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PHASE -2 REPORT OF FINAL YEAR PROJECT

ON

"An Intelligent Real-Time Water Containment Measurement System"

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

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CERTIFICATE

Certified that the project work entitled **"An Intelligent Real-Time Water Containment Measurement System"** carried out by Ms. PREMA E V (4JN17CS060) a bonafide student of **J N N College of Engineering** in partial fulfilment for the award of Bachelor of Engineering in **Computer Science and Engineering** of the Visvesvaraya Technological University, Belagavi during the year **2020-21**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library.

The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said Degree.

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1.

2.

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 an IoT based model for water quality monitoring is put forth in this project. The water quality measurement parameters such as pH, turbidity, conductivity are collected using web-page. The data is analysed through ML algorithms. Later the water potability is predicted based on the inputs given. The containment quality of the water predicted is mailed to the user. Data predicted from different users are reflected in admin dashboard.

Acknowledgements

On the very outset of this project report on "**An Intelligent Real-time Water Containment Measurement System**", we would like to extend our sincere & heartfelt obligation towards all the persons who have helped us in this endeavor. Without their active guidance, help, co-operation & encouragement, we would not have made headway in the project.

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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 measuremet 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 is incresing 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 has a lot of consequences in real world, because 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 of water is essential.

1.3 Water quality measurement

In water quality management, 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 direct influenced by drinking. Infirmity and desolation leads 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 pure 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 Monitering

Internet of Things (IoT) enables us to build a system without human interference. In other words it 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. It 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 it 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. In the Chapter 4 looks after the brief explanation of system requirements. Later in Chapter 5 discusses and explains the design of the project and the implementation procedure. Chapter 6 is the major section giving the results and snapshots of the project. Finally Chapter 7 concludes the report along with possible future enhancements for this project.

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 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 an idea was introduced 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 user can check the quality of the water anytime and from anywhere. By keeping this in mind, this system was designed.

2.2 Problem Statement

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. Using traditional approaches of monitoring water quality in the water management system are not completely safe and time consuming. So, an automatic real-time monitoring system is proposed to monitor the health of the water.

2.3 Objectives

Objectives of this project are:

- The main objective is to measure the water quality. Measuring water quality will help to take measures to reduce pollution that are caused due to hazardous substances and other human causes.
- The major concern is to find out whether water is pure or contaminated. Treating water at early stages reduce pollution, minimize the health problems that are caused due to water i.e., water borne diseases.
- Ensuring pure water availability: Water should be purified in a fastest way possible before it's fully contaminated.
- Automate the process of checking water quality: Web-page does all of the work and it will be faster than the normal process. This immediate reporting cause to resolve the issues in less time so citizens will not face those issues for longer time.
- Make life of authorities easy, makes the process fast and reduces the cost.
- To make system to be more economical, convenient and the system is also expected to be more user friendly.
- To make system monitor the water quality automatically, triggers alarms immediately to prevent any health hazards and does not require people on duty.
- Number of possible health hazards can be avoided and it will help people to become conscious about contaminated water.

2.4 Summary

As discussed above this system is developed for Water quality measurement. This chapter deals with the issues related to potability of water. And the main objectives of the project are discussed.

Chapter 3

LITERATURE SURVEY

Literature review of the problem shows that there have been several approaches to address the issue of gesture recognition using several different methods.

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 the 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 the experiments were conducted on water and water conducts electricity, it 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:

Sensor array consists 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. 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. This paper adopted 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.

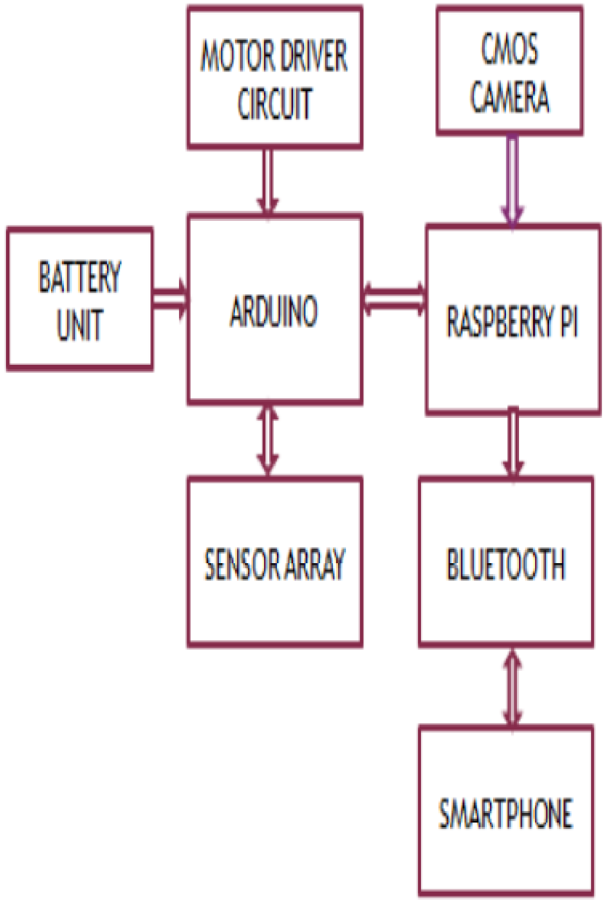

Figure 3.1: Architecture of robot fish

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 Online Monitoring of Water Quality Using Raspberry Pi3 Model B:

In this proposed system, to check water quality they have used Raspberry Pi3 Model B

Contributions:

This Online Monitoring of Water Quality using Raspberry Pi3 Model B is very useful for smart cities in different aspects. In cities there are different water source located in the different areas and water get pollute many times and the people do not get information about this. The system is designed to solve this issue and will provide pollution details of the water source located in the different areas throughout the city. The concerned authority can access the information from anywhere and anytime to get the details. Accordingly, they can take the decision on this immediately. This system can be used for commercial & domestic purposes and water supply agencies. In health department, for identifying the cause of water diseases.

Methodology:

The device consists of several sensors for measuring water quality parameters such as pH, turbidity, conductivity sensors. The data from the sensors are sent directly to the Raspberry pi3 model B. So that the proposed system gets the data from the sensors and processes them, put the data in a text file which is transmitted to IoT. For transmitting data to the IoT, gateway is created on the Raspberry pi 3 model B using FTP (file transfer protocol) protocol. In the proposed system, for monitoring the processed data on the internet, cloud computing technology is used which provides the personal local server. In cloud computing, separate IP address is provided which make possible to monitor data from anywhere in the world using the internet. To access that monitor data and make system user-friendly browser application is introduced which work on HTTP. So, by using browser application user can access and monitor the data from all over the word.

Such a connected device is shown in Figure 3.2.

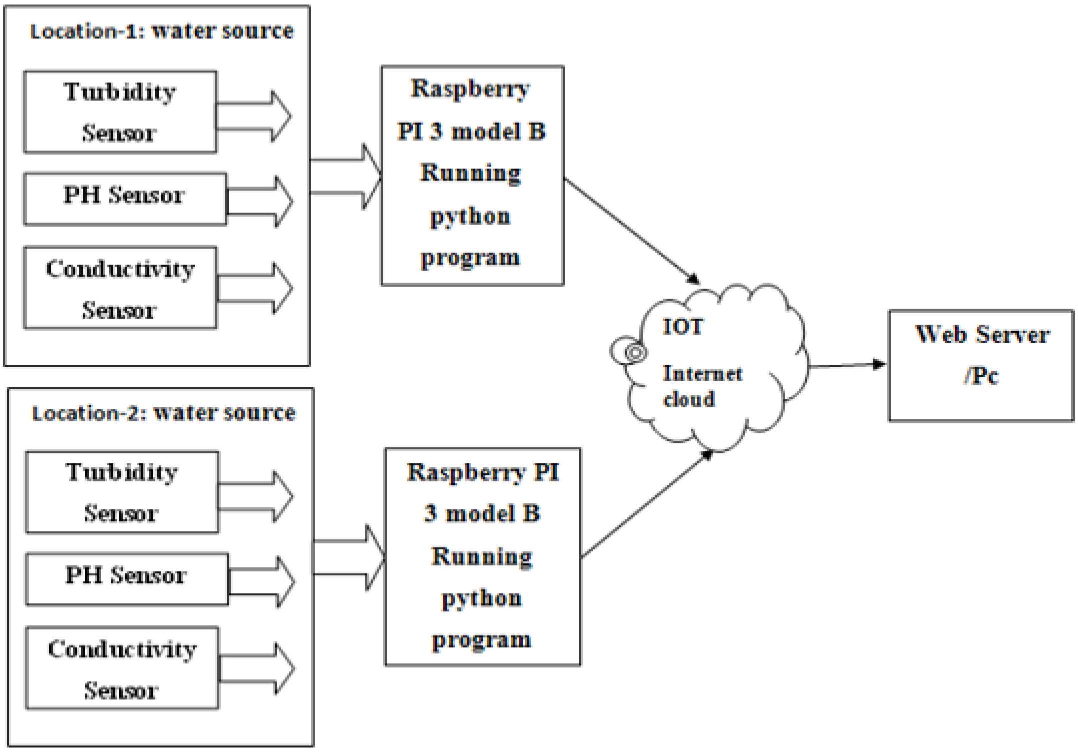

Figure 3.2: Block diagram of the proposed system

Limitations:

- It of high cost and more time consuming since, they are going to take water samples from two different places and for this more man power needed.
- There are a limited number of parameters tested in the system such as pH, Turbidity and conductivity. Parameters such as, salinity, phosphorous, and nitrogen, which contribute to water quality, are not tested.

3.4 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.

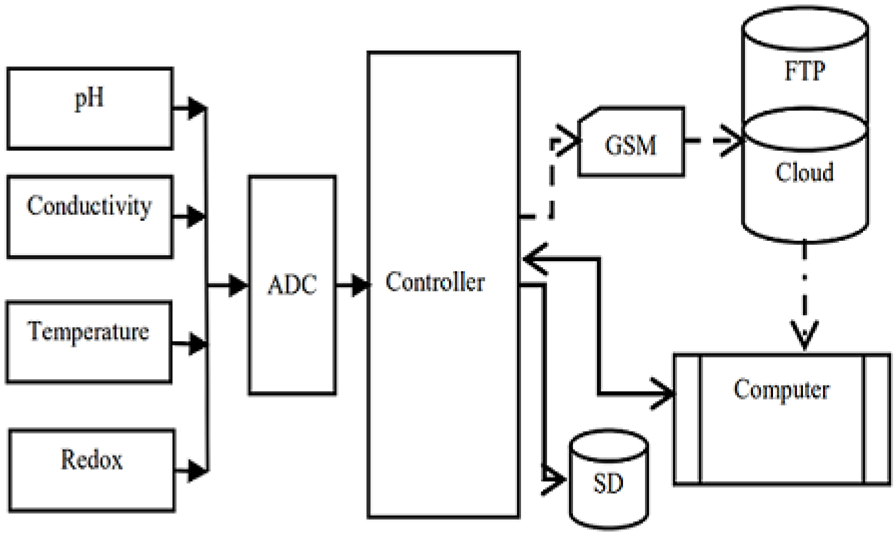

Figure 3.3: Water moniter system architecture

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.

3.5 Water Quality monitering and control using Wireless Sensor Networks

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

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.

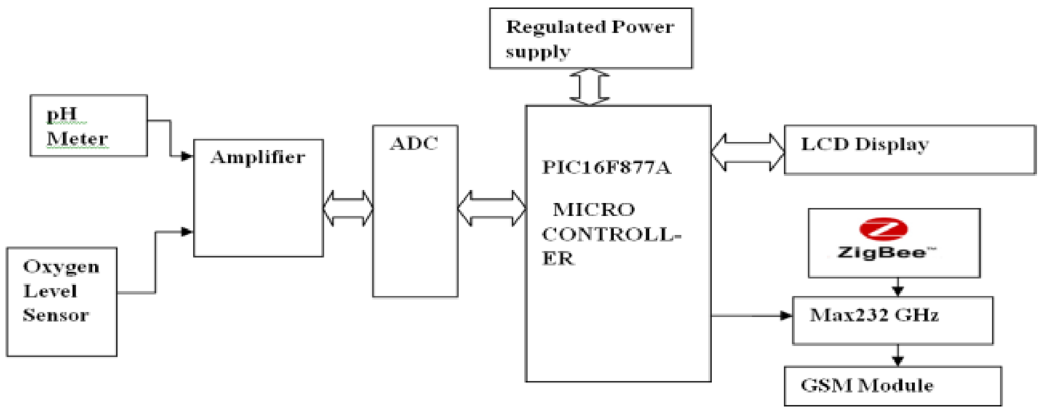

Figure 3.4: Water Quality monitering and control using WSN

In this paper different sensors are used to measure water pH, conductivity, dissolved oxygen (DO) and temperature.The general characterization of this water quality system is that it has three sensors for measuring Ph (Potential of Hydrogen), EC (Electrical Conductivity) and DO(Dissolved Oxygen). These sensors will sense the water sample and send analog data to analog to digital converter. PIC16F877A micro-controller, an open-source electronics prototyping platform based on flexible, easy-to -use hardware and software was used to acquire and process sensor data. This digital data then will be sent to Zigbee Wireless sensor node is equipped with sensor and micro-controller units, Global

Positioning System (GPS) receiver, power supply and Zigbee transceiver. 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. Then the Zigbee transceiver again fetches the values and transmits to the mobile phone through GSM to the relevant stakeholders. If the GSM network is available it will send alert messages otherwise it will stored in PC till network is available. The experimental values are sent simultaneously to the mobile phone in the time interval of 10 minutes.

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 damage of sensors due to temperature.

3.6 Reconfigurable Smart Water Quality Monitoring System in IoT Environment

Water monitering system has been deployed in an IoT enviroment.

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.

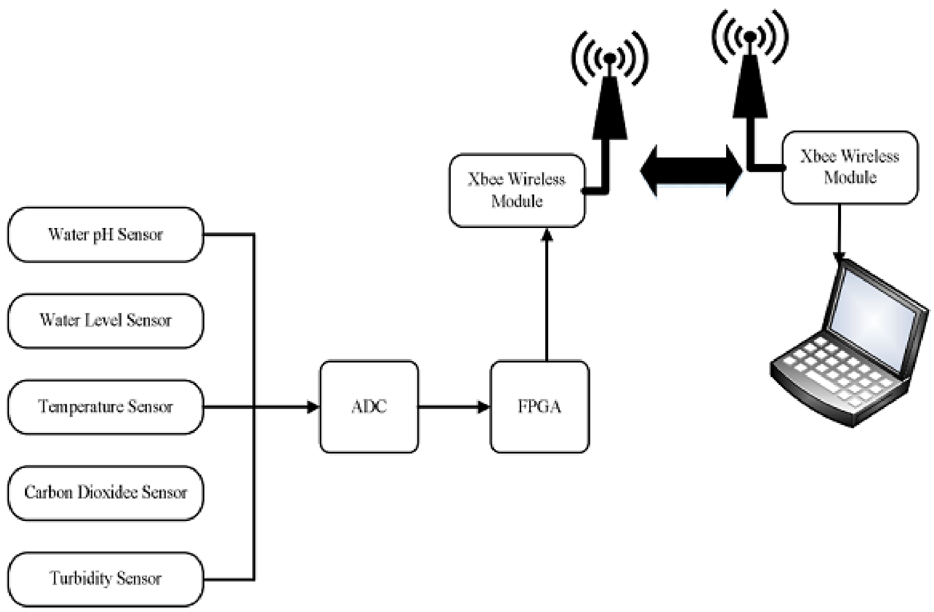

Figure 3.5: Smart water moniter Architecture.

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. And the measured data of water parameters are collected by the sensor nodes and sent to FPGA board. The analog output of CO2 sensor and Turbidity sensor are digitalized by AD7928 Analog to Digital converter. And they created a software program that runs on the Nios II system. This program logic is used to display the wirelessly received data of water parameters on PC, the Pythons codes are used to display on the Grafana. The monitoring PC is operated in Linux mode.

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 it needed the maintenance.
- Maintenance becomes costly.

3.7 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 analyzed report is sent 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 pre programmed.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.

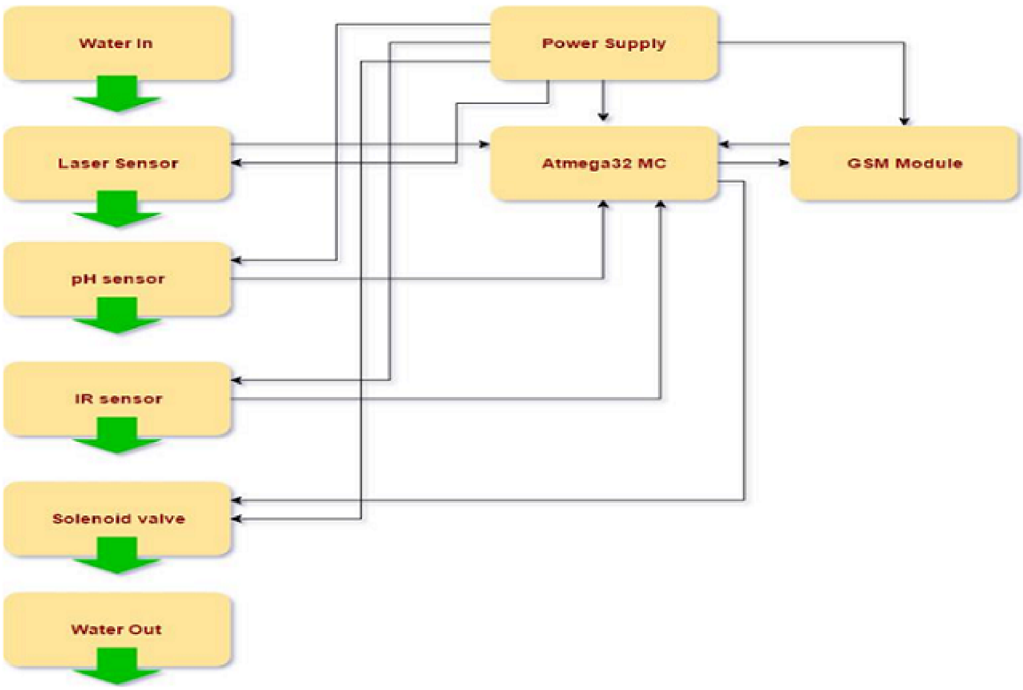

Figure 3.6: Proposed system

- 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 and flushing it off is not a good idea or using it to irrigation purpose may also affect the crops

3.8 Detection of Water Level, Quality and Leakage using Raspberry Pi with Internet of Things

An survey on water level and quality monitoring system using IoT is discussed in this section.

Contributions:

In the current days industrial waste water has a major effect on human, animal and plant life. The contaminated water from industries effects the environment in several ways. This waste water has to be continuously analyzed and purified in order to make it as clean water. This project focusses on analyzing the water level, water quality and pressure of flowing water. Water quality is to be determined by considering several parameters like pH, turbidity. Water level is determined by considering the distance of water using ultra sonic senor. With the help of Raspberry Pi some Parameters of the water is determined. The proposed system measures the level, turbidity, pressure and pH and these measured values are stored into database, and based on the threshold values set, Raspberry Pi notifies the registered user by sending text SMS with the values and these values can also be retrieved through website.

Methodology:

A tank containing water is immersed with pH and turbidity sensors for water quality measurement, FSR sensor for water pressure detection and LED lights and ultrasonic sensors for determining the water level. These sensors measure the corresponding values in the water. Outputs of the pH sensors are converted from analog to digital by Raspberry pi using ADC. System uses LAN for communication with the control center. It's a real time system and it doesn't need any man machine interaction for activity in the water quality measuring system. This requires a LAN or internet connection for communication. The systematic arrangements of the components are shown in the Fig 3.7.

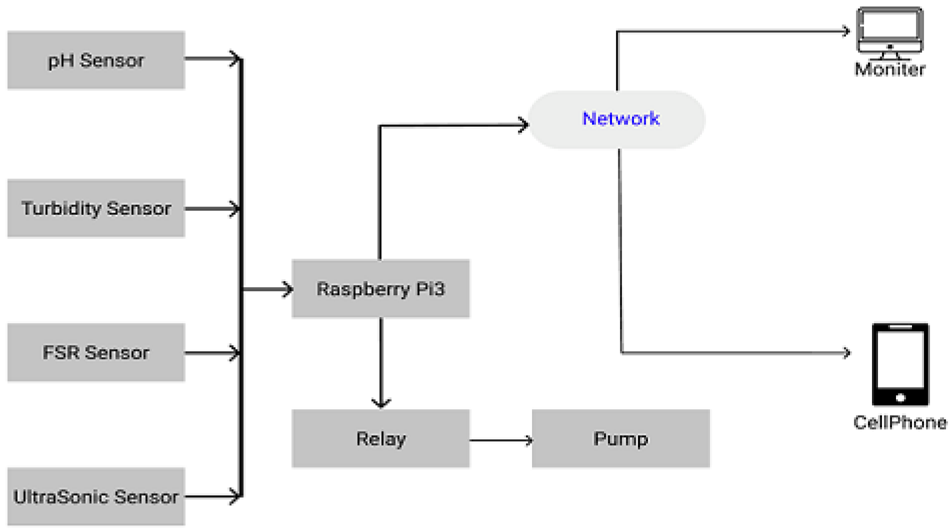

Figure 3.7: Water leakage and quality check system architecture

The system uses pump which is kept inside water container. Water pump is controlled by relay to switch on or switch off the pump. When motor runs water flows into the tank. The tank is immersed with pH and turbidity sensor to check the quality of the water. Its reading is displayed in the monitor. Also the pipe is fixed with FSR sensor to detect the water pressure to identify the leakage. Its reading is shown in the monitor continuously. The ultrasonic sensor is fixed at the top of the tank to detect the water level. LED is used to indicate the water level in the tank. No analog is available in raspberry pi since it contains only digital pins, but the pH sensor is analog. Hence ADC is needed to convert analog to digital. It uses three LEDs to indicate the level of the water. LED 1 is fixed to indicate the lowest level. LED 2 is fixed to indicate the medium level. LED 1 is fixed to indicate the highest level. When water reaches lowest level the LED 1 blinks and pump will be automatically switched on and when it reaches the highest level the LED 3 blinks and pump will be switched off and message is sent to the mobile with details of the water quality, level and pressure using way2sms gateway.

Limitations:

- The limitation of this system is it relays on residential water tanks and if any issues found treating it may be harder to common people.
- Its suitable for a particular area not for large system

3.9 Development of Surface Vehicle for water quality monitoring and measurement

An surface vehicle like boat was deployed in water to detect the water quality.

Contributions:

This project has successfully created the control system for the double hull USV, and has been proved in the field with two different type of weather conditions and different inspection route. However due to physical size of the vehicle itself, the full scan of the water reservoir was not possible, therefore, this will be the first point for the future improvement. Secondly, the “ducted fan” system for USV proved its usefulness, but it can be only used for backup system. It is Portable, battery-operated Wi-Fi access point for surface communication between a PC or handheld device and the vehicle. It has point-to-click, which is used to take images clearly to the point with geo-locations. The integration of onboard sensors including a GPS, laser scanners, sonars and cameras allow to operate successfully in previously unmapped shallow water environments, as well as avoid mobile obstacles. Hence, this paper propose and development of Surface Vehicle which carry a mobile water quality sensor to perform a real time scan of water qualities. Secondly, due to no mobile signal coverage, development will also include the communication relay via Surface vehicle.

Methodology:

In another research carried out towards Water Quality Monitoring, EcoMapper which is an autonomous underwater vehicle employed in water. Standard sensors include conductivity, temperature are included. All these sensors are embedded inside the vehicle. Instead of collecting sample for inspection, this project also selected a continuous monitoring sensor. ARK sensor system is used to monitor Chlorophyll-a, Dissolved oxygen, Electrical conductivity, Potassium ion, pH, temperature and Turbidity. Even though ARK system can give multiple reading at same time, but the hardware itself was designed for stationary point monitoring, therefore to have a water reservoir to equip “Enough” ARK system will be not be economically possible, hence, the this project will make the ARK system become “MOBILE”.

Figure 3.8: Surface vehicle

The method maps “water quality, the currents of the water and bathymetry”. There is side scan sonar that can be added on. This will help us to know about the depth of water. The vehicle is equipped with a Wi-Fi model. This model sends data to base station where they analysed the water data. It has Rechargeable lithium-ion Smart Battery provides mission duration of 8+ hours at 2-4 knots on a single charge. The full operation require almost 2hr, with inspection of 5 points by using ARK system and total of 20L of water sample are collected. Each of the inspection require the ARK system to stay around 2 to 5 min depends on the wind and wave speed.

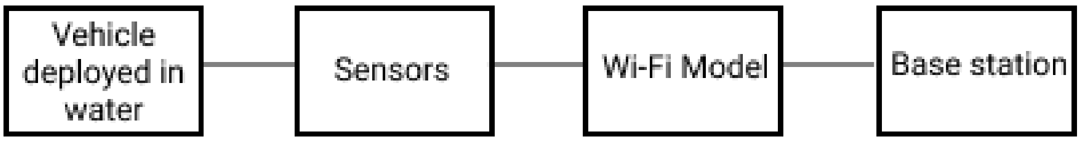

Figure 3.9: Block diagram of the proposed system

Limitations:

- Apart from the sensor measurement, water sample collection is required, and because for different type of chemical analysis, therefore require certain amount of sample (more than 1L)
- Weather has significant effect for the inspection mission, but also contamination spare fast in bad weather (such as heavy rain and strong wind).
- Each inspection mission will require at least 3 people (one for driving the boat, two for water sample collection and monitoring), which is a risk for human health if water is contaminated.
- Boat’s propeller has high chance get jam on the grass when close to the shore and Boat fuel is enough to run point to point in the water reservoir, but not enough for scanning of the whole area.
- The major drawback of this system is that only one person can deploy the EcoMapper which has 8-14 hour life span at the speed of 2-4 knots.

3.10 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 :

- Measurement of pH, temperature, turbidity, quantity of water using sensors at remote area and 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 and control data communication between source and nodes.
- To simulate and analyze quality parameters for quality control. (Graphical and numerical record using VB & MATLAB), then publish the corresponding record over web for public information and further assessment of water resource.

This system is equipped with different sensors like pH, Turbidity, Temperature and rain is fixed. the data or signals from these is passed to signal converter and fed to analog to digital converter. This ADC helps us to convert analog signals from sensors to digital. the data then passed to raspberry pi 3 module, which uses DC power supply. The data then sent to receiver side with the help of Wi-Fi module.

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

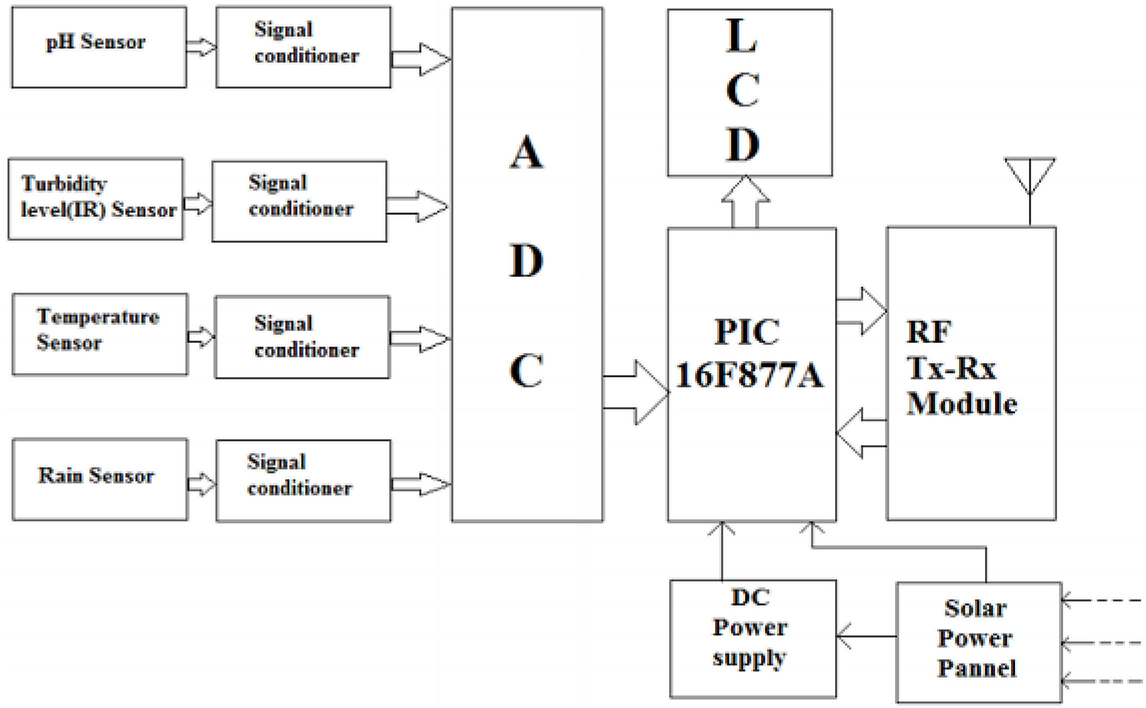

Figure 3.10: Block diagram of Transmitter

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 and sends a signal to the RF receiver on the receiver side. The signals then sent to level converter circuit. 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.

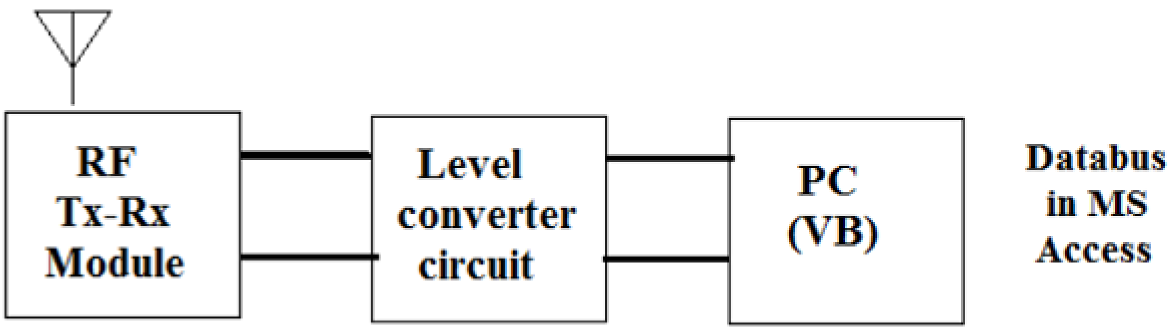

Figure 3.11: Block diagram of Receiver

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

3.11 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.

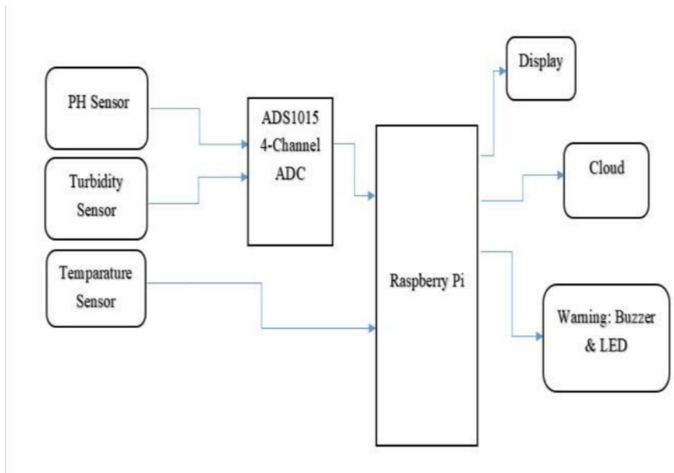

Figure 3.12: System architecture of real time water quality check

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.

3.12 Sensor Based Water Quality Monitoring System

A sensor based system was developed to measure water quality.

Contributions:

This model can detect pollution remotely and take necessary actions. Here they monitored water parameters such as temperature, pH. They quantified relative value for water level and measure water consumption through flow sensor.

Methodology:

The system working mechanism is shown in Figure 3.13.

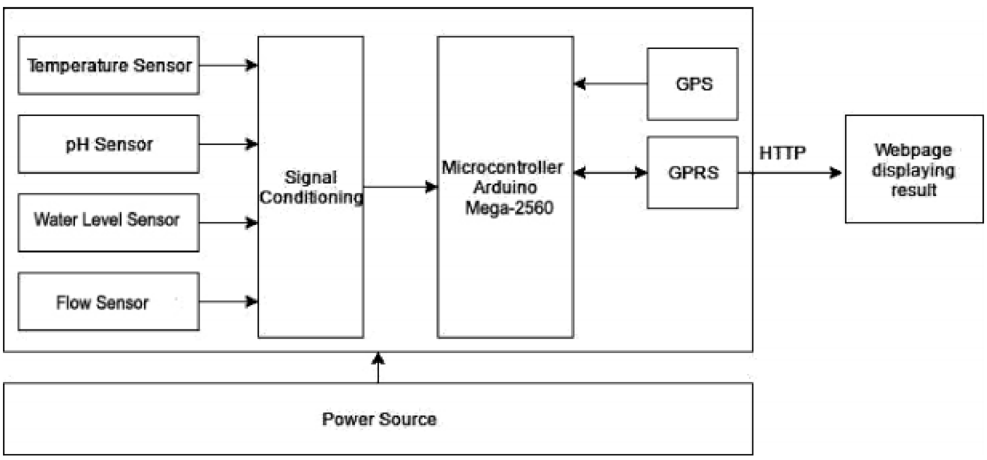

Figure 3.13: System architecture of sensor based system

In the proposed system, physical and chemical properties of water in different water sources such as drinking water, swimming pool water, water bodies and industrial waste water are investigated. In this research, water was monitored for physical and chemical parameters of the aforementioned water sources by using an IoT based sensor network. All the sensors, LCD and GSM shield connected to arduino mega. There is also a buzzer and LED connected to Arduino mega. It is required to connect a register in between cathode and anode node of an LED. In this project arduino mega act as a high value device and all the sensors are connected to it. A microcontroller is used as a sensor node which stores real time data and sends the data to the cloud storage via Wi-Fi. There is also a GSM shield connected to microcontroller which sends the text notification to mobile device. Http protocol transfer the data to cloud and a webpage running on a local host server displays the result.

Limitations:

- Due to limitation of time and budget they focused on measuring quality of water parameters.
- This project can be extended into efficient water management system of a local area.

3.13 Summary

This chapter gives the overview of the literature survey done before starting the project.

Chapter 4

REQUIREMENT ANALYSIS

4.1 Specific requirements

The water quality detecting model is designed using random forest algorithm. The algorithm is implemented using python programming language and flask framework. The android application is designed using kotlin.

4.1.1 Python Programming Language

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and largescale projects.

Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library.

Python was conceived in the late 1980s as a successor to the ABC language. Python 2.0, released in 2000, introduced features like list comprehensions and a garbage collection system capable of collecting reference cycles. Python 3.0, released in 2008, was a major revision of the language that is not completely backward-compatible, and much Python 2 code does not run unmodified on Python 3.

The Python 2 language was officially discontinued in 2020 (first planned for 2015), and "Python 2.7.18 is the last Python 2.7 release and therefore the last Python 2 release." No more security patches or other improvements will be released for it. With Python 2's end-of-life, only Python 3.5.x and later are supported.

Python interpreters are available for many operating systems. A global community of programmers develops and maintains CPython, an open-source reference implementation. A non-profit organization, the Python Software Foundation, manages and directs resources for Python and CPython development.

4.1.2 Flask Framework

Flask is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries. It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. Extensions exist for object-relational mappers, form validation, upload handling, various open authentication technologies and several common framework related tools. Extensions are updated far more frequently than the core Flask program.

Applications that use the Flask framework include Pinterest and LinkedIn.

4.2 Functional requirements

The following are the functional requirements for the project:

- Data collection : Initially the dataset is collected to train the model. Then the user input is taken through the web-page which is to be predicted for contamination.
- Potability measurement : The parameters such as pH, conductivity, turbidity are given input through web-page. Based on the values, an intelligent machine learning algorithm is used to predict whether water is safe or unsafe.
- Admin login in web-page : This page is designed for the authority to view the total percentage of safety of water in a pie chart and can view the percentage of safety in a particular city in a bar graph.
- Android Application : A mobile application is provided which is an interface for the authority. The authenticated authority can check the compatibility at a particular place.

4.3 Non-functional requirements

The functionalities to be fulfilled in the project is supplemented by a list of nonfunctional requirements. These non-functional requirements evaluate the performance of the project using various parameters as follows:

- Accuracy in predicting the safety of water : The water safety prediction should be accurate to avoid the issues or health hazards caused due to contaminated water.

- Reliability : The system is reliable in terms of contamination prediction. The reliability is increased with regular enhancement of performance with the data updation from the users.
- Responsiveness : The process of prediction should take minimal time to retrieve the data and do the computations without any latency. So that the system becomes more and more responsive for the user.
- Deployability : The application can be installed on any basic smart phone which can be used with a user authentication procedure.

4.4 Software requirements

- Programming Language used : Python with Machine learning library
- Front End : XML, HTML and CSS
- Back End : Firebase
- Operating System : Windows 7 and above
- Mobile application development using Kotlin in android studio
- Flask micro-framework

4.5 Summary

The chapter 4 considers all the system requirements which the project require to develop this proposed system. Section 4.1 grants specific requirements like programming languages, what framework are used and under which platform this project has been done throughout the project in detail. The functional requirements for this project have been explained in section 4.2. The non-functional requirements for this project have been explained in section 4.3. The hardware requirements for this project have been explained in section 4.4. The back end software is clearly explained in section 4.5. The challenges are explained in the section 4.6.

Chapter 5

DESIGN AND IMPLEMENTATION

5.1 Design Issues

- Poor internet connectivity - It could be a problem with modem or router or poor signals.
- Non-availability of sensors to get the pH, conductivity and turbidity values.
- Public may be unaware of the measures to be taken for the contaminated water.
- Climatic variations can adversely affect the pollution level. So the water need to be tested regularly for the contamination.
- Providing and convincing water supply agencies and health departments to use this System i.e Implementation in public places.
- Educating the people about the need of quality water and implementing in rural areas.
- Improper usage of water without knowing the pollutants can cause health hazards.

5.2 System Architecture

Here a water containment monitoring system to monitor the health of water is designed. The proposed solution contains 4 layers: Input layer, Cloud layer, ML layer and Front end or Output layer as shown in Figure 5.1.

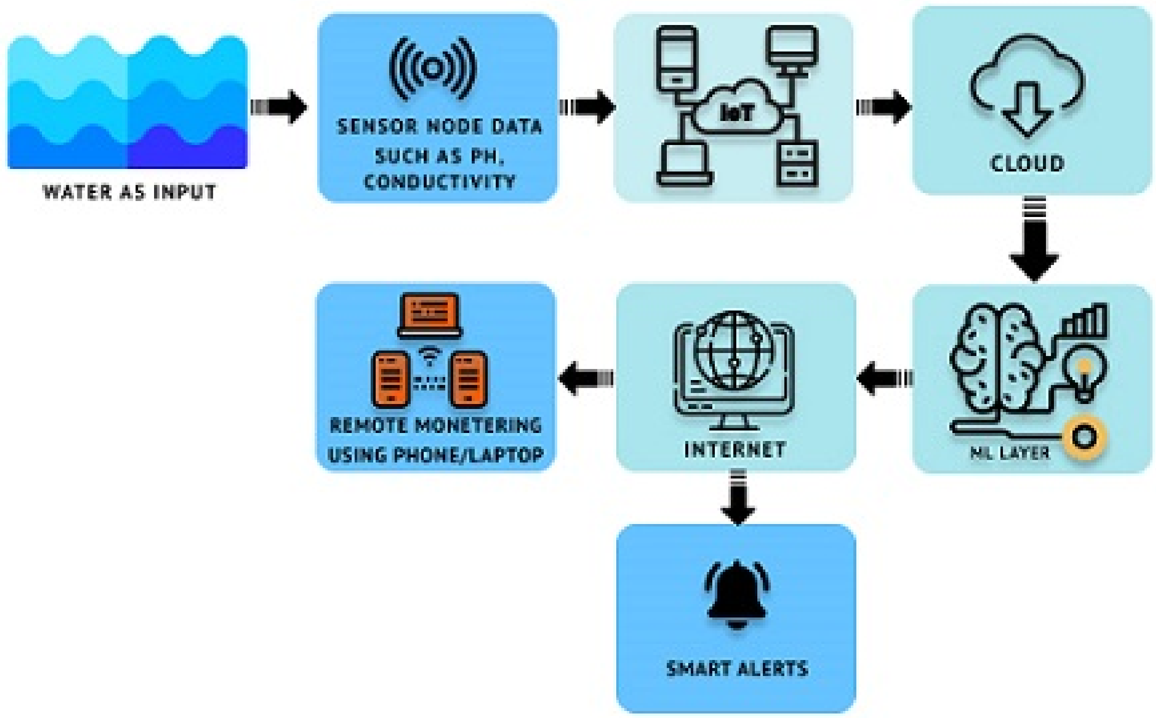

Figure 5.1: System Architecture

In this architecture following modules are designed:

Input layer: Here a web-page is designed where form take pH, conductivity and turbidity as input. Which is then 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: The system requires internet connection for communicating with cloud storage of firebase. Cloud storage is the place where all data received from the web-page is stored into database. All data stored in cloud can be retrieved through web portal or android application.

ML layer: Data is fed to the Machine Learning algorithm,Random classifier. 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 Safe or Unsafe.

Output layer: : The predicted water quality status is mailed to the user. The water quality will be updated in Web-page and Android application.The statistics of the data predicted is visualized in the form of bar graph and pie chart and reflected in admin web-page. The android application is used to know the water quality in a particular area.

Following are the brief ideas of implementation for the above discussed system:

(a) To measure water parameters such as pH, conductivity and turbidity using web-page.

(b) To send the data collected to the firebase.

(c) To analyse and evaluate quality parameters.

(d) To alert the user through mail when water quality is detected.

5.3 Module Specification

Module Specification is the way to improve the structure of the design by breaking down the system into modules and solving it as independent task. By doing so the complexity is reduced and the modules can be tested independently. This model can divided into 4 modules - data collection, data preprocessing, classification module and data prediction module. The flow of the data model is represented in the Figure 5.2 .

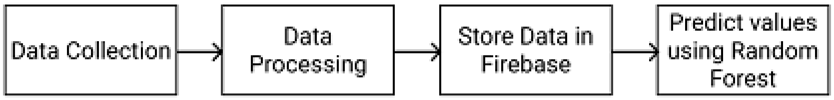

Figure 5.2: Model splitted into modules

5.3.1 Detailed design of each module specified

A detailed design is the ongoing process of each segregated module which has been completed in the earlier stages of implementation. Prior to this detailed designing an overall draft design is shown, and now in detailed design each indivisual step is explained elaborately. It basically saves a lot of time in understanding the model with just explanations and another plus point of these design process is to make implementation easier.

5.3.1.1 Data collection module

Data collection is the process of gathering and measuring information on targeted variables in an established system, which then enables one to answer relevant questions and evaluate outcomes. Data collection is important step in designing the project. The data is collected for water quality prediction. Initially the dataset is acquired regarding the various water parameters that are observed.

The data collection process is carried through a web-page. The water parameters and the data required - pH, conductivity, turbidity, water ID, latitude, longitude are collected. If the data entered is not valid error message will be displayed and waits for the valid input to be given, if data entered are valid then it will proceeded to next step. If the ID given already exists in the database then the parameters are updated to the same id. If the ID does not exist then new data is inserted into the database.

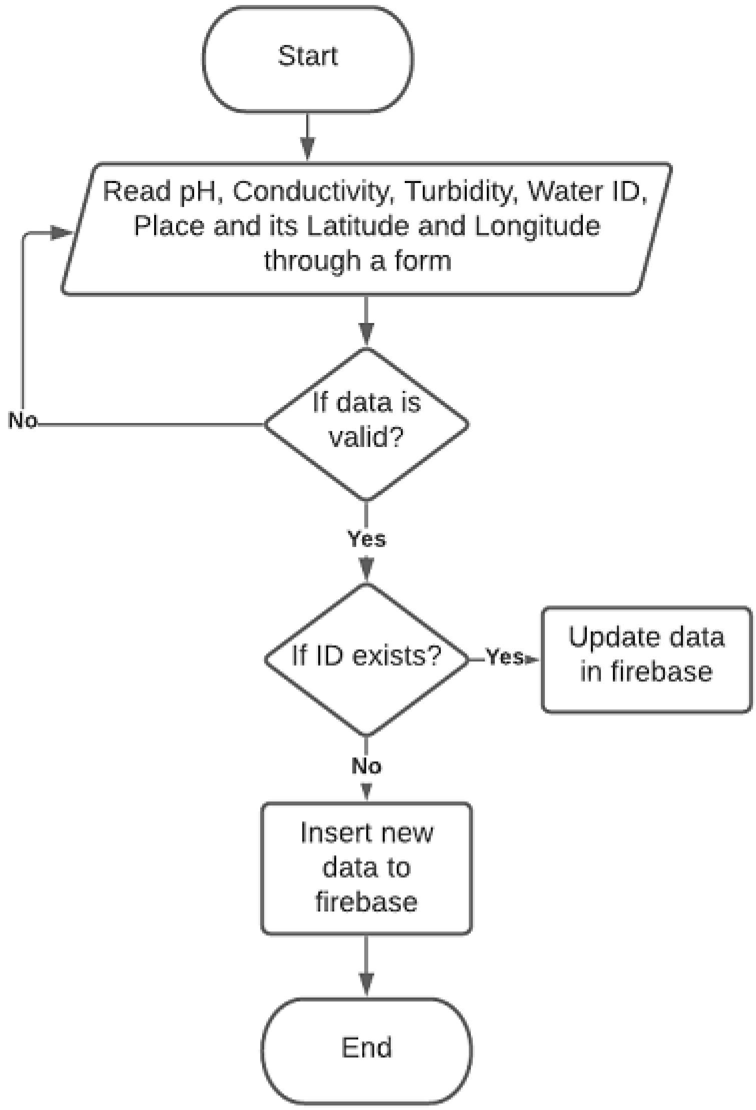

Figure 5.3: Flow chart of data collection module

5.3.1.2 Data pre processing module

The main functionality of this module is to clean the data and address it to the pre-processing method.

Data pre-processing is a data mining technique that involves transforming raw data into an understandable format. Real world data is often incomplete, inconsistent, and/or lacking in certain behaviors or trends, and is likely to contain many errors. Data pre-processing is a proven method of resolving such issues. Data pre-processing prepares raw data for further processing.

Data goes through a series of steps during pre-processing. They are :

1. Data Cleaning : Data is cleansed through processes such as filling in missing values,

smoothing the noisy data, or resolving the inconsistencies in the data.

2. Data Integration : Data with different representations are put together and conflicts within the data are resolved.

3. Data Transformation : Data is normalized, aggregated and generalized.

4. Data Reduction : This step aims to present a reduced representation of the data in a data warehouse.

5. Data Discretization : Involves the reduction of a number of values of a continuous attribute by dividing the range of attribute intervals.

During this data pre processing in the project, the unsoughted special characters such as ’^’ , ’_’ and null values are replaced with mean of all other values with the help of fillna method. Unwanted spaces in the cells are removed. Spurious cell data is replaced with relevant data.

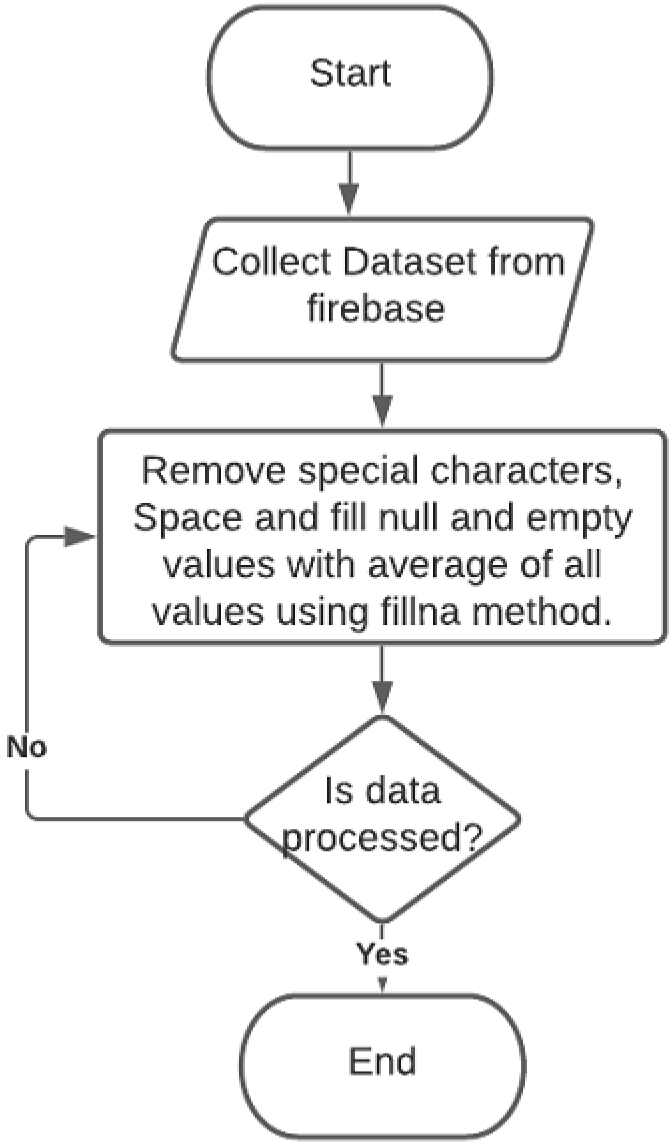

Figure 5.4: Flow chart of Data processing module

5.3.1.3 Prediction of water using Random Forest Classifier

The algorithms used in the project is Random forest. Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset". Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting. The below diagram explains the working of the Random Forest algorithm:

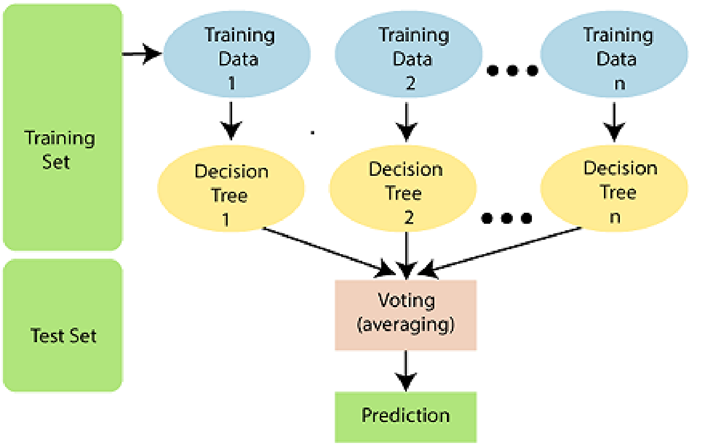

Figure 5.5: Flow of Random Forest Algorithm

Since the random forest combines multiple trees to predict the class of the dataset, it is possible that some decision trees may predict the correct output, while others may not. But together, all the trees predict the correct output. Therefore, below are two assumptions for a better Random forest classifier: There should be some actual values in the feature variable of the dataset so that the classifier can predict accurate results rather than a guessed result. The predictions from each tree must have very low correlations. This project uses Random Forest as it takes less training time as compared to other algorithms. It predicts output with high accuracy, even for the large dataset it runs efficiently. It can also maintain accuracy when a large proportion of data is missing.

5.4 Implemetation

In this section the implementation of various modules involved in the design of intelligent real-time water containment measurement system is discussed.

5.4.1 Implementation of User Interface

User interface implementation contains the water measurement details which are being read using the web-page. The details of measurement include pH, Conductivity and Turbidity, which gives the result whether the water is safe or unsafe for drinking according to the user input. The web-page also contains admin login, where the admin gets the details of overall percentage of safety in the pie chart and safety percentage in a particular city in the bar graph, which is represented by the google visualization written in javascript.

5.4.2 Implementation of ML algorithm

Random forest Classifier is used to cassify the potability of water. In this project, Inference tree for water quality data consists of 3 nodes. All the terminal nodes contain the probabilities of each class (Potable and Non-Potable). The prediction process happens as shown in the Figure 5.6.

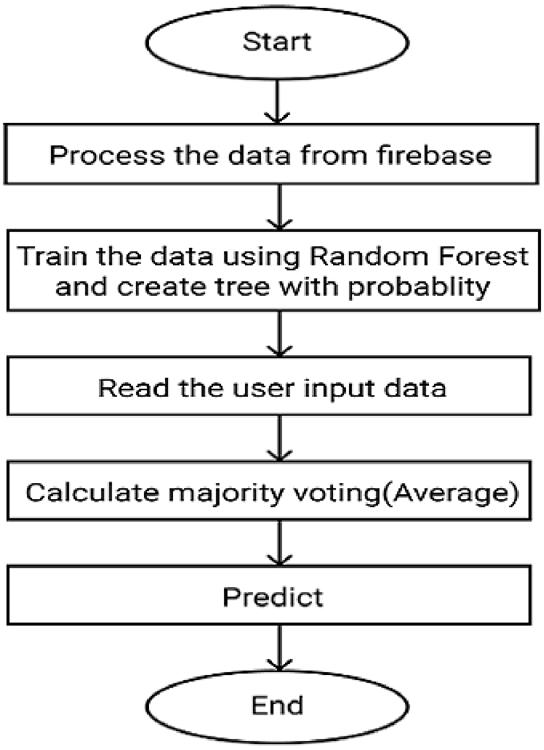

Figure 5.6: Flow chart of Prediction of water quality

The steps involved in prediction can be explained as below,

Step 1: The data stored in the firebase which contains features and labels are used to train the system using the Random forest algorithm with .fit() method.

Step 2: After training the system the test instance for getting the prediction of best class is provided. Here the test instance means the report data of various attributes which are fed to the trained machine.

Step 3: Then testing instance values are substituted to the decision tree.

Step 4: Now these values are substituted to get the final average value.

Step 5: This will predict which class of potability is best for the water data which is given as input.

5.4.3 Implementation of Mail

As a sign of alert message, the mail notification has been created using Yagmail, which is SMTP client that aims to send mails. The mail contains the parameters pH, Conductivity, Turbidity and the place details with the water potability status.

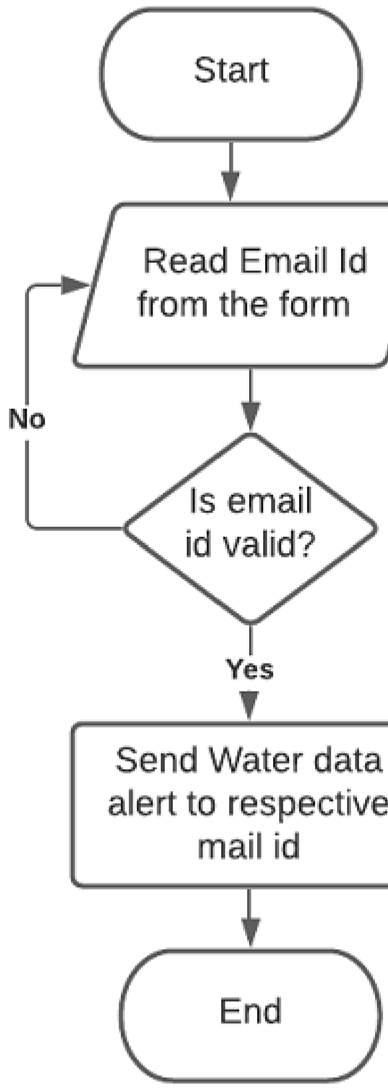

Figure 5.7: Flow chart of Alert mail

5.4.4 Implementation of firebase

Cloud firestore from firebase is used as the backend database. The whole platform is a Backend-as-a-Service solution both for mobile and web-based applications that includes services for building, testing, and managing apps. BaaS solutions allow you to eliminate the need in managing backend databases and obtaining corresponding hardware. Instead, you can plug them into your app via dedicated APIs for each separate service.

Cloud Firestore is a cloud-hosted, NoSQL database that an iOS, Android, and web applications can access directly via native SDKs. Cloud Firestore is also available in native Node.One can also create sub-collections within documents and build hierarchial data structures that scale as your database grows. Figure below shows the Water quality details stored in the backend.

5.5 Android App (Smart Water)

Kotlin is a cross-platform, statically typed, general-purpose programming language with type inference. Kotlin is designed to interoperate fully with Java, and the JVM version of its standard library depends on the Java Class Library, but type inference allows its syntax to be more concise. Kotlin mainly targets the JVM, but also compiles to JavaScript or native code. Android Studio is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development.

Kotlin is used to build android application. Here, user can login/register using email id and password. If entered email and password is correct, user will be directed to page where the user can know the potability in particular place. When clicked on the marker the user inputs given and potability status in the given place are displayed.

5.6 Working of the system

The implementation of this project is to measure water quality. At first data is taken from the user through web page. These, data then fed into ML algorithm. The water quality is measured based on the parameters given such as pH, Conductivity and Turbidity and the predicted potability is displayed and the same details is sent to the user through mail. Similarly an android application was developed, where the authority can check the potability at different places.

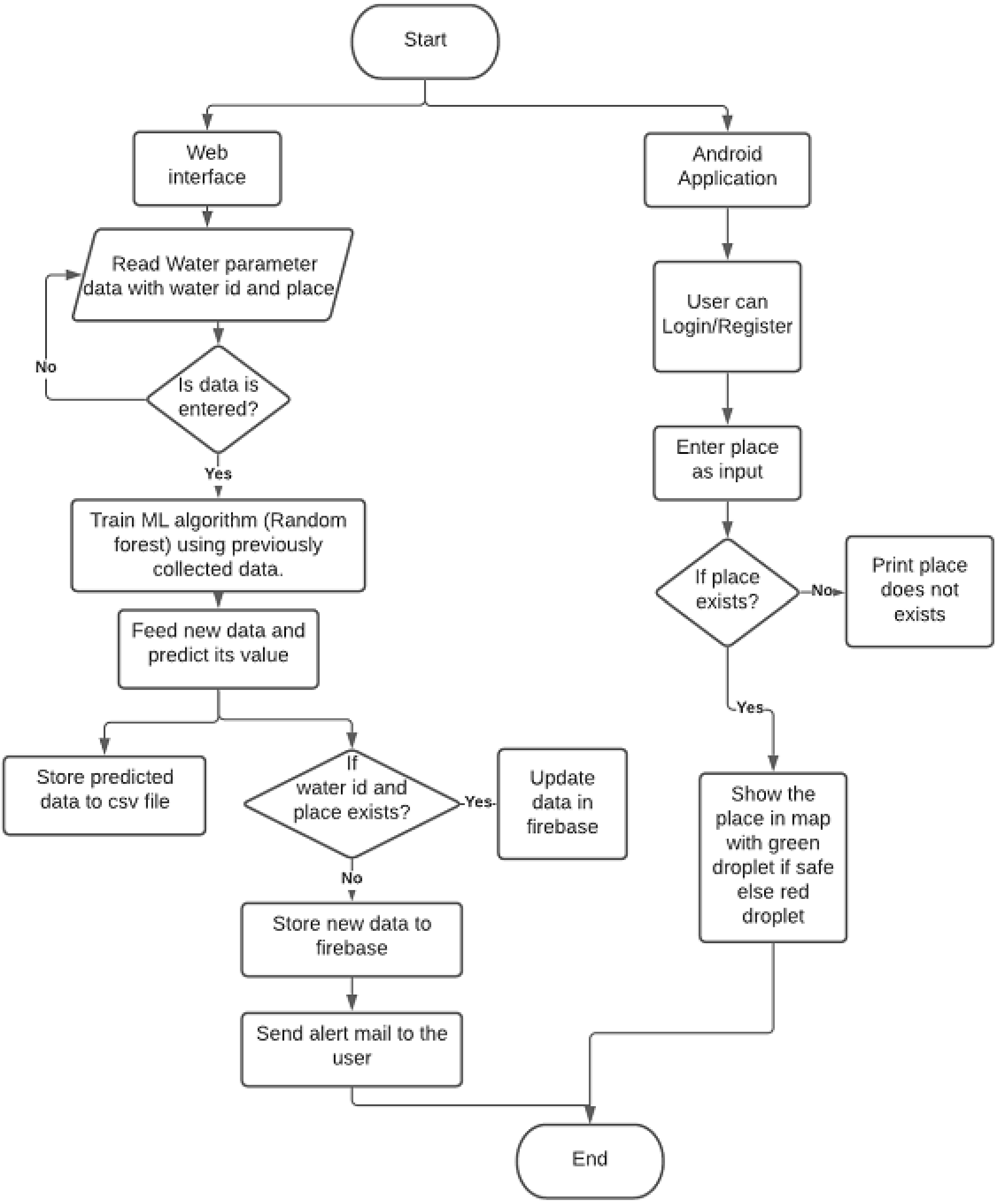

Figure 5.8: Working of the system

5.7 API's Used

5.7.1 WEB API's

Table 5.1: Web API's used in project

	CODE	DESCRIPTION
Firebase Connection	app.config['KEY']="	Here, it connects the firebase using the API key of the firebase.
Firebase Authentication	firebase.FirebaseApplication()	It authenticate the Firebase by giving its real time URL. Flask will refer to the given URL to store the data.
Get data from firebase	result = fb.get('/water', None)	get method is used to retrieve the data from the firebase.
Split the data	train_test_split()	Split arrays or matrices into random train and test subsets
Train the model	model.fit()	It fits a number of decision tree classifiers on various sub-samples of the dataset.
Mail through yagmail	yag.send(to="", subject="",contents=)	yagmail is a GMAIL/SMTP client that aims to make it as simple as possible to send emails using send() method
Pie chart	google.visualization.PieChart(); chart.draw();	Google visualization is used to draw pie chart using method draw(). A pie chart that is rendered within the browser using svg.
Bar graph	google.visualization.ColumnChart(); chart.draw(data, options);	Column chart method is used to draw the Vertical bar graph.
Upload data using POST	fb.post('/', {key:value});	POST method is used to push the data to the firebase.
Updating using put	fb.put('/', {key:value});	PUT method is used to write to existing data to the firebase.

5.7.2 Android Application API's

Table 5.3: Android Application API's used in project

	CODE	DESCRIPTION
Firebase Authentication	FirebaseAuth.getInstance().	To obtain an instance of this class by calling getInstance() .
SignIn	signInWithEmailAndPassword()	Tries to sign in a user with the given email address and password.
On complete listener	OnCompleteListener<Auth>() {}	To handle success and failure in the same listener
Intent	intent = Intent(this@LoginActivity, MainActivity::class.java)	An intent is a description of an operation to be performed. Its most significant use is in the launching of activities.
Toast	Toast.makeText(Context, text, duration)	A toast provides simple feedback about an operation in a small popup. Toasts automatically disappear after a timeout.
Get reference	getReference().child()	A Reference represents a specific location in your Database and can be used for reading or writing data to that Database location.
Put and get data through intent	putExtra() and getExtra()	putExtra() adds extended data to the intent. It has two parameters, getExtra() fetches data which was added using putExtra().
Add marker with icons	GoogleMap.addMarker()	Markers identify locations on the map.Markers are objects of type marker, and are added to the map with this method.
Animate camera	map.animateCamera();	A class containing methods for creating CameraUpdate objects that change a map's camera
Move cameras	map.moveCamera();	To move the camera in order to focus the map to a specific location

5.8 Summary

This Chapter gives a detailing on the system architecture and the modules specification. The implementation of the project is explained.

Chapter 6

RESULTS AND ANALYSIS

6.1 Web Application Interfaces

A web application (or web app) is application software that runs on a web server, unlike computer-based software programs that are run locally on the operating system (OS) of the device. Web applications are accessed by the user through a web browser with an active network connection. A Web user interface or Web app allows the user to interact with content or software running on a remote server through a Web browser.

6.1.1 Form to enter water quality parameters

As shown in Fig. 6.1, the form input consists of water parameters such as Water ID, pH, Conductivity, Turbidity and user details such as Email ID. It also has area, Latitude and Logitude of that water ID. The input is taken and stored in the database.

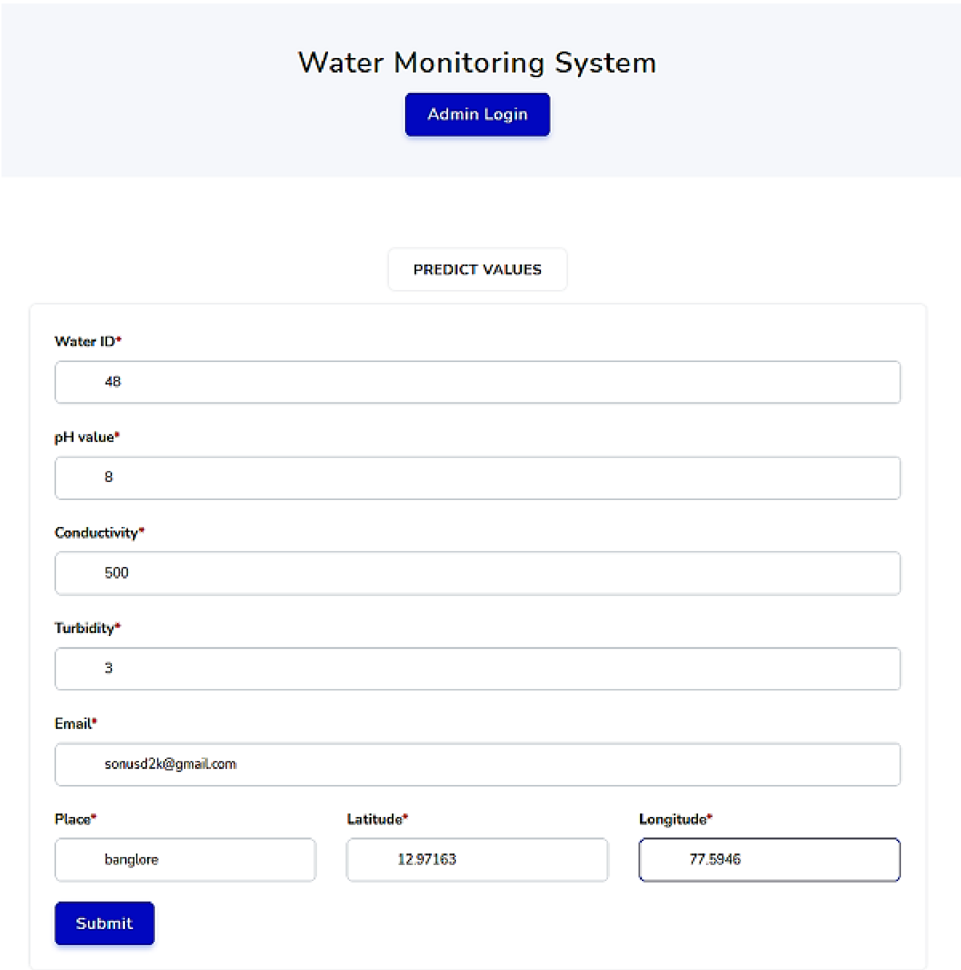

Figure 6.1: Form interface

6.1.2 Prediction of water quality

This project has used ML algorithm to train the system about the predictions, more the data provided the system predicts more accurately. User gives the input values of pH, Conductivity and Turbidity to predict the water as Safe or Unsafe using the Random Forest classifier for comparing through multiple decision trees while training the system. After the training and testing of the data the system is able to predict if the water is safe or unsafe for drinking.

Figure 6.2: Prediction of water Quality

6.1.3 Alert message

Alert messages are sent to mail as shown in Figure 6.3 using yag mail. When the input parameters are given the model detects the quality of water and sends safe or unsafe alert message to mail.

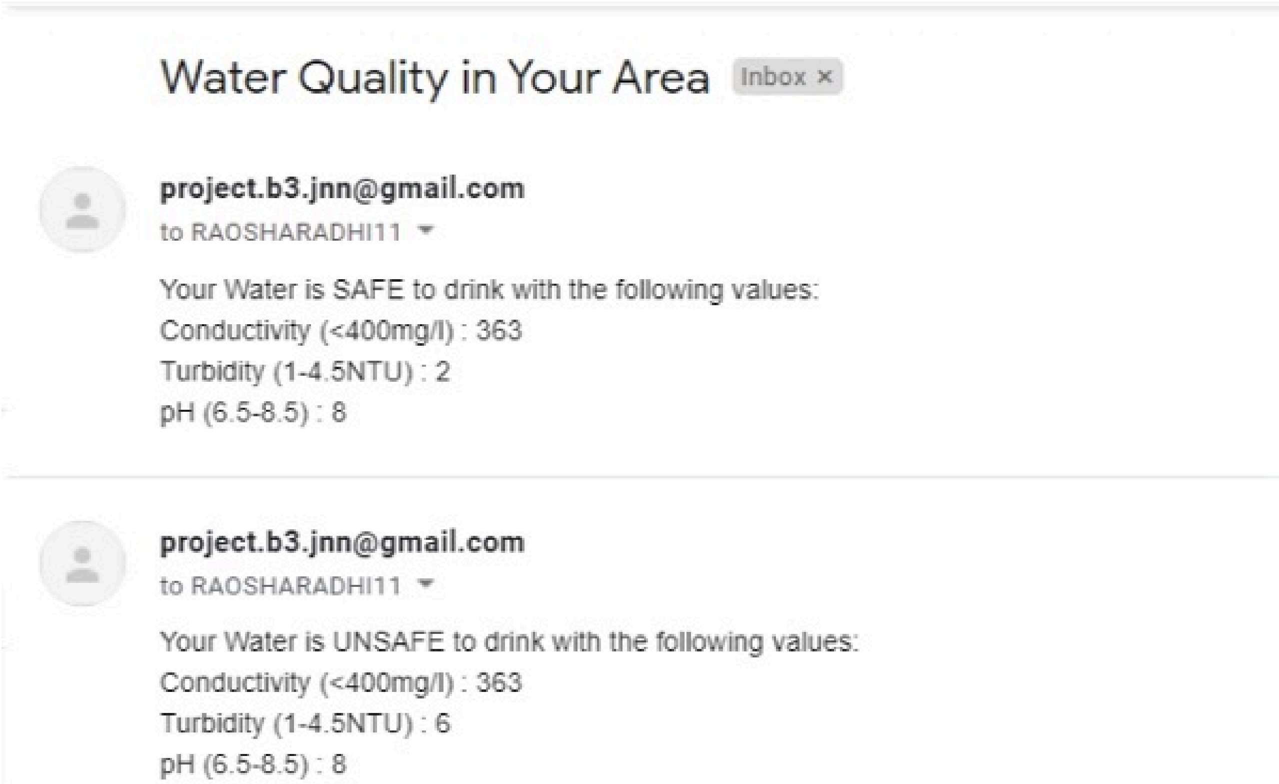

Figure 6.3: Notification sent through mail

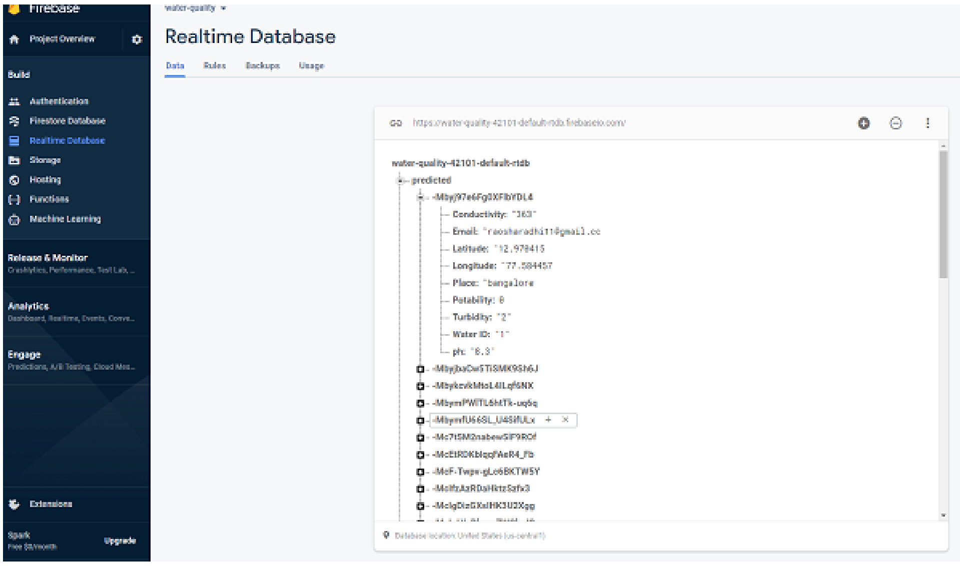

Figure 6.4: Predicted data store in firebase

6.1.4 Admin login

Admin login is a set of credentials used to authenticate a user or authority admin. Most often, these consist of a username and password. Using this facility admins can organize and manage the activity of the server. The admin login opens up to a dashboard consisting the details of the water monitoring system that includes the pie chart and bar graph visual representations.

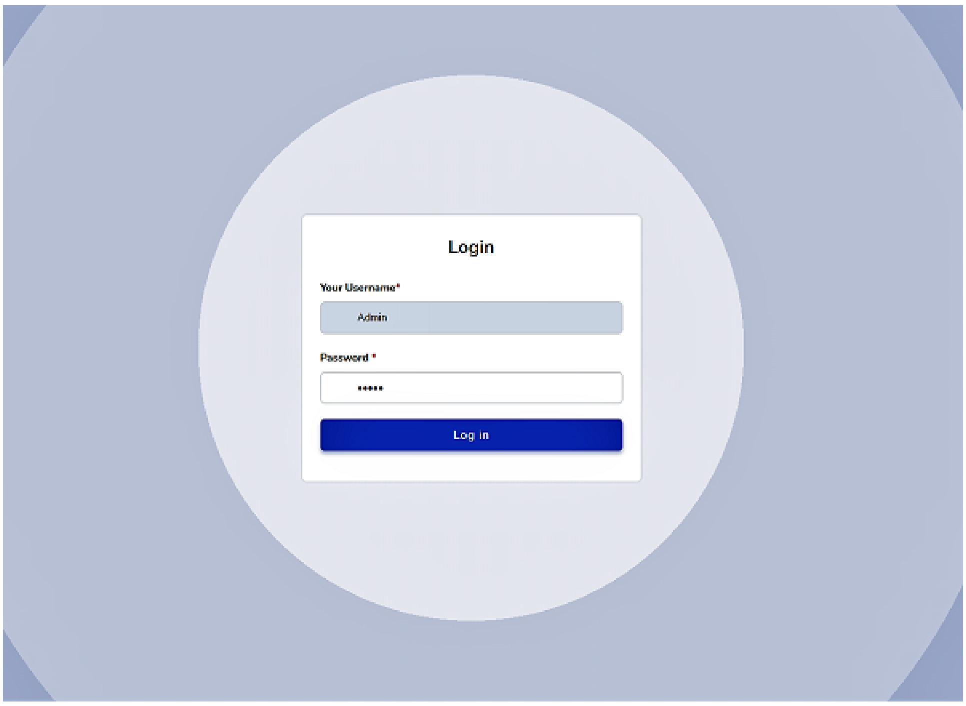

Figure 6.5: Admin login

6.1.5 Data visualization

Data visualization is the practice of translating information into a visual context, such as a map or graph, to make data easier for the human brain to understand and pull insights from. The main goal of data visualization is to make it easier to identify patterns, trends and outliers in large data sets.

Data visualization in this system is done using google visualization tools like 3d pie chart and bar chart types for representation. Both pie chart and bar chart is rendered within the browser. Also tooltips when hovering over slices is displayed. The graphs made is shown in Figure 6.6 and Figure 6.7.

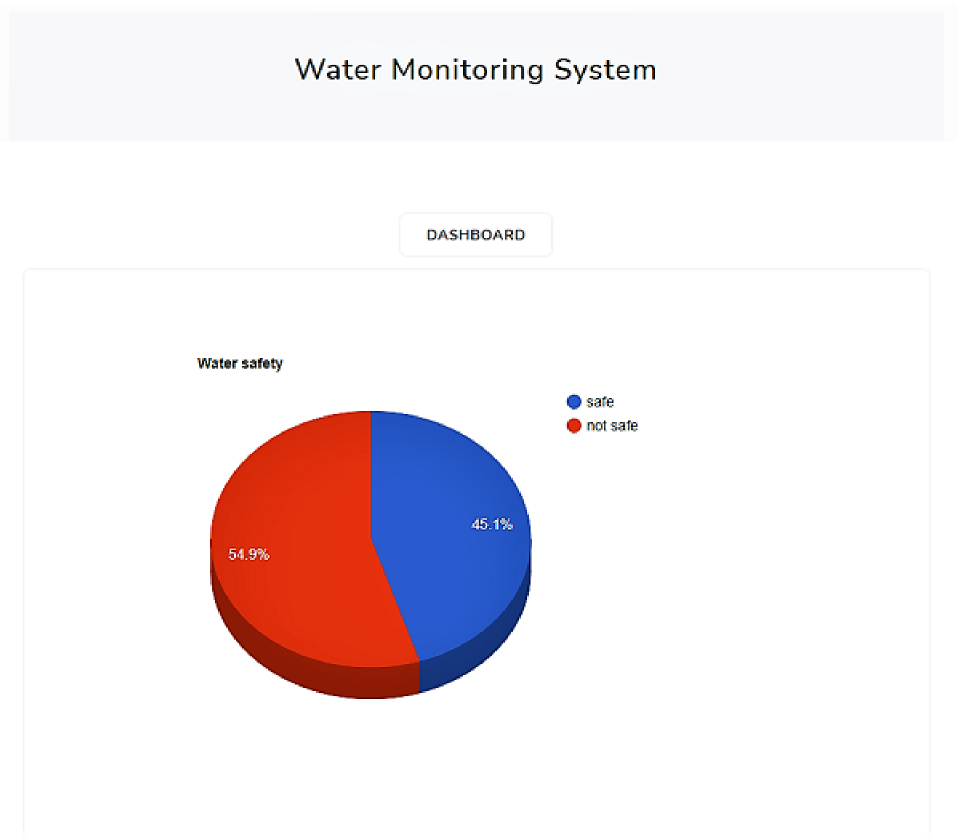

Figure 6.6: Visualization of predicted Data using pie chart

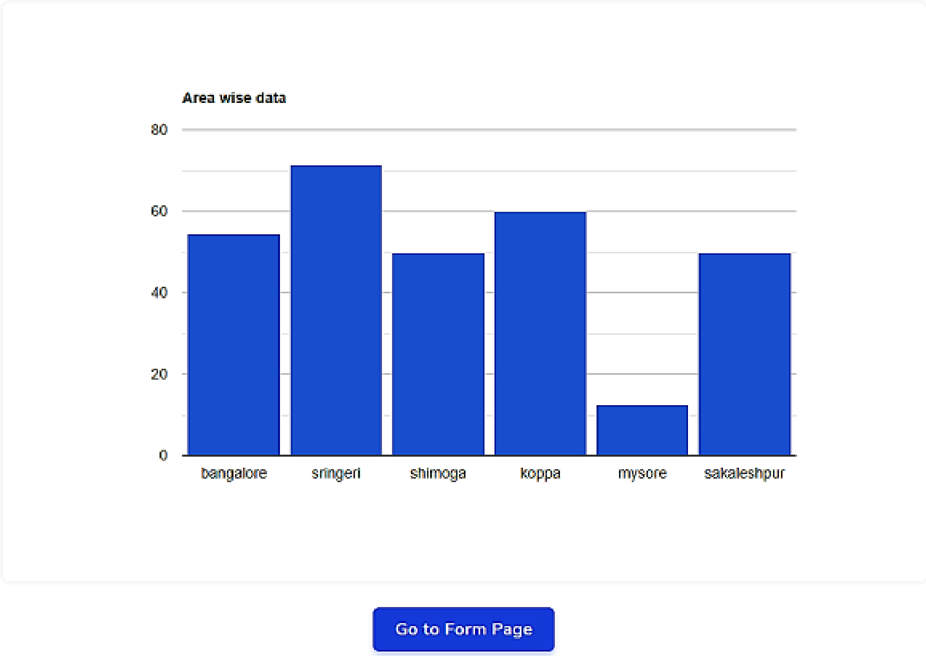

Figure 6.7: Visualization of predicted Data using Bar graph

6.2 Android Application Interfaces

6.2.1 Login/Authentication

The Login screen of the mobile application is as shown in the Figure 6.7 and the new user register screen is as shown in Figure 6.8. The interface expects the user to login or register using email id and password.

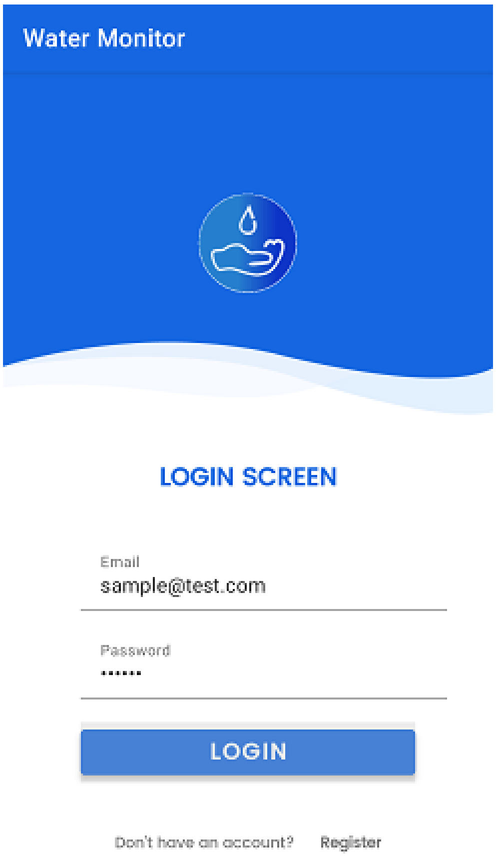

Figure 6.8: Login screen

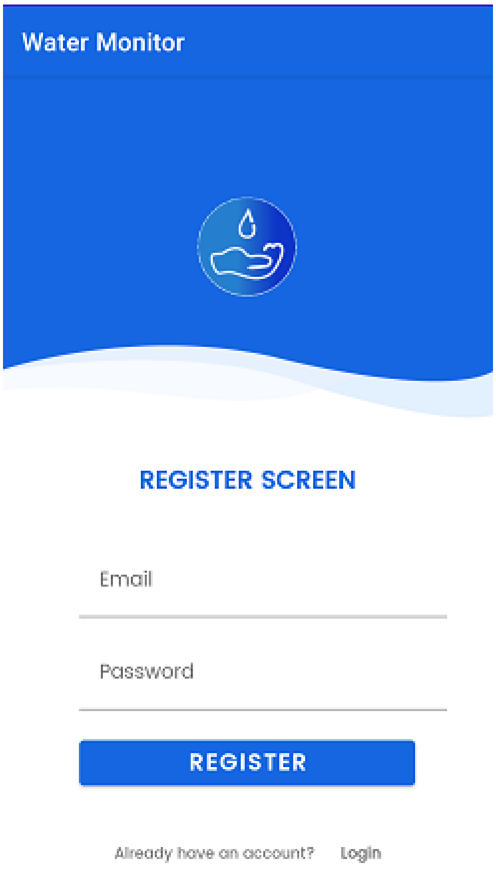

Figure 6.9: Register screen

6.2.2 Reading location input

The location search screen of the mobile application is as shown in the Figure 6.9. The interface expects the user to authority to enter the location of which they have to check the water potability.

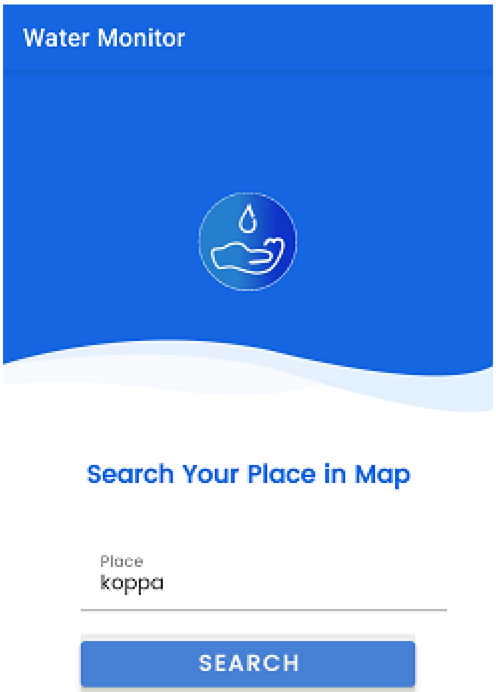

Figure 6.10: Location search screen

6.2.3 Output shown in map

A potability and parameters given in the respective place is displayed in the interface as shown in Figure 6.10. This interface shows the exact location of the user in that city in maps.

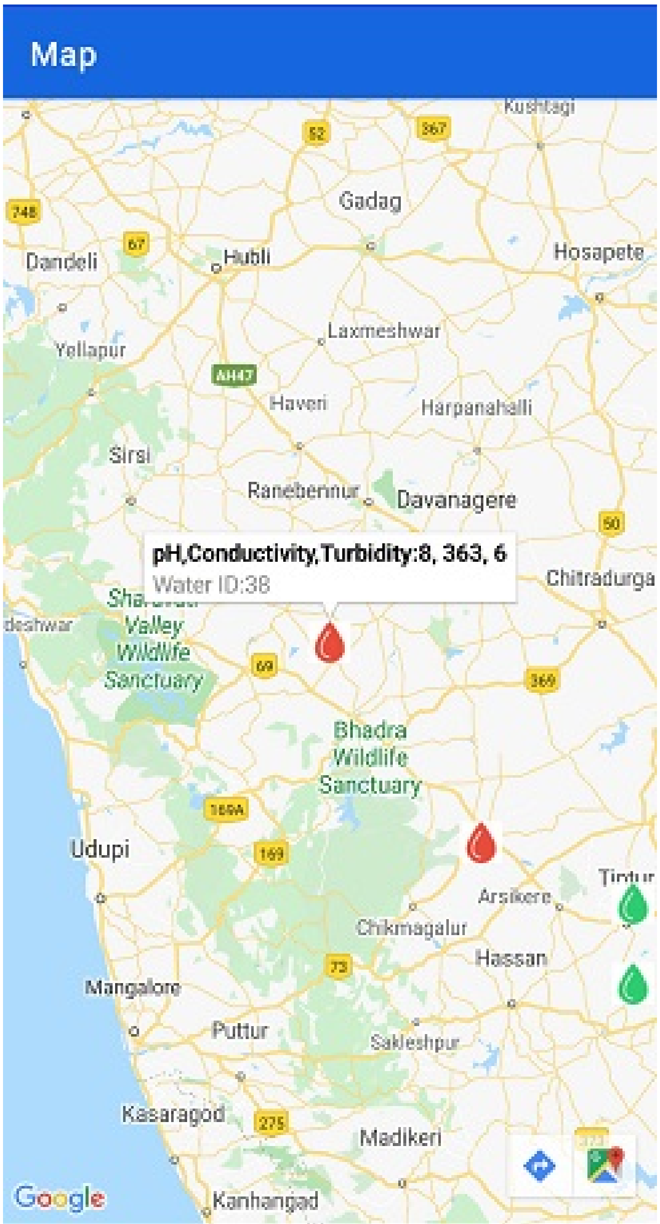

Figure 6.11: Map of the searched location

6.3 Applications

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

- This system can be used to be implement as real time portable product for measuring water containment levels. The levels 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.

6.4 Summary

The snapshots of the results obtained and the applications of the project is detailed in the chapters.

Chapter 7

CONCLUSION

In our project we aimed to predict the portability of water(drinkability of water) using the pH, Turbidity and Conductivity as our base data on which we predicted the potability. This idea sprouted because of the health issues and deaths happening through out the world beacuse of the water pollution which might be purely and unknowningly or irresponsible blunder. As this pollution may happen at any given point of treatment of the water because of industrial wastes. So this problem can be overtaken by this proposed idea. In this proposal we are willing to predict the water quality and send mail about water quality parameters. We also developed a mobile app where user can check the details of water quality through map. Totally, we expect this system to prevent any health hazards to people and does not require people on duty. The system is likely to be more economical, convenient, fast and portable.

7.1 Future Scope

The project can be enhanced by implementing wireless sensor network and taking real time data. The number of parameters to be sensed can be increased by the addition of multiple sensor data to measure dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia nitrogen, nitrate, nitrite, phosphate. The system can be expanded to monitor air pollution, industrial and agricultural wastes and so.

Bibliography

[1] Matthew Dunbabin , Alistair Grinham and James Udy, “Development of Surface Vehicle for water quality monitoring and measurement”, Australasian Conference on Robotics and Automation (ACRA), December 2-4, 2009, Sydney, Australia

[2] 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.

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

[4] 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.

[5] M. B. Kalpana, “Online monitoring of water quality using raspberry pi3 model B”, (IJITR) Volume No.4, Issue No.6, October – November 2016, 4790-4795..

[6] 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

[7] Mr. Vikas Mane1, Mr. Pranav Medsinge, Mr. Akash Chavan, Mr. Sudhakar Patil Department of E&TC, “Water Quality Measuring System Using Wireless Sensor Network”,2016

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

[9] 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.

[10] Arjun K 1, Dr. Latha C A, Prithviraj, “Detection of water level, quality and leakage using raspberry pi with internet of things”, (IRJET) Volume: 04 Issue: 06, June -2017, eISSN: 2395 -0056

[11] Jyotirmaya Ijaradar, Subhasish Chatterjee, “Real-Time Water Quality Monitoring System” ,UG Student, Dept. of ECE, Centurion University, Odisha, India

[12] Bishwajit Paul, "Sensor Based Water Quality Monitoring System", A thesis Submitted to the School of Engineering and Computer Science, BRAC University, August 2018