Sponsored Thesis Project Competition on

“RE-IMAGINING URBAN RIVERS”

Season- 3

Project Title : Intelligent Water Quality Detection tool for rejuvenating water body

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PREFACE

Today we can see that most of the river and lakes, which have made our life prosper for ages is towards exhaustion. These are mainly due to the people's ignorance of the things that are effortlessly available to them and, their care for them has gradually decreased. And this negligence has led to the contamination of 351 rivers from 400 rivers as of the 2021 river census. River pollution has caused the lives of many living beings including humans. Dwelling on these contaminated water bodies has created many health risks like cancer, diarrheal disease, respiratory disease, neurological disorder and cardiovascular disease. The major contaminants are factory effluents which comprise 75% of pollution by releasing chemicals like fluoride, nitrates, arsenic etc. , the rest 25% of pollution is caused by dumping of human, animal and plant waste into the water bodies. Moreover, disposal of dead bodies, and immersion of idols have caused these water bodies to degenerate. Another serious issue is the decreasing amount of pure water, like the groundwater. This is caused by the excessive or unwanted usage of these water bodies.

Water quality prediction provides an important suggestion for the prevention of water pollution. At present, the water quality assessment involves gathering of water samples at various locations monthly or weekly and tested in laboratories. This method is not good because water samples from a few locations can be tested simultaneously. This procedure involves a lot of manual work and high equipment costs. The implementation of this method is not possible in largely populated countries like India and China.

According to that, it is very necessary to implement and adopt the distributed aqua prediction model that can provide a powerful tool to implement the aqua resource management system. This proposed water quality detection tool detects the quality of water at any place by giving the longitude and latitude of one location. The proposed water quality detection tool produces high data capabilities, fewer error rates and good data quality.

ACKNOWLEDGEMENTS

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1. Introduction

Today, we can see that most of the rivers and lakes that have sustained human lives for centuries are nearing their end. These are mainly due to the people's ignorance of the things that are effortlessly available to them and their care for them has gradually decreased. And this negligence has led to the contamination of 351 rivers from 400 rivers as of the 2021 river census. River pollution has caused the lives of many living beings including humans. Dwelling on these contaminated water bodies has created many health risks like cancer, diarrheal disease, respiratory disease, neurological disorder, and cardiovascular disease. The major contaminants are factory effluents which comprise 75% of pollution by releasing chemicals like fluoride, nitrates, arsenic, etc., the rest 25% of pollution is caused by dumping of human, animal, and plant waste into the water bodies. Moreover, the disposal of dead bodies and immersion of idols have caused these water bodies to degenerate. Another serious issue is the decreasing amount of pure water, like groundwater. This is caused by the excessive or unwanted usage of these water bodies.

Water quality prediction is a key idea for water pollution prevention. Currently, water quality assessment involves collecting water samples from various areas on a monthly or weekly basis and testing them in laboratories. This method is ineffective since water samples from multiple locations might be analyzed at the same time. This technique requires a lot of manual labor and expensive equipment. This strategy cannot be implemented in densely populated nations such as India and China.

As a result, it is critical to construct and adopt the distributed aqua prediction model, which can serve as a powerful tool for implementing the aqua resource management system. This suggested water quality detection tool detects water quality at any location by providing the longitude and latitude of a single site. The proposed water quality detection tool is a low-cost method that yields high data capacities, low error rates, and high data quality. Water quality data can be collected and transferred from previously inaccessible places using low-cost IoT devices using cellular or satellite connectivity, contributing to a more comprehensive understanding of global water resources.

2. Literature Review

Monitoring water quality is vital in the current scenario since industrialization causes severe water pollution and different researchers take different approaches;

Sathish Pasika and Sai Teja Gandla [1] proposed a system consisting of four sensors thatwhich are used to measure temperature, turbidity, pH value present in the water, and ultrasonic sensor. The system hardware was designed by using two target boards : Arduino Mega an ATmega2560-based microcontroller and Node MCU, which is an open source IOT platform. All the data which are collected by the four sensors are processed by the MCU unit and then it is updated to the Thingspeak application which is a mobile-based application using Wi-Fi communication. The whole system is embedded-C and the same can be simulated in Arduino IDE.

Mukta et al. [2] developed an IoT-based Smart Water Quality Monitoring (SWQM) system that helps in the incessant measurement of the quality of water on the basis of four different parameters of water quality i.e., pH, temperature, turbidity, and electric conductivity. Four different sensors are coupled to Arduino Uno in order to sense the quality parameters. The data collected from all four sensors are communicated to a desktop application which is developed in the .NET platform and the extracted data are matched with the standard values. The standard values to which we are comparing the values from the sensors are the government-prescribed values. The water samples are taken from different areas and every time the data collected will be stored. On the basis of the collected data from sensors, the developed SWQM model will efficiently examine the water quality by employing a fast forest binary classifier for the classification of the sample of water under test whether potable or not.

Vaishnavi . V and Dr. M.A Gaikwad [3] proposed real-time monitoring of water quality in the IoT environment. The proposed circuit consists of a pH sensor, Arduino, temperature sensor and power supply, and Wi-fi module. The core controller is accessing the sensor values and it will process the data which is given by the sensors to transfer the data through the internet. The flow sensor is also used along with the temperature sensor, turbidity this sensor is used to measure the flow of water through the flow sensor. The sensor can be used in the distribution of water pipes. As the water pipes contain moisture there is the formation of bacteria through which they may get contaminated so when the water flow is sensed the data will be displayed on LCD which is also integrated with the Arduino.

Yuhao Wang and Ivan Wang-Hei Ho [4] proposed Deteriorating water quality leads to the freshwater biodiversity crisis. The interrelationships among water quality parameters and the relationships between these parameters and taxa groups are complicated in affecting biodiversity. Nevertheless, due to the limited types of Internet-of-Things (IoT) sensors available on the market, a large number of chemical and biological parameters still rely on laboratory tests. With the latest advancement in Artificial intelligence and the IoT (AIoT), this technique can be applied to real-time monitoring of water quality, and further conserving biodiversity. A comprehensive literature review on water quality parameters that impact the biodiversity of freshwater and identified the top 10 crucial water quality parameters. Among these parameters, the interrelationships between the IoT measurable parameters and IoT unmeasurable parameters are estimated using a general regression neural network (GRNN) model and a multivariate polynomial regression (MPR) model based on historical water quality monitoring data. Conventional field water sampling and in-lab experiments, together with the developed IoT-based water quality monitoring system were jointly used to validate the estimation results along an urban river in Hong Kong. The GRNN can successfully distinguish the abnormal increase of parameters against normal situations. For the MPR model of degree 8, the coefficients of determination results are 0.89, 0.78, 0.87, and 0.81 for NO3-N, BOD, PO4, and NH3-N, respectively. The effectiveness and efficiency of the proposed systems and models were validated against laboratory results and the overall performance is acceptable with most of the prediction errors smaller than 0.2 mg/L, which provides insights into how AIoT techniques can be applied to pollutant discharge monitoring and other water quality regulatory applications for freshwater biodiversity conservation.

Harish H. Kechannavar, Prasad M. Pujar, Raviraj M. Kulkarni and Umakant [5] have proposed Freshwater is the planet's most important natural resource and is prone to pollution, making it necessary for real-time monitoring. The Internet-of-Things (IoT)- enabled water quality monitoring (WQM) system enables real-time monitoring of freshwater resources. The WQM uses physicochemical parameters, such as temperature, pH, dissolved oxygen, electrical conductivity, biochemical oxygen demand, nitrate, and total dissolved solids to control the water quality. The advent of IoT has proven its effectiveness in capturing, studying, and continuously transmitting environmental data in real-time. Mineral-rich watersheds experience the exploitation of available resources in and around rivers, leading to urgent real-time monitoring of river water. The operation pollutes the water by mixing different types of toxic waste, namely, urban, industrial, and agricultural, making it unusable for human activities. In India, the traditional method of taking samples from the site, bringing them to the laboratory, and performing the analysis of the samples is in practice, it takes a day or two to get results and it does not happen in real-time, causing water-borne diseases among inhabitants of watersheds.

This article attempts to assess the water quality of the Ghataprabha river. Water samples are taken from the river via the WQM system from identified sampling points and subjected to linear regression analysis to estimate the relationships and goodness of fit between the parameters. Once the parameter relationship is known, a one-way ANOVA is applied to the water samples, and the water quality is analyzed using the ANOVA hypothesis. Additionally, the river data set can be used to train the WQM system.

Harleen Kaur, Anand Kr Shukla and Harpeet Singh [6] have proposed that nowadays Indian agriculture is declining, disturbing production. It is essential to solve this problem in the agriculture field to improve the growth of crops. The solution for this low growth of crops is the use of modernizing the way of monitoring the agricultural fields. The use of the internet of things in agriculture improves smart agriculture. The different applications of IoT enhance the way of agriculture. Internet of Things information technologies and techniques provide different applications of agriculture such as irrigation, water monitoring, soil monitoring, and pesticide control techniques. Different remote systems and wireless communication techniques are used in agriculture. Various sensors and models for monitoring are introduced using IoT technologies. Experiments are performed on the different IoT sensors and IoT systems which provide knowledge and smart results for smart agriculture. The combination of sensors and agriculture can enhance the development of techniques of smart agriculture, effective solutions to the issues of agriculture, and improve growth.

Quichan BAI, Jiahao Wu, and Chunxia JIN [7] have proposed that due to the poor real-time performance of water quality monitoring, secondary pollution, high cost, and other issues, this paper proposes to use wireless sensor network technology to design a water quality monitoring system. The system has strong real-time, online monitoring functions, and acquires multiple parameter data that affect water quality, timely and accurately monitors water quality information, prevents water environmental pollution, reduces the impact of water pollution, and meets the requirements of efficient and intelligent water quality.

From the literature review, all the works use common water quality parameter temperature, pH, BOD, DO, and Nitrate.

3. Proposed Work

The water quality parameter values are collected from the various locations through temperature sensors, pH sensors, Turbidity sensors, DO sensors, ORP sensors, Temperature sensor. Then the data is distributed worldwide in multiple forms like file formats, message queue formats, web services, and databases. This tool can minimize the logistics and workers needed for capturing samples to be agents and various sensors can help to reduce errors in records and delays in obtaining data. The description of parameters and the standard range of each parameter is given below

- Water temperature is an important element of control strategies against Legionella. Wherever possible, water temperatures should be kept outside the range of 25–50 °C and preferably outside the range of 20–50 °C to prevent the growth of the organism.
- pH sensor is one of the most essential tools that's typically used for water measurements. This type of sensor is able to measure the amount of alkalinity and acidity in water. The pH of most drinking water lies within the range of 6.5–8.5.
- All aquatic animals need DO to breathe. Low levels of oxygen (hypoxia) or no oxygen levels (anoxia) can occur when excess organic materials, such as large algal blooms, are decomposed by microorganisms. Dissolved oxygen sensors and dissolved oxygen probes are used to measure the amount of oxygen that is in dissolved water, by unit volume. Healthy water should generally have dissolved oxygen concentrations above 6.5-8 mg/L and between about 80-120 %.
- Nitrate is found naturally in water and is not harmful at low levels. At high levels, however, nitrate is harmful to aquatic ecosystems and, if found in potable water, can also be harmful to human health. Natural processes can cause low levels of nitrate in drinking water—usually less than 3 mg/L. The health concern is with levels of nitrate over 10 mg/L. High levels of nitrate in water can be a result of runoff or leakage from fertilized soil, wastewater, landfills, animal feedlots, septic systems, or urban drainage.

The following figures depict the proposed architecture

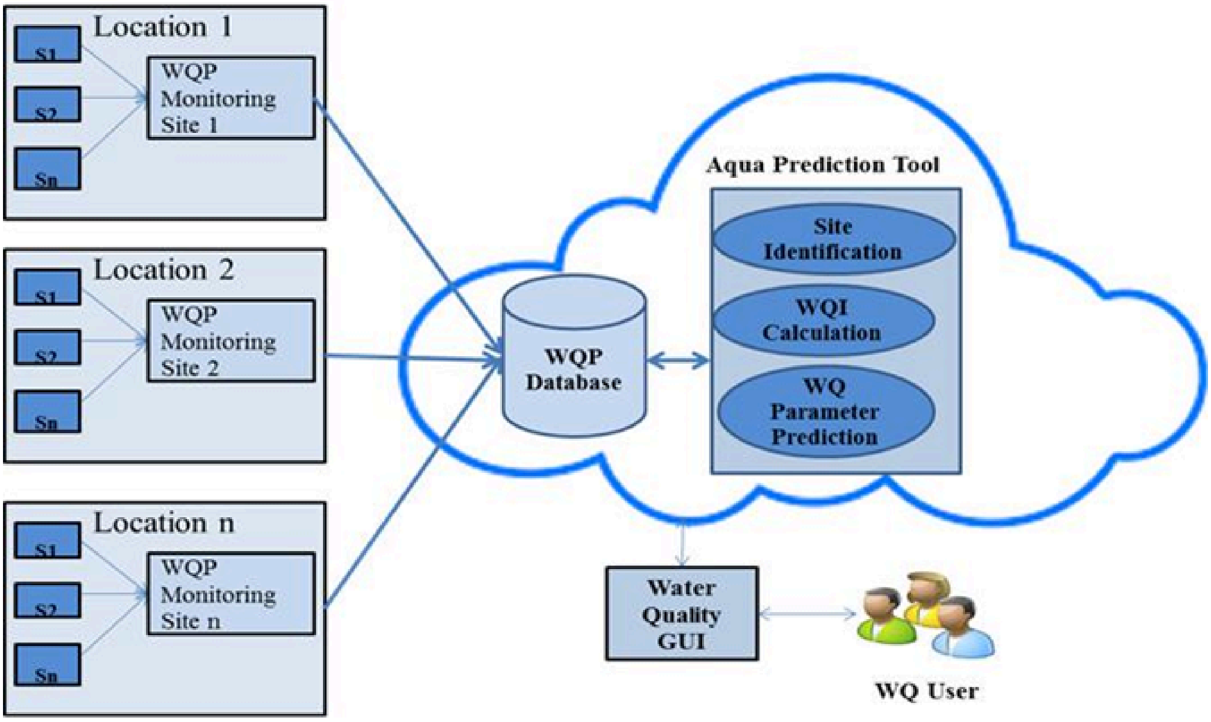


Figure 3.1: Proposed Architecture of Water Quality Prediction

3.1 Methodology

The outline of the proposed methodology includes

- **3.1.1 Data acquisition and collection**

The water quality parameter values are collected from the various locations through temperature sensors, pH sensors, BOD sensors, DO sensors, and Nitrate sensors. For training the machine learning models, water quality datasets are collected via the Kaggle machine learning repository. The sample dataset consists of 3352 records and it is given below

Table: 3.1 Sample water quality dataset

	A	B	C	D	E	F	G	H	I	K	L	O
1	Stationcoc	Locations	Lat	Lon	Capitalcity	State	Temperatı	D.O	pH	B.O.D	Nitrate	class
2	1001	BEAS AT U	32.24495	77.19108	Shimla	HIMACHA	9	9	8	0.1	0.2	1
3	1002	BEAS AT D	31.96058	77.11401	Shimla	HIMACHA	10	9	8	0.3	0.4	1
4	1003	BEAS AT D	26.88789	75.81148	Shimla	HIMACHA	11	9	8	0.2	0.3	1
5	1004	BEAS AT U	47.35194	19.63362	Shimla	HIMACHA	13	9	8	0.2	0.4	1
6	1005	BEAS AT E	25.99279	91.82611	Shimla	HIMACHA	14	10	8	0.2	0.5	1
7	1550	U/S MANL	31.70817	76.93137	Shimla	HIMACHA	16	9	8	0.2	0.5	1
8	1006	BEAS AT D	31.70817	76.93137	Shimla	HIMACHA	16	9	8	0.5	0.7	1
9	2604	BEAS AT D	31.89964	76.59795	Shimla	HIMACHA	19	8	8	0.5	0.5	1
10	1007	BEAS AT D	15.88435	78.11938	Shimla	HIMACHA	19	8	8	0.6	0.4	1
11	1008	BEAS AT D	31.88176	76.21465	Shimla	HIMACHA	19	8	8	0.7	1.1	1
12	1009	BEAS AT D	31.97658	76.0508	Shimla	HIMACHA	20	8	8	0.5	0.4	1
13	1693	BEAS AT T	31.93113	75.89406	Chandigar	PUNJAB	15	8	8	0	0.8	1
14	1694	U/S PATH/	32.26434	75.64211	Chandigar	PUNJAB	18	7	8	1	1.6	1
15	1695	U/S PATH/	32.26434	75.64211	Chandigar	PUNJAB	15	7	7	1	2	1
16	1010	BEAS AT N	31.94001	75.24791	Chandigar	PUNJAB	15	8	8	0.5	0.6	1

waterattributes

3.1.2 Data Preprocessing

Incomplete/Missing data processing, Outlier detection, and elimination, and Feature selection methods are used to improve the quality of data sets.

The missing data is replaced by the mean value of the corresponding field.

```
df['Temperature'].fillna(value=df['Temperature'].mean, inplace=True)
```

3.1.3 Artificial Neural Network

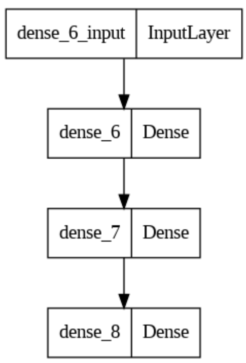


Fig: 3.2 ANN model architecture

The proposed water quality prediction model uses an artificial neural network model with two hidden layers using relu activation function with 70% training and 30% testing split. The output layer uses sigmoid activation with a stochastic gradient descent optimizer.

Compared to other machine learning algorithms like Naive Bayes, linear model, and decision tree this ANN generates 97% training and prediction accuracy.

Artificial Neural Networks contain artificial neurons which are called units. These units are arranged in a series of layers that together constitute the whole Artificial Neural Network in a system. A layer can have only a dozen units or millions of units as this depends on how the complex neural networks will be required to learn the hidden patterns in the dataset. Commonly, Artificial Neural Network has an input layer, an output layer as well as hidden layers. The input layer receives data from the outside world which the neural network needs to analyze or learn about. Then this data passes through one or multiple hidden layers that transform the input into data that is valuable for the output layer. Finally, the output layer provides an output in the form of a response of the Artificial Neural Networks to input data provided.

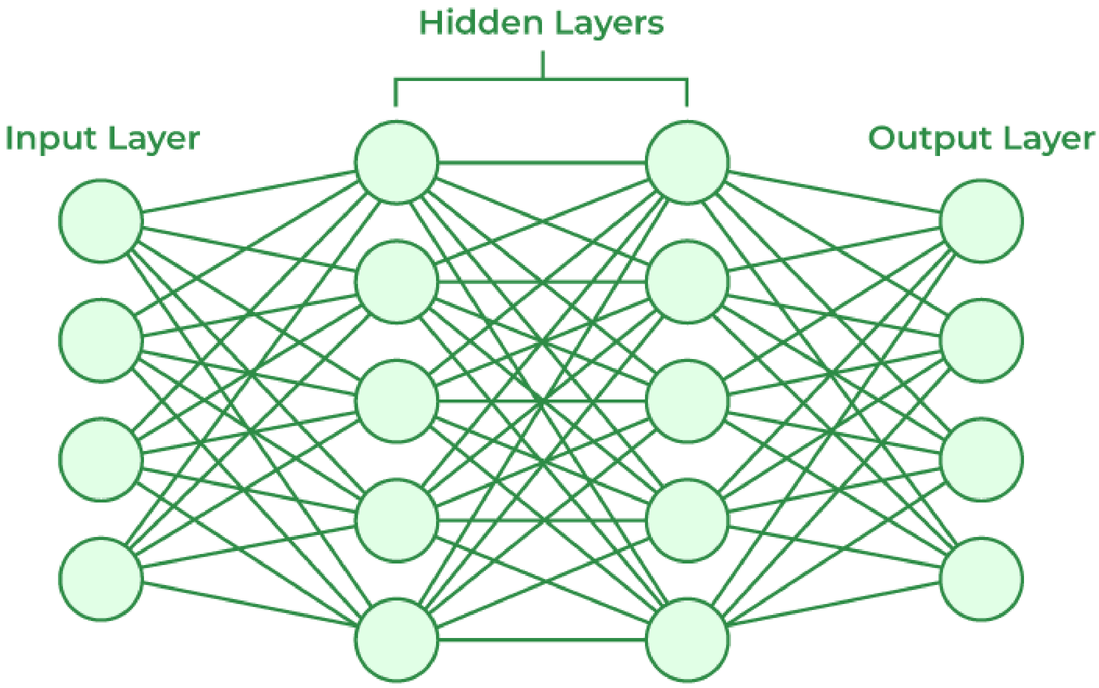


Fig. 3.3 Artificial Neural Network Structure

3.1.4Testing the model

Testing and evaluation of the model can be done on sensed real-time data. using ANN model.
In the majority of neural networks, units are interconnected from one layer to another. Each of these connections has weights that determine the influence of one unit on another unit. As the data transfers from one unit to another, the neural network learns more and more about the data which eventually results in an output from the output layer.

The structures and operations of human neurons serve as the basis for artificial neural networks. It is also known as neural networks or neural nets. The input layer of an artificial neural network is the first layer, and it receives input from external sources and releases it to the hidden layer, which is the second layer. In the hidden layer, each neuron receives input from the previous layer neurons, computes the weighted sum, and sends it to the neurons in the next layer. These connections are weighted means effects of the inputs from the previous layer are optimized more or less by assigning different-different weights to each input and it is adjusted during the training process by optimizing these weights for improved model performance

4. Experimental Setup

4.1 Case Study

The Pazhayar river is one of the important rivers in the Kanyakumari district for drinking and irrigation purposes. Kanyakumari district its area of 1,684 sq.km and occupies 1.295 percentage of the total area of the Tamil Nadu. This district lies between 77 0-15' and 77 0-36' of the eastern longitude and 8 0- 35' and 8 0-35' of the north latitude. Kanyakumari district enjoys a warm climate.

***Fig.4.1. Pazhayar Dam with Sky Lotus*.**

The 2022 census total population of seven famous villages and two urban habitations along this river bank is **5,76,018**. Calculation of water supply based on the **135 LPCD**, the total quantity of water consuming in above area is **7,55,72,200 litter/ day**, and its **sewage generation (80% of the consuming water)** is **4,64,57,832 litter/day**. This much quantity of sewage has been discharged into the **Pazhayar** river without any treatment. It will create major cause of ecological damage and pose serious health hazards.

The analysis of water quality study has been planned for seven locations of Surulacode (At 0.00km -N 08◦12.326'- E077◦25.184'), Putheri (At16.00 Km- N 8◦11.889'-E077◦26.338'), Ozhiginasery(At18.00km- N 08◦11.514' –E 077◦26.348') , Edalakudi (At 23.00 Km- N 08◦09.501' – E 077◦27.912'), Suchindram (At 25.00 Km N 08◦09.349' – E 077◦28.191'), North

Thamaraikulam(At 32.00km- N 08◦07.972' – E 077◦28.957') and Manakudi (At 35.00km- N 08◦05.407'-E077◦29.131')In The Pazhayar River.

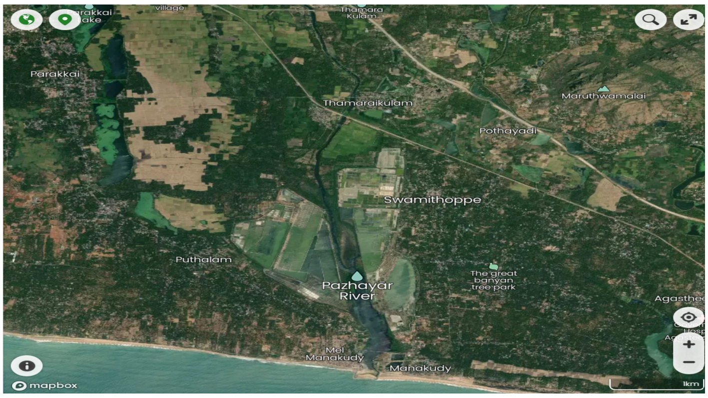


Fig.4.2. Pazhayar River

The following table specifies the lab report of the water samples taken from six substations of Pazhayar river taken in the month of February 2023 manually and the test was performed in the Chemistry lab at St. Xavier's Catholic College of Engineering

Table :4.1 Water quality parameters of six substations

Stations	pH	EC (µs/cm)	DO (mg/l)	BOD (mg/l)	Nitrate (mg/l)
Manakudi	8.08	680	6.2	3	0.76
Putheri	7.46	30	6.1	3.12	1.01
Suraliode	7.46	32	5.4	4.04	0.8
Suchindrum	7.80	40	5.1	4.06	1.57
Edalakudi	7.42	40	7	3.21	1.6
Ozuginaseri	7.45	32	5.8	3.21	1.02

4.2 Sketch of Prototype

The following figures show the working model of the proposed water quality prediction tool. It is a floating model embedded with sensors to automatically test the water quality paramters

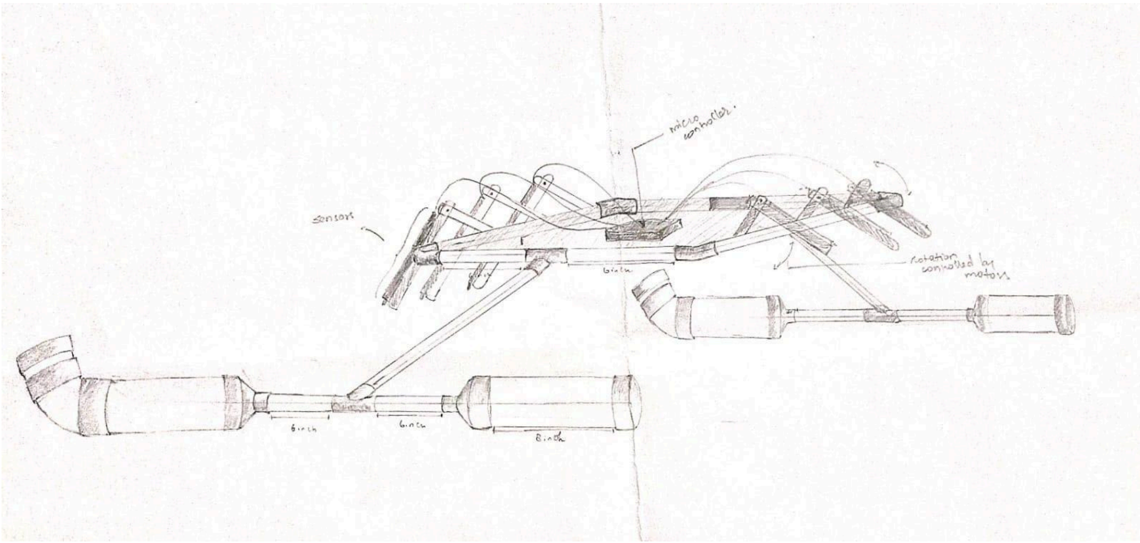


Figure 4.3 Prototype Sketch

4.3 Software Components

Python, Google Colab, Arduino IDE, Thinkspeek,Blynk

4.4 Hardware Components

The components or elements which are used to design the project are

✓ EC Sensor ✓ ORP Sensor ✓ DO Sensor ✓ Temperature Sensor ✓pH Sensor ✓ Turbidity Sensor ✓ ATMEGA 328p microcontroller, ESP8266 Wi-Fi Module

4.4.1 Sensors Used

Figure 4.4 Associated sensors

EC (Electrical Conductivity) Sensor

Grove EC Sensor is a analog electrical conductivity meter. The electrical conductivity sensor (EC sensor) measures the electrical conductivity in a solution which usually used for aquaculture and water quality testing. The Grove - Electrical Conductivity Sensor is specially designed for a low-cost system with a relatively high accuracy which can cover most applications. The Grove connector and BNC probe interface make it easy to use and very suitable for Arduino and Raspberry Pi project. This Kit includes an EC probe and a driver board, and the driver board support both 3.3V and 5V system.

Feature

- Widely used for most applications of aquaculture and water quality testing
- Compact size for easy deployment
- Support with both Arduino and Raspberry Pi
- Cost-effective

ORP (Oxidation Reduction Potential) Sensor

Grove - ORP Sensor Kit (HR-O) is a Grove sensor that measures the ORP value, detecting quality of the liquid. It works with a 5-meter IP68 ORP probe, offering a -2000mV to 2000mV sensing range, operating under 0-80℃, supporting Arduino programming. The sensor is environmentally friendly and RoHS certificated.

Feature

- Grove ORP Sensor Upgrade: Assemble 5-meters IP68 ORP probe, offering -2000 mV to 2000 mV sensing range, operating under 0-80℃, member of simple-to-use Grove ecosystem
- Enhanced Measurement Performance: Maintain ±15mV sensing accuracy at 0-60°C
- Working Voltage: 3.3/5V
- Arduino Support
- RoHS Certification
- Application
- Monitor and control of oxidation-reduction reactions
- Disinfected water detection
- Health-friendly water detection
- Determine the types of microbial
- Detect anaerobic microbial activity
- Wastewater treatment
- aquaculture
- Industrial sewage discharge monitoring

DO (Dissolved Oxygen) Sensor

A dissolved oxygen meter is used to measure the dissolved oxygen in water, to reflect the water quality. It is widely applied in many water quality applications, such as aquaculture, environment monitoring, natural science, etc.

There's an old saying regarding keeping fish, "Good fish deserves good water". Good water quality is very important to aquatic organisms. Dissolved oxygen is one of the important parameters to reflect water quality. Low dissolved oxygen in the water will lead to difficulty in breathing for aquatic organisms, which may threaten their lives.

The probe is galvanic, does not need polarization time, and stays available at any time. The filling solution and membrane cap are replaceable, leading to the low maintenance cost. The signal converter board is plug-and-play and works from 3.3V - 5V which makes it compatible with most popular microcontrollers such as ESP32, Raspberry Pi and Arduino

Feature

Dissolved Oxygen Probe:

- Galvanic probe, no need polarization time
- Filling solution and membrane cap is replaceable, low maintenance cost

Signal Converter Board:

- 3.3~5.5V wide-range power supply, compatible with most Arduino microcontroller
- 0~3.0V analog output, compatible with all microcontrollers with ADC function.
- Gravity interface, plug, and play, easy to use

DS18B20-TEMPERATURE SENSOR

The **DS18B20** is a 1-wire programmable Temperature sensor from maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. The constriction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy. It can measure a wide range of temperature from **-55°C to +125°** with a decent accuracy of **±5°C**. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

Feature

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit
- Programmable alarm options

- Available as To-92, SOP and even as a waterproof sensor

PH SENSOR

the Grove - PH sensor can output signal which corresponding to the hydrogen ion concentration that measured by PH electrode. Because it can be directly connected to controller,and then you can observe the PH value at any time. This device can be used for PH measurements, such as waste water, sewage and other occasions.

Feature

- Grove Interface
- Wide measuring range
- Usage Life is two years
- Isopotential Point: pH 7.00 (0 mV)

TURBIDITY SENSOR

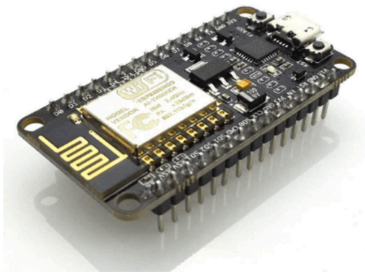
The Grove turbidity sensor can measure the turbidity of the water (the number of suspended particles). The optical sensor of this module can measure the density of turbid water and the concentration of extraneous matter using the refraction of wavelength between photo transistor and diode. By using an optical transistor and optical diodes, an optical sensor measures the amount of light coming from the source of the light to the light receiver, in order to calculate turbidity of water. The output mode can be selected by adjusting the switch on the board. Supports analog and digital output. The sensitivity can be adjusted by the on-board knob.

Feature

- Low power consumption
- Small size: 2.0cm x 4.0cm Grove module
- Only 3 pins needed, save I/O resources
- Easy to use: Grove connector, plug and play
- Output mode optional, support analog output and digital output

MAIN HARDWARES

ATMEGA 328p MICROCONTROLLER
(ARDUINO UNO)



ESP8266 WI-FI MODULE

Figure 4.5 Associated Hardware

ARDUINO UNO

Arduino UNO is a microcontroller board based on the **ATmega328P**. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

Feature

- The operating voltage is 5V
- The recommended input voltage will range from 7v to 12V
- The input voltage ranges from 6v to 20V
- Digital input/output pins are 14
- Analog i/p pins are 6
- DC Current for each input/output pin is 40 mA
- DC Current for 3.3V Pin is 50 mA
- Flash Memory is 32 KB
- SRAM is 2 KB
- EEPROM is 1 KB
- CLK Speed is 16 MHz

ESP8266 MODULE

The **ESP8266** is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and microcontroller capability, produced by Espressif Systemsin Shanghai, China. The chip was popularized in the English-speaking maker community in August 2014 via the **ESP-01** module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first, there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation.

Feature

- Processor: L106 32-bit RISC microprocessor core based on the Tensilica Diamond Standard 106Micro running at 80 or 160 MHz
- Memory:
- 32 KiB instruction RAM
- 32 KiB instruction cache RAM
- 80 KiB user-data RAM
- 16 KiB ETS system-data RAM
- External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)
- IEEE 802.11 b/g/n Wi-Fi
- Integrated TR switch, balun, LNA, power amplifier and matching network
- WEP or WPA/WPA2 authentication, or open networks
- 17 GPIO pins
- Serial Peripheral Interface Bus (SPI)
- I²C (software implementation)
- I²S interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC (successive approximation ADC)

Prototype

Figure 4.6 Prototype

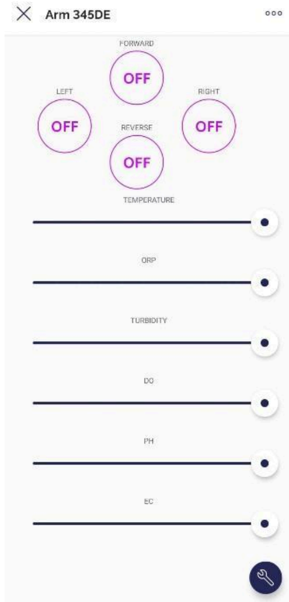


Figure 4.7 Remote Control Interface

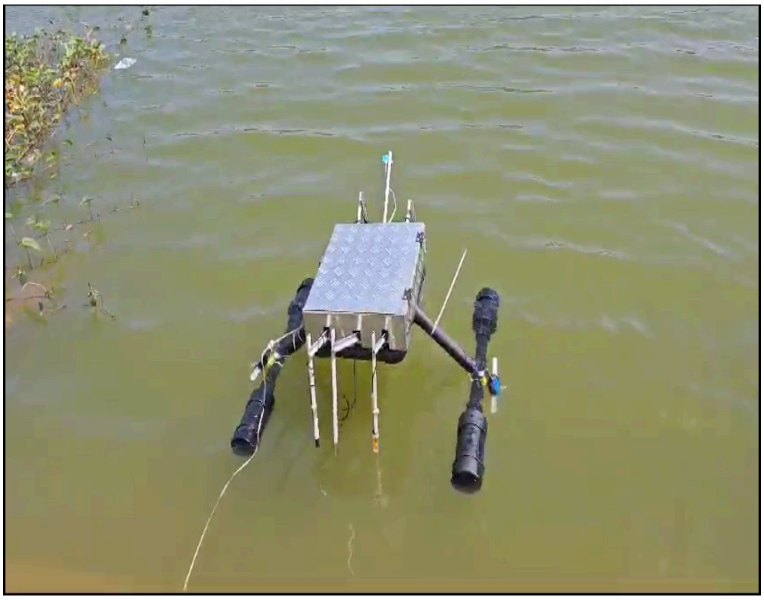


Figure 4.8(a)

Figure 4.8(b)

Realtime deployment

Result

```
pH Val: 7.4      ORP: 345mV      EC:785ms/cm     Celsius temperature: 22 turbidity:7.341 NTU
pH Val: 7.4      ORP: 345mV      EC:785ms/cm     Celsius temperature: 22 turbidity:7.341 NTU
pH Val: 7.4      ORP: 345mV      EC:785ms/cm     Celsius temperature: 22 turbidity:7.341 NTU
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pH Val: 7.4      ORP: 345mV      EC:785ms/cm     Celsius temperature: 22 turbidity:7.341 NTU
pH Val: 7.4      ORP: 345mV      EC:785ms/cm     Celsius temperature: 22
```

Figure 4.9 Result

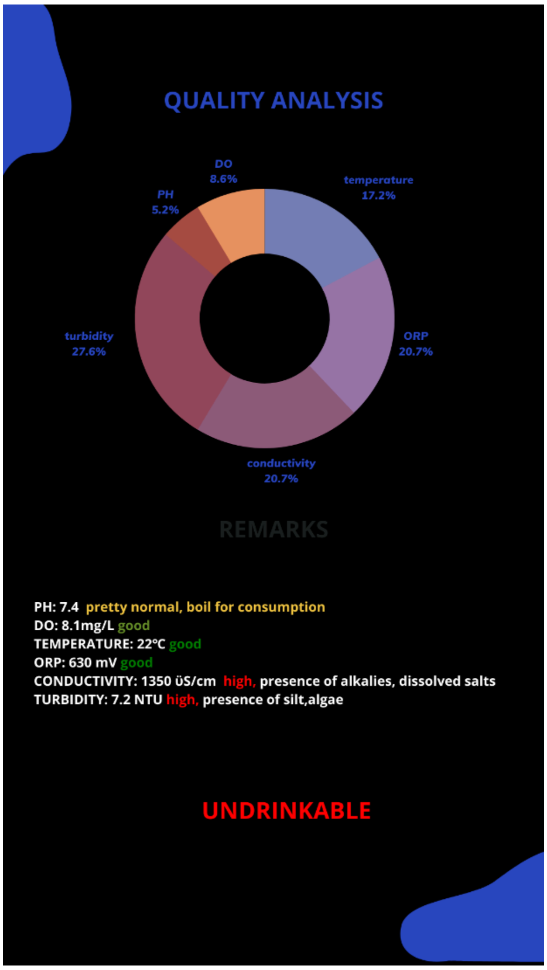

Figure 4.10 Outcome

5. Future Work

An interactive user interface is under development through which an individual who possess this application can be aware of the quality of water they are consuming, from the vicinity of their home.

It also reduces the need of manual labour and the time taken to get the result form the laboratory. The organization that has this device can deploy it in desired water body and the data is automatically sent to the assigned server, which will then be processed and output will be given to the locals as well as the officials and in case of any abnormalities it will also be flagged to concerned authorities.

6. Conclusion

Water quality monitoring system using IoT (Internet of Things) technology offers numerous benefits and is a valuable tool for ensuring the safety and integrity of our water resources. By leveraging interconnected devices, sensors, and data analysis, such a system can provide real-time and accurate information about water quality parameters. Firstly, IoT-enabled water quality monitoring systems offer increased efficiency and automation. Traditional methods of water quality monitoring often rely on manual sampling and laboratory analysis, which can be time-consuming and costly. IoT devices can continuously monitor key parameters such as pH levels, temperature, dissolved oxygen, turbidity, and chemical contaminants, eliminating the need for frequent manual sampling. Secondly, real-time data collection and analysis allow for rapid detection of water quality issues. By transmitting data to a centralized system or a cloud-based platform, anomalies or deviations from the desired water quality standards can be detected immediately. This enables prompt intervention and mitigation measures to be implemented, reducing the potential risks to public health and the environment. Furthermore, IoT-based water quality monitoring systems provide greater accessibility to information. Users can access real-time data remotely through web based interfaces or mobile applications, enabling timely decision-making and response to water quality concerns

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Annexure

from google.colab import files

uploaded = files.upload()

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn import preprocessing
df=pd.read_csv("combinedwaterpar.csv")
dataset=df.values
#split dataset in features and target variable
feature_cols = ['D.O', 'pH', 'Conductivity', 'B.O.D','Nitrate']
X = df[feature_cols] # Features
Y = df.classlabel # Target variable
# Split dataset into training set and test set
X_train, X_test, Y_train, Y_test = train_test_split(X,Y, test_size=0.3,
random_state=1) # 70% training and 30% test
```

```
df['Temperature'].fillna(value=df['Temperature'].mean, inplace=True)
print(df['Temperature'])
```

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.optimizers import SGD,RMSprop,Adam
watermodel= Sequential([Dense(32, activation='relu', input_shape=(5,)),
                   Dense(32,activation='relu'),
                   Dense(1,activation='sigmoid'),])
```

```
watermodel.compile(optimizer='sgd',loss='binary_crossentropy',
metrics=['accuracy'])
```

```
from tensorflow.keras.utils import plot_model
plot_model(model)
```

```
waterhist=watermodel.fit(X_train, Y_train,batch_size=8,epochs=10)
```

```
watermodel.save('waterqualitymodel.h5')
print(waterhist.history['accuracy'])
print(waterhist.history['loss'])
```

```
#Visualize tramodel_historyining results
acc = waterhist.history['accuracy']
loss=waterhist.history['loss']
epochs=10
epochs_range = range(epochs)

plt.figure(figsize=(8, 8))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.legend(loc='lower right')
```

```
plt.ylabel('Accuracy')
plt.xlabel('Epochs')
plt.title('Training Accuracy')

plt.subplot(1, 2, 2)
plt.plot(epochs_range, loss, label='Training Loss')
plt.legend(loc='upper right')
plt.ylabel('Loss')
plt.xlabel('Epochs')
plt.title('Training Loss')
plt.show()
```

```
accu=watermodel.evaluate(X_test,Y_test)
print("Test Accuracy="+str(accu))
```

```
from sklearn.metrics import accuracy_score,confusion_matrix
from sklearn.metrics import precision_score, recall_score,
f1_score,cohen_kappa_score,roc_auc_score
import sklearn.metrics as metrics
import numpy as np
```

```
predictions = watermodel.predict(X_test)
print(predictions)
plt.hist(predictions)
```

Intelligent Water Quality Detection tool for rejuvenating water body

CERTIFICATE OF COMPLETION

This is to certify that this thesis project titled "**Intelligent Water Quality Detection Tool**" was carried out by Sh./Smt. **SHAHUL HAMEED MAHEEN**, a student of **B.TECH Information Technology**, at the **St. Xavier's Catholic College of Engineering, Kanyakumari, Tamil Nadu**. The research for this project was undertaken under the guidance of the afore-mentioned institute and completed during the period of **FEB 2023** to **AUG 2023**.

This project was shortlisted under the *Sponsored Thesis Project Competition on "RE-IMAGINING URBAN RIVERS" (Season- 3)* hosted by the National Institute of Urban Affairs (NIUA) and the National Mission for Clean Ganga (NMCG).

This report has been submitted by the student as a final deliverable under the competition. All parts of this research can used by any of the undersigning parties.

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Authorized Representative	- Dr. J. Annrose
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Name	- National Mission for Clean Ganga
Authorized Representative	- G Asok Kumar, Director General
Signature	-