Visvesvaraya Technological University

BELAGAVI, KARNATAKA.

ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ

ಬೆಳಗಾವಿ, ಕರ್ನಾಟಕ

A PROJECT PHASE-1 REPORT

ON

"IoT based Water Purification Level Indicator for Household and Water distribution points."

(Funded by NSTEDB, DST, Govt of India & Implemented by EDII, Ahmedabad)

Submitted to Visvesvaraya Technological University in partial fulfillment of the requirement for the award of Bachelor of Engineering degree in Computer Science and Engineering.

Submitted by

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March 2022

National Education Society ®

Jawaharlal Nehru New College of Engineering

Department of Computer Science & Engineering

CERTIFICATE

This is to certify that the project entitled

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Students of 7th semester B.E. CS&E, in partial fulfillment of the requirement for the award of degree of Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University, Belagavi during the year 2021-22

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Abstract

Water is an important resource for life of every living organism. Water Pollution is a major global problem. It has been surveyed that water pollution is the leading cause of deaths and diseases in human and marine life. So, we come up with an IoT based model for water quality monitoring. The data like pH, turbidity, TDS etc. will be collected using sensors and accessed in real time basis and will be updated to cloud layer. We will analyse the data through ML algorithms. Later we will predict the water quality. And when water quality is not in accepted range alert will be sent to concerned authority.

Acknowledgements

On the very outset of this project report on "**IoT based Water Purification Level Indicator for Household and Water Distribution points**" we would like to extend our sincere & heartfelt obligation towards all the persons who have helped us in this endeavour. Without their active guidance, help, co-operation & encouragement, we would not have made headway in the project.

We are grateful to our institution "**Jawaharlal Nehru New College of Engineering and the Department of Computer Science and Engineering**" for imparting us the knowledge with which we can do our best.

We would like to thank our beloved guide **Dr. Nirmala Shivanand Ph.D. Professor, Dept. of CS&E**. Also, we would like to thank our beloved coordinators **Dr.Sankhya N Nayak** ,**Ph.D. Associate.Prof**, Dept.of Computer Science and Engineering**, Dr.Ravindra S ,Ph.D. Associate.Prof,** Dept.of Computer Science and Engineering, **Mr. Sandeep S, M.Tech Asst. Professor**, Dept.of Computer Science and Engineering and **Mrs. Namitha M.V, M.Tech Asst. Professor**, Dept.of Computer Science and Engineering. We are highly indebted to them for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

We would also like to express our gratitude and thanks to **Dr. Poornima K.M, Professor** and **Head of the department**, Computer Science and Engineering and **Dr. K. Nagendra Prasad, Principal,** Jawaharlal Nehru New College of Engineering for all their support and encouragement. We are thankful to and fortunate enough to get constant encouragement, support and guidance from all Teaching staffs of the Department of Computer Science and Engineering which helped us in successfully completing our project work. Also, I would like to extend our sincere regards to all the non-teaching staff of department of computer science and engineering for their timely support. Thanking you all,

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Chapter 1

Introduction

In this chapter an overview of water quality measurement is provided. The importance of water, efficient water quality measurement and management and their role in pollution detection of water is discussed. Role of IT in water quality management is also provided.

1.1 Overview of Water

Environment around us consists of five key elements. These are soil, water, climate, natural vegetation and land forms. Among these, water is the most essential element for human to live. It is also important for the survival of other living habitants. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is must for public health. More water is wasted in many uncontrolled ways. This problem is quietly related to poor water allocation, inefficient use and lack of adequate and integrated water management. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. Water resources is not handled properly in highly populated regions leads to discharge of toxic chemicals, climate changes, growing population, untreated sewage and other human activities.

1.2 Importance of Water quality

Global warming was created in the 21st century due to increase in population. Because of this, there is no protection for the drinking water. In modern days, observing the water quality meets lot of consequences in real world, because of water resources are limited by global warming, increment of population, etc. The most important factor, for human health and for socio-economic growth of country desires water. Not only for human beings, all the organisms, agriculture and industrialization need water is essential one.

1.3 Water quality measurement

In this paper, we take India as an example for the most powerful nation and developing country in the world, as well as India faces more challenges on the economic side and growing of population. All the other developing countries give water as a basic requirement for 72% of the population lives and rural areas especially. Contaminated water supply deteriorated the safety for human and directly influenced by drinking.

Infirmity and desolation lead to major caused by contaminated water. Hence, Water-Borne diseases such as dengue, cholera and malaria etc., are reduced for major health concerns. In India, infant mortality is major caused by diarrhoea. No proper cleaning of water and sanitation leads to 70% of diarrhoea cases. According to research of WHO 844 million people lack even a basic drinking –water service, including 159 million people who are dependent on surface water

1.4 Importance of Water quality detection

In the 21st century providing pure drinking water is becoming a major challenge worldwide. International governing bodies such as United Nations (UN) and World Health Organization (WHO) also recognized human right to sufficient, continuous, safe, and acceptable, physically accessible, and affordable water for personal and domestic use.

Apart from drinking water to survive, there are various industries and chemical and biological laboratories where highly purified water is essential. Besides this, the uses of impurity free water include- coolant in nuclear reactors, boilers, automotive cooling, cleansing of surgical apparatus. There has been a great deal of interest in the detection of impurities in distilled water. Monitoring the quality of surface water will help protect our waterways from pollution. Farmers can use the information to help better manage their land and crops. Our local, state and national governments use monitoring information to help control pollution levels.

1.5 Role of IoT in Water Monitoring

Sensing components to bring water quality maintenance. Internet of Things (IoT) enables us to build a system without human interference. In other words IoT is an environment that has the ability to transfer data over a network without human to human or human to computer interaction. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for direct integration between the physical world and computer-based system and it provides more efficiency, accuracy as well as economic benefits.

Five key IoT issue areas are examined to explore some of the most pressing challenges and questions related to the technology. These include security, privacy, interoperability and standard, legal, regulatory and rights, emerging economies and development.

The Internet of things (IoT) is the network of physical devices, vehicles, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. Each thing is uniquely

identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of about 30 billion objects by 2020. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

1.6 Organization of the report

The rest of the report is organized as follows: Chapter-2 brings out Problem Statement and Objectives of the project. An exhaustive Literature Survey is explored in Chapter-3. System design with elicitation of Requirements is put in Chapter-4. The Program Outcomes and Program Specific Outcome mappings to this project is also shown in Chapter 4.

Chapter 2

PROBLEM STATEMENT AND OBJECTIVES

This chapter discusses in detail the problems of the existing system. A detailed problem specification is given. A problem statement covering problems handled in this project is also discussed. The objectives of this project work are also enlisted.

2.1 Problem Specification

In the environment, water is the utmost crucial element for human life. Water pollution is a foremost global problem which needs ongoing evaluation and adaptation of water resource. With rapidly rising population in India, Fresh Water Management is very much essential which demands an increase in agricultural, industrial and other requirements. Monitoring the water quality helps in detecting the pollution in water, toxic chemical and contamination.

Diseases spread by unsafe water include cholera, giardia, and typhoid. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways. Due to the fast-growing urbanization supply of safe drinking water is a challenge. In India most of the people use simple water purifier which is not enough to get surety of pure water.The records show that more than 14,000 people die daily worldwide due to water pollution.

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water, which may cause in death of marine life. The polluted water will affect agriculture too. It may cause plants to die and affect human health. Using traditional approaches of monitoring water quality in the water management system are not completely safe and time consuming. Existing water treatment systems cannot remove the dissolved contaminants, dangerous particles and chemicals mixed.

So we come with a solution which monitors water quality continuously without Human Intervention. An automatic real-time monitoring system is required to monitor the health of the water. So that it can warn us automatically if there is any problem with the reserved water. And we can check the quality of the water anytime and from anywhere. By keeping this in mind, we designed this system.

2.2 Problem Statement

Due to the fast-growing urbanization supply of safe drinking water is a challenge. Using traditional approaches of monitoring water quality in the water management system are not completely safe and time consuming. Existing solution accumulate all possible values of water quality deciding parameters and manually come to a conclusion whether the water is consumable or not. So, an automatic real-time monitoring system is required to monitor the health of the water.

2.3 Objectives

Objectives of this project are:

- Acquiring the water quality measuring parameters by sensors.
- Storing data in cloud for easy access and security.
- Use of ML algorithm for quick analysis to classify water quality as drinkable, utility or other purpose.
- Designing of user friendly app for displaying the output.

Chapter 3

LITERATURE SURVEY

The proposed design falls in the CIoT framework. The framework of CIoT, serves as a transparent bridge between physical world like objects, and social world together with itself to form an intelligent system.

3.1 Detection of Impurities in Water by Measuring Capacitance

The detection of impurities in water is done in the discussed paper.

Contributions:

Detection of unhygienic impurities in water is one of the major concerns of human society. The detection of impurity in water is not only important for drinking water but also for water in industrial use. The type of impurity to be detected varies with the variation of the use of water. A low cost parallel plate based capacitive sensor is designed and implemented for the experimental setup. This paper investigates the impurities with different concentrations of Sodium Chloride (NaCl), Sugar(C6H12O6), Ferrous Sulphate (FeSO4) and Copper Sulphate (CuSO4). The maximum error is below 6%, which is accurate enough to serve our purpose.

Methodology:

In this system, impurities in water are detected by measuring capacitance. The sensor consists of two parallel conducting (copper) plates. One of the plates has a dimension of 2 inch × 1 inch and the other plate is built with slightly larger dimensions (2.1 inch × 1.1 inch) for purposes of alignment. The sensor plates are constructed on copper clad substrate boards. Since our experiments were conducted on water and water conducts electricity, we insulated the copper plates by coating it with varnish oil. Contact wires were soldered out for connection purposes. At first the sensor circuit was immersed into the sample. The resulting capacitance was shown on the 16×2 alphanumeric display. 3 repetitions were done and the average was taken as the corresponding reading. The

detection circuit proposed is a RC oscillator with a time constant proportional to the capacitance. The resulting time constant is measured by Arduino Uno microcontroller board. Simulations of the oscillator circuit are performed using Proteus. This paper investigates the impurities with different concentrations of different salts. Empirical relationships are developed to identify the type of impurity and its concentration. The capacitance of the sample solution decreases with increase in concentration of impurity.

Limitations:

- It is very difficult to determine the total amount of impurity in a sample by direct chemical analysis.
- Copper plate gets corroded easily, it has shorter life and it needs to be replaced often.
- This approach could not be used to the detection of impurities in non-binary solutions, containing more than one kind of impurities.

3.2 Design of Robotic Fish for Aquatic Environment Monitoring

A smart vehicle called Robot fish was deployed in water to measure quality.

Contributions:

This paper presents the design of a robotic fish system that integrates an Android smartphone and a robotic fish for debris monitoring. The smartphone based aquatic robot can accurately detect debris in the presence of various environments. This system measures various contaminants like chemical and natural threats from weather change, industrial contamination, and offensive waste disposal. The developed system has autonomous navigation ability and can detect the behaviour of water. In this paper, the focus on the aquatic environment is takes place.

Methodology:

Robotic unit is consisting of array of sensors and camera which is movable around its axis and also vertically. Raspberry Pi is used for video processing and sending the video to the user through the Bluetooth is used for communication between Arduino and Raspberry Pi(ARM Processor). Motor driving circuits are used for operating motors. The gliding robotic fish is capable of moving in water by a DC motor. The motor is manipulated by a programmable control board, which can communicate with the smartphone through either a USB cable or short-range wireless links such as Bluetooth. The Raspberry Pi is a credit card sized computer that plugs into your TV and a keyboard. It plays high-definition video. Raspberry Pi has a strong processing capacity because of using the ARM11 architecture and

Linux-based system. In terms of control and interface, it has 8 GPIO, 1 UART, 1 I2C and 1 SPI, which are basically meet the control requirement. It consists of the image processing components. The image registration aligns successive frames to ease the impact of camera shaking caused by waves. We adopt the background subtraction approach to reduce energy consumption in image processing and to detect the foreground debris object.

Architecture of robot fish is shown in Figure 3.1.

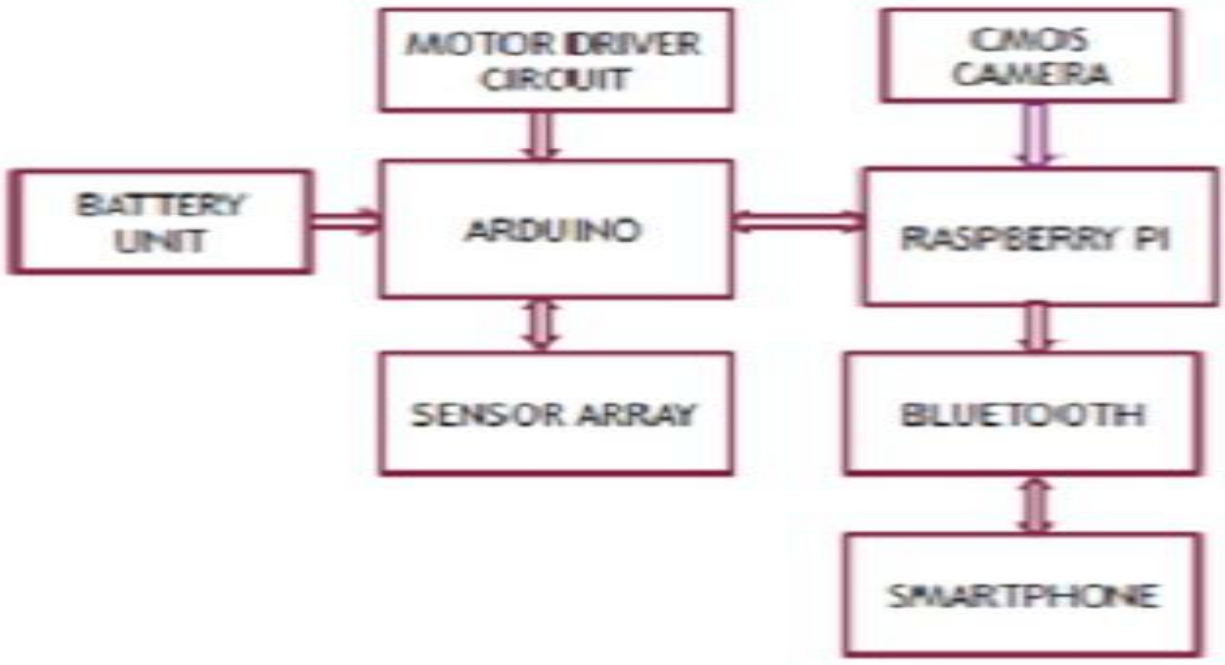

Figure 3.1: Architecture of robot fish

Limitations:

- The drawback of this system is chances of battery depletion from the robotic fish and an abrupt cease of the fish while monitoring water quality.
- It requires a man to go into water and deploy the hardware system inside.

3.3 Smart water quality monitoring system

A quick method to detect water pollution is proposed in this system.

Contributions:

Alerts have been set to notify the user of certain conditions such as battery life and progress report. It is designed to send alarm based on reference parameter to the ultimate user for immediate action to ensure water quality. It is low cost and System is accurate enough predict the data through GSM in sea water.

Methodology:

In this proposed system, they have determined which water parameters would provide a close indication for water pollution. Through extensive research, the parameters were chosen to be composed of pH, oxidation and reduction potential (ORP) and temperature. Further these values are sent through ADC (Analog & digital converter), &the data is further processed in micro controller. An FTP solution was developed initially on a local network, however without the intervention of local Internet Service Providers this seemed like the least convenient option.

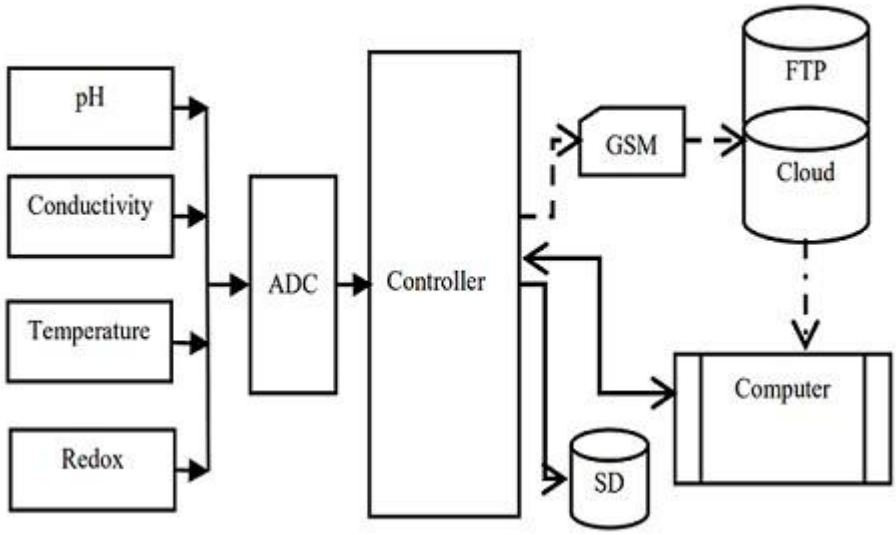

Figure 3.2: Water monitor system architecture

A cloud server has also been considered to act as an intuitive and a more permanent solution. Work is still in progress on this matter. Moving on, since the equipment has an SD storage option, data logging was ultimately done on the hardware itself in text format which can easily be read by practically any application.

Limitations:

The drawbacks of this system are:

- It collects the water and then water is tested in indoor. And this system only measures water quality in sea water.
- The system gets a 15 minutes sleep time after an hour of continuous readings.

3.4 Water Quality monitoring and control using Wireless Sensor Networks

In this paper we used different sensors to measure water pH, conductivity, dissolved oxygen (DO) and temperature.

Contributions:

The system uses low cost sensors and open source hardware aiming at providing continuous water quality measurements at substantially reduced cost. The system has capability to continuously measure water quality parameters and transmit them to a database in real-time.

The resulting values can finally send to the mobile phone device by 10 minutes. With the use of mobile phones platforms, the values of measured parameters are displayed in easy-to-comprehend as text message format anytime and anywhere.

Methodology:

Wireless sensor node is equipped with sensor and micro-controller unit system is shown in Figure 3.4.

- In this paper we used different sensors to measure water pH, conductivity, dissolved oxygen (DO) and temperature.
- Wireless sensor node is equipped with sensor and micro-controller units, Global Positioning System (GPS) receiver, power supply and Zigbee transceiver. Several sensors used for detection of water quality parameters and also it is sensor unit consideration.
- The general characterization of water quality have three sensors for measuring Ph(Potential of Hydrogen), EC (Electrical Conductivity) and DO(Dissolved Oxygen).
- The pH, EC and DO sensors are interfaced to the microcontroller using their respective circuits from Atlas Scientific. For their operation the all sensors are powered by Power supply.
- The Zigbee transceiver transmits sensed parameter values and GPS information to a gateway node. To connect all the sensors to the micro-controller unit, a WaGoSy sensors carrier board can be used. The sensors were calibrate to ensure correct operation and accuracy in the resulting water quality parameter values.

- PIC16F877A micro-controller, open-source electronics prototyping plat form based on flexible, easy-to -use hardware and software was used to acquire and process sensor data.

- Once the information are captured, the WSN sensor nodes capture the data through the Zigbee transceivers and send the values to the PC. Then the Zigbee transceiver again fetches the values and transmits to the mobile phone through GSM to the relevant stakeholders. The experimental values are sending simultaneously to the mobile phone after 10 minutes.

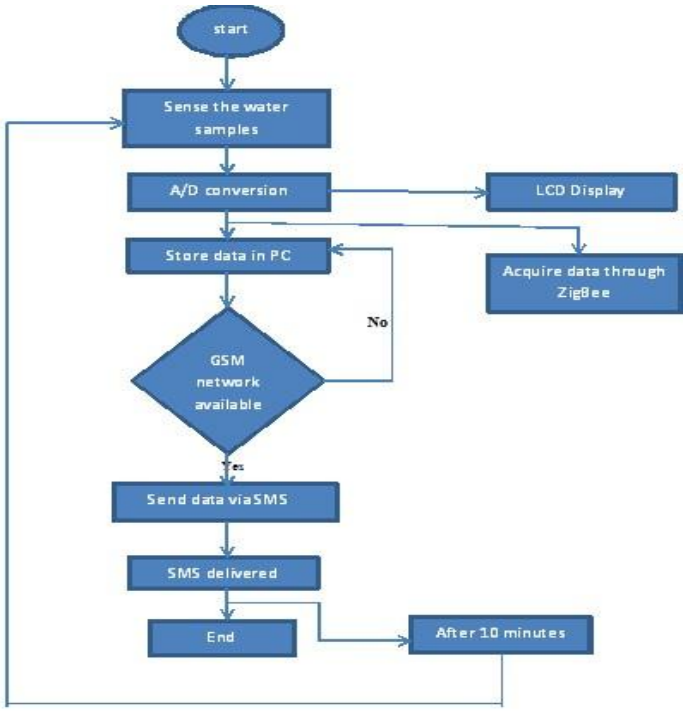

Figure 3.3: Water Quality monitoring and control using WSN

Limitations:

- This system cannot be used in industrial standards as it can be deployed in major water bodies like river and lakes.

- The maintenance could be a bit more as there is a possibility of corrosion of sensors due to temperature.

3.5 Advanced Water Impurity Detection System

In this paper they tried to measure multiple impurities.

Contributions:

The system was tested and found to be working in the desired manner and multiple impurities were detected and alert was produced. The design makes use of giving the people to use quality water and indicating them regarding the auto monitoring. The Physical impurities like deposition of sand, mud, rust, Chemical intrusions and Salinity of the water are monitored, computed and analysed that report is send immediately and documented.

Methodology:

The idea is to place the corresponding sensors in two parallel vertical tubes near to the inlet of the tank running all the way to the Bottom of the tank. The sensors are placed at different levels of the water distribution tank.

- As the water enters the tank the device checks the pH level of the water. If the pH of the water is not within the normal range device the outlet solenoid valve of the tank is closed immediately and an alert is sent to the authorities. If the pH level is normal the device moves on to check the value of the IR and the laser sensor.
- The laser sensor is fixed near to the inlet of the tank. The laser output is received by a LDR. If any solid impurity passes through the inlet and to the laser light the intensity of the light reduces and there is a dip in the output of the LDR. This is how the laser sensor detects the solid impurities.
- Similarly, the IR transmitter produces a specific output in normal colourless water which is noted and preprogramed. If there is any change in the colour of the water the output produced by the IR receiver changes and hence the microcontroller produces a colour change alert to the authorities. The system is shown in figure.

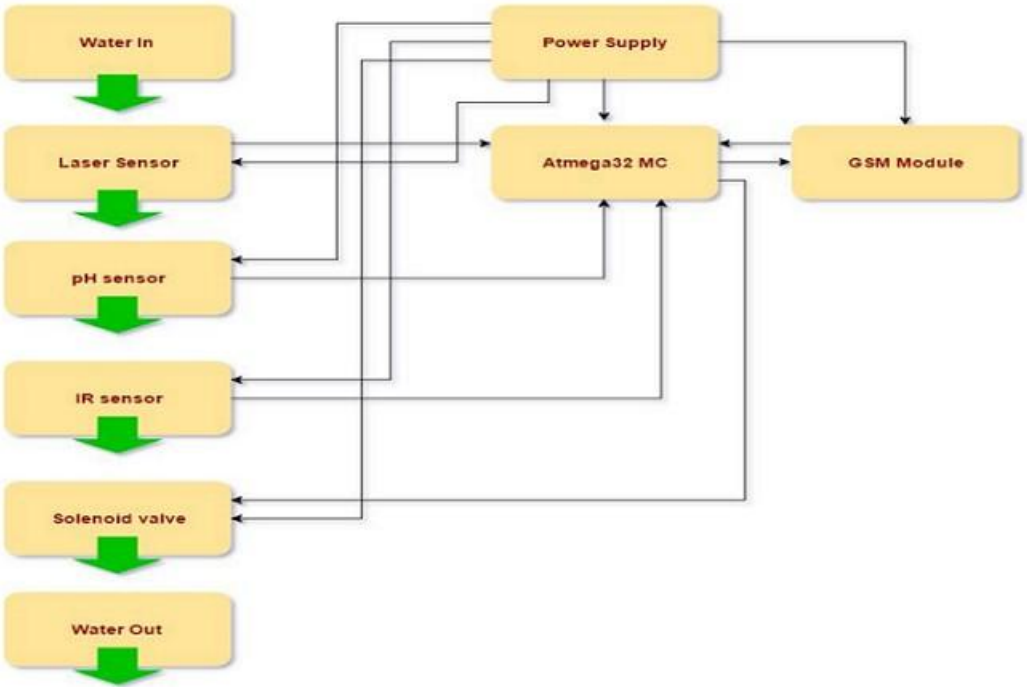

Figure 3.4: Proposed system

- If any of the above sensor values changes from the corresponding pre programmed values, the outlet solenoid valve is closed. If the water present in the tank is impure the authorities can send a message back to the device to flush the water.
- The flush valve present is opened and the impure water can be redirected for other purposes. The device resets itself and checks the water present in cycles. The time period of each cycle is 30 seconds.

Limitations:

- This system finds its application mainly in public water distribution networks and if the sensitivity of the sensors are made more precise, then it can be used for industrial standard use.
- A facility is provided that enables alert signal generation and sending to the authorities and ask “Flush On Request”. Water is a national resource and must be used wisely used and flushing it off is not a good idea or using it to irrigation purpose may also affect the crops

3.6 Reconfigurable Smart Water Quality Monitoring System in IoT Environment

Water monitoring system has been deployed in an IoT environment.

Contributions:

The proposed system is a reconfigurable smart sensor devise which can be configured as needed. This system gave the society a very good measurement and monitoring of the water level, pH, turbidity, temperature, and co2 levels on the banks of water bodies The results of the five parameters of water quality are verified that the system achieved the reliability and feasibility of using it for the actual monitoring purposes. The proposed system will assist in protecting the ecological environment of water resources. The smart water quality monitoring system minimizes the time and costs in detecting water quality.

Methodology:

Smart water quality uses various components as shown in Figure 3.5.

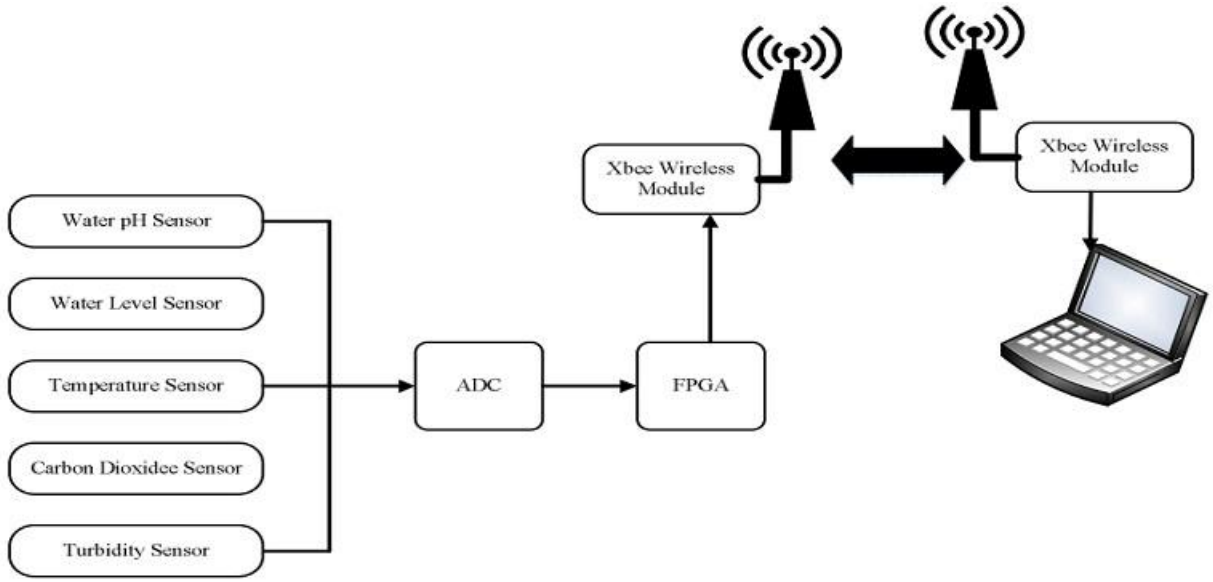

Figure 3.5: Smart water monitor Architecture.

The whole system is implemented in the following manner:

- In the proposed smart WQM system, a reconfigurable smart sensor interface device that integrates data collection, data processing, and wireless transmission is designed. The water quality monitoring system consists of a group of sensors to monitor the water parameters such as water level, water temperature, carbon dioxide (CO2) on the surface of water, turbidity of water and water pH value. The sensor nodes are stationed at the bank of the water.

- The measured data of water parameter are collected by the sensor nodes and sent to FPGA board. The analogue output of CO2 sensor and Turbidity sensor are digitized by AD7928 Analog to Digital converter. The Ultrasonic sensor and pH sensor are interfaced with RS232 and the default state is UART mode which acts as the transmission (TX) line. The default baud rate is 9600, 8 bits, no parity, no flow control and one stop bit.

- The temperature sensor DS18B20 communicates over a 1-wire bus which requires only one data line (and ground) for communication with a microcontroller. Serial Peripheral Interface (SPI) bus is used in embedded system to communicate the microprocessor to off-chip sensors, conversion, memory, and control devices. The architecture of SPI is designed for connecting on-chip processors and peripherals together into a system-on-a-programmable chip (SOPC). When the transmitted data from sensor nodes are received by the gateways, SPI transfers the incoming data through the UART interface to the processor.

- The SPI controller performs nRF24L01 module initialization, receives and sends packets. The Avalon bus is an interface protocol that is designed to connect on-chip processors and peripherals together into the SOPC. The Avalon bus specifies the port connections between master and slave components, and specifies the timing by which these components communicate. The Nios II processor is connected to its embedded peripherals such as parallel input/output (PIO), SPI, on-chip random access memory (RAM), JTAG UART, Timer, UART (RS232 serial port), synchronous dynamic random access memory (SDRAM) controller by means of the Avalon.

- The multiple slave devices are attached on the Avalon on-chip bus such as SPI, UART, and general purpose input/output (GPIO) and custom logic. The Nios II processor is a general purpose configurable soft core processor and it includes a 32-

bit central processing unit (CPU) and a combination of peripherals and memory on a single chip. The configuration of Nios II selected the Nios II/fast in order to provide the most effective performance to the processing unit. The SDRAM synchronizes itself with the timing of the CPU. Therefore, the memory controller identifies the exact clock cycle when the request data is ready. The UART issued to connect Nios II processor to the Zigbee hardware for wireless transmission.

Limitations:

- It has high complexity as hardware and software used are more and are complex to understand.
- More man power is needed and more the hardware more we need the maintenance.
- Maintenance becomes costly.

3.7 Water Quality Measuring System Using Wireless Sensor Network

A Water quality measurement has been developed that monitors the water usage through wireless sensor network. Details are provided in this section.

Contributions:

The proposed system is using high power RF based WSN for water quality monitoring system offers low power consumption with high reliability. The use of natural solar energy helps to reduce power consumption & operating cost. Another important fact of this system is the easy installation of the system where the base station can be placed at the local residence close to the target area and the monitoring task can be done by any person with minimal training at the beginning of the system installation. WSN technology provides us approach to real time data acquisition, transmission and processing. No carbon emission, more flexible to deploy at remote site. It checks quality of water at the places where generally it is inconvenient to take frequent tests manually.

Methodology:

The pH level, temperature and turbidity level are the parameters that are analyzed and control to improve water quality.

The objectives of idea implementation are as follows:

- Measurement of pH, temperature, turbidity, quantity of water using sensors at remote area.
- To provide power to sensor nodes using solar energy.
- To collect data from various sensor nodes and send it to base monitoring station by wireless system.
- To control data communication between source and nodes.
- To simulate and analyse quality parameters for quality control. (Graphical and numerical record using VB & MATLAB)
- To publish the corresponding record over web for public information and further assessment of water resource.

The detailed block diagram of water quality monitoring system is shown in Figure:

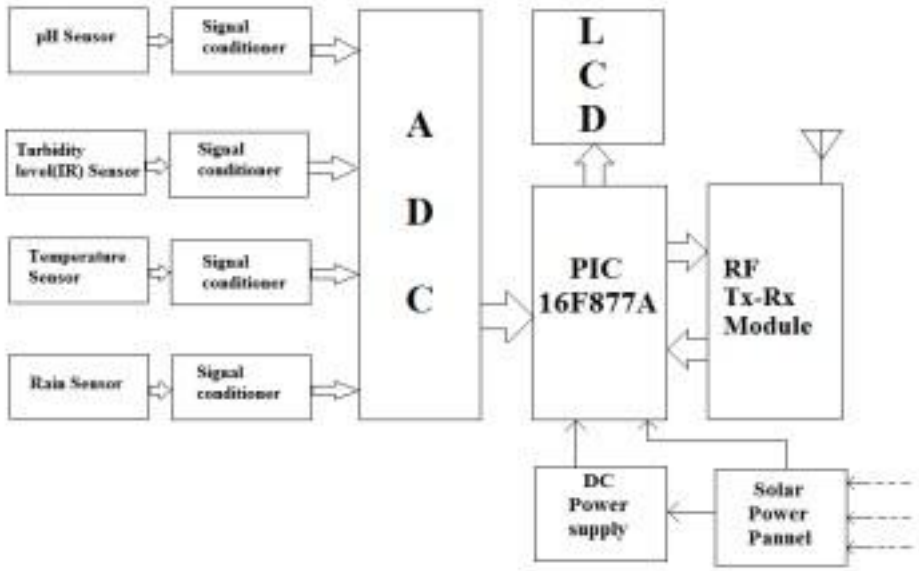

Figure 3.6: Block diagram of Transmitter

The GUI platform was successfully developed using the MATLAB software that was able to interact with the hardware at the base station. Once the battery powered sensor node is turned on; the temperature, pH, rain and turbidity sensors dipped in water start sensing the respective data. de sends a signal to the RF receiver on the receiver side. The 'Graph' push button plots the different values that are obtained at the receiver side. Once the values are plotted, it is inherently saved and stored in MS Excel Database, which can be accessed by clicking on the 'Database' tab.

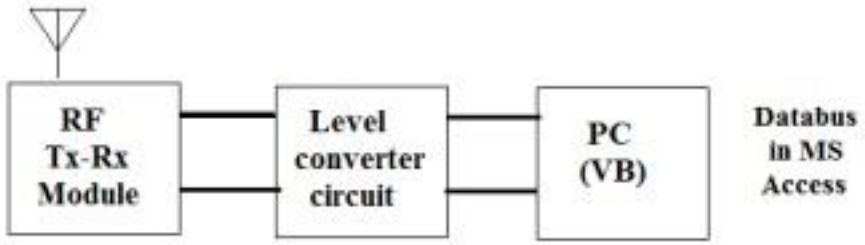

Figure 3.7: Block diagram of Receiver

Limitations:

- The analysis of the material contents in the soil in that particular region can be monitored easily at the base station using this system. In order to monitor water quality in different sites, future works can be focused on establishing a system with more sensor nodes and more base stations.
- The connections between nodes and base station can be done using Ethernet. The Ethernet can also be connected to Internet so that users can login to the system and get real time water quality data faraway.
- This system can be also used for water pollution control in different conditions. Also it can be made to guess abnormal moments under sea by measuring the turbidity at sea shore

3.8 Real-Time Water Quality Monitoring System

An overview of faster encoding and decoding of QR Codes is discussed in this section.

Contributions:

The system can monitor water quality automatically, triggers alarms immediately to prevent any health hazards and it is low in cost and does not require people on duty. So, the system is likely to be more economical, convenient and fast. The system has good flexibility. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters. The operation is simple. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value.

Methodology:

The system working mechanism is shown in Figure 3.12.

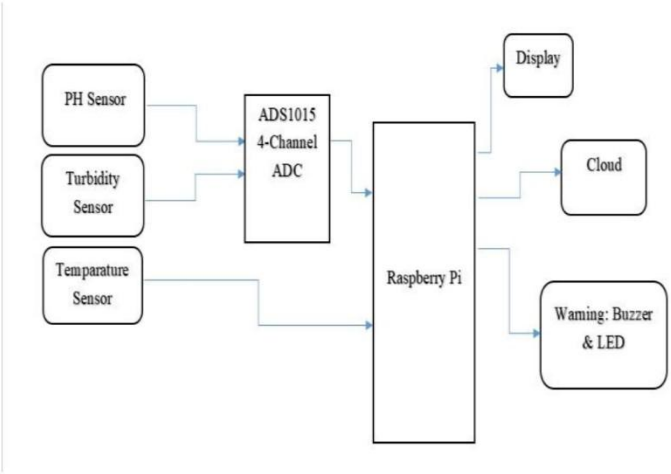

Figure 3.8: System architecture of real time water quality check

In this research paper, they have developed a system for real time quality assessment for water health at residential places using Raspberry Pi. pH, Turbidity and Temperature sensors are used to gather the parameters necessary to monitor water health in real time. To measure various chemical and physical properties of water like pH, temperature and particle density of water using sensors. Send the data collected to a Raspberry Pi, show the data in display and send it to a cloud-based Database using Wired/Wireless Channel. Trigger alarm when any discrepancies are found in the water quality. Data visualization and analysis using cloud-based visualization tools.

Limitations:

- There is no continuous and remote monitoring, human resource is required.
- Less reliable, no monitoring at the source of waters i.e. no on field monitoring
- The frequency of testing is very low.

3.9 Water Quality Monitoring with Arduino Based Sensors

This paper deals with measuring the water quality parameters using Arduino.

Contribution:

The quality of surface water is largely affected by natural processes as well as manmade impacts, whereas surface water runoff is a seasonal phenomenon largely affected by climate; anthropogenic discharges represent a constant polluting source to rivers and streams. The main objectives of the study are to develop Internet of Things (IoT) systems, consisting of multiple sensors, communication link, storage and processing capabilities, energy for powering the device, etc., in order to monitor water quality of rivers/streams and also to identify the causes and factors contributing to water quality issues around the vicinity if any. The system used is an Arduino microcontroller with four accommodating sensors: pH, Temperature, Turbidity and TDS.

Methodology:

Design and Development The development of a simple prototype system fit for water quality monitoring needs to be comprised of the following components:

1. Multiple sensors to collect relevant data from the environment.
2. A central microcontroller loaded with a computer program to read analogue data and convert them to digital output.
3. A portable laptop with relevant software to read the digital data and present the data in an understandable format on a screen, as well as to provide power to the microcontroller.

The main component of the monitoring system is the Arduino UNO R3 Board.It is a microcontroller board based on the ATmega328 with three important features:

1. A total of 6 analog input pins labelled A0 to A5 to allow up to a maximum of 6 analog sensors to connect directly to the Arduino.

2. A total of 2 power supplies pin labelled 3.3 volts and 5 volts with in-built voltage regulation to provide power to sensors.
3. A USB plug that can be used in conjunction with a USB cable to connect with a microprocessor.

The system used is an Arduino microcontroller with four accommodating sensors: pH, Temperature, Turbidity, and Total Dissolved Solids (TDS). Sensors were chosen based on ease of use, measurability (of parameters), portability, as well as being economical and cost-effective as a strict budget must be adhered to

Figure 3.9 below shows the connection of the sensors to the Arduino microcontroller and operating laptop.

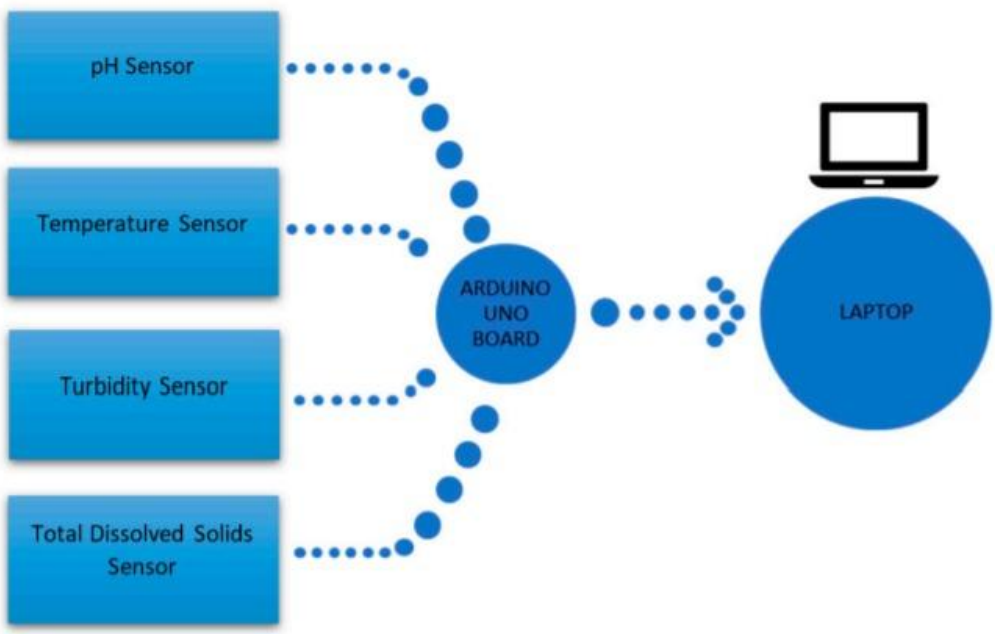

Figure 3.9. Block diagrams of the connections

Limitation:

The results seem to indicate that the stream is healthy, however more tests are required to further determine data validity and operability of the current system before the system can be deployed elsewhere. The prototype yet lacks many capabilities and thus require upgrades and expansions; namely, to give it the ability to transmit data through a wireless network to a remote laptop or mobile at any given time and location, and a stronger memory drive or the ability to store data in databases.

Chapter 4

SYSTEM DESIGN

4.1 Hardware requirements

- pH, Turbidity and other sensors to sense the water quality
- Arduino (IoT device).
- LED for output display
- WiFi module
- Breadboard, Resistors and Jumper wires

4.2 Software requirements

- Cpp in Arduino and ML algorithms
- Firestore/cloud store for storage
- IoT Platform
- Web interface / Notification through SMS

4.3 Challenges

- Climatic variations can adversely affect the pollution level. In the rainy season, the pollution level adversely increases as water combines with the waste dumping and eventually leaches out to the nearest water resources. This leaching causes the rapid spread of various epidemics and related health issues.
- Need to monitor different scenarios: Due to the waste dumping, the water resources in the dumping area become polluted. Thus, we have to monitor the water to

analyse the pollutants because this will affect the health of the people. Hence, an integrated system must be deployed which can detect pollutants.

- The system must also be capable of integrating more than one communication technology as the sensors will use different communication technologies to communicate with the platform and the gateway.
- Improper usage of water without knowing the pollutants can cause health hazards.
- No expert monitoring in IT in traditional method.
- Providing and convincing water supply agencies and health departments to use this System i.e., Implementation in public places.
- Damage of parts while transportation and Misuse of the system
- Educating the people about the need of quality water and implementing in rural areas.
- Keeping system safe during floods.

4.4 System Architecture

- Here we come up with an automatic real time water containment monitoring system to monitor the health of water. The proposed solution contains 4 layers: IoT layer, Cloud layer, ML layer and Front end or Output layer as shown in figure 4.1.

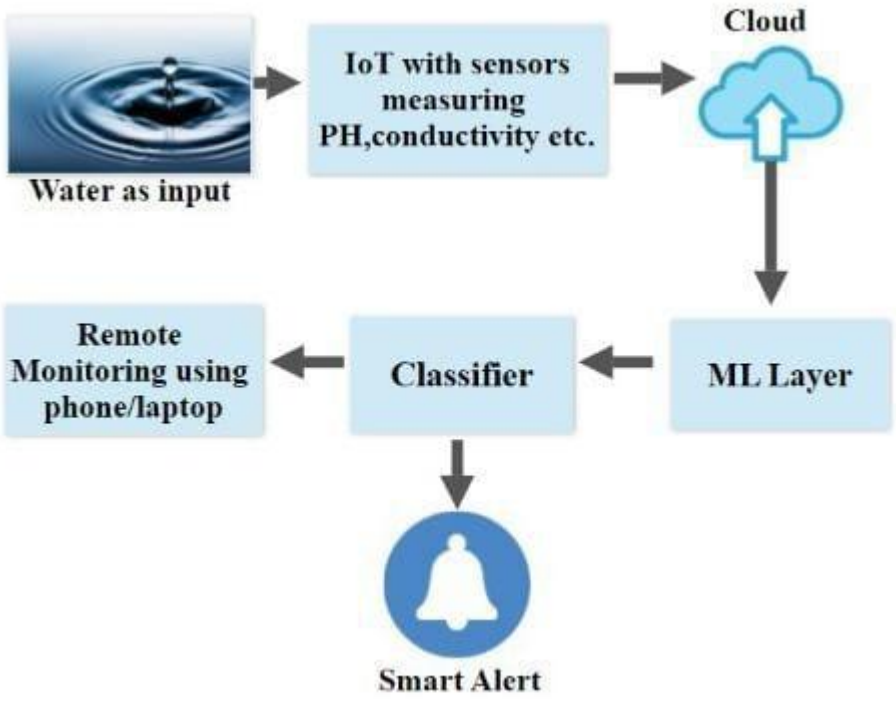

Figure 4.1: System Architecture

In this architecture following modules are designed:

- IoT layer: Here we develop an Intelligent IoT based Water Monitoring System where we use pH, TDS, turbidity etc. measuring sensors that are deployed in water tanks or reservoirs which communicate through microcontroller to processors such as Arduino etc. which gives pH, TDS and Turbidity output based on Water quality, which will be sent to Cloud layer. This layer has the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.
- Cloud layer: Processor collects the data in each predefined time interval. This data remains in memory until it is sent to the cloud storage or if network is not available then stored in local file system. This system requires internet connection for communicating with cloud storage. Cloud storage is the place where all data from Arduino is stored into database as well as the web portal is hosted. All data stored at cloud can be accessed through web portal.
- ML layer: We feed the Machine Learning algorithm to analyse the data captured

- to predict the contamination level of water. Machine learning algorithm deployed towards analysing the data captured towards predicting the water quality as Drinkable, Utility or others.
- Output layer: The predicted water quality will be updated in Web page or Android app. The Output layer is also used for sending notifications/SMS for actionable entities. Authorities can get access to reports generated.
- Following are the brief ideas of implementation for the above discussed system:

  (a) To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc. using available sensors at a remote place.

  (b) To assemble data from various sensor nodes and send it to the base station by the wireless channel.

  (c) To simulate and evaluate quality parameters for quality control.

  (d) To alert an authorized person through any communication forms routinely when water quality detected does not match the pre-set standards, so that, necessary actions can be taken.

4.5 Applications

Real time water containment system can be applied in following use cases:

- This systemiscanbeusedtobeimplementasrealtimeportableproductformeasuringwater containment levels. The levels are can be intelligently predicted using Machine Learning algorithm.
- In distribution tanks to provide adequate water supply with good quality water to each house, industry, and others.
- In helping authorities to monitor the water quality accurately as it will achieve a stronger accuracy of the prediction in the water level.
- The system is likely to be more economical, convenient and fast. The system has good flexibility.

- Number of possible health hazards can be avoided and it will help the people to become conscious about contaminated water.
- Smart cities can be enabled by performing analytics on the use of water and deriving new insights like where pollution is more, contamination is more and others

4.6 Program Outcome (PO) and Program Specific Outcomes (PSO)

Table 4.1 shows the PO mappings and Table 4.2 shows PSO mapping of the project

Table 4.1: PO Mapping

PO#	Mapping level	Justification
1	Moderate	We will be analysing the parameters such as temperature, pH and conductivity, and so on using mathematical and statistical model.
3	Strong	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
5	Moderate	We are trying to build an accurate system with appropriate techniques and using resources to predict the expected outcomes and we will try to overcome the limitations if any.
6	Strong	The main reason of our project is to benefit the society's health using professional engineering practice and safety which has been a legal and cultural issue.
7	Strong	The plausible impact of our project would be to help our society in a sustainable development of our environment.

8	Strong	Here we try to fulfil engineering ethics such as honesty, impartiality, fairness and equity and responsible towards the public welfare.
9	Strong	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Strong	We are communicating effectively among ourselves, professors and engineering community. By taking their assistance we prepare report and design documents

Table 4.2: PSO Mapping

	Justification
PSO - 1	We apply concepts in the core areas of Computer Science & Engineering – Networking, Mathematical Modelling and System Programming to address technical issues.
PSO - 2	Design and develop computer based systems by applying standard practices and principles using appropriate tools and programming languages for real world problems.

Bibliography

[1] Jamil Wahid and Q. Ahsan, "Detection of impurities in water by measuring capacitance", (IEEE) 8th International Conference on Electrical and Computer Engineering, 20-22 December, 2014, ISBN: 978-1-4799-4166-7.

[2] Maindalkar, A and Ansair, S M (2015). "Design of Robotic Fish For Aquatic Environment Monitoring", International Journal of Computer Applications,Vol.117(17), pp.31-34

[3] A.N.Prasad, K. A. Mamun, F. R. Islam, H. Haqva , "Smart Water Quality Monitoring System", School of Engineering and Physics University of the South Pacific Laucala (2015), Fiji Islands

[4] "Water Quality Measuring System Using Wireless Sensor Network" Mr. Vikas Mane, Mr. Pranav Medsinge, Mr. Akash Chavan, Mr. Sudhakar Patil Department of E&TC, Sanjeevan Engineering & Technology Institute, Panhala, Shivaji University Kolhapur, Maharashtra, India

[5] Cho Zin Myint, Lenin Gopal and Yan Lin Aung, "Reconfigurable smart water quality monitoring system in IoT environment", (IEEE) 2017 IEEE/ACIS 16th International Conference on Computer and Information Science (ICIS), ISBN: 978-1-5090-5507-4.

[6] Anand K R, Antony K A, Gipin Antony Joseph, Sabareesh Sajin, Fareeda A Kareem, "Advanced water impurity detection system", (IJIRSET) Volume 6, Special Issue 5, March 2017, ISSN (Online): 2319 – 8753.

[7] "Real-Time Water Quality Monitoring System" Jyotirmaya Ijaradar1, Subhasish Chatterjee2 1UG Student, Dept. of ECE, Centurion University, Odisha, India 2UG Student, Dept. of CSE, IEI Bangalore, Karnataka, India

[8] "Sensor Based Water Quality Monitoring System" By Bishwajit Paul , A thesis Submitted to the School of Engineering and Computer Science, BRAC University, Dr, Ashraful Alam, Supervisor. Committee Member BRAC University 66 Mohakali Dhaka 1212 BANGLADESH August 2018

[9] "Quality Monitoring with Arduino Based Sensors" By Wong Jun Hong Norazanita Shamsuddin, Emeroylariffion Abas, Rosyzie Anna Apong, Zarifi Masri, Hazwani Suhaimi, Stefan Herwig Gödeke and Muhammad Nafi Aqmal Noh. Submitted to Faculty of Integrated Technologies, Universiti Brunei Darussalam, Jalan Tungku Link BE1410, Brunei;