. It continuously senses the values of pH, temp, turbidity, and ORP and the resulting values are displayed to the LCD, PC or mobile in real-time. If the acquired value is above the comments will be displayed as ‘GOOD’. A bar/line graph will also be shown for perfect understanding. Most of our development is done through the IBM platforms so that the sensors suggested that no need of particular testing. But user performance is well and good.

CHAPTER 9

ADVANTAGE AND DISADVANTAGE

ADVANTAGE

1.We can see the results from the hand set.

2.We can monitor the ph level.

3.We can deliver the good quality water through our app.

DISADVANTAGES

The drawback of the system is to the sensors and the maintain is somewhat hard its not like that fully on electronic device but there are sensors are present and we need to maintain.

CHAPTER 10

Conclusion

In this way that we can monitor the system from remote and we can make the living beings to drink and use good water by using this product.

CHAPTER 11

FUTURE SCOPE

We are seeing most of the natural resources are destroyed and being destroyed such that we the remaining for the feature generations. So, we can use this and ewe can save the river water from the harmful chemicals and we can preserve that water for the feature generations. These days everything is becoming artificial so many diplomats are said that the worlwar-3 should be on water. And so many rivers re-flowing from other neighboring countries there is chance that they can poisonous the flow such that the water become harmful and dangerous so that we can use this.

Chapter 12

APPENDIX

```
<html>
    <head>
        <meta charset="UTF-8">
        <title> Login </title>
        <link rel="stylesheet" href="{{ url_for('static', filename='style.css') }}">
    </head>
    <body></br></br></br></br></br>
        <div align="center">
          <div align="center" class="border">
            <div class="header">
              <h1 class="word">Login</h1>
            </div></br></br></br> <h2
           class="word">
              <form action="{{ url_for('login') }}"
method="post">                                  <div class="msg">{{ msg
                                                }}</div><input
                                                id="username"name="username"
 type="text" placeholder="Enter Your Username" class="textbox"/></br></br>
                                    <input id="password" name="password" type="password"
 placeholder="Enter Your Password" class="textbox"/></br></br></br>
                                <input type="submit" class="btn" value="Sign In"></br></br>
              </form>
            </h2>
            <p class="bottom">Don't have an account? <a class="bottom"
 href="{{url_for('register')}}"> Sign Up here</a></p>
          </div>
        </div>
    </body>
</html>
```

Register.html

```
<html>
    <head>
        <meta charset="UTF-8">
        <title> Register </title>
        <link rel="stylesheet" href="{{ url_for('static', filename='style.css') }}">
    </head>
    <body></br></br></br></br></br>
```

```
            <div align="center">
              <div align="center" class="border">
                  <div class="header">
                      <h1 class="word">Register</h1>
                  </div></br></br></br> <h2
                 class="word">
                          <form action="{{ url_for('register') }}"
method="post">                                    <div class="msg">{{ msg }}</div>
                                                    <input id="username" name="username"
 type="text" placeholder="Enter Your Username" class="textbox"/></br></br>
                                        <input id="password" name="password" type="password"
 placeholder="Enter Your Password" class="textbox"/></br></br>
                                <input id="email" name="email" type="text"
 placeholder="Enter Your Email ID" class="textbox"/></br></br>
                                <input type="submit" class="btn" value="Sign
Up"></br>                                          </form>
                                                    </h2>
                                                  <p class="bottom">Already have an account?
                                                  <a
 class="bottom" href="{{url_for('login')}}"> Sign In here</a></p> </div>
            </div>
        </body>
 </html>
```

Style.css

```
  .header{ padding: 5px 120px; width: 150px;
                    height:
                    70px; background-color: #236B8E;
                }

                .border{ padding: 80px 50px;
                    width: 400px; height:
                    450px;
                    border: 1px solid #236B8E; border-radius:
                    0px; background-color: #9AC0CD;
                }

                .btn {
                    padding: 10px 40px; background-
                    color: #236B8E; color: #FFFFFF;
```

```
        font-style: oblique; font-weight:
        bold; border-radius: 10px;
}

.textbox{ padding: 10px 40px;
        background-color: #236B8E; text-
        color: #FFFFFF; border-radius: 10px;
}

::placeholder { color:
        #FFFFFF; opacity: 1; font-
        style: oblique; font-
        weight: bold;
}

.word{ color: #FFFFFF; font-
        style: oblique; font-
        weight: bold;
}

.bottom{ color: #236B8E; font-
        style: oblique; font-
        weight: bold;
}
```

Python code

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

#Provide your IBM Watson Device
Credentials organization = "uyyqeq"
deviceType = "12345" deviceId =
"12345" authMethod = "token"
authToken = "12345678"

# Initialize GPIO def
myCommandCallback(cmd): print("Command
received: %s" % cmd.data['command'])
status=cmd.data['command'] if status=="light
on":

    print ("led is on")

  elif status == "light off":

    print ("led is 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()

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

deviceCli.connect()

while True:

      #Get Sensor Data from DHT11

      temp=random.randint(90,110)
      Humid=random.randint(60,100)

      data = { 'temp' : temp, 'Humid': Humid }

      #print data def myOnPublishCallback(): print ("Published Temperature = %s C" % temp,
      "Humidity = %s %%" % Humid, "to IBM Watson") success =
      deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
      on_publish=myOnPublishCallback) if not success:

         print("Not connected to IoTF")

      time.sleep(10) deviceCli.commandCallback

      = myCommandCallback


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

GitHub link

https://github.com/IBM-EPBL/IBM-Project-51278-1660977114