REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM

A PROJECT REPORT

Submitted by

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TABLE FOR CONTENT

7. **CODING & SOLUTIONING (Explain the features added in the project along with code)**
    a. Feature 1
    b. Feature 2
    c. Database Schema (if Applicable)
8. **TESTING**
    a. Test Cases
    b. User Acceptance Testing
9. **RESULTS**
    a. Performance Metrics
10. **ADVANTAGES & DISADVANTAGES**
11. **CONCLUSION**
12. **FUTURE SCOPE**
13. **APPENDIX**

    Source Code

    GitHub & Project Demo Link

1. INTRODUCTION

Water is the primary need of all living beings and living without water is impossible. With the advancement of technology and industrialization, environmental pollutions have become a major concadvancemer pollution is one of the most serious types of this environmental pollution. Our lives depend on the quality of water that we consume in different ways, from juices which are produced by the industries. Any imbalance in the quality of dissolved deseverely affect the humans' health and at the same time it would affect the ecological balance among all species. Water quality refers to the chemical, biological, radiological, and biological parameters of thewater.The essential parameters of the water quality vary based on the application of water. For example, for aquariums, it is necessary to maintain the temperature, pH level,dissolved oxygen level, turbidity, and the level of the water in a certain normal range in order to ensure the safety of the fish inside the aquarium. For the industrial and household applications, however, some parameters of the water are more essential tobe monitored frequently than the others, depending on the usage of the water.

1.1 Project Overview

Water quality testing is an inevitab part of environmental monitoring. There are various parameters that affect the quality of water in the environment that can be physical, chemical or biological. Physical properties of water quality are temperature

and turbidity. Chemical properties of water include parameters such as pH and dissolved oxygen. Biological parameters of water quality include algae and phytoplankton. Various papers suggest various methods for measuring the quality of water even though some are theoretical methods. For example the quality of water can be measured with the help of solar power or wireless sensor network. Depending up on the parameters monitored the accuracy of the result produced by each method may vary. This increases the scope of this topic since it consist of machine learning and data mining applications. In the suggested method, there are two components- hardware and software. Hardware component is used to collect data from various water bodies. Data collected from each water body will be saved to the database with the corresponding location. Software component is a mobile application through which users gets information about the quality of water in their surrounding area . Thesystem canmonitor water parameters to an accuracy comparable with standard manual techniques and it can control chemical dosages to an accuracy of +/-1.3ml. Tests have been performed using both rated and proportional pump control. Data can be written directly to an Excel worksheet for through and analysis. The system can publish its display to a webpage which can be accessed for both monitoring and control purposes using a laptop, PDA or mobile phone.

1.2 Purpose

Monitoring system is software that helps system administrat

monitor their infrastructure.These tools monitor system devices, traffic, and applications, and sound the alarmin the event of malfunctions and disruptions. There are lots of monitoring systems on the market, from freeware to profession software.The report provides information on local drinking water quality, including the water's source, contaminants found in the water, and how consumers can get involved in protecting drinking water. Monitoring provides the objective evidence necessary to make sound decisions on managing water quality todayand in the future

Benefits:

Restoring water systems once they have become impaired by contaminants is often a lengthy and costly process. It’s generally more cost-effective to prevent water quality degradation than to restore it after it has become .Water quality standards limit the amount of solids such as dirt and sand from getting into state waters. The U.S. Army Corps of Engineers is charged with keeping both the Duluth harbor and the Mississippi River navigable, and preventing sediment erosion saves the Army Corps extra dredging and expense.

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2. LITERATURE SURVEY

2.1 Existing problem

Existing system has a mechanisms which are semi-automated or manually controlled devices which are to be handled by a person responsible for monitoring the water quality . There is need to have human intervention in taking various reading of the water parameters.The instruments or tools are used either by putting/inserting awater sensing part into water and seeing the result on smalldisplay device or by directly inserting a portable device in water and watching the output on the display. Central WaterCommission (CWC) monitors water quality, by collecting samples from representative locations within the processing and distribution system.These samples are analyzed at the well- equipped laboratories.At these laboratories, samples of raw water, filter water andtreated water are taken for analysis, these analysis can be performed by human intervention which for specific period only. The disadvantage of this system is, water is not monitoring seamlessly, and it always needs a human intervention.

2.2 References

.[1] . K . Khurana, R. Singh , A. Prakash, Rn. Chhabrab, “An IoT Based Water Health Monitoring System ”, International Journal of Computer Technology and Applications (IJCTA) , 9(21) , pp. 07-13, 2016
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[2] Guidelines for Water Quality Monitoring Central", Central Pollution Control Board, 2007-2008

[3] A.S. Rao, S. Marshall, J. Gubbi, M. Palaniswami, R. Sinnott, V. Pettigrove, "Design of Low-cost Autonomous Water Quality Monitoring System", International Conference on Advances in Computing, Communications and Informatics (ICACCI),2013.

[4] ISO 7027, Water Quality, International Standard, 1990.

[5] WQA Glossary of Terms, by the Water Quality Association, Illinois 60532 USA, 3rd Edition, 1997.

[6] V. S. Hart, C. E. Johnson, and R. D. Letterman, An Analysis of Low - Level Turbidity measurements

2.3 Problem Statement Definition

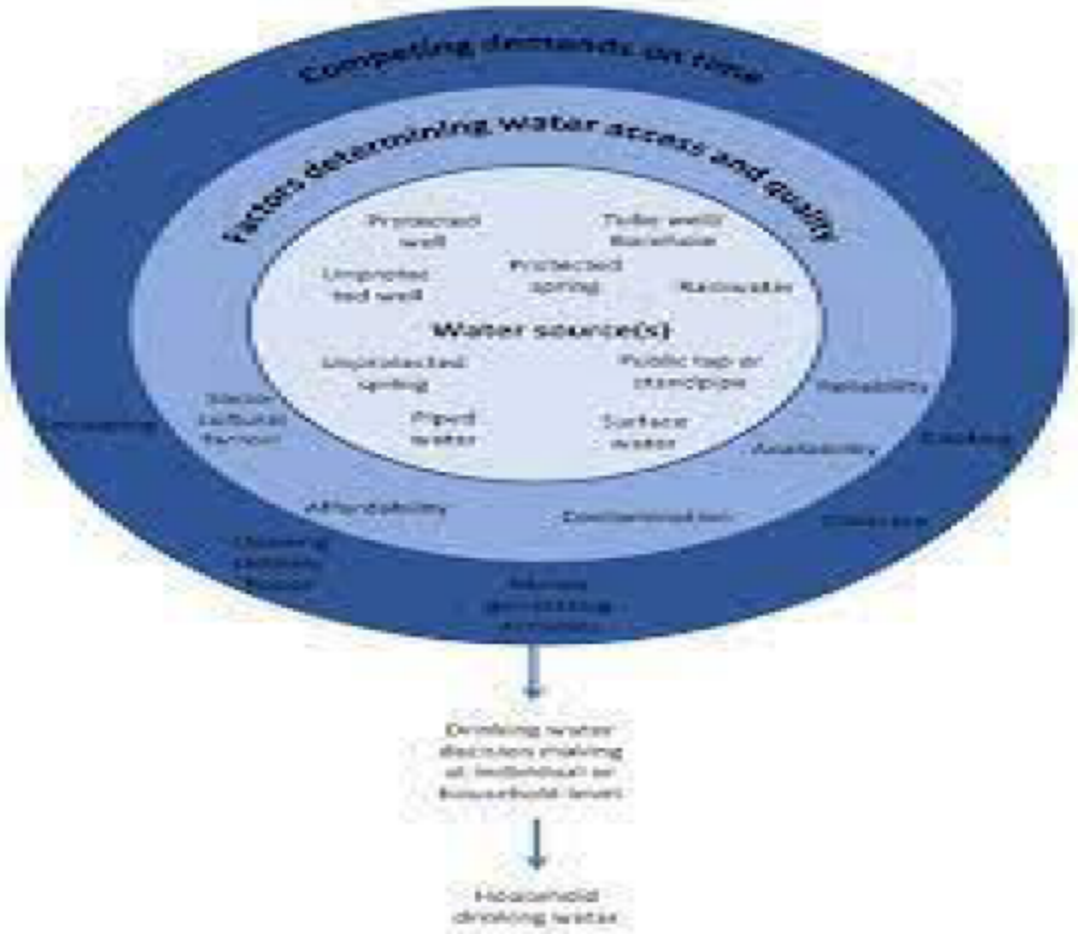
The most frequent water quality issue is due to the high content of iron (iron(III) oxide) and magnesium content in raw water of treated water. Water quality disorders occur as a result of changes in the color of the water that turns yellow to a dark brown color. The color change is due to action chemical reactions that are used in the water treatment process at the Treatment Plant (Kasan, 2006). This water treatment diagnostic and auditing process still uses manual methods, where water will be measured and the quality index will be clinically measured inside the laboratory. Besides, low pH levels cause fish killed by animals system and causing physical damage, which in turn makes them more vulnerable to disease.

Water is the most important source of survival for all beings on earth. Therefore, water safety issues are a very important issue. Consumer complaints and reports made by the relevant government departments indicate that consumers are dissatisfied with the quality of water supplied (Nithyanandam, Huan, & Thy, 2015). Hence, a concept in which equipment, machines, sensors and devices are connected to the Internet and there is data collection and transfer through the network developed to follow the river water quality index. Integration of the elements of sustainability and IR4.0 through the Internet of Thing by adopting electronic and Internet applications of Thing has a very positive impact to refresh the approach to lesions in Malaysia.

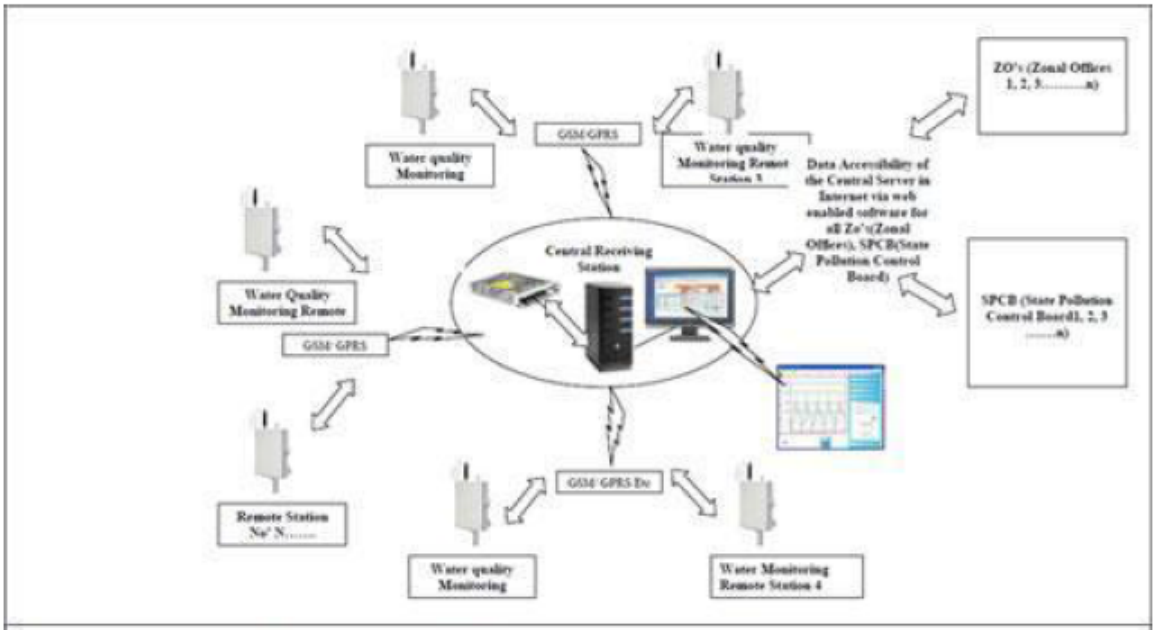
3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.


Competing demands on time
Factors determining water access and quality
Water source(s)
Affordability
Drinking water decision making at individual or household level
Household drinking water

Example:



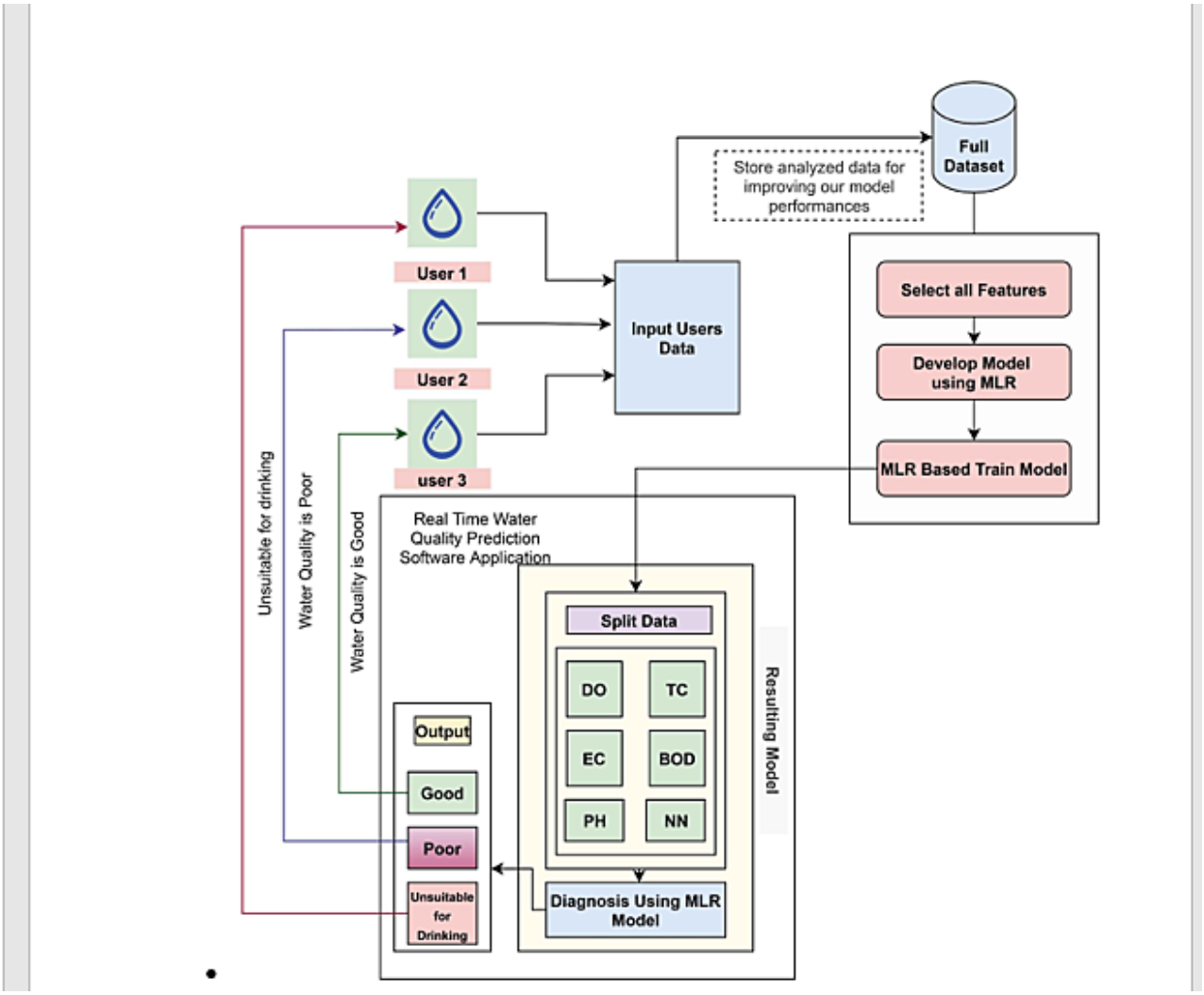
Source: Central Pollution Control Board

3.2 Ideation & Brainstorming

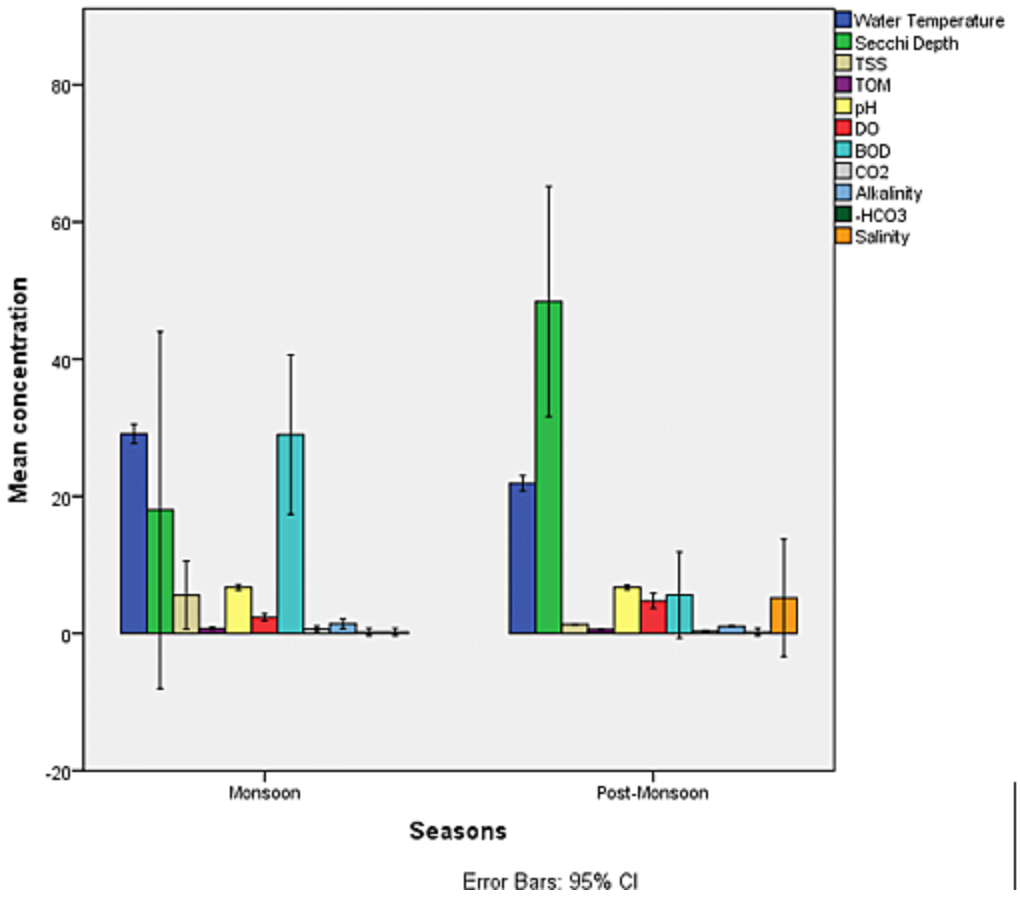
The system consists of several sensors which is used to measure physical and chemical parameters of the water. The main components of Wireless Sensor Network (WSN) include a microcontroller for processing the system, communication system for inter and intra node communication and several sensors. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology.

Step-1: Team Gathering, Collaboration and Select the Problem Statement

Step-2: Brainstorm, Idea Listing and Grouping



step 3: idea prioritization



3.3 Proposed solution

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Real time river water quality monitoring system which can be applied in remote rivers, lakes, coastal areas and other water bodies is presented
2.	Idea / Solution description	Collecting water samples for Laboratory analysis or by using probes which can record data at a single point in time .
3.	Novelty / Uniqueness	analyse data continually and instantly alert users to changes in the system, giving peace of mind and reducing the need for unreliable and expensive sampling.
4.	Social Impact / Customer Satisfaction	River pollution can impact all living beings.better Moni vegatation, health.

5.	Business Model (Revenue Model)	toring & control measures can impactSell the sensors & monitoring Systems as a services
6.	Scalability of the Solution	The prototype of real time sense water monitoring integrates may sensor such as turbidity sensor and quite unique.

3.4 Problem Solution Fit

1. If you want to do your part to keep water clean and pure in a manner that will protect the environment, it's important that you focus on water conservation when possible.

2. If you take a shower every day, opt for shorter showers that don't go longer than you require. You could also decide to take a bath, which uses much less water.

PURPOSES:

1. "Monitoring provides the objective evidence necessary to make sound decisions on managing water quality today and in the future.
2. Monitoring system is software that helps system administrators monitor their infrastructure. These tools monitor system devices,

traffic, and applications, and sound the alarm in the event of malfunctions and disruptions. There are lots of monitoring systems on the market, from freeware to professional software.

3. The report provides information on local drinking water quality, including the water's source, contaminants found in the water, and how consumers can get involved in protecting drinking water.

Template

4 . REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3		
FR-4		

4.2 Non-functional Requirements:

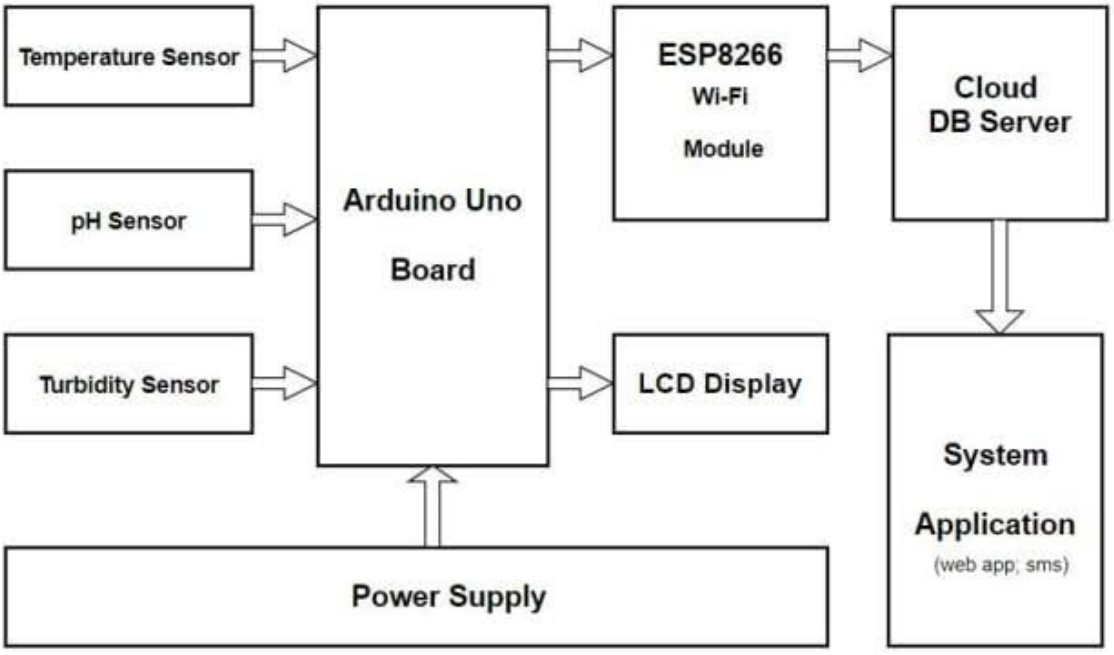
Following are the non-functional requirements of the proposed solution.

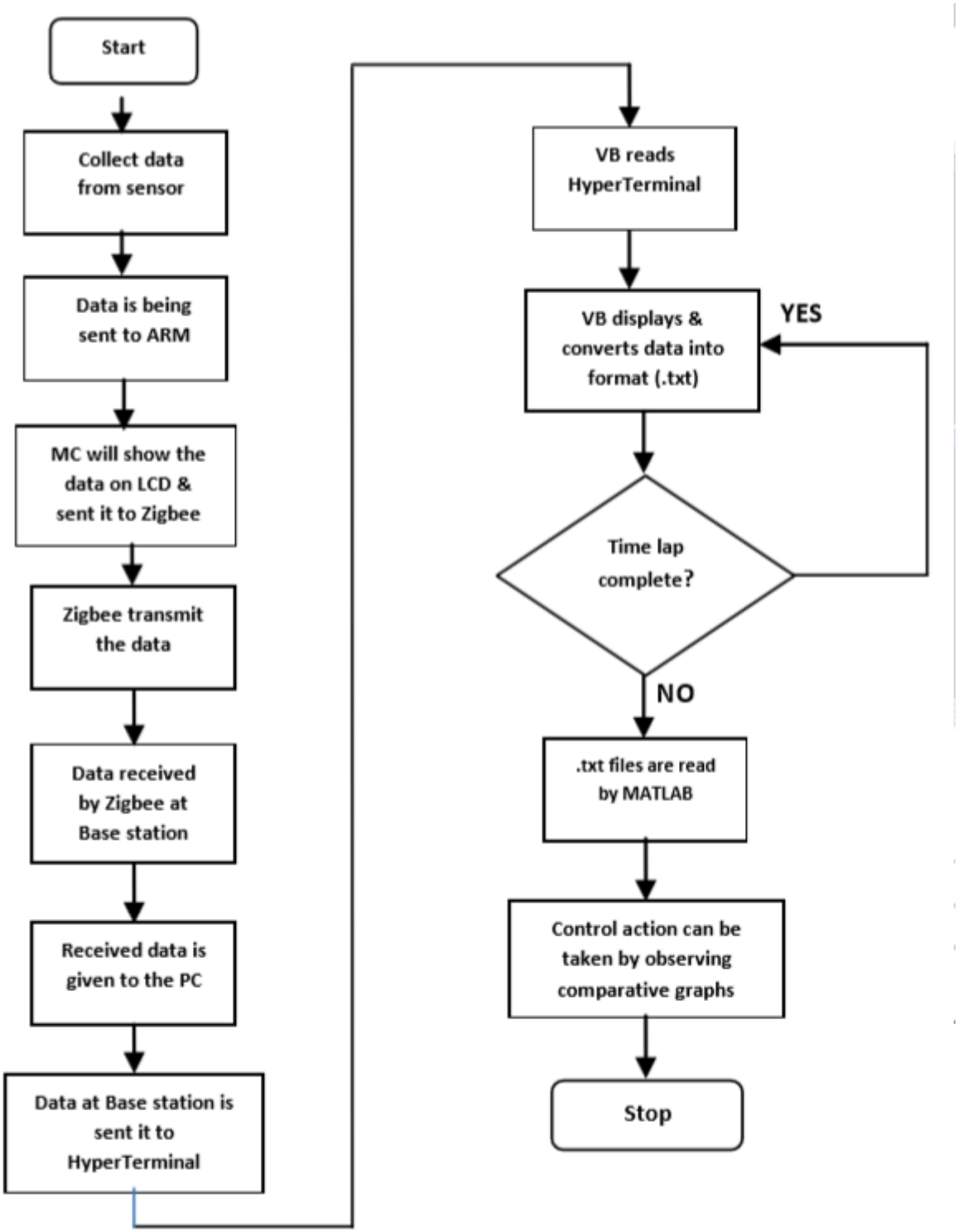
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The results were obtained by performing usability evaluation through the use modified goal usability
NFR-2	**Security**	This system uses different sensors for monitoring the water quality by determin pH, turbidity, conductivity and temperature.
NFR-3	**Reliability**	WSN is used to measure pH, temperature, turbidity and quantity of water us sensors at remote area using Microcontroller.
NFR-4	**Performance**	Water quality can be measured by collecting water samples for laboratory analy or by using probes which can record data at a single point in time, or logged regular intervals over an extended
NFR-5	**Availability**	The water quality measuring system that we have implemented checks the quality water in real time through various sensors
NFR-6	**Scalability**	The objective of water quality monitoring is to obtain quantitative information on physical, chemical, and biological characteristics of water via statistical sampling

5. PROJECT DESIGN

5.1 Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.




Start
Collect data from sensor
Data is being sent to ARM
MC will show the data on LCD & sent it to Zigbee
Zigbee transmit the data
Data received by Zigbee at Base station
Received data is given to the PC
Data at Base station is sent it to HyperTerminal
VB reads HyperTerminal
VB displays & converts data into format (.txt)
YES
Time lap complete?
NO
.txt files are read by MATLAB
Control action can be taken by observing comparative graphs
Stop

User Stories

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

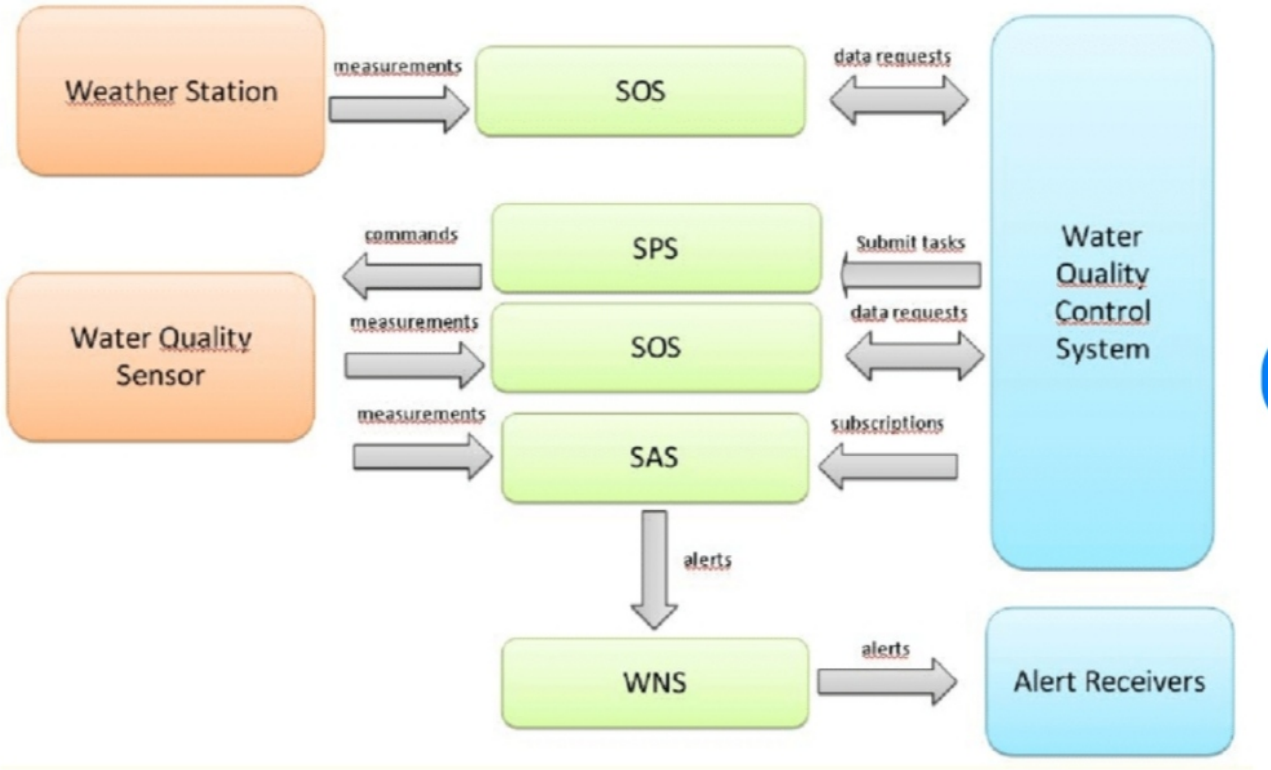
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard					
Customer (Web user)						
Customer Care Executive						
Administrator						

5.2 Solution & Technical Architecture

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

1. Find the best tech solution to solve existing business problems.
2. Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
3. Define features, development phases, and solution requirements.
4. Provide specifications according to which the solution is defined, managed,

and delivered.



5.3 User stories

- The quality parameters are labeled datasets including desired outputs of specific combination of inputs. Theneural network will produce output to classify water quality as dangerous, be careful, and good. The classificationlayer will run on top of Hadoop cluster.

- The advantages of using neural network based analytics are likeArtificial Neural Networks (ANNs) are good in learning and modeling non-linear relationships, and high volatile data [18]. Though neural networks are prone to over fitting, the neural network

model used inwater qualitymonitoring system is not complex enough to cause over fitting problem. there are many counter measures to avoid over fitting.

- Also, computation overload is not going to delay the response of system as there are only a fewwater quality parameters.

6 . PROJECT PLANNING &

SCHEDULING

6.1 Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2
Sprint-1	Login	USN-2	As a user, I will receive confirmation email once I have registered for the application	1
Sprint-2	User interface	USN-3	As a user, I can register for the application through Facebook	2
Sprint-1	Data visualization	USN-4	As a user, I can register for the application through Gmail	2
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	1
	Dashboard			

6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart:

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

6.3 Reports from JIRA

1.Real time visualization of temperature variation in water sample

2. Real time visualization of PH variation in water sample

3. Real time visualization of turbidity variation in water sample


Field 3 Chart
Water Quality Monitor
75
50
25
0
-25
turbidity
14:10
14:20
14:30
14:40
Date
ThingSpeak.com

7. CODING & SOLUTIONING

7.1 Feature 1

```
//include libraries
#include <SoftwareSerial.h>
#include <LiquidCrystal.h>
//for bluetooth - create an object called BTserial, with RX pin
at 3 and TX pin at 2
SoftwareSerial BTserial(3,2); // RX | TX
//decraration of all our variables
float reads;
int pin = A0;
float vOut = 0 ;//voltage drop across 2 points
float vIn = 5;
float R1 = 1000;
float R2 = 0;
float buffer = 0;
float TDS;
float R = 0;//resistance between the 2 wires
float r = 0;//resistivity
float L = 0.06;//distance between the wires in m
double A = 0.000154;//area of cross section of wire in m^2
float C = 0;//conductivity in S/m
```

```
float Cm = 0;//conductivity in mS/cm
int rPin = 9;
int bPin = 5;
int gPin = 6;
int rVal = 255;
int bVal = 255;
int gVal = 255;
//we will use this formula to get the resistivity after using
ohm's law -> R = r L/A => r = R A/L
//creating lcd object from Liquid Crystal library
LiquidCrystal lcd(7,8,10,11,12,13);
void setup() {
//initialise BT serial and serial monitor
Serial.begin(9600);
BTserial.begin(9600);
//initialise lcd
lcd.begin(16, 2);
//set rgb led pins (all to be pwm pins on Arduino) as output
pinMode(rPin,OUTPUT);
pinMode(bPin,OUTPUT);
pinMode(gPin,OUTPUT);
pinMode(pin,INPUT);
//Print stagnant message to LCD
lcd.print("Conductivity: ");
```

```
}
void loop() {
reads = analogRead(A0);
vOut = reads*5/1023;
Serial.println(reads);
// Serial.println(vOut);
buffer = (vIn/vOut)-1;
R2 = R1*buffer;
Serial.println(R2);
delay(500);
//convert voltage to resistance
//Apply formula mentioned above
r = R2*A/L;//R=rL/A
//convert resistivity to condictivity
C = 1/r;
Cm = C*10;
//convert conductivity in mS/cm to TDS
TDS = Cm *700;
//Set cursor of LCD to next row
lcd.setCursor(0,1);
lcd.println(C);
//display corresponding colours on rgb led according to the
analog read
if( reads < 600 )
```

```
{
if (reads <= 300){
setColor( 255, 0, 255 ) ;
} if (
reads >
200){
setColor( 200, 0, 255 ) ;
}
}
else{
if( reads <= 900 )
{
setColor( 0, 0, 255 ) ;
} if( reads >
700 )
{
setColor( 0, 255, 255 ) ;
}
}
//send data to Ardutooth app on mobile phone through
bluetooth
BTserial.print(C);
BTserial.print(",");
BTserial.print(TDS);
```

```
BTserial.print(";");
delay(500);
}
void setColor(int red, int green, int blue)
{
analogWrite( rPin, 255 - red ) ;
analogWrite( gPin, 255 - green ) ;
analogWrite( bPin, 255 - blue ) ;
}
```

Software required:

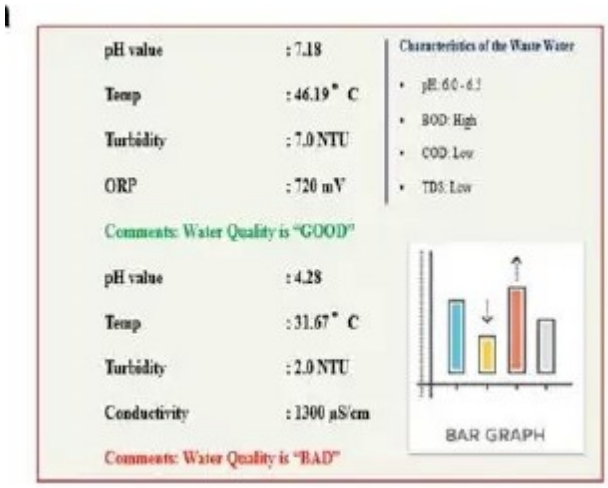
Arduino & C

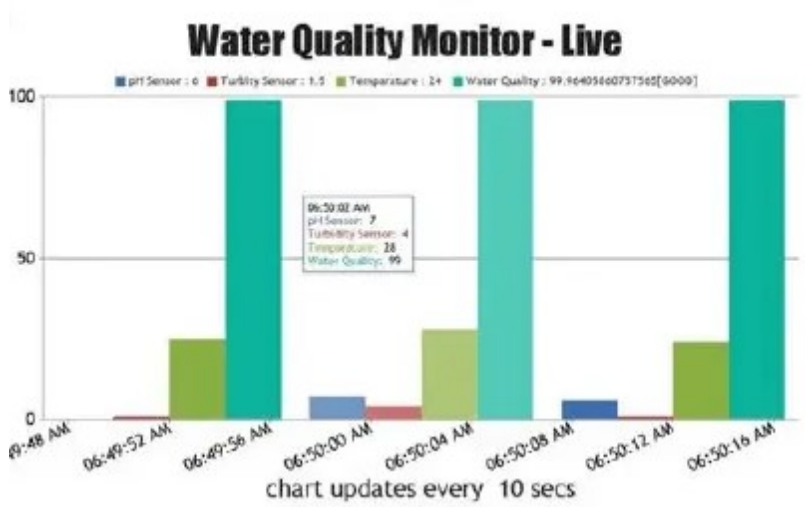
System required:

RAM-minimum 4gb processor-Min. Configuration OSWindows/ Linux/Mac

7.2 Feature 2

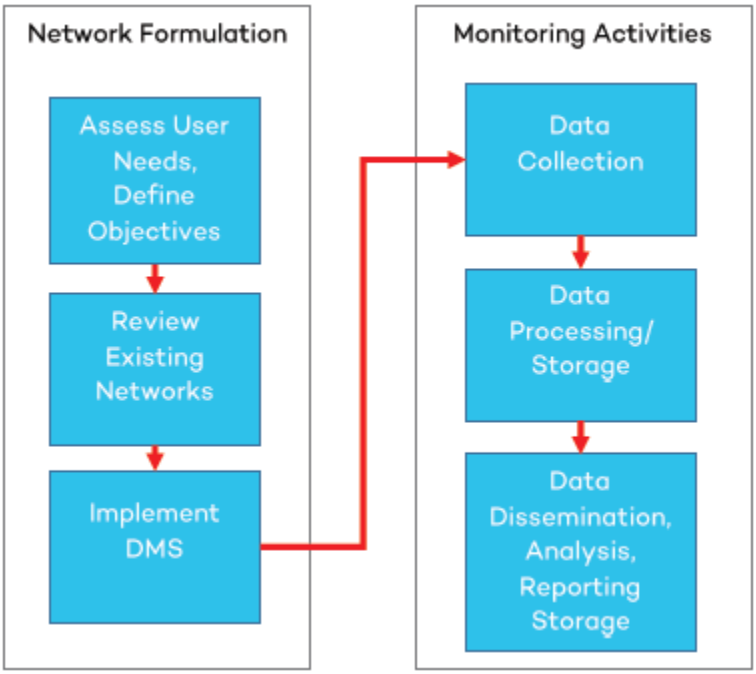
Output





7 .3 Database Schema (if Applicable)

Institutional, human and budgetary supports are aprerequisite for smooth operation and maintenance of the observation stations and the associated collection of data (World Bank, 2015). The institutions supporting the HIS must be developed in such a manner that the system is sustainable in the long run. The staff carrying out different activities under HIS are to be made available and must have the essential training to carry out the desired tasks.



8 . TESTING

8.1 Test Cases

Water quality depends on water composition influenced by natural processes and human activities.

Water quality is characterized on the basis of water parameters (physical, chemical, and microbiological), and human health is at risk if values exceed acceptable limits . Various agencies such as the World Health Organization (WHO) and Centers for Disease Control (CDC) set exposure standards or safe limits of chemical contaminants in drinking water.

A common perception about water is that clean water is good-quality water indicating knowledge gap about the presence of these substances in water. Ensuring availability and sustainable management of good-quality water is set as one of the Sustainable Development Goals (SDGs) and is a challenge for policy makers and Water, Sanitation and Hygiene (WASH) practitioners, particularly in the face of changing climatic conditions, increasing populations, poverty, and the negative effects of human development.

Water quality tests will give information about the condition of the waterway. By testing water over a period of time, the changes in the quality of the water can be seen. Parameters that may be tested include temperature, pH, turbidity, salinity, nitrates and phosphates.

8.2 User Acceptance Testing

User Acceptance Testing (UAT),which is performed on most UIT properties,sometimes called beta testing or end-user testing,is a phase of software development in which the software is tested in the ‘’real world’’ by the intended audience or business representative.

This type of testing is not intended to be menu-driven,but rather to be performed by business users to verify that the application will meet the needs of the end-user,with scanerios and data representative of actual usage in the field.

Test cases should be prepared by the business analyst,again allowing adequate time for review and approval by the business owner,and again ensuring that they are complete,approved, and uploaded to Zephyr before development exit.

9 . RESULTS

The system was tested under different conditions and withdifferent qualities of water. The output of the system wassuccessful and in accordance with the research objectives. As mentioned, the sensor readings are obtained on an LCD
screen on the device prototype itself.

We have identified a suitable implementation model that consists of different sensor devices and other modules, their functionalities are shown in figure. In this implementation model we used ATMEGA 328 with Wi-Fi module. Inbuilt ADC and Wi-Fi module connects the embedded device to internet. Sensors are connected to Arduino UNO board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated.

After sensing the data from different sensor devices, which are placed in particular area of interest. The sensed data will be automatically sent to the web server, when aproper connection is established with sever device.

10 . Advantages & Disadvantages

Advantages:

1.Water purification can protect against harmful organisms

Studies have shown that unfiltered water may comprise microorganisms causing diarrhoea, vomiting and even death. Water filtration systems are required to clean the water and kill these microorganisms in order to provide people with safe drinking water. Without water purification or some sort of treatment, 90 percent of the world’s water supply is unfit for drinking.

2 .Water purification removes toxic metals

Apart from the microorganisms that untreated water contains, it is also seen as a source of various minerals, including copper and magnesium. Even though some of these minerals do not necessarily pose a threat to

one’s health or life, they may react and respond to different minerals, like lead and copper, which are harmful to the human body. A variety of treatments, such as disinfectant agents, chemicals and filtration systems, are employed to help decrease risk and illness by removing as much as possible of the minerals from the water.

Disadvantages

1 .Water purification may not remove pesticides

Pesticides are often used on farms or garden and run the risk of discharging into water supplies. In the event that there is a well that is contaminated, it has to be tested for pesticide pollution, as only municipal water can be treated. In dealing with pesticides and using home water filtration systems, it may not always prove to be as effective. These systems can help with the removal of chlorine and other weighty and intense metals like mercury. It may however, not be able to remove pesticides. Of a bigger concern is long-term exposure to these pesticides in water which increases—increase the danger of getting serious diseases such as cancer.

2.Water purification require regular maintenance

Water purification systems that are home-made are not always effective in providing safe drinking water. These systems have to undergo regular maintenance and often have to be replaced in order to effectively filter out all the dangerous organisms and metals. Non-adherence to these prescriptions will cause one a lot more harm than drinking directly from a tap.

Water purification is an admirable concept, but should be implemented with utmost care. Water and filters should be maintained regularly, efficiently and effectively in order to secure safe drinking water. Water should be clear of microorganisms and toxic metals which can cause life threatening diseases. The water should be life-enhancing, and not life-threatening.

11 . CONCLUSION

In this work, the design and demonstration of a prototyperemote, automatic, portable, real time, and low cost waterquality monitoring system is described. In this system, low cost components i.e. microcontroller, LCD screen and other components are used to achieve the objectives of the proposed design with acceptable accuracy.

Compared to the previous related works, the cost of the system prototype is considerably low. Toensure the portability of the device, a self-made, small size Arduino microcontroller is used. The developed system was tested under different conditions, with solution of water with different impurities, and in different periods of time.

The results of the test for all times have been successful. We conclude that all the objectives of the proposed system have been achieved. To test more parameters of the water quality for some applications, other sensors can be included in the system. The system has wide application and it is usable and affordable by all categories of users.

12 . FUTURE SCOPE

At the time of paper submission the test rig is nearing completion and some preliminary testing has been conducted. Extensive testing of the monitoring and control system's response over extended periods of time is required and will be conducted along with testing of the system's response to standard pollutants and shock dosage of chemicals .

Dialogue with the relevant authorities has been opened in order to develop the best possible data analysis. A workshop showcasing the completed test rig with industry is scheduled for February 2010. The fiber optic turbidity sensor is currently under development and testing will occur in spring 2010.

Initial experimentation with biosensor components and processes will be conducted in parallel with these tests. Upon completion of these experiments the automated biosensor will be built it.

13 . APPENDIX

Source code

```
/

volatile char line2[MAXLINELENGTH];
/A7_Client.cpp
//Adapted from https://github.com/adafruit/Adafruit_GPS/blob/master/Adafruit_GPS.cpp
//Adafruit GPS library //16 Nov 2016 Capstone Project Water Quality Monitoring System

#include "A7Client.h
"
 #define A7Client_ENABLE_DEBUG
#define A7Client_ENABLE_RESP_DEBUG

SoftwareSerial* serialA7 = NULL

// how long are max NMEA lines to parse?
#define MAXLINELENGTH 100

// we double buffer: read one line in and leave one for the main program
```

```
volatile char line1[MAXLINELENGTH];
// our index into filling the current line volatile uint8_t lineidx=0;
// pointers to the double buffers volatile char* currentline = line1;
volatile char* lastline;
volatile boolean recvdflag = false;
volatile boolean inStandbyMode;

A7Client::A7Client(uint8_t rx, uint8_t tx, uint32_t baudRate){
serialA7 = new SoftwareSerial(rx, tx);
serialA7->begin(baudRate);
}
bool A7Client::init(){
}
bool A7Client::checkResponse(const char* resp, unsigned int timeout, unsigned int
chartimeout)
{
int len = strlen(resp);
int sum = 0;
unsigned long timerStart, prevChar; //prevChar is the time when the previous Char has
been read. timerStart = millis();
prevChar = 0;
while (1) {
if (serialA7->available()) {
char c = serialA7->read();
//debug purpose
```

```
#ifdef A7Client_ENABLE_RESP_DEBUG
Serial.print(c);
#endif
////
prevChar = millis();
sum = (c == resp[sum]) ? sum + 1 : 0;
if (sum == len)break;
}
if ((unsigned long) (millis() - timerStart) > timeout * 1000UL) {

Serial.println(F("Timeout"));
return false;
}
//If interchar Timeout => return FALSE. So we can return sooner from this function.
if (((unsigned long) (millis() - prevChar) > chartimeout) && (prevChar != 0)) {
Serial.println(F("InterChar Timeout"));
return false;
}
}
serialA7->flush();
return true;
}
void A7Client::changeBaud(){
while (1) {
Serial.println(F("Trying to change baud rate at 115200"));//change baud
```

```
rate at 115200
serialA7->write("AT+IPR=9600\r\n"); //need to change baud rate at every
startup, default
is 115200kbps
serialA7->write("AT+IPR=9600\r\n");
serialA7->write("AT+IPR=9600\r\n");
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serialA7->write("AT+IPR=9600\r\n");
serialA7->write("AT+IPR=9600\r\n");
if (checkResponse("\r\n", DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT )) {
//we got a response!
serialA7->end();
serialA7->begin(9600);
break;
}
else {
//try changing the baud to 9600... serialA7->end();
serialA7->begin(9600);
Serial.println(F("Trying to check baud rate at 9600"));
serialA7->write("AT\r\n"); //The first resposnd is almost always +CME
ERROR:58
something due to the try at 115200 kbps.
if (checkResponse("\r\n", DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT )) {
```

```
//we got a response!
break;
} else {
serialA7->write("AT\r\n");
if (checkResponse("OK\r\n", DEFAULT_TIMEOUT, DEFAULT_INTERCHAR_TIMEOUT ))
{

break;
} else {
serialA7->flush();
serialA7->write("AT\r\n");

if (checkResponse("OK\r\n", DEFAULT_TIMEOUT, DEFAULT_INTERCHAR_TIMEOUT )) {

break;
}
}
}
//If there is no response, change it back to 115200 baud and repeat...
serialA7->end();

serialA7->begin(115200);
}
}
Serial.println(F("Baud changed to 9600"));
```

```
}
bool A7Client::startGPS(){
serialA7->write("AT+GPS=1\r\n");
if(checkResponse("OK\r\n",  15,  DEFAULT_INTERCHAR_TIMEOUT
)){ //15 seconds, serialA7->write("AT+GPSRD=1\r\n");
if(checkResponse("OK\r\n",                    DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT
)){

Serial.println(F("GPS Started"));
return true;
}else {
Serial.println(F("GPS Start Failed 1"));
return false;
}
}else {
Serial.println(F("GPS Start Failed 2"));
return false;
}
}
bool A7Client::readGPS(){
Serial.println(F("reading from GPS..."));
if          (checkResponse("+GPSRD:$",          DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT
)){
Serial.println(F("After checkresponse?"));
lineidx = 0;
```

```
char c = 0;
// char buffer[20];
// while(serialA7->available()){
while(!recvdflag){
while(serialA7->available()){
// Serial.println(F("Reading..."));
c = serialA7->read();
Serial.print(c);
if (c == '\n') {
currentline[lineidx] = 0;
if (currentline == line1) {
currentline = line2;
lastline = line1;
} else {
currentline = line1;
lastline = line2;
}
lineidx = 0;
recvdflag = true;
Serial.println(F("Looks like array is READY!"));
// Serial.println("----");
// Serial.println((char *)lastline);
// Serial.println("----");

return true;
}
// Serial.println(F(""));
```

```
currentline[lineidx++] = c;
if (lineidx >= MAXLINELENGTH){
lineidx = MAXLINELENGTH-1;
return false;
}
}
}
}
}
char* A7Client::lastNMEA(void){
recvdflag = false;
return (char*) lastline;
}
uint8_t A7Client::parseHex(char c) {
if (c < '0')
return 0;
if (c <= '9')
return c - '0';
if (c < 'A')
return 0;
if (c <= 'F')
return (c - 'A')+10;
// if (c > 'F')
return 0;
}
bool A7Client::parse(char *nmea) {
// do checksum check
```

```
// first look if we even have one
if (nmea[strlen(nmea)-4] == '*') {
uint16_t sum = parseHex(nmea[strlen(nmea)-3]) * 16;
sum += parseHex(nmea[strlen(nmea)-2]);
// check checksum
//shouldn't we start from i=0?????
for (uint8_t i=0; i < (strlen(nmea)-4); i++) {
// Serial.println(nmea[i]);
sum ^= nmea[i];
}
if (sum != 0) {
// bad checksum :(
Serial.print(F("Checksum = "));
// Serial.println(sum);
return false;
}
}else {
Serial.println(F("No * delimiter"));
return false;
}
int32_t degree;

long minutes;
char degreebuff[10];
// look for a few common sentences
if (strstr(nmea, "GPGGA")) {
// found GGA
```

```
char *p = nmea;
// get time
p = strchr(p, ',')+1;
float timef = atof(p);
uint32_t time = timef;
hour = time / 10000;
minute = (time % 10000) / 100;
seconds = (time % 100);
milliseconds = fmod(timef, 1.0) * 1000;
// parse out latitude
p = strchr(p, ',')+1;
if (',' != *p)
{
strncpy(degreebuff, p, 2);
p += 2;
degreebuff[2] = '\0';
degree = atol(degreebuff) * 10000000;
strncpy(degreebuff, p, 2); // minutes
p += 3; // skip decimal point
strncpy(degreebuff + 2, p, 4);
degreebuff[6] = '\0';
minutes = 50 * atol(degreebuff) / 3;
latitude_fixed = degree + minutes;
latitude = degree / 100000 + minutes * 0.000006F;
latitudeDegrees = (latitude-100*int(latitude/100))/60.0;
latitudeDegrees += int(latitude/100);
}
```

```
p = strchr(p, ',')+1;
if (',' != *p)
{
if (p[0] == 'S') latitudeDegrees *= -1.0;
if (p[0] == 'N') lat = 'N';
else if (p[0] == 'S') lat = 'S';
else if (p[0] == ',') lat = 0;
else return false;
}
// parse out longitude
p = strchr(p, ',')+1;
if (',' != *p)
{
strncpy(degreebuff, p, 3);
p += 3;
degreebuff[3] = '\0';
degree = atol(degreebuff) * 10000000;
strncpy(degreebuff, p, 2); // minutes
p += 3; // skip decimal point
strncpy(degreebuff + 2, p, 4);
degreebuff[6] = '\0';

minutes = 50 * atol(degreebuff) / 3;
longitude_fixed = degree + minutes;
longitude = degree / 100000 + minutes * 0.000006F;
longitudeDegrees = (longitude-100*int(longitude/100))/60.0;
longitudeDegrees += int(longitude/100);
```

```
}
p = strchr(p, ',')+1;
if (',' != *p)
{
if (p[0] == 'W') longitudeDegrees *= -1.0;
if (p[0] == 'W') lon = 'W';
else if (p[0] == 'E') lon = 'E';
else if (p[0] == ',') lon = 0;
else return false;
}
p = strchr(p, ',')+1;
if (',' != *p)
{
fixquality = atoi(p);
}
p = strchr(p, ',')+1;
if (',' != *p)
{
satellites = atoi(p);
}
p = strchr(p, ',')+1;
if (',' != *p)
{
HDOP = atof(p);
}
p = strchr(p, ',')+1;
if (',' != *p)
```

```
{
altitude = atof(p);
}
p = strchr(p, ',')+1;
p = strchr(p, ',')+1;
if (',' != *p)
{
geoidheight = atof(p);
}
Serial.println(F("Completed conversion!"));
return true;
}
return false;
}
int A7Client::connect(IPAddress ip, uint16_t port){
char host[16] = {0};
snprintf(host, 15, "%d.%d.%d.%d", ip[3], ip[2], ip[1], ip[0]);
return connect(host, port);

}
int A7Client::connect(const char *host, uint16_t port)
{
serialA7->write("AT+CIPSTART=\"TCP\",\"");
serialA7->write(host);
serialA7->write("\",");
serialA7->print(port); //Too lazy to solve this uint16_t into uint8_t problem
```

```
serialA7->write("\r\n");
Serial.println(F("Opening TCP via AT"));
if(checkResponse("CONNECT OK\r\n", DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT )){
serialA7->flush();
A7_DEBUG("Connected");
return true;
}else {
A7_DEBUG("Connect failed");
return false;
}
}
void A7Client::A7_DEBUG(char *msg){
#ifdef A7Client_ENABLE_DEBUG
Serial.print(F("Debug: "));
Serial.println(msg);
#endif
}
size_t A7Client::write(uint8_t b){
return write(&b, 1);
}
size_t A7Client::write(char *buf){
if (buf == NULL) return 0;
return write((const uint8_t *)buf, strlen(buf));
}
size_t A7Client::write(const uint8_t *buf, size_t size)
{
```

```
serialA7->write("AT+CIPSEND\r\n");
if(checkResponse(">", DEFAULT_TIMEOUT, DEFAULT_INTERCHAR_TIMEOUT ))
{
A7_DEBUG(">shown, sending bytes");
serialA7->write(buf, size);
//serialA7->write(0x0D);
//serialA7->write(0x0A);
//serialA7->write(0x0D);
//serialA7->write(0x0A);
serialA7->write(0x1A); //required on A7 module to signal the end of command
if(checkResponse("OK\r\n", DEFAULT_TIMEOUT, DEFAULT_INTERCHAR_TIMEOUT
))
{

A7_DEBUG("Send succeeded");
return size;
}
}
}
size_t A7Client::writeSerial(uint8_t b){ //send command directly thorugh serial
return writeSerial(&b, 1);
}
```

```
size_t A7Client::writeSerial(char *buf)
{
  if (buf == NULL) return 0;
   return writeSerial((const uint8_t *)buf, strlen(buf));
}
  size_t A7Client::writeSerial(const uint8_t *buf, size_t size)
{
    return serialA7->write(buf, size);
}
   int A7Client::available()
{
  return serialA7->available();
}
  int A7Client::read()
{
    return serialA7->read();
}
  int A7Client::read(uint8_t *buf, size_t size)
{
return size;
}
void A7Client::flush()
{
serialA7->flush();
}
int A7Client::peek()
{
```

```
serialA7->peek();
}
void A7Client::stop()
{
if (connected())
{
serialA7->write("AT+CIPCLOSE\r\n");
if(checkResponse("OK\r\n",                    DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT
)){

A7_DEBUG("Close succeeded");
}else{
A7_DEBUG("Close failed");
}
}else
{
A7_DEBUG("Nothing to be closed");
}
}
uint8_t A7Client::connected()
{
    serialA7->write("AT+CIPSTATUS\r\n");
   if(checkResponse("CONNECT  OK  \r\n",  DEFAULT_TIMEOUT,
DEFAULT_INTERCHAR_TIMEOUT ))
{
    serialA7->flush();
```

```
    A7_DEBUG("Connected");
     return 1;
}else
{
A7_DEBUG("Not connected");
    return 0;

}
}
A7Client::operator bool()
{
    return (connected()==1);
}
```

Github final Code Link: https://github.com/IBM-EPBL/IBM-Project-32000-1660207329

Project Demo Video Link: https://youtu.be/EivZzAc7Df4