DESIGN AND DEVELOPMENT OF REAL TIME REMOTE WIRELESS SENSOR NETWORKS FOR WATER QUALITY MONITORING

Dissertation Report submitted in partial fulfillment of the requirement for the degree of

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in

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under the supervision of

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CERTIFICATE

This is to certify that synopsis report entitled **"Design And Development Of Real Time Remote Wireless Sensor Networks For Water Quality Monitoring"**, submitted by **Archna Gupta** in partial fulfillment for the award of degree of Master of Technology in Computer Science & Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been made under my supervision.

This synopsis has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: **Dr. YashwantSingh**

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DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled **"Design And Development Of Real Time Remote Wireless Sensor Networks For Water Quality Monitoring"** in partial fulfillment of the requirements for the award of the degree of Master of technology and submitted in Department of Computer Science and Engineering, Jaypee University of Information Technology, Waknaghat is anauthentic record of work carried out by **Archna Gupta** during the period from July 2016 to May 2017 under the supervision of **Dr. Yashwant Singh,** Associate Professor, Department of Computer Science and Engineering, Jaypee University of Information Technology, Waknaghat.

I have not submitted the matter embodied in this dissertation for the award of any other degree.

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Date: **Archna Gupta**

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ABBREVIATIONS

WQM – Water Quality Monitoring

SN - Sensor Node

MATLAB – Matrix Laboratory

KMS - Knowledge Management System

RS - Remote Sensing

WP - Water pollution

DO - dissolved oxygen

CW – Command Window

EW – Editor Window

WS – Workspace

GUI – Graphical User Interface

ST – Static Text

ET – Edit Text

SEP – Stable Election Protocol

GA – Genetic Algorithm

WSN – Wireless Sensor Network

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ABSTRACT

Water contamination is one of the significant apprehensions for the green globalization. To evade the water contamination, the first importance step ought to be to assess certain parameters like pH, turbidity, conductivity, and so on, as the dissimilarities in the estimations of these constraints demonstrate the nearness of poisons. At this moment, the appraisal of nature of water is completed by compound test or research focus test, where the testing sorts of types of gear are static and tests are given to testing supplies. Henceforth, the current water quality checking structure is a manual system with dull process and is uncommonly dreary. Remembering the ultimate objective to assemble the repeat, the testing apparatuses can be placed in the stream water and area of defilement can be made remotely. This proposes a Sensor-Based Water Quality Monitoring System. The system improvement incorporates of data checking centers, a base station and a remote station. Each one of these stations is related using remote correspondence interface.

This research work deals with clustering approach which will be energy efficient to increase the lifespan of the network. Then the optimization approach is implemented to optimize the performance of the network. The cluster is having cluster head and the communication is done through various cluster heads of different clusters which will be responsible to transmit data to the base station to save the energies of the nodes in the network which will have equal probability to become the cluster head in the next round. So this thesis deals with optimize water quality approach which will provide better realization of the network in real world scenario.

CHAPTER 1

INTRODUCTION

The water climate, comprising of the surface water condition and underground water condition, can be separated into water bodies like streams, lakes, stores, seas, swamps, icy masses, springs, and shallow or no-limit underground waters. The water condition, and additionally other ecological components like soil, life form and environment, etc., constitutes a natural compound. Once a change or harm to the water condition is seen in this compound, changes to other ecological components unavoidably happen [1]. Because of the speed of Indian's economic change, we can observe the subsequent accelerating of sullying and harm to the water condition. In this insight, water quality monitoring, as one of the significant procedures for water asset administration and water contamination control, is observed to be more and more basic.

1.1Wireless Sensor Networks

Wireless sensor networks (WSN) are spatially distributed autonomous sensors dedicated for sensing and computing physical or chemical parameters. These parameters may range from temperature, humidity, pressure, wind direction and speed to illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels and vital body functions [2]. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable [3]. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. A WSN has a number of inherent characteristics including uncontrollable environments, topological constraints, and limited node resources for energy and computational power [4].

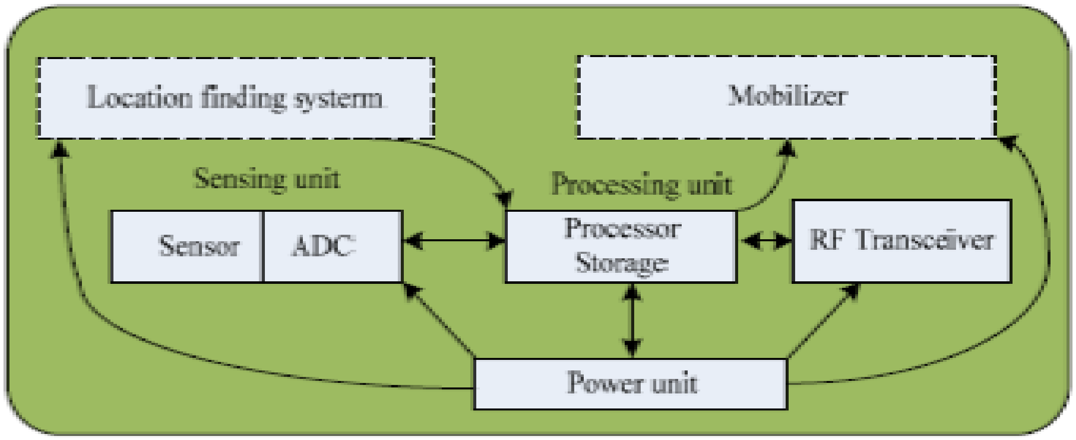


Figure 1 Wireless sensor network structure [3]

1.2 Applications of WSN

Potential applications of sensor networks include:

- Water quality monitoring
- Health care monitoring
- Air pollution monitoring
- Forest fire detection
- Landslide detection
- Natural disaster prevention
- Monitoring of weather conditions
- Ocean sensing and monitoring
- Coral reef monitoring
- Marine fish farm monitoring.
- Military surveillance (e.g. Leak detection),
- Ecology (e.g. Water quality and biological quality)
- Public safety (e.g. Seismic and tsunami monitoring).
- Air traffic control
- Robot control.[5]

1.3Water Quality Monitoring

Water quality refers to the physical, chemical and biological characteristics of water. It is the measure of condition of water relative to the requirements of humans or other species. Most common standards to access the quality of water are potability, environmental water quality and industrial and domestic use.[6]

1.4Water Quality Monitoring Using WSN

Water quality monitoring is commonly defined as the sampling and analysis of water (lake, stream, river, estuary, or ocean) and conditions of the water body. Water quality monitoring can evaluate the physical, chemical, and biological characteristics of a water body in relation to human health, ecological conditions, and designated water uses. Water quality can be monitored either by the conventional method which includes sampling, transporting, measuring data in laboratory or by the recent technology of remote sensing using wireless networks[7]. At present there are mainly three methods for monitoring water environments, each of which has its advantages and disadvantages:

1) Artificial sampling through portable water quality detecting devices and subsequent lab analysis. This technique applies only to samplings on cross-sections of river & lakes with a sampling frequency ranging from several times a day to monthly.

2) Automatic and constant evaluation of water environment parameters by a automatic monitoring arrangement consisting of screens and control centers, and additionally a few observing sub-stations. Information can be remotely and consequently exchanged. Each station gives its in-situ water environment parameters. These structures can be expensive and have a significant impact the encompassing ecological atmosphere.

3) Water condition checking by remote detecting innovation, in particular recognizing the range particulars of an electromagnetic wave (radiation, reflection and diffusing) in a non-contacting strategy as for the water body. After the evaluation of the data from the accumulation of expressive spectra, its material science and concoction attributes are to be distinguished. However this strategy can just give a low precision &it is additionally difficult to make ongoing checking.

4) Water quality monitoring innovation acknowledged utilizing some sensitivity of oceanic life forms to the presence of toxic materials in water bodies by measuring or breaking down the change of exercises of various life forms in various water situations, then going to a subjective assessment report of the water quality. Still, these routes can in no way, shape or form be plausible to achieve high exactness for water condition checking.

In a nation like India, which has a huge water region and different water bodies, it will be inadequate to depend on the current number of observing stations and customary checking advancements to fulfill the current monitoring needs, which underlines the way that water environment observing must be constant, dynamic, large scale and quick; the water quality conjecture must be expeditious and precise. In this sense, innovative work on dynamic water condition observing innovation, meeting the previously mentioned needs, must be directed critically, so as to accomplish exactness and completeness in reports of the changing circumstance of the water condition lastly lessen water sullying.

1.5Problems in water quality monitoring

Urban communities are confronting extraordinary difficulties. The pace of urbanization is totally exponential. moreover, as a result of environmental change and other ecological pressures, urban areas are logically required to become 'smart' and take generous measures to meet stringent targets forced by responsibilities and legal obligations [8]. S Smart towns are the need of the hour, and enhancing the system states of towns to quicken change is required. The accessibility of smart solutions for urban communities has risen quickly in the course of the most recent decade. Subsequently, technical answers exist for each city to end up smarter. The challenge is to implement suitable arrangements effectively, instead of concentrating only on new innovation improvement. Smart urban areas can't be built up through an interwoven approach, but by the well ordered acknowledgment of incremental enhancements[9].

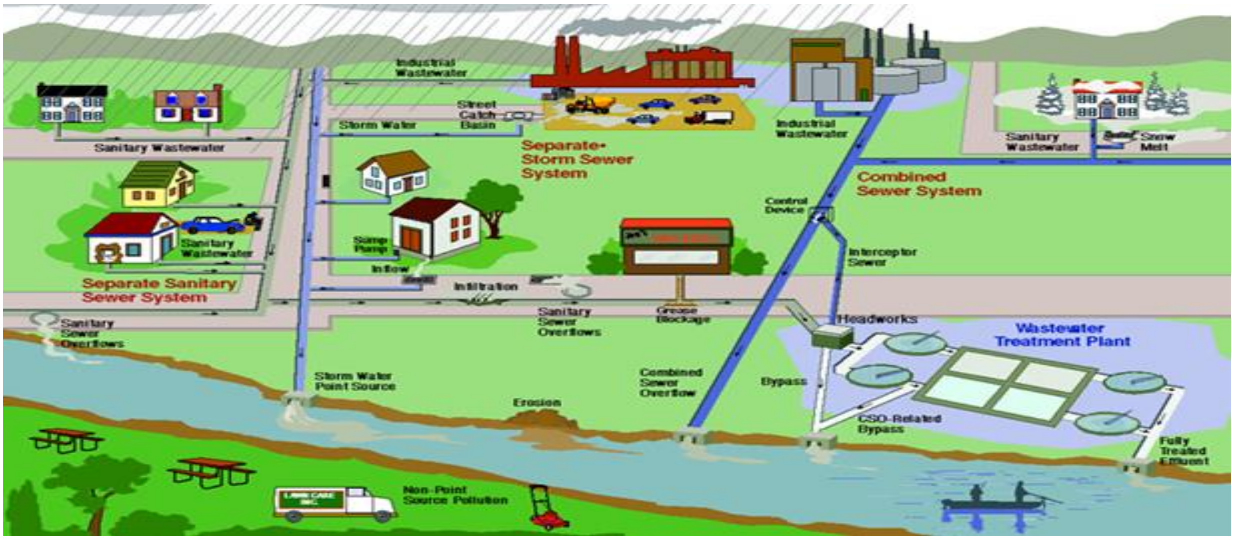


Figure 2: Problems in water quality monitoring

The capacity to monitor water quality parameters continuously or Semi continuously offers exciting possibilities to resource managers wishing to better manage the water resources in their care.

1.6Need of Water Quality Monitoring

Over the previous decade, online water quality monitoring has been broadly utilized since many nations are known to have major issues related to environmental pollution [10]. Water is a restricted and fundamental asset for industries, agriculture, and every one of the species existing on the earth including human beings. Any unevenness in water quality would extremely influence the well being of humans and other creatures. It'll additionally influence the environmental balance among species [11]. In the 21st century, there were loads of innovations, and consequently, there was an increase in contamination, global warming and so on. consequently, there is scarce potable water for the total populace [12]. The drinking water is all the more valuable and significant for all the people so the element of water ought to be observed progressively. Right now water quality monitoring continuously confronts challenges as a result of a worldwide temperature alteration, constrained water assets, developing populace, and so forth.

Hence, there is a need of creating enhanced techniques to screen the water quality parameters continuously.

The WHO (world health organization) evaluated, in India among 77 million people suffer due to lack of safe drinking water. WHO additionally gauges that 21% of disorders are identified with dangerous water in India. Likewise, more than 1600 deaths alone are cause because of looseness of the bowels in India day by day. Subsequently, different water quality parameters, for example, dissolved oxygen (DO), conductivity, pH, turbidity and temperature ought to be checked progressively. The water quality parameter pH demonstrate water is acidic or basic. Immaculate water has 7 pH values, under 7 values show acidity and more than 7 demonstrate alkalinity. The normal range of pH is 6 to 8.5.For potable water, if the normal range of pH doesn't safeguard it makes the aggravation the eyes, skin and mucous films. Additionally, it causes the skin issues. The dissolved oxygen (DO) is demonstrated as the oxygen that is dissolved up in water. It makes the drinking water taste better. The conductivity indicates the capacity of water to pass an electrical momentum. In water it is influenced by different dissolved solids, for example, chloride, nitrate, sulfate, sodium, calcium, and so on. Turbidity is described as the degree at which the water loses its transparency. It is considered as a decent measure of the brilliance of water. Water temperature, demonstrates how hot or cold water is. The worsening of water assets turns into a common human issue [13]. The customary techniques for water quality monitoring incorporate the manual sampling of water from various areas. These water samples are tested in the research center utilizing the analytical advancements. Such methodologies are tedious and are not to be viewed as efficient. In addition, the momentum techniques incorporate investigation of different sorts of parameters of water quality, for example, physical and chemical. traditional strategies for the water quality monitoring have the impediments like complex system, long sitting tight time for results, low estimation exactness and high cost [14]. Subsequently, there is a requirement for consistent observing of water quality parameters continuously.

Figure 3: Water Environment

1.7Significance of Water Quality Monitoring

the significance of having clean, safe potable water is known to all. The water supplied to the food industries, to clean the machineries, and to meet the needs of animals must meet the same as that of potable water. rule 761 of the Milk Act requires that all drain houses have an asset of consumable water. Ontario Drinking Water Standards depict consumable water as having zero E. coli and zero coliform per 100 ml.Water polluted by specific microbes can bring about genuine animal medical problems that specifically influence drain quality. Coliforms, for example, E. coli, are an indication of fecal contamination of the water supply, and can build the danger of mastitis developing in the group. Pseudomonas microscopic organisms are exceptionally normal in water sources and, in high amounts, can likewise bring about mastitis. Pseudomonas microscopic organisms can likewise promptly produce tenacious biofilms which adhere themselves to hardware surfaces, and discontinuously shed large amounts of microorganisms into other sustenance things.

Figure 4: Significance of water quality monitoring

Problems that arise from poor water quality are not limited to bacteriological quality. Hard water, buffers, & sediment can reduce the effectiveness of chlorinated alkali cleaners, acids & sanitizers in your water system. Muddy or cloudy water can indicate that there is sediment, or high levels of floating soil elements, in your water supply. In the presence of alkaline cleaners, these particles can settle out of the water and deposit back on to the system. This creates an opportunity for a biofilm to form & negatively affect your milk quality.Hard water can reason serious problems that will be expensive in the long run. High calcium or mineral salt levels in your water source decreases the effectiveness of your cleansers. Scale can also build up in the milk lines, causing milk stone to deposit in the milk line more easily, which will eventually lead to a biofilm problematic.

in case, water is too hard (other than 30 grains for every gallon), you ought to consider introducing a water conditioner. Milder water will clean your drain lines all the more productively by lessening the amount of cleanser required, sparing you cash while refining your drain quality. Hard water can likewise abbreviate the life of your water warmer. At the point when built up from hard water happens on the basics in a water heating appliance, the water may not warm up as quickly or to the best possible temperature (no less than 76 degrees Celsius). This can enable certain microorganisms to prosper and trade off the nature of your drain. A basic initial step to setting up and assessing a draining gear wash framework incorporates an investigation of water hardness properties. Counsel your mechanical assembly merchant who is able to comportment these tests.

Water sampling bottles used for microorganisms testing are readily accessible at region health unit. Counsel with your district health unit in charge for accurate inspecting system. Since water quality can vacillate consistently, it is imperative to test when the danger of sullying to wells is higher, for example, amid spring keep running off, after a substantial precipitation, or on the off chance that you see any adjustments in the water color or odour. Additionally adjustments in land use beside wells, and well repairs should be taken care of. Everybody ought to know about and test their own well water out of worry for their own particular wellbeing, the soundness of their creatures, and the effect it might have on their drain quality.

1.8 Challenges in Water Quality Monitoring

i. Battery power is constrained and generally batteries can't be revived, likewise in light of the fact that sun oriented vitality can't be exploited.

ii. The available bandwidth is extremely restricted.

iii. Channel qualities, including long and variable propagation delays, multi-path and fading problems.

iv. High bit error rates.

v. Underwater sensors are inclined to failures as a result of fouling, consumption, etc[15]

1.9 Factors that influence Water Monitoring

i. **Path loss**:

a. Attenuation: It is principally incited by absorption because of transformation of acoustic energy into heat, which increments with distance and frequency.

b. Geometric Spreading. This alludes to the spreading of sound energy occurring due to expansionof the wave-fronts.

ii. **Noise:**

a. Man made noise. This is chiefly brought about by hardware clamor (pumps, decrease gears, power plants, and so forth.), and transportation action (hull fouling, animal life on hull, cavitation).

b. Ambient Noise. Is identified with hydrodynamics (development of water including tides, streams, storms, wind, rain, and so forth.), seismic and natural wonders.

iii. **Multi-path**: Multi-path propagation may lead to serious debasement of the acoustic communication signal motion, since it creates Inter-Symbol Interference (ISI).

iv. **Doppler spread**: The Doppler frequency spread can be huge in UWA channels, resulting into degradation of digital communications. Transmissions taking place at a high data rate may result into adjacent symbols interfering with each other at the receiver.

1.10 Conventional Approach

There are two popular strategies for water monitoring:

i. Samples of water were gathered from different locales. These samples were then taken to the research facilities and checked for different parameters.[16]

ii. Sensors were deployed underwater that record information amid the observing mission, and afterward recuperate the instruments.[17]

1.11 Limitations of Conventional Approach

i. Real time monitoring is next to impossible. This is critical particularly in observation or in environmental surveillance applications, for example, seismic predictions.

ii. No connection is feasible between inland control frameworks and the checking instruments.

iii. If breakdown or misconfigurations happen, it may not be possible to recognize them before the instruments are recouped.

The amount of information that can be recorded amid the observing mission by each sensor is constrained by the limit of the locally available capacity gadgets (memory space, hard disks, etc).[18]

1.12 Why WSN

The remote sensor systems incorporates both static and versatile hubs. Mobility upgrades the execution of this sensor network in quite a few ways.

i. It provides a means to sending, reconfiguring, and recovering the hubs in the system.
ii. It allows extensive territory scope with inadequate systems which is particularly imperative in a submerged situation- a significantly harder space to access than earthbound space. The portable hubs can move over the field to guarantee the essential availability.
iii. Mobile hubs can go about as data mules and go from hub to hub over an inadequately deployed sensor system to gather data[19].

Among the proposed arrangements, remote water monitoring in light of satellites was generally utilized as a feature of waterways, lakes, oceans and seas analysis efforts. Fundamentally, estimations were acquired utilizing electromagnetic radiations (microwaves, ultra-violet and warm infra-red and so on). Be that as it may, for most water quality measurements the exactness of the observation relies on the image handling abilities of the satellite. Higher precision requires complex types of equipments and therefore prompts a costly arrangement. Also, numerous parameters, which influence the water quality, similar to dioxin or other heavy metals, can't be assessed with optical remote detecting techniques. Hence , Underwater Wireless Sensors Networks (UWSN) have been uncovered as a promising innovation for water quality reconnaissance. the reasonable organization of submerged sensors system can be a correlative approach with satellite observation for a precise remote detecting of water quality. Satellite offers a broad view of the water quality while for particular interest regions, underwater sensors provide the narrower and detailed view.

1.13 Advantages of Using WSN In WQM

i. Infrastructure
ii. Delay tolerance
iii. Variation in various analysis methods
iv. Manpower for data management and statistical tool
v. Real time monitoring
vi. Alerts or early warning system
vii. Precision
viii. Installation, handling and maintenance
ix. Non-continuous, in-situ monitoring
x. Low cost
xi. Network flexible structure[20]

1.14. System Architectureof Water Monitoring System

In Fig 1.4 portrays, It characterizes the general architecture of water monitoring framework. A sensor is an equipment gadget that delivers a quantifiable reaction signal to an adjustment in a physical condition, for example, temperature, pressure and humidity. The recurring simple signal detected by the sensors is digitized by a simple to-advanced converter and sent to the processor for further administration. A sensor node can have one or a few sorts of sensors coordinated in or associated with the node.

To start with the water level pointer is utilized to show level of water in the tank. Driven light sensor will settled in the side of the tank. In the tank we settled the Number of Led light in light of size of the tank. For instance: We utilize LED 1,LED 2 and LED 3 sensor settled. Driven 1 is the most minimal point, LED 2 is the center point and LED 3 is the most astounding point. At the point when the water will achieve the Lowest Point LED 1 sensor light, The microcontroller (PID) will passed the information flag to the pump and the pump will naturally ON. At that point when the water will achieves the most elevated point LED 3 sensor then the pump will be consequently off. By utilizing this idea we can effortlessly abstain from overflowing and the water level will be shown to client on monitoring. automatic water level detecting would help in decreasing the home power consumption.

The second step i.e., is water quality checking uses three types of sensors, for example, pH, temperature and turbidity sensor. These sensors will localize inside the water tank..pH sensor is used to check the hydrogen value in the water. The hydrogen level in water indicates the acidity or alkalinity of water. Temperature sensor is used to find the hotness or coldness of water. Sometimes, the temperature may change the pH value so the priority is given to temperature and turbidity sensors[21].

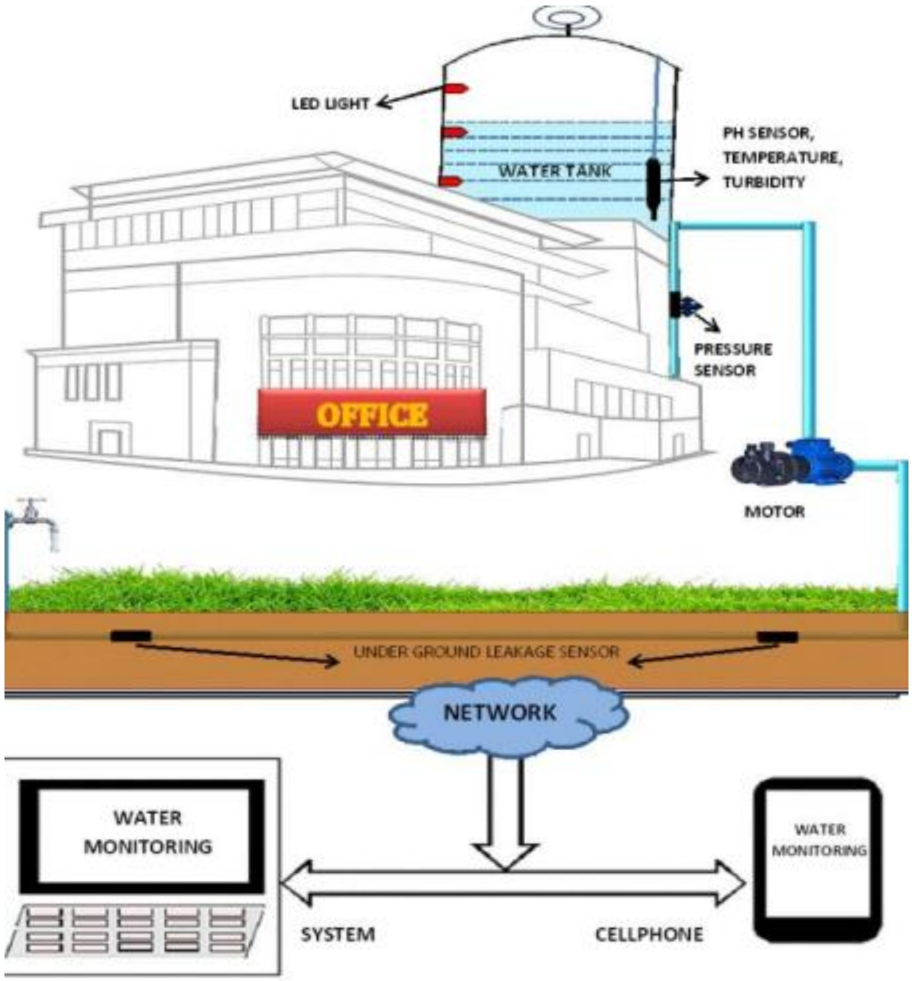


Figure 5: Architecture of Water Monitoring

The final step is to check for any leakage in the pipes. For this purpose, pressure sensors may be used.These sensors are attached to the surface of pipes in order to get the accurate and continuous value of pressure. Incase any pipes bursts or leaks, it will be indicated to the agent. A relative pressure sensing method based on force sensitive resistors (FSR) is used for pressure quantities in the proposed UWSN for pipeline monitoring. All the sensors are connected to the Wireless sensor network. A wireless sensor network consists of specialized transducers with infrastructuresdisposition that is based on radio communication to monitor and record physical or environmental conditions. GSM (Global System for Mobile Communication) is a digital mobile communication system. GSM is a cellular arrangement which resources that cell phones joint to it by infiltrating for cells in the immediate vicinity.

CHAPTER 2

LITERATURE SURVEY

2.1Background

O'Flynn,et.al [22**]**present a Smart Coast Multi Sensor System for water quality monitoring. The aim of this system is to provide a platform that should be capable of meeting the monitoring requirements of the Water Framework Instruction. The physical parameters such as temperature, conductivity, pH, turbidity and water level and chemical parameters like phosphate and dissolved oxygen are investigated. The Plug & Play capabilities enabled by the Wireless Sensor Network platform established at Tyndall National Institute, Cork, Ireland allow for integration of sensors as required. Moreover some custom sensors are also developed within the project.

An ISO/IEC/IEEE21451 based network of smart sensors is suggested by **Adamo, et.al** [23] for in situ and continuous space-time monitoring of superficial water bodies, in particular for seawater. The system is aimed at being an important tool for the evaluation of water quality. In addition, it proves to be a valid support in making strategic decisions concerning critical atmosphere issues. The motive behind this system is to capture possible extreme events and to collect data for long period of time.

The sensing of DO for a fish farm is described in **Parmar, et.al** [24]. In this paper, the author has linked one master with 2 slaves using a transmission rate of 9600 b/s. The wireless broadcast follows the standard IEEE 802.15.4 protocol & implements the routing protocol based on ZigBee. Main feature of this request is that it is extensible to any type of monitoring structure just by interfacing an appropriate sensor.

A low cost system design for real time water quality monitoring in internet of thing proposed by **Vijayakumar et.al** [25] utilizes sensors to check many important physical & chemical parameters of water. The parameters such as turbidity, temperature, pH, dissolved oxygen conductivity of water can be measured. The measured standards from the sensors can be treated by the core controller. The raspberry PI B+ model may be used as a core regulator. Finally, the sensor data can be observed on internet using cloud computing.

An automated warning SMS alert system as presented by **Boyne,et.al** [26] uses GSM module having knowledge of AT commands.. After examination of the conception & the trademarks of PLC in combination embedded systems, the build out of the entrenched Programmable Logic Controller for water quality & index measurement is proposed by the seamless mixture of the Keil, Flash magic software & the Microcontroller with analog signal training for sensors input data.

A Water Sensor Network (WSN) system prototype developed for water quality monitoring in Lake Victoria Basin is propound by **Faustine et.al [27]**.The development was followed by evaluation of prevailing environment including availability of cellular network coverage at the site of operation. The system contains of an Adriano microcontroller, water quality sensors, & a wireless communication module. Parameters like temperature, dissolved oxygen, pH, and electrical conductivity are detected in real-time and the information in graphical & tabular formats is disseminated to relevant stakeholders through a web-based portal and mobile phone platforms. The investigational results have shown that the system has great operational prospects in real world atmosphere for optimum control and protection of water resources by providing key actors with relevant and timely information to facilitate quick action taking.

Jiang, et.al [28] defined devoted to the explanation and illustration for our new water environment monitoring scheme design. The system had positively accomplished the online auto-monitoring of the water temperature and pH value atmosphere of an artificial lake. The system's capacity volume ranges from 0 to 80 °C for water temperature, by an accuracy of ±0.5 °C; from 0 to 14 on pH value, by an accuracy of ±0.05 pH units. Sensors appropriate to different water quality situations should be installed at the nodes to meet the checking demands for a variety of water environments & to obtain different parameters. The monitoring scheme thus promises broad applicability prospects.

A configuration model that improves the reuse & facility of the monitoring project is described by **Zhang et.al** [29]. The developed software signifies the monitoring hardware and analysis the data with expert knowledge to implement the auto control. The monitoring system has been an outcome of the digital, intelligent, & effectively ensures the quality of aquaculture water. Practical deployment results indicate the system reliability and real-time characteristics. Also, it displays good effect on environmental monitoring of water quality.

Karuppasamy et.al [30] have built up a model for water quality checking in lakes. The framework comprises of a PIC microcontroller, water quality sensors, and remote system communication module. It identifies water temperature, ph (Potential of Hydrogen), and electrical conductivity progressively and circulates the data which is sent to pertinent partners through an online gateway and can be picked up by means of cell phone stages. This information is indicated with the area of the lakes where it has been deployed.

A framework design comprising of data collecting nodes, a base station and a remote station is suggested by **Barabde et.al** [31]. Each of these stations is connected by means of remote connection module. The information from nodes is transmitted to the base station comprising of ARM controller intended for extraordinary reduced space application. Information gathered by the base station, for example, pH, turbidity, conductivity, and so on is sent to the remote checking station. Information gathered at the remote site can be shown in visual organization on a server PC with the help of MATLAB. This approach brings a few points of interest over current observing frameworks as far as cost, portability and applicability are concerned.

Valerio et.al [32] proposed the concept of a wireless sensor network (WSN) designed for real time remote sea water quality monitoring. Each network node is equipped by sensors measuring temperature, ambient light, conductivity, dissolved oxygen, pH, dissolved ions and turbidity for an automated diagnosis that enables the early identification of critical situations in the water quality, allowing an immediate intervention favoring pollution control.

Vasilescu et.al [33] introduce a novel platform for underwater sensor systems to be utilized for surveillance of coral reefs and fisheries over long periods of time. The sensor arrangement comprises of statics well as portable sensor nodes. The nodes have a point to point communication utilizing a novel rapid optical correspondence framework coordinated into the TinyOS stack, and they communicate utilizing an acoustic convention incorporated in the TinyOS stack. The hubs have an assortment of detecting capacities, including cameras, water temperature, and weight. The versatile hubs can find and drift over the static hubs for information muling, and they can carry out maintenane capacities, for example, topology, migration, and recuperation. In this paper they depict the equipment and programming design of this submerged sensor arrange. They then depict the optical and acoustic systems administration conventions and present exploratory systems administration and information gathered in a pool, in rivers, and in the sea. In the end, they depict their trials with versatility for information muling in this system.

The issue of deploying a UWSN in a range portrayed by the topographical irregularity of the detected event is raised by **Aitsaadi et.al** [34]. Their particular application setting respects the checking of the water quality in a small geographical range (e.g. a lake). For this reason, they propone a Differentiated Deployment Algorithm (DDA) in view of a meshs portrayal technique propelled from the picture preparing and 3D displaying field.

A new type of heavy metal monitoring framework is produced by **Lin et.al** [35] which is made up of an observing terminal, entryway, GPRS system and upper PC checking focus. The framework distinguishes the heavy metal particle fixations by particle particular elecrode cluster and came into the framework error automatic remuneration technique in the identification procedure. The gathering information was transported to the evaluation centre through the communication between the remote sensors constituted by CC2530 and General Packet Radio Service arrange. The test outcome demonstrates that the framework can enhance the accuracy significantly and fortifies the constant transmission limit successfully. The framework is dependable in transmission, high ongoing execution, adaptable in systems administration and can be connected to consistent remote checking of overwhelming metals contamination.

A novel Autonomous Surface Vehicle capable of navigating throughout the complex inland water storages is proposed by **Rao et.al** [36] which measures a range of water quality properties and greenhouse gas emissions. This information is collected through a

16 ft long solar powered catamaran throughout the cross section of water column while the vehicle keeps moving. The credibility of this framework is increased due to its integration into a storage scale floating sensor network to permit remote mission uploads, information download and versatile examining procedures. The technique uses vehicle design and operation including control, laser-based obstacle evasion, and vision-based inspection capabilities.

Considering the advantages of the WSN, **Mingfei et.al [37]** present a system framework for the real-time monitoring on the water quality in aquaculture. A structure of the wireless sensor network to collect and continuously transmit data to the monitoring software is designed. Then they accomplish the configuration model in the software that enhances the reuse and facility of the monitoring project. Moreover, the monitoring software developed to represent the monitoring hardware and data visualization, and analyze the data with expert knowledge to implement the auto control. The checking framework has been an acknowledgment of the advanced, smart systems and viably guarantees the nature of aquaculture water. Down to earth sending results are to demonstrate the framework unwavering quality and ongoing attributes, and to show great impact on ecological observing of water quality.

Kulkarni et.al [38]have presented a system architecture constituted by distributed sensor nodes and a base station. technology like Zigbee is used for the communication between nodes and base station. The challenging part of this project is the design and implementation of a prototype model using one solar powered node and WSN technology. Data collected by various sensors at the node side such as pH, turbidity and oxygen level is sent via WSN to the base station. At the base station, data is collected from the remote site can and displayed in visual format and analyzed using different simulation tools. The high points of this novel system are no carbon emission, low power consumption, more flexibility to deploy at remote site and so on.

Two different architectures for two-dimensional and three-dimensional underwater sensor networks and the underwater channel are proposed by **Akyildiz** [39]. The fundamental difficulties for the advancement of proficient systems administration arrangements postured by the submerged condition are detailed at all layers of the convention stack.

Static two-dimensional UW-ASNs for ocean bottom monitoring: In this, sensor nodes are anchored to the bottom of the ocean. The main purpose of using this architecture is the surveillance of underwater environment, especially for the predicting the movement of tectonic plates.

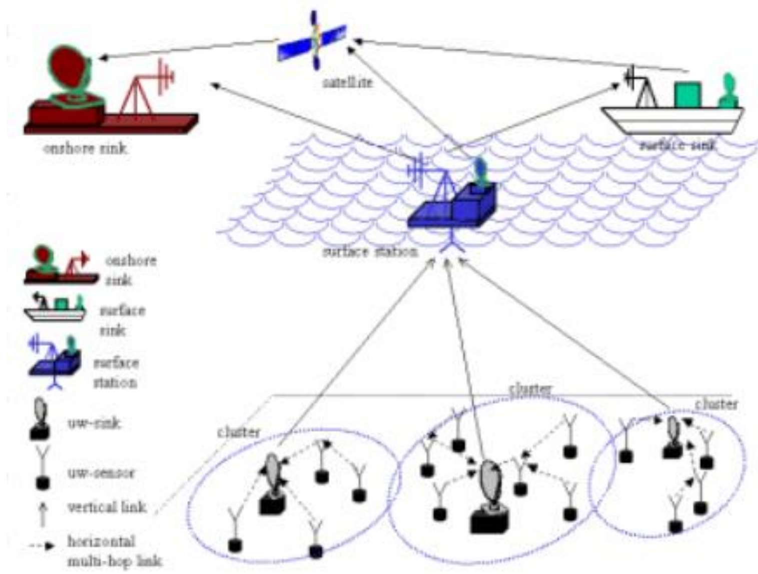


Figure 6: 2D Architecture of underwater sensor networks[39]

i. *Static three-dimensional UW-ASNs for ocean column monitoring*: in this architecture, the depth at which the nods are deployed can be controlled by the client. This type of architecture finds its applicability in monitoring water biogeo-chemical processes, water streams and pollution.

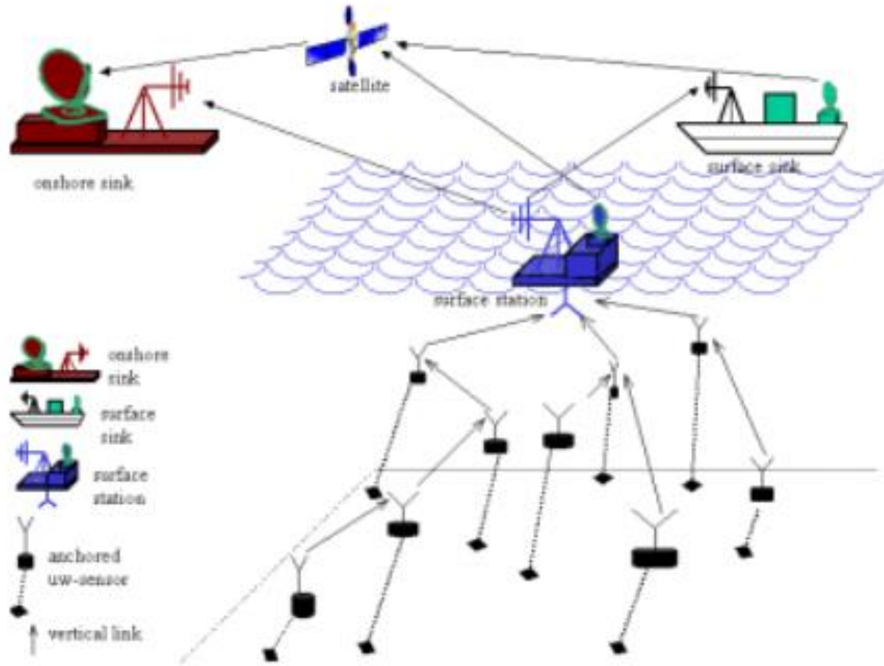


Figure 7: 3 D architecture of underwater sensor networks.[39]

A water quality monitoring system using wireless sensor network (WSN) technology and powered by solar panel is described by **Ruan Yue et.al [40]**. A novel system architecture constituted by several distributed sensor nodes and a base station is suggested in order to monitor water quality in different field sites and in real-time. The nodes and base station are connected using WSN technology. A prototype system using one node powered by solar cell and WSN technology is designed and implemented. Various parameters such as as pH, turbidity and oxygen density are collected by the sensor modules on the wireless nodes and sent via WSN to the base station.

Slim Rekhis et.al [41] present a framework which combines Wireless Sensor Networks (WSNs) and Radio Frequency Identification (RFID) systems. The system exploits the advantages of a set of fixed RFID tags that are arranged adjacent to the waterway and a set of mobile sensor nodes which integrate RFID readers. This framework can offer several improvements in comparison to the existing water monitoring platforms such as:

reduced cost, decreased energy consumption, scalability, system performance monitoring, and tolerance to errors and loss of information.

An less expensive, easy, ad hoc establishment and easy to handle and maintain setup is emphasized upon by **Zulhani Rasin et.al** [42]. The utilization of remote system for observing purpose won't just decline the general checking framework cost in term of research centre setup and work cost, yet will likewise give adaptability in term of separation or area. In this paper, the essential plan and usage of WSN including a powerful transmission Zigbee based innovation together with the IEEE 802.15.4 perfect handset is proposed.

An arrangement of water quality ordering is utilized by **Bhagat S. Chauhan [43]** et.al in management of water assets. The large scale invertebrate fauna display a gigantic scope of diversity in stream bed and are highly sensitive or tolerant to changes in water quality. Bio observing instrument considers the participation, nonattendance, recurrence of appearance, vanishing and wealth of these microscopic organisms alongside biochemical oxygen interest for evaluating contamination. The effluents released from Baddi modern center point into waterway water contain both natural and inorganic poisons.

Li Zhenan et.al [44] outline A smart strategy that consolidates checking and incitation abilities. They limit their concentration to the checking and control of water quality in characteristic water bodies, for example, waterways and lakes. Significant specialized difficulties, for example, sensor determination and control over remote systems are examined and suitable calculations are embraced in light of framework outline prerequisite.

A framework for identification of substantial metal particle fixations is characterized by **Ke Lin et.al**. [45] the framework is made out of observing terminal, entryway, GPRS system and upper PC checking station. It distinguishes the overwhelming metal particles fixations by particle particular anode exhibit and framework mistake programmed compensation technique. The gathered data is transported to the monitoring station through the coordinated effort among the remote sensor arrange constituted by CC2530 and General Packet Radio Service organize.

2.1 Parameters

Table 1: Physical Parameters

S.No	Parameters	Desirable Range For Drinking Water	Maximum Range For Drinking Water	Units
1	Tubidity	5	10	NTU
2	pH value	6.5-8.5	-	-
3	Temperature	0-30	-	˚C
4	Conductivity	150-500	-	µS/cm
5	Alkalinity	300	600	mg/l

Table 2: Chemical Parameters

S.No	Parameters	Desirable Range For Drinking Water	Maximum Range For Drinking Water	Units
1	“Mercury	0.001	-	mg/l
2	Iron	0.3	1	mg/l
3	Chlorides	250	1000	mg/l
4	Dissolved Solids	500	2000	mg/l
5	Calcium	75	200	mg/l
6	Copper	0.05	1.5	mg/l
7	Manganese	0.1	0.3	mg/l
8	Sulphate	200	400	mg/l
9	Nitrate	50	-	mg/l
10	Fluoride	1.0	1.5	mg/l
11	Cadmium	0.01	-	mg/l
12	Selenium	0.01	-	mg/l
13	Arsenic	0.05	-	mg/l
14	Lead	1.5	-	mg/l
15	Chromium	50	-	mg/l
16	Barium	700	-	mg/l
17	Boron	2.4	-	mg/l
18	Uranium	0.1	-	mg/l”

Table 3: Biological Parameters

S.NO	Parameter	Desirable limit
1	Bacteria	Must not be detected in any 100ml sample
2	Chlorophyll	None proposed
3	Submerged Aquatic Vegetation	None proposed

Table 4: Effects Of Excess Of Metals

S.NO.	Parameters	Effects
1	Mercury	Harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and may be fatal.
2	Cadmium	Cadmium is of no use to the human body and is toxic even at low levels. Cadmium can impact nearly all systems in the body, including cardiovascular, reproductive, the kidneys, eyes, and even the brain.
3	Lead	Lead causes long-term harm in adults, including increased risk of high blood pressure and kidney damage.
4	Arsenic	Long-term exposure to arsenic in drinking water can cause cancer in the skin, lungs, bladder and kidney. It can also cause other skin changes such as thickening and pigmentation.
5	Chromium	Chromium compounds are respiratory tract irritants, resulting in airway irritation, airway obstruction, and lung, nasal, or sinus cancer.
6	Barium	Small amounts of water-soluble barium may cause a person to experience breathing difficulties, increased blood pressures, heart rhythm changes, stomach irritation, muscle weakness, changes in nerve reflexes, swelling of brains and liver, kidney and heart damage
7	Uranium	Uranium's main target is the kidneys
8	Selenium	Not eating enough selenium can cause heart problems and muscle pain. Muscle pain has also been noted in people fed intravenously for a long time with solutions that did not contain selenium. Selenium sulphide is however carcinogenic and may cause cancer.

9	Fluoride	Fluoride can cause arthritic symptoms and bone fracture well before the onset of crippling fluorosis, and can affect many other tissues besides bone and teeth, including the brain and thyroid gland.
10	Nitrate	The affected individual suffers from oxygen deprivation.
11	Sulphate	Dehydration has been reported as a common side-effect following the ingestion of large amounts of magnesium or sodium sulfate. Children and the elderly are at potentially high risk of diarrhea.
12	Manganese	Not expected to cause any adverse effects.
13	Copper	Too much copper can cause adverse health effects, including vomiting, diarrhea, stomach cramps, and nausea. It has also been associated with liver damage and kidney disease.
14	Chlorides	Hypertension
15	Iron	Iron is an essential element in human nutrition, and the health effects of iron in drinking water may include warding off fatigue and anemia.
16	Dissolved Oxygen	Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.
17	Dissolved Solids	Cancer, coronary heart disease, arteriosclerotic heart disease, and cardiovascular disease

CHAPTER 3

PROBLEM STATEMENT

Progressively, water asset management revisions have demonstrated the utilization of remote detecting systems to comprehend the extent of water surfaces and their volumetric qualities. This study investigates how remote detecting technology can be practical and incorporated in the management of water properties and the infrastructure that controls them.

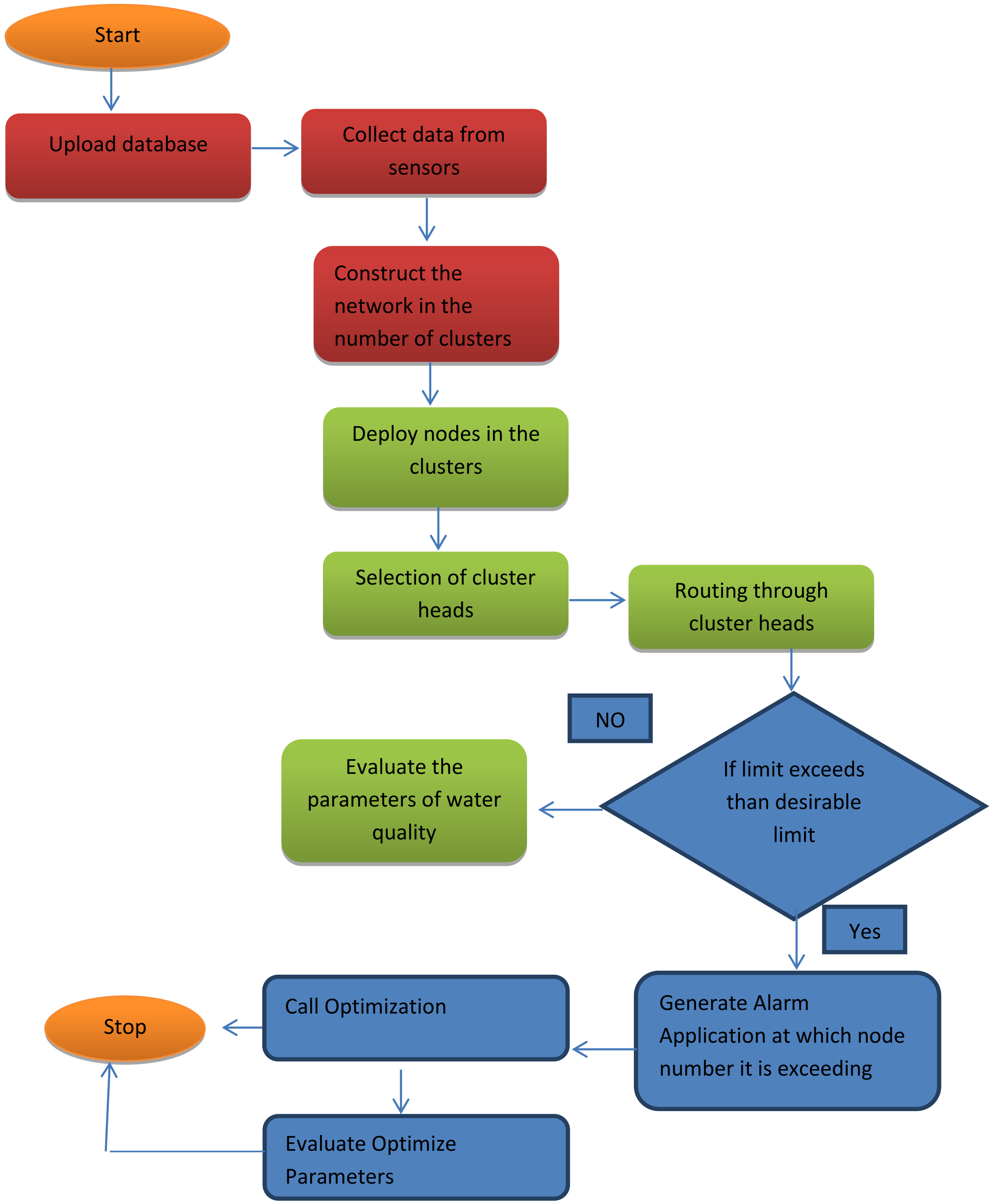
One of these issues is water shortage, which as of now has a suggestively negative effect on river water potentials in a large portion of urban territories. Water shortage is additionally exacerbated by issues identifying with water resources infrastructure. In the rural areas, a significant percentage of the water is utilized for irrigation which results in unrecoverable losses of water happening inside the water system systems and fields. Another concern is the increase in water salinity. Persistent monitoring studies have demonstrated that right now over half of inundated areas have increased levels of salinity.Consequently, the profitability of agricultural land reductions, and their products don't meet ecological prerequisites.

Urban foundations should better address the difficulties of city atmosphere: energy and water shortage, contamination and outflows, waste disposal, and dangers from ageing frameworks. The expanded adaptability of our social orders has made extreme rivalry among urban areas for venture, ability, and occupations. Constant observing has been utilized broadly for mechanical process control for a long time and has prompted new ideal models, for example, the Internet of Things [46]. The checking of most extreme water quality parameters (for instance shading, turbidity, particle retention or pH) still includes taking different samples from the water body or effluent stream, and transporting these to a research center for examination.

CHAPTER 4

PROPOSED SOLUTION

The proposed solution deals with the water monitoring alert system which is one of the main field in water resource management systems. The work comprises of the energy consumption and throughput of the network which reduces the effect of the network failure and increase the lifespan with high performance using hierarchical clustering and optimization approach in water quality monitoring system. We have compared the work with the scenario using optimization approach and without optimization. We have used stable election protocol approach because it will provide hierarchy in ordered manner to transmit the packets using cluster heads. In this the cluster heads will communicate to each other which will help to save the energies of the other nodes and will decrease the chances of failure in harsh environments. The optimization is need to reduce the effect of error rates which will overcome the problem of energy consumption of the network. The packet deliveries is also one of the main performance parameter and is optimized using Genetic algorithm which gives the best possible solutions from the number of solutions and will reduce the chances of degrading performance of the nodes in the network


Start
Upload database
Collect data from sensors
Construct the network in the number of clusters
Deploy nodes in the clusters
Selection of cluster heads
Routing through cluster heads
NO
If limit exceeds than desirable limit
Evaluate the parameters of water quality
Yes
Generate Alarm Application at which node number it is exceeding
Call Optimization
Stop
Evaluate Optimize Parameters

CHAPTER 5

OBJECTIVES AND METHODOLOGY

5.1 Objectives

1. To study the basic concepts of water quality monitoring resources and their pros and corns.
2. To implement the effective approach using stable election protocol to reduce the uncovered losses of water in the sensor networks and field.
3. To implement the optimize Genetic approach to increase the lifetime of the network
4. Evaluate the parameters in terms of levels of the water quality parameters.

5.2 Methodology

1. Firstly we will collect the data

2. Then we will construct the network using clustering approach

3. The network is divided into clusters and then we will deploy the number of nodes in the cluster

4. Then we will select the cluster heads and using those cluster heads we will perform routing because cluster heads are the responsible nodes which will communicate with the cluster heads of different in the network

5. If the limit exceeds than the desirable limit then an alert will be generated and at which nodes it is exceeding it will show the node id also

6. Then we will evaluate the performance parameters

7. Then we will apply the optimization approach and will generate the optimize parameters to evaluate the network lifetime

CHAPTER 6

DESIGN AND IMPLEMENTATION

6.1 Simulation Tools Used

The subsequent development Tools have been used for the implementation of this project. Tools other than the below mentioned may also be used, depending upon the interest and skills of the programmer. The used tools are:

1. Least amount of 4 GB of RAM- 4GB or above
2. Processor- Intel Pentium III or above
3. MATLAB- R2011a

Table 5: simulation tools used

Processor	Core 2 Duo or higher
RAM	4 MB
Operating system	Windows 7,8,10
Software	Matlab 2013a, MATLAB 2014a,MATLAB 2016a

6.2MATLAB

“MATLAB stands for MATRIX LABORATORY. MATLAB was initially developed with a motive to make the access to matrix software easier with the help of LINPACK (LINEAR SYSTEM PACKAGE). besides this, MATLAB is an advanced and customized programing language. it has complex information structures, contains built in editors and troubleshooters so as to and support object oriented programming. These issues make MATLAB a suitable apparatus for instructing and research.

1. MATLAB is an interactive system where the data elements are entered in the form of array and there is no need to predefine the dimensions of the array.
2. MATLAB has been available for commercial use since 1984 and has now become the most sought after tool in most of the universities and companies across the globe.
3. Correct applications are gathered in bundle alluded to as tool stash. There are tools for sign handling, agent calculation, control hypothesis, proliferation, enhancement and numerous different fields of connected science and building.

6.2.1Advantages of Matlab

- **i.** Large databases are available for built-in-algorithms, especially for image processing.
- **ii.** Algorithms can be tested iteratively without any need of compiling again and again.
- **iii.** Ability to process both still images and videos.
- **iv.** Ability to call inside libraries.
- **v.** Online help as well as examples are available for written documents.
- **vi.** Toolboxes are easier to use and therefore, it is easy to use for new users.

6.2.2 Matlab characteristics

- vii. Imitative from FORTRAN
- viii. Developed to access LINPACK and EISPACK matrix
- ix. Rewritten in C
- **x.** The Math Works includes was formed by 1984 to marketplace and go on with expansion of MATLAB.

6.2.3Strength of Matlab

- xi. Act a calculator or as a programming language

xii. Used for calculation and graphics plotting

xiii. Easy to learn

xiv. The fault is easy when performing matrix operations containing few OOPs concepts.

6.3 Stable Election Protocol

Existing SEP[11] is a heterogeneity-mindful convention and selection probabilities of hubs are weighted by introductory energy of every hub in respect to that of different hubs in a system. A Stable Election Protocol for grouped heterogeneous remote sensor systems (SEP) is created for the two-level heterogeneous systems, which incorporate two sorts of hubs, the advance hubs and typical hubs as indicated by the underlying energy. The rotating age with decision probability is specifically related with the underlying vitality of hubs. The likelihood limit, which every hub utilizes to decide whether it should become a cluster head is as follows:

$$T(s) = \begin{cases} \frac{p}{1-p*mod(r,round(\frac{1}{p}))} \end{cases} \qquad \text{ifs} \in G \qquad (1)$$

Where G is the arrangement of hubs that are qualified to be bunch heads at round$r$, when node s find it is eligible to be a cluster head, it will decide a casual number between 0 and 1. If the amount is less than threshold (s), the node si becomes a cluster head through the current round. Also, for two-level heterogeneous networks, p is defined as follow:

$$pnrm = \frac{popt}{1+a.m} \qquad (2)$$

if s is the normal node

$$padv = \frac{popt}{1+a.m} \times (1+a) \qquad (3)$$

if s is the advanced node SEP, which improves the stable region of the clustering hierarchy process using the characteristic parameters of heterogeneity, namely the fraction of advanced nodes (m) and the additional energy factor between advanced and normal nodes (α). In order to prolong the stable area, SEP attempts to maintain the restriction of well-balanced energy utilization. Spontaneously, advanced nodes have to develop into cluster heads more often than the normal nodes, which is equivalent to an evenhandedness restraint on energy consumption..

6.4 Genetic Algorithm

A genetic algorithm is arranged as a worldwide inquiry heuristic algorithm in which an ideal arrangement is evaluated by producing diverse people [24,25]. This algorithm is includes processes like focused fitness functions. Underneath, the principal parts of a genetic algorithm are described.

6.4.1 Initialization

Initially, the genetic algorithm begins with a primary population including random chromosomes that consist of genes with a sequence of 0 s or 1 s. In the next step, the process biases individuals toward the optimum explanation through repetitive processes such as crossover and selection operators. A new population can be produced by two methods [26]: steady-state GA and generational GA. In the first case, one or two members of population are replaced, while the generational GA replaces all of the produced individuals at each generation.

6.4.2 Fitness

The fitness function is defined for the genetic algorithm as a scoring process to each chromosome according to their qualifications. This value is a peculiarity for survival & further reproduction [26]. The fitness function is severely problem dependent, so that for some problems, it is hard or even impossible to define. In nature, individuals are authorized to pass on to the new generation according to their fitness value, which determines the fate of individuals.

6.4.3 Selection

During each successive generation, a new population is generated by selecting members of the current generation to mate based on fitness. Fitter individuals are virtually always selected, which leads to a preferential assortment of the best solution. Most of the functions have a stochastically designed element to choose small number of less fit individuals to maintain the diversity of the population. Of the several selection methods, Roulette-Wheel is chosen to distinguish appropriate individuals with the following probability:

$$Pi = \frac{Fi}{\sum_{f-1}^{n} Fi}$$

where Fi and 'n' are the fitness chromosome and the size of population, respectively. According to the Roulette Wheel, each individual is assigned a value between 0 and 1.

6.4.4Fitness Parameters

The fitness of a chromosome represents its qualifications on the bases of energy consumption minimization and coverage maximization. Some important fitness parameters are described below:

- Direct Distance to Base Station (DDBS): total direct distance between the whole sensor nodes and the BS, denoted by di, is calculated as below:

$$DDBS = \sum_{i-1}^{m} di$$

where 'm' is the number of nodes. As can be seen from the above formula, energy consumption logically depends on the number of nodes, such that it will be extreme for large WSN. On the other hand, DDBS will be acceptable for smaller networks with a few closely located nodes.

- Cluster based Distance (CD): This parameter is the sum of the distances between CHs and BS, added to the sum of the distances between associated member nodes and their cluster heads.

- Cluster-based Distance-Standard Deviation (CDSD): Standard derivation measures the variation of cluster distances, rather than one average cluster distance. CDSD is different depending on whether there is a random or deterministic placement of sensor nodes.

6.5 Result and Discussions

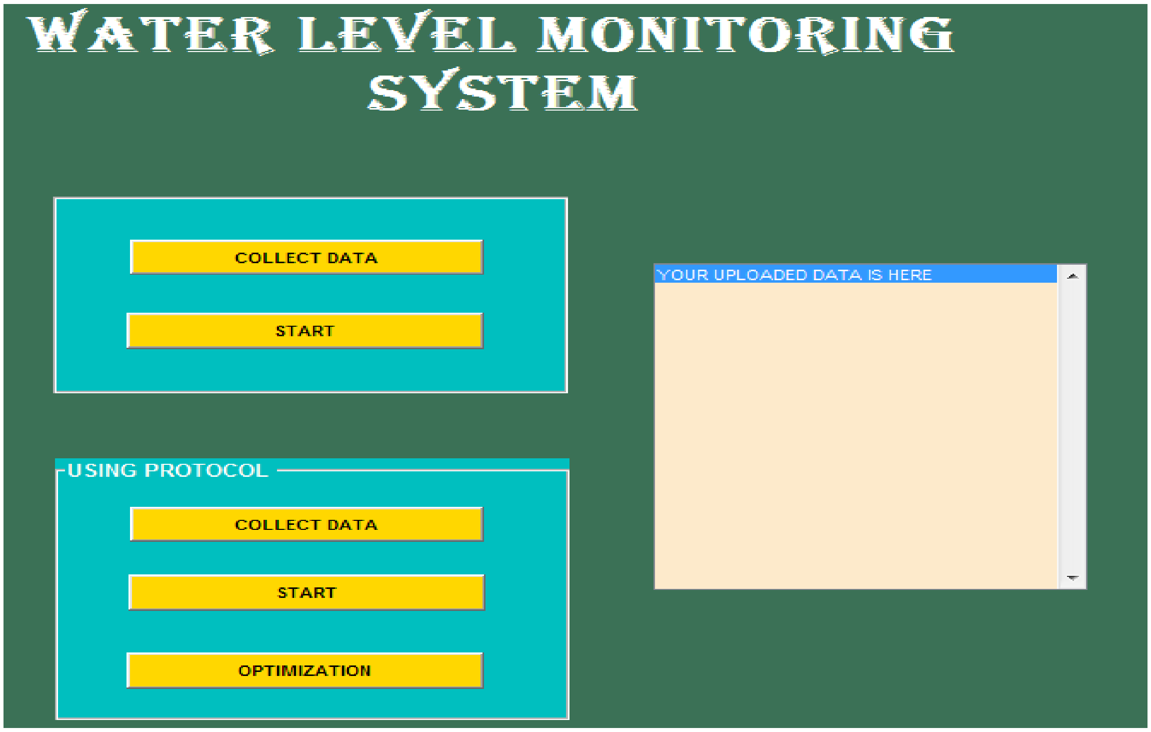


Figure 8 : Main Panel

The above figure shows the graphical user interface using user interface controls which are used to interact with real world scenario. It consists of different panels and pushbutton. The panel shows the communication without using protocol and using stable election protocol.

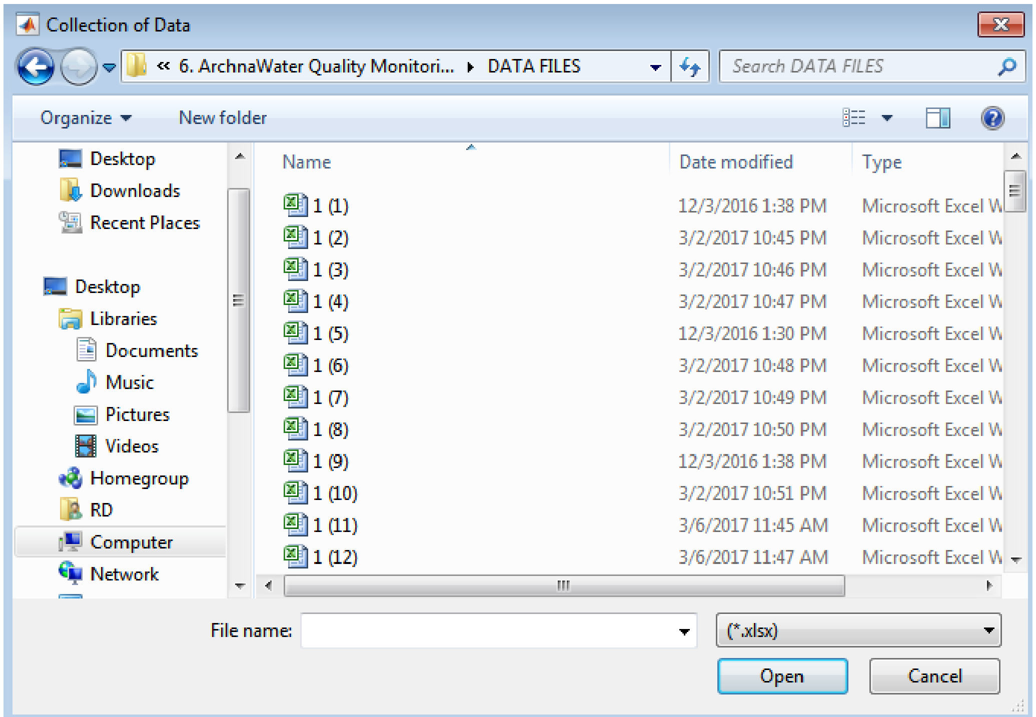
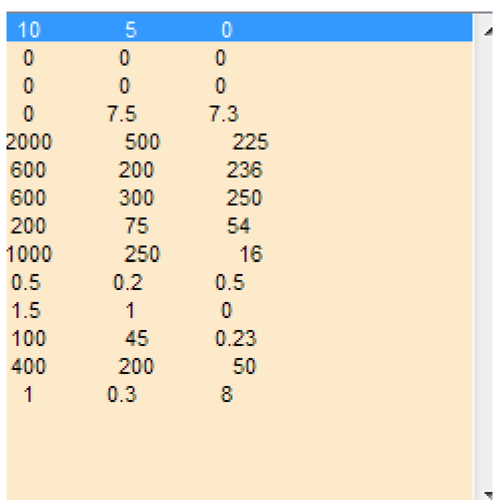


Figure 9 : Dataset Uploaded

The above figure shows the set of database which are collected from various monitoring centers and will be uploaded after clicking on upload data button. The dataset includes the permissible and desirable limits of various elements which are used to monitor water qualities.



10	5	0
0	0	0
0	0	0
0	7.5	7.3
2000	500	225
600	200	236
600	300	250
200	75	54
1000	250	16
0.5	0.2	0.5
1.5	1	0
100	45	0.23
400	200	50
1	0.3	8

Figure 10: Uploaded data

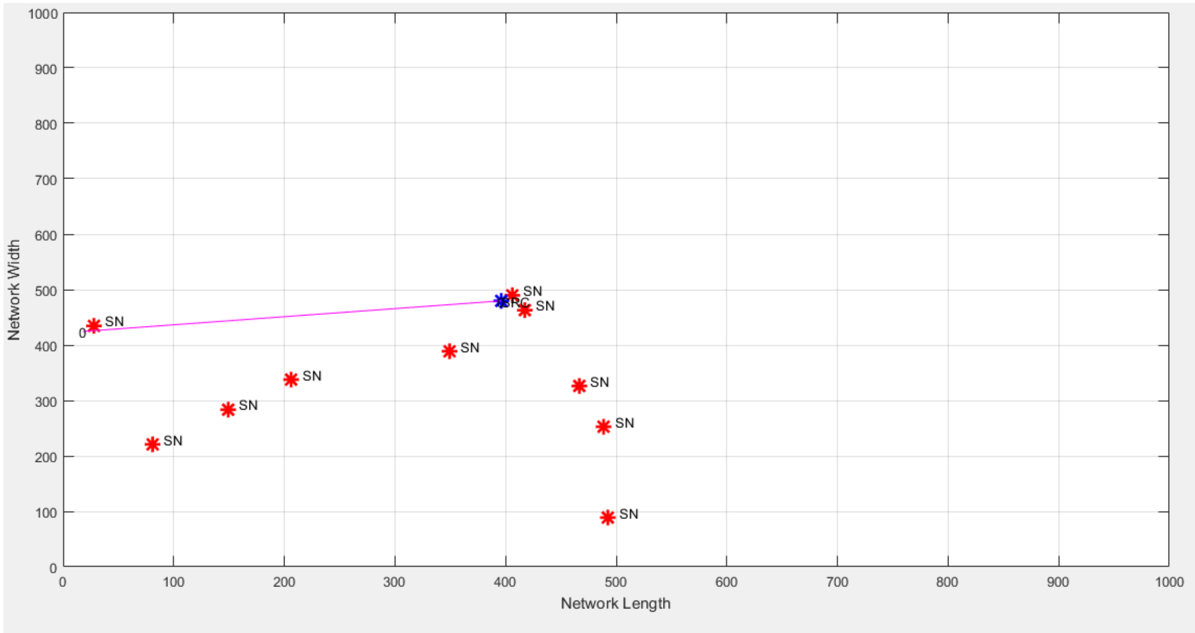


Figure 11: Deployment of nodes

The above figure shows the network having area of 1000*1000 meters and the nodes are deployed in the network which is in red color and shows that nodes are receiving data which are uploaded from the database. The blue color is the source node from which the data is started and communicates with the other nodes and receiving of the data takes place to that node having more energy to transmit the data.

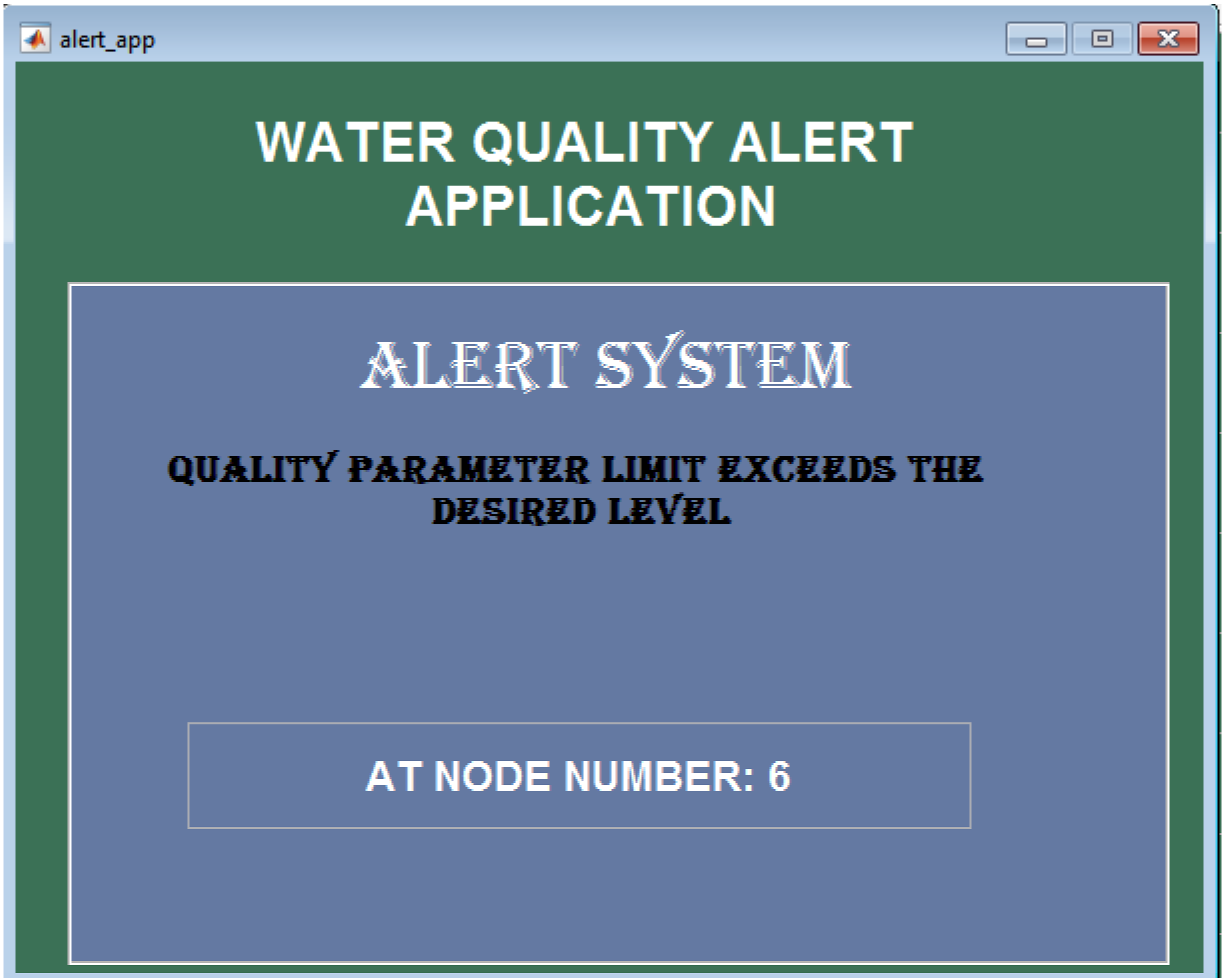


Figure 12: Alert system

The above figure shows the shows the alert system when the limit exceeds than the desired limit then it will pop up a raise system with node id that at which node the limit is exceeding which will interact with the real world scenario.

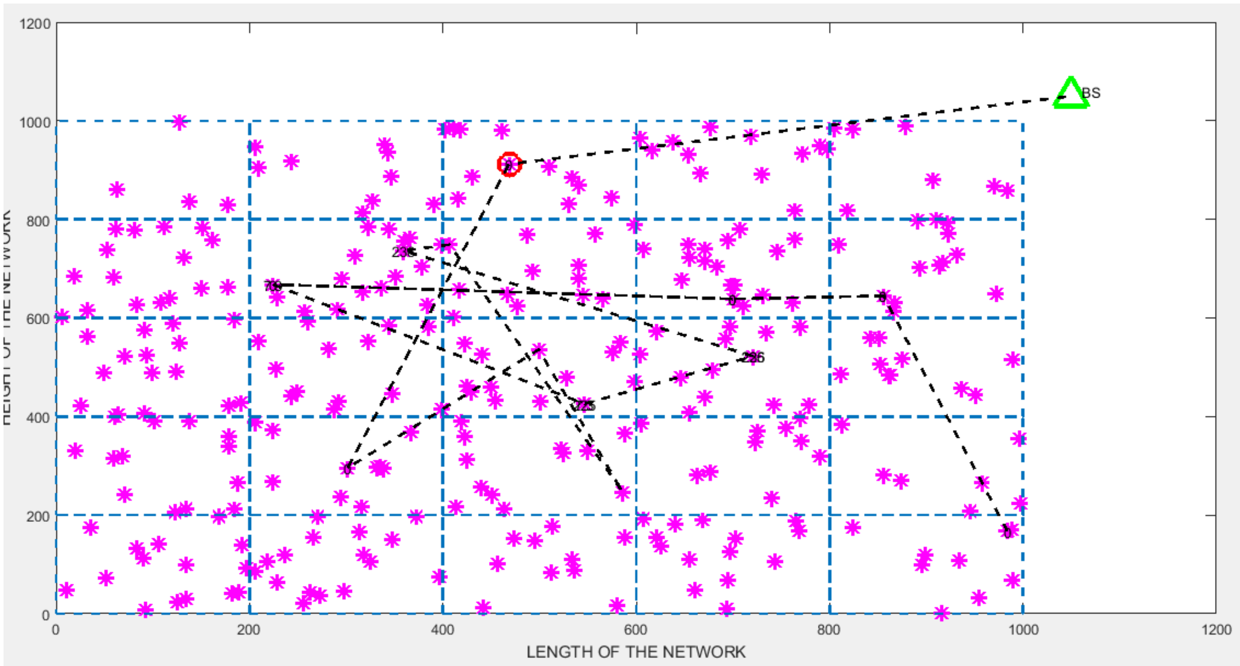


Figure 13 communication among cluster heads using Stable Election Protocol

The above figure shows the routing using stable election protocol in which cluster are evaluated and deployment nodes takes place and shows the routing using various cluster heads and then cluster heads will communicate to each other and then It will send data packets to the base station. This is the heterogeneous network which nodes consists of different energies. Each cluster is having one cluster head for particular round and will communicate with cluster heads of different clusters to save the energies of the nodes.

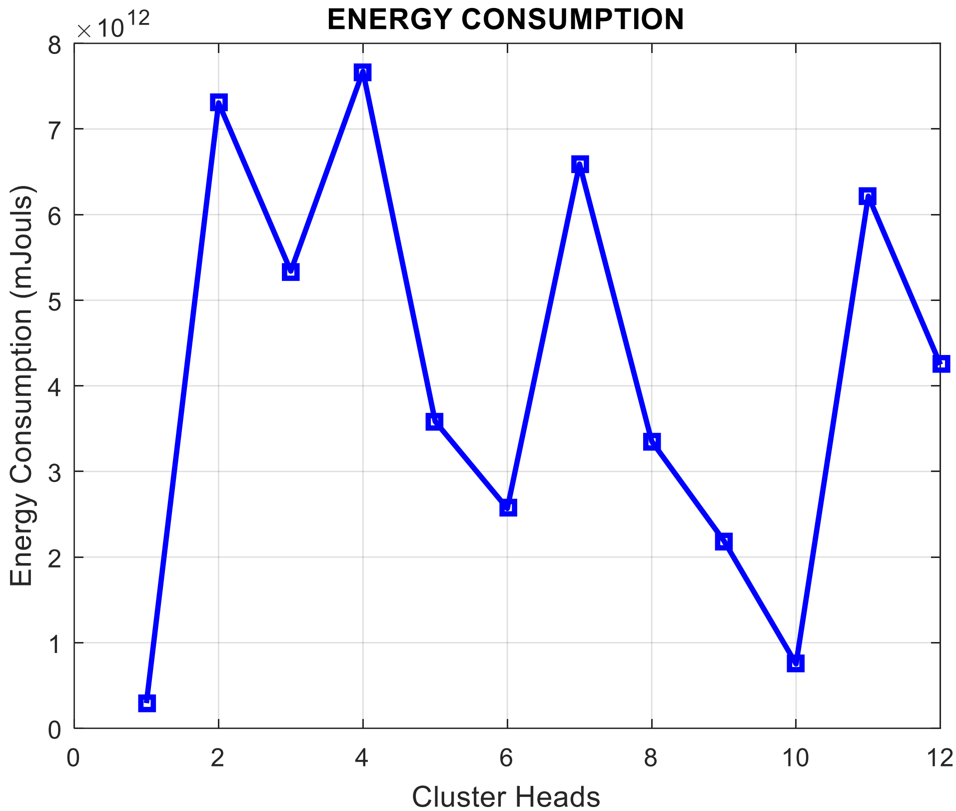


Figure 14: Energy consumption using Stable Election Protocol

The above figure shows the energy consumption of the network and shows that cluster heads are consuming $8*10^{12}$ mJouls . The energy consumption is plotted with respect to the number of cluster heads

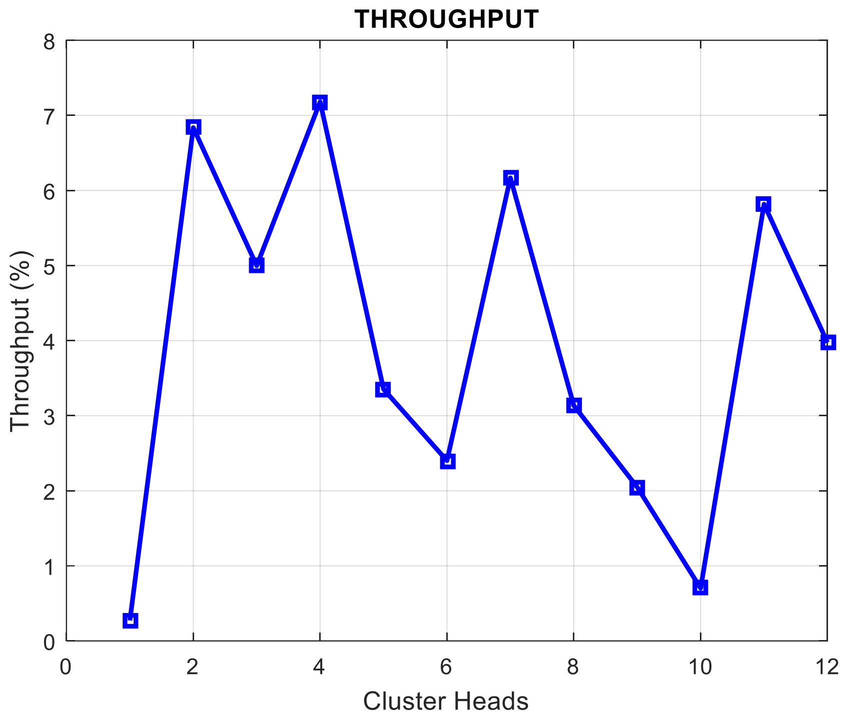


Figure 15: Throughput using Stable Election Protocol

The above figure shows the throughput of the network and shows the overall performance in the network. Throughput shows that the efficient delivery of the packets and showing less percentage which is further improved using optimization

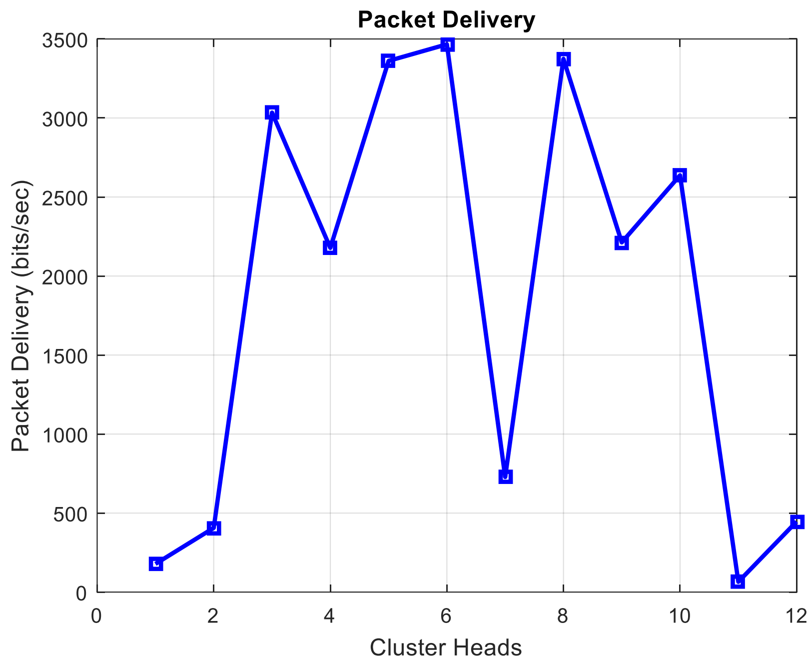


Figure 16: Packet delivery using Stable Election Protocol

The above figure shows the packet delivery of the network in terms of bits per second and shows successful delivery bits. The packet deliveries must be high for the high network lifetime.

Optimization results

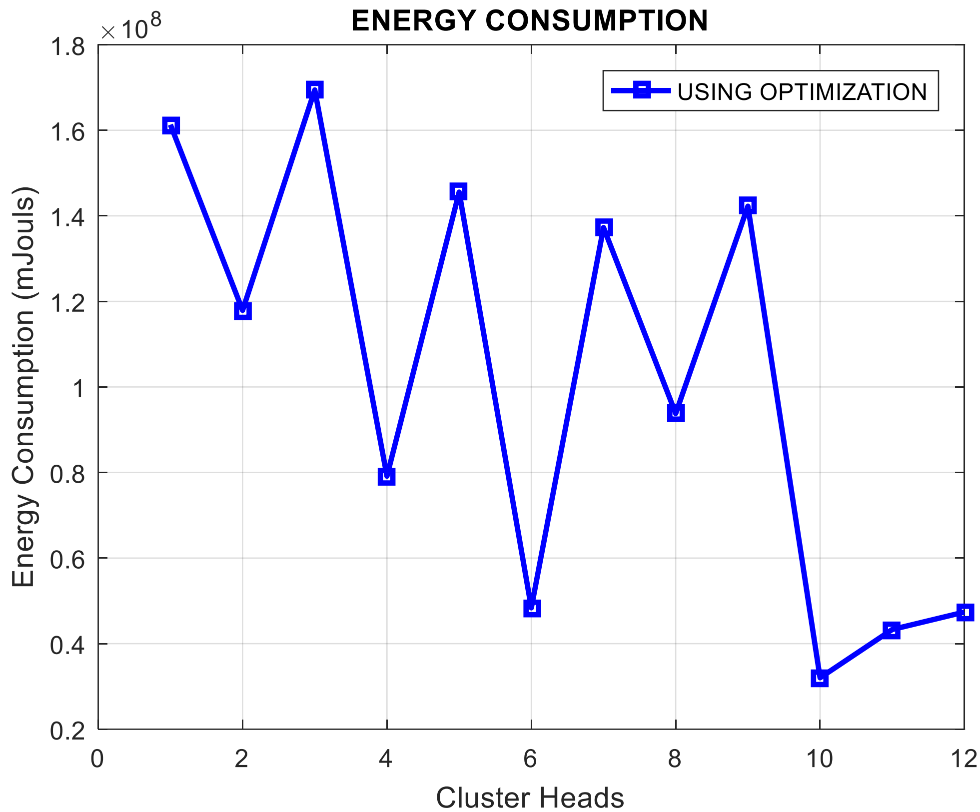


Figure 17: Energy with optimised Stable Election Protocol

The above figure shows the energy consumption of the network after optimization which shows the consumption of energy in low manner with respect to without optimization which shows that the optimization is showing better energy consumption of the network in which operations are performed using cluster heads.

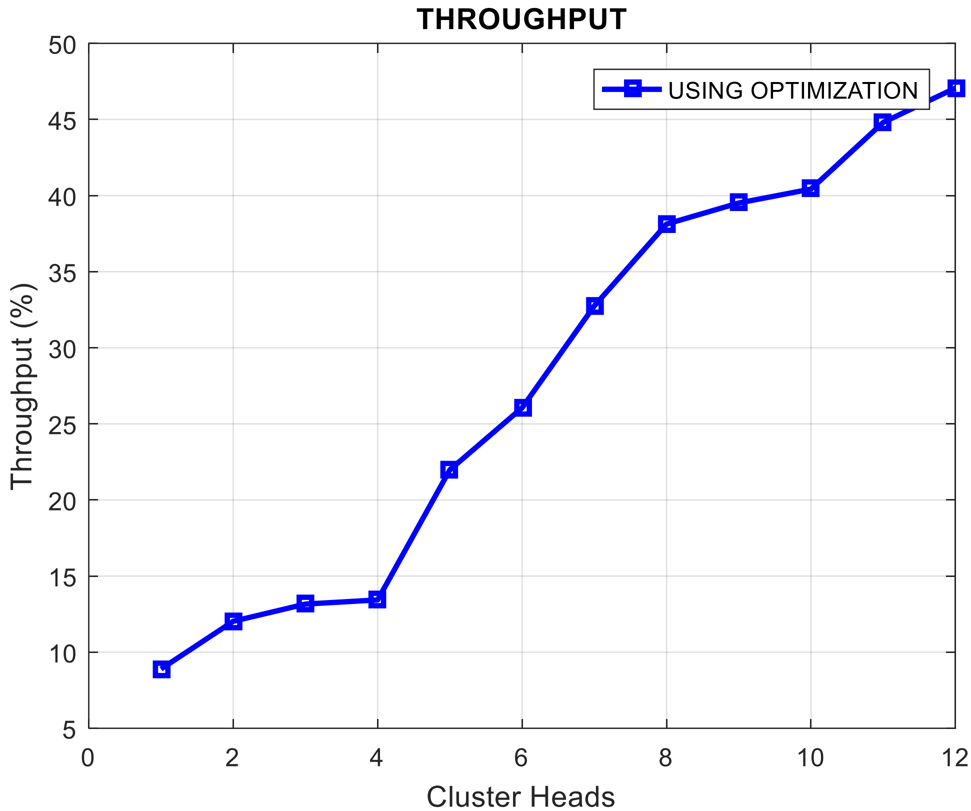


Figure 18: Throughput using optimised Stable Election Protocol

The above figure shows the throughput of the network after optimization and shows 45 percent high optimize throughput than without optimization. The throughput must be high for efficient packets delivery to the base station through inter cluster communication

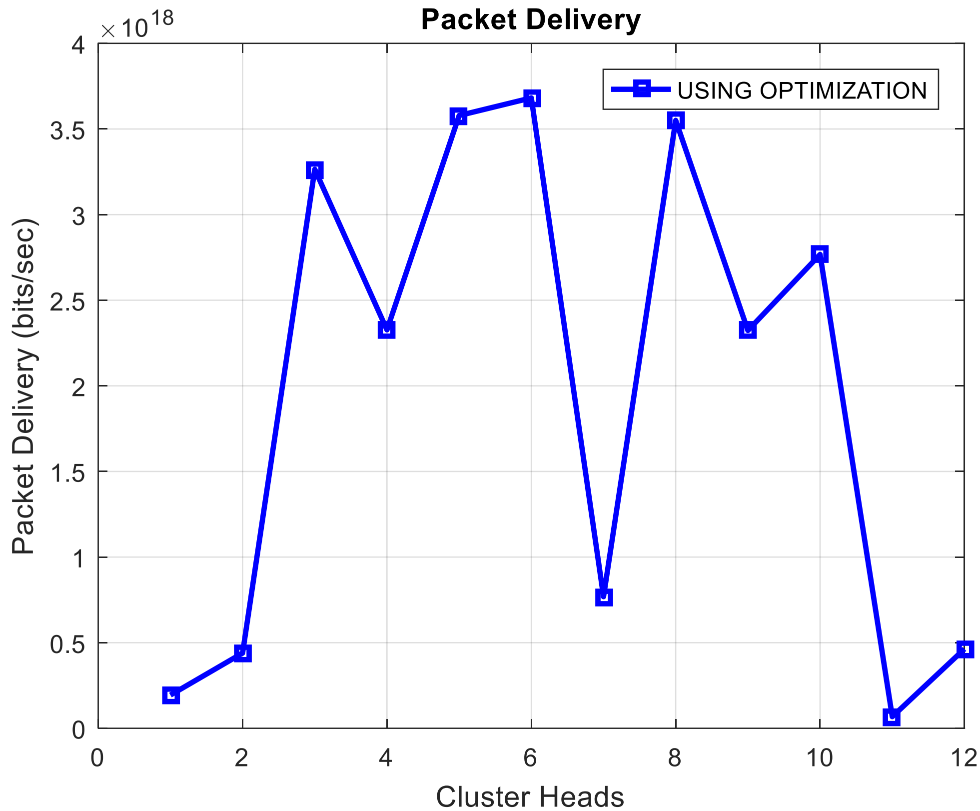


Figure 19: Packet delivery using optimised Stable Election Protocol

The above figure shows the packet delivery of the network using optimization and we can compare it without optimization and shows that after optimization more bit rate are delivering in efficient manner with any loss of packets to the base station. The proposed optimize approach is performing better to increase the lifespan of the network.

CHAPTER 7

CONCLUSION

A addresses about developing an efficient wireless sensor network (WSN) based water quality monitoring system, which examines “water quality”, an important factor as far as, irrigation; domestic purposes; industries; etc. are concerned. Water pollution can be easily detected by this system, which will help in controlling it.Another important fact of this system is the easy installation of the system that is 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 very less training at the beginning of the system installation. Performance modeling is one important aspect in different environments to be studied in the future as different kind of monitoring application requires different arrangementsduring system installation.

So, an efficient clustering approach will provide better performance to Increase the life span of the network with less error probability and less energy consumption, high throughput and packet delivery. SO this develop system provides better monitoring of water quality for the real time scenarios.

In the future, hybrid optimizations can be implemented so as to achieve better results. Moreover, there is a lot of scope in the field of security in controlling and monitoring the levels and quality of water. Performance modeling is one important aspect in different environment to be studied in the future as different kinds of monitoring application require different arrangement during system installation

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Appendices

3) Depth & Spring level ....

4) Date & Time of collection 25-4-16

5) Name & Designation of the person

Collecting the sample. SDE Punjab & Sewraj Board S/Divi, Pathankot

6) Date & time of receipt at Laboratory 26-4-16

7) Date & time of commencing examination 26-4-16

Lab Test Details

Sr. No.	Quality Parameter	Unit of measurement	BIS Permissible limit	BIS Desirable Limit	Actual Level
1	Iron	Mg/l	0.3	0.3	0.2
2	Colour	Units on pt-Co scale			Colourless
3	Taste & odour	Qualitative			Acceptable
4	Fluoride	Mg/l	1.5	1.0	0.15
5	Chloride	Mg/l	1000	250	10
6	TDS	Mg/l	2000	500	190
7	Alkalinity	Mg/l	600	200	86
8	Calcium	Mg/l	200	75	32
9	Magnesium	Mg/l	100	30	5
10	Sulphates	Mg/l	400	200	—
11	PH	PH	>8.5 to < 6.5	8.5 to 6.5	7.2
12	Turbidity	NTU	5.00	1	0.70
13	Hardness	Mg/l	600	200	100
14	Nitrates	Mg/l	45	45	—

Water Supply & Sanitation Department, (PUNJAB)

District Water Testing lab at Rajpura

Particular of Sample

Sample No. 3

1 Name of Place BANUR

2 Block STP, BANUR

3 Source of the sample and its. Location FROM RAMESH HOUSE.

4 Date & time of Collection 15/09/2016 08:00 AM

5 Name & designation of the Person colleting the Sample Er. KARANDEEP SINGH (J.E)

6 Date & Time or receipt at Laboratory 15/09/16

7 Date & time of commencing of Examination 15/09/16

Sr. No.	Test	Result	REQUIRED (DESIRABLE LIMIT)	PREMISSIBLE LIMIT IN CASE OF OTHER ALTERNATIVE SOURCE
1	Total Alkalinity (as Ca CO_3) mg/1	168	200 mg/L	600 mg/L
2	Calcium (as Ca), mg/1	64	75 mg/L	200 mg/L
3	Chlorides (as Cl), mg/1	7	250 mg/L	1000 mg/L
4	Fluorides (as F), mg/1	0.1	1.0 mg/L	1.5 mg/L
5	Total Hardness (as Ca CO_3) mg/1	218	300 mg/L	600 mg/L
6	PH	7.56	6.5-8.5	NO RELAXATION
7	Total Dissolved Solid, mg/1	332	500 mg/L	2000 mg/L
	Dissolved Suspended			
8	Turbidity (NTU)	<1.0	5	10
9	Iron (as Fe), mg/1	0.01	0.3 mg/L	1.0 mg/L
10	Residual Chlorine, (as Cl), mg/1	0.04	0.2 mg/L	--

Remarks: (In view of the above analysis)

The following parameters are more than the 'acceptable' but less than the 'Cause for rejection' limits.

CHEMIST

District Water Testing Lab at Rajpura

1 Sample consumed in testing.

2 Sample is not drawn by us unlesss otherwise stated.

Water Supply & Sanitation Department, (PUNJAB)

District Water Testing lab at Rajpura

Particular of Sample Sample No. 1

1. Name of Place BANUR
2. Block BASSI ISS KHAN
3. Source of the sample and its. Location From Gurmail Singh House
4. Date & time of Collection 15/09/2016 10:00 AM
5. Name & designation of the Person colleting the Sample Er. Karandeep Singh (J.E)
6. Date & Time or receipt at Laboratory 15/09/2016
7. Date & time of commencing of Examination 15/09/2016

Sr. No.	Test	Result	REQUIRED (DESIRABLE LIMIT)	PREMISSIBLE LIMIT IN CASE OF OTHER ALTERNATIVE SOURCE
1	Total Alkalinity (as Ca CO_3) mg/l	182	200 mg/L	600 mg/L
2	Calcium (as Ca), mg/l	65mg/l	75 mg/L	200 mg/L
3	Chlorides (as Cl), mg/l	20	250 mg/L	1000 mg/L
4	Fluorides (as F), mg/l	0.2	1.0 mg/L	1.5 mg/L
5	Total Hardness (as Ca CO_3) mg/l	216	300 mg/L	600 mg/L
6	PH	7.45	6.5-8.5	NO RELAXATION
7	Total Dissolved Solid, mg/l	344	500 mg/L	2000 mg/L
	Dissolved Suspended			
8	Turbidity (NTU)	<10	5	10
9	Iron (as Fe), mg/l	0-01	0.3 mg/L	1.0 mg/L
10	Residual Chlorine, (as Cl), mg/l	0.05	0.2 mg/L	–

Remarks: (In view of the above analysis)

1. The following parameters are more than the 'acceptable' but less than the 'Cause for rejection' limits.

CHEMIST

District Water Testing Lab at Rajpura

1. Sample consumed in testing.
2. Sample is not drawn by us unless otherwise stated.

. WATER TESTING LABORATORY / MOBILE WATER .G LABORATORY DEPARTMENT OF W/S & SANITATION, PUNJAB

ANALYSIS REPORT OF WATER SAMPLE

AMRITSAR

Particular of Sample — Sample No. 228

1. Name of Place A/mrc Roja Sansi Asa

District Asr .... Block .... Village .... Location ....

2. Source of the sample (Tick) Canal / Tubewell / Hand Pump / Any Other ....

3. Name / Designation of the person who collected the sample S.D.E Pb. W/s. Sew Sj, No 8 Asa

4. (i) Date & Time of receipt in the Lab 18/5/2-16

(ii) Commencement of Test 19/5/2-16

5. Type of Disinfection (Tick) Silver Ionization / Chlorination / None

Sr. No.	Test	Desirable Limit	Permissible Limit	Result
1.	Turbidity (NTU) Max	5.0	10	Nil
2.	Colour (Visual)	----	Un objectionable	Colourless
3.	Taste & Odour (Qualitative)	----	Un objectionable	ordinary
4.	pH	6.5 to 8.5	No relaxation	7.7
5.	Total Dissolved Solids mg / l Max.	500	2000	220
6.	Total Alkalinity (as Ca, CO_3), mg/l, Max	200	600	236
7.	Total Hardness (as Ca, CO_3), mg/l, Max	300	600	248
8.	Calcium (Ca), mg/l, Max.	75	200	52
9.	Chloride Mg/l. Max.	250	1000	16
10.	Residual Chlorine (as Cl), mg/l, Max.	0.2	0.5	—
11.	Fluorides (as F), mg/l, Max	1.0	1.5	0.20
12.	Nitrate (as NO_3), mg/l, Max	45	100	—

Water Supply & Sanitation Department, (PUNJAB)

District Water Testing lab at Rajpura

Particular of Sample — Sample No. 1542

1. Name of Place WATER TREATMENT PLANT RAJPURA
2. Block RAJPURA
3. Source of the sample and its. Location CANAL BASED
4. Date & time of Collection 15-09-2016
5. Name & designation of the Person colleting the Sample SH. SATPAKSH S.D.B
6. Date & Time or receipt at Laboratory
7. Date & time of commencing of Examination 16-09-2016

Sr. No.	Test	Result	REQUIRED (DESIRABLE LIMIT)	PREMISSIBLE LIMIT IN CASE OF OTHER ALTERNATIVE SOURCE
1	Total Alkalinity (as Ca CO_3) mg/1	60.0	200 mg/L	600 mg/L
2	Calcium (as Ca), mg/1	24.0	75 mg/L	200 mg/L
3	Chlorides (as Cl), mg/1	40.0	250 mg/L	1000 mg/L
4	Fluorides (as F), mg/1	0.12	1.0 mg/L	1.5 mg/L
5	Total Hardness (as Ca CO_3) mg/1	100.0	300 mg/L	600 mg/L
6	PH	7.48	6.5-8.5	NO RELAXATION
7	Total Dissolved Solid, mg/1	253.0	500 mg/L	2000 mg/L
	Dissolved	--		
	Suspended			
8	Turbidity (NTU)	0.25	5	10
9	Nitrates (as No_3), mg/1	--	45 mg/L	100 mg/L
10	Iron (as Fe), mg/1	0.01	0.3 mg/L	1.0 mg/L
11	Residual Chlorine, (as Cl), mg/1	0.2	0.2 mg/L	--

Remarks: (In view of the above analysis)

1. The following parameters are more than the 'acceptable' but less than the 'Cause for rejection' limits.

District Water Testing Laboratory SANGRUR

ANALYSIS REPORT OF WATER SAMPLE

PARTICULARS OF SAMPLE

1. Name of Place:

District: Sangrur Block...Sunam......Village...Cheema.......Location...T|W No-3

2. Source of the Sample (Tick) Canal/Tubewell/Handpump/Anyother

3. Name/ Designation of the Person

   Who Collected The Sample

4. 1) Date & Time of Receipt in the Lab.............................29|9|16..............................

   2) Commencement of Test..30|9|16.........................

5. Type of Disinfection(Tick) Silver lionization/ Chlorination/ None

Sr. No.	Test	Desirable	Permissible	Result
1	Turbidity (NTU) max	5.0	10	Nil
2	Colour (Visual)	-	Un- objectionable	colourless
3	Taste and Odour	-	Un- objectionable	ordinary
4	PH	6.5 to 8.5	No Relaxation	7.3
5	Total Dissolved Solids mg/l Max	500	2000	445
6	Calcium (Ca) mg/l.Max	75	200	30
7	Chloride	250	1000	28
8	Total Alkainity (as Ca, Co_3) mg/l	200	600	226
9	Total Hardness (Ca, Co_3) mg/l	300	600	232
10	Residual Chlorine (as Cl) mg/l	0.2	0.5	Nil
11	Flurides (as F) mg/l	1	1.5	0.20
12	Nitrate (as NO_3) mg/l	45	100	12
13	Sulphate (as SO_4) mg/l	200	400	Nil
14	Iron (as Fe) mg/l	0.3	1.0	Nil

Bacteriological Parameters:

Test for Total Coliform by MPN method with Maconky Broth

1) **Test for Fecal Coliform b MPN method with A1 Broth**