PROJECT REPORT

on

Development of Water Pollution Monitoring System

Submitted By

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Submitted in partial fulfilment of the requirements

for

Degree of Bachelor of Engineering

Guided by: -

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DEPARTMENT OF INFORMATION TECHNOLOGY

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

2021-2022

Institute Vision:

Emerge as a leading Institute for developing competent and creative Professionals.

Institute Mission:

- Providing Quality Infrastructure and experienced faculty for academic excellence.
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DEPARTMENT OF INFORMATION TECHNOLOGY

SESSION 2021-2022

CERTIFICATE

This is to certify that the Project titled **"Development of Water Pollution Monitoring System"** is a bonafide work of **Ms. Namrata Thakre, Ms. Shweta Lanjewar, Ms. Natasha Ramtekkar, Mr. Himanshu Saha and Ms. Vijayalaxmi Yelchalwar** carried out for the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering in **Information Technology, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur.**

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Designation: _____

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Date: _____

DECLARATION

We, hereby declare that the Project titled **"Development of Water Pollution Monitoring System"** submitted herein has been carried out by us in the Department of Information Technology of S. B. Jain Institute of Technology Management and Research, Nagpur under the guidance of **Ms. Snehal P. Dongre**. The work is original and has not been submitted earlier as a whole or in part for the award of any degree / diploma at this or any other Institution / University.

Ms. Namrata Thakre _____

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ABSTRACT

Water pollution is one of the biggest threats to our surroundings. To supply good quality of water it is important to monitor the quality of water. So, we are designing a cheap and time-saving water pollution monitoring system. The system comprises of different sensors which is used to measure the physical and chemical parameters of the water. The parameters such as temperature, pH, turbidity, TDS sensor of the water can be measured. The measured values from the sensors are provided to Arduino, it reads the data and provide the results. Finally, the sensor data gets appended in the file and can also be viewed on Arduino serial monitor.

Keywords: pH sensor, Turbidity sensor, TDS sensor, Arduino model

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
pH	POTENTIAL OF HYDROGEN
TDS	TOTAL DISSOLVED SALT
RC	REMOTE CONTROL
GPS	GLOBAL POSITIONING SYSTEM
LED	LIGHT EMITTING DIODE
VCC	VOLTAGE COMMON COLLECTOR
GND	GROUND
Rx	RECEIVING
Tx	TRANSMITTING
CSN	CHIP SELECT NOT
CE	CHIP ENABLE
SCK	SERIAL CLOCK
MOSI	MASTER OUT SLAVE IN
MISO	MASTER IN SLAVE IN
V	VOLT

LIST OF PUBLICATION/PARTICIPATIONS

Sr. No.	Title	Event Name / JournalName/ Conference	Date	Remark
1	Development of WaterPollution Monitoring System	International Journal Of Advanced Research In Science, CommunicationAnd Technology (IJARSCT)	01/01/22	Participated
2	Development of WaterPollution Monitoring System	International Conference On Tech Trends In Science& Engineering (ICTTSE)	25/02/22	Participated

CHAPTER NO 1

INTRODUCTION

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1.1 PROJECT BACKGROUND

Quality of drinking water plays a vital role in the health of animals and human beings. Rivers, lakes, ponds are major sources available for drinking water. Irrigation, fishery, and energy production organizations are highly relied on water quality. Therefore, the quality of water of rivers and lakes ought to be kept at a certain level. But still, many of the people don't get plenty and clean drinking water and the fact that government's responsibility to guarantee that clean water is conveyed to its citizens. Hence it is necessary to monitor the quality of water which will be utilized for consumption.Monitoring is characterized as the collection of data at set locations and at standard interims to provide the information which may be used to direct the current conditions, build-up trends, etc.

Water quality is affected by both point and non-point sources of pollution, which include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off.Other sources of water contamination include floods and droughts and due to lack of awareness and education among users. The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment sanitation, storage and disposal are critical elements to maintain the quality of water resources.

Conventional water quality checking methods include sampling and consuming which eventually leads to delayed in detection of impurities and reaction to those contaminants in water. So, there should be more efficient and productive checking strategies to monitor the quality of water So,we have designed a solution for easy water quality checking of water bodies with ease. We will design Remote Control (RC) boat which will help to measure the pH level and turbidity level. This will further help us to maintain the water clean. This project is remote-operated and controlled by an RC remote. Thus, this will help to maintain the water quality.

1.2 PROBLEM STATEMENT

The quality of drinking water plays a crucial role in the health of animals and human beings. Lakes and reservoirs, canals one of the major sources of drinking water. Water quality monitoring of these water bodies requires a lot of effort as operators need to get in a boat with all sensors and manually check the entire water body. The current manual method for monitoring of the water quality requires Money, Time consuming and labor intensive. So, we are designing a solution for easy waterquality checking of vast water bodies with ease.

1.3 PURPOSE OF STUDY

Arduino is open source, both in its software and hardware specification so that hobbyists can assemble the simplest Arduino modules themselves by hand. More sophisticated pre-assembled Arduino modules can be purchased and are modestly priced. The hardware comes in many format specifications, from a small wearable device to larger surface-mounted modules. The primary mode of computer connection is via USB, though Bluetooth, serial, and Ethernet form factors also exist.

The Arduino software is free and open source. The programming platform is based on the popular Wiring language. The IDE is based on Processing, which is a well-known language among designers. Unlike most microcontroller interfaces, Arduino is cross-platform, so it can be run on Windows, Linux, and macOS.

Monitoring water quality is very important for maintaining ecosystem health and the livelihood of the population. Since water quality is an important aspect in human life. The system proposed here is a water quality monitoring system in the Arduino platform that measures the pH, Turbidity, TDS and presence of suspended items on the water bodies like lakes and rivers using sensors. These sensed parameters are sent to the Arduino and then the values of the parameter are appended in the file, so that proper action can be taken by the authority in cleaning the water bodies to reduce the possible problem that could occur.

1. Objectives

- To study, water quality and importance of water quality monitoring.
- To develop a system with Ease and convenience of usage.
- To improve data collection system in survey of water quality for large water bodies.

1.4 TECHNOLOGICAL BASE

This Project can be implemented by using various technologies like-

2. C++

C++ is a high-level object-oriented programming language that helps programmers write fast, portable programs. C++ provides rich library support in the form of Standard Template Library (STL).

3. Features:

- **Object-oriented**: C++ is an object-oriented programming language. This means that the focus is on "objects" and manipulations around these objects. Information about how these manipulations work is abstracted out from the consumer of the object.
- **Rich library support**: Through C++ Standard Template Library (STL) many functions are available that help in quickly writing code. For instance, there are standard libraries for various containers like sets, maps, hash tables, etc.
- **Speed:** C++ is the preferred choice when latency is a critical metric. The compilation, as wellas the execution time of a C++ program, is much faster than most other general purpose programming languages.
- **Compiled**: A C++ code has to be first compiled into low-level code and then executed,unlike interpreted programming languages where no compilation is needed.
- **Pointer Support**: C++ also supports pointers which are widely used in programming and areoften not available in several programming languages.

JAVA

Java is a programming language and a platform. Java is a high level, robust, object-oriented, and secure programming language. Java was developed by Sun Microsystems (which is now the subsidiary of Oracle) in the year 1995. James Gosling is known as the father of Java. Before Java, its name was Oak. Since Oak was already a registered company, so James Gosling and his team changed the name from Oak to Java.

4. Features:

- **Object Oriented**: In Java, everything is an Object. Java can be easily extended since it is based on the Object model.
- **Platform Independent:** Unlike many other programming languages including C and C++, when Java is compiled, it is not compiled into platform specific machine, rather into platform-independent byte code. This byte code is distributed over the web and interpreted by the Virtual Machine (JVM) on whichever platform it is being run on.
- **Simple:** Java is designed to be easy to learn. If you understand the basic concept of OOP Java,it would be easy to master.
- **Secure:** With Java's secure feature it enables to develop virus-free, tamper-free systems. Authentication techniques are based on public-key encryption.
- **Architecture-neutral:** Java compiler generates an architecture-neutral object file format, which makes the compiled code executable on many processors, with the presence of Java runtime system.
- **Portable:** Being architecture-neutral and having no implementation dependent aspects of the specification makes Java portable. The compiler in Java is written in ANSI C with a clean portability boundary, which is a POSIX subset.
- **Robust:** Java tries to eliminate error-prone situations by emphasizing mainly on compile timeerror checking and runtime checking.
- **Multithreaded:** With Java's multithreaded feature it is possible to write programs that can perform many tasks simultaneously. This design feature allows the developers to construct interactive applications that can run smoothly.

- **Interpreted:** Java byte code is translated on the fly to native machine instructions and is not stored anywhere. The development process is more rapid and analytical since the linking is an incremental and light-weight process.
- **High Performance:** With the use of Just-In-Time compilers, Java enables high performance.
- **Distributed:** Java is designed for the distributed environment of the internet.
- **Dynamic:** Java is more dynamic than C or C++ since it is designed to adapt to an evolving environment.

PYTHON

Python is a dynamic, high level, free open source and interpreted programming language. It supports object-oriented programming as well as procedural oriented programming.

Features:

- **Easy-to-learn:** Python has few keywords, simple structure, and a clearly defined syntax. This allows the student to pick up the language quickly.
- **Easy-to-read:** Python code is more clearly defined and visible to the eyes.
- **Easy-to-maintain:** Python's source code is fairly easy-to-maintained.
- **A broad standard library:** Python's bulk of the library is very portable and cross-platformcompatible on UNIX, Windows, and Macintosh.
- **Interactive Mode:** Python has support for an interactive mode which allows interactive testing and debugging of snippets of code.
- **Portable**: Python can run on a wide variety of hardware platforms and has the same interface on all platforms.
- **Extendable:** You can add low-level modules to the Python interpreter. These modules enable programmers to add to or customize their tools to be more efficient.
- **Databases:** Python provides interfaces to all major commercial databases.
- **GUI Programming:** Python supports GUI applications that can be created and ported to many system calls, libraries, and windows systems.

CHAPTER NO 2

LITERATURE SURVEY

CHAPTER 2

LITERATURE SURVEY

2.1 RELATED WORK

Wong Jung et al. [1] Water is a quintessential element for the survival of mankind. Its variety of usesmeans that it is always in a constant state of demand. The supply of water most primarily comes fromlarge reservoirs of water such as lakes, streams, and the ocean itself. As such, it is good practice to monitor its quality to ensure it is fit for human consumption. Current water quality monitoring is often carried out in traditional labs but is time consuming and prone to inaccuracies. Therefore, this paper aims to investigate the feasibility of implementing an Arduino-based sensor system for water quality monitoring. A simple prototype consisting of a micro-controller and multiple attached sensors was employed to conduct weekly onsite tests at multiple daily intervals. It was found that the system worksreliably but is reliant on human assistance and prone to data inaccuracies. The system, however, provides a solid foundation for future expansion works of the same category to elevate the system to being Internet of Things (IoT) friendly.

S.Geeta et al. [2] Smart solutions for water quality monitoring are gaining importance with advancement in communication technology. This paper presents a detailed overview of recent works carried out in the field of smart water quality monitoring. Also, a power efficient, simpler solution for in- pipe water quality monitoring based on Internet of Things technology is presented. The model developed is used for testing water samples and the data uploaded over the Internet are analyzed. Thesystem also provides an alert to a remote user, when there is a deviation of water quality parameters from the predefined set of standard values.

Nikhil Kedia et al. [3] "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation ComputingTechnologies (NGCT-2015) Dehradun, India. This paper highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores

the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.

Omar Faruq et al. [4] A water quality monitoring system based on micro-controllers for people living in Bangladesh's outskirts, where safe drinking water is not available, is provided in this paper. The device has been designed with a high degree of accuracy and is sensitive to several water parameters such as temperature, turbidity, and hydrogen potential. (pH) displayed on the LCD monitor. Finally, in this paper, each of the parameter values are compared with the predefined equipment, and sensor values and error are calculated.

A Catalyst for Water Quality Improvements [5] NPS pollution encompasses a wide range of sources that are not subject to Federal or often state Regulation. The scope of the problem expands as a result of Population growth and land use changes. Even as waters are restored, others are Identified as impaired as a result of development pressures and other factors such as recent assessment of existing water quality problems. The vast extent and continuous nature of NPS pollution is a daunting challenge That requires problems be addressed through a variety of approaches using Multiple funding sources. Although not the entire remedy, §319 funding is an Essential part of the solution to the costly challenges of NPS pollution—it is A critical source of support for NPS management programs and for watershed Projects. State NPS programs typically leverage other programs and funding Sources to achieve water quality improvements. This report highlights some of the many accomplishments of the NPS Program and describes how the program has evolved and is addressing a variety of water quality problems around the country. In the years to come, NPS practitioners at the federal, state, tribal and local levels will continue to work hard together to ensure clean, safe water is available for people, plants and animals—not an easy task by any means. It will take hard work and time to accomplish all that needs to be done.

2.2 WEBSITES

- **Plans to Prevent the Degradation of Water Quality in Brunei**

This article talks about water pollution in Brunei. High levels of water pollution in the Brunei River have been traced to waste water treatment plants, industrial discharge, and polluted streams. Point and non-point pollution sources – including residential, industrial and agricultural outlets – are currently the main sources of pollution in Brunei River. The country is considering taking steps to address the water problem, including introducing legislation to improve watershed protection and manage pollution. The country has built reservoirs and dams to help prevent seawater intrusion and manage its river flow, utilized hydro-logical data network with technological advances, secured international cooperation from countries like Singapore and improved water quality monitoring. Furthermore, the country has had initial success in adapting to the threats of climate change.[1]

- **Turbidity in the USGS Water Science School**

This explains about turbidity and water in detail. Turbidity makes water cloudy or opaque. High concentration of particulate matter affects light penetration and ecological productivity, recreational values, and habitat quality, and cause lakes to fill in faster. In streams, increased sedimentation can occur, which can result in harm to habitat areas for fish and other aquatic life. Particles also provide attachment places for other pollutants, notably metals and bacteria. For this reason, turbidity readings can be used as an indicator of potential pollution in a water body. Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent health concern. Turbidity can provide food and shelter for pathogens.[2]

- **Water Pollution: Everything You Need to Know**

This article explains about water pollution in detail. Categorist of water pollution such as groundwater, surface water, ocean water, point water etc. Used water is wastewater. It comes from us sinks, showers, and toilets (think sewage) and from commercial, industrial, and agricultural activities(Think metals, solvents, and toxic sludge). Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment. It's generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and

medicine.[3]

- **RF-RADIO FREQUENCY-2020**

This paper consists of topic like balanced electro absorption modulated RF photonic link. Graphene and MWCNT thick films: preparation and RF electrical properties study. A broadband outlook on flexible and textile RF energy harvesting and wireless power transfer: from near-field to 5G. Designs and Simulations of Millimeter Wave On-chip Single Turn Inductors for 0.13 μm RF CMOS Process Technology. Harmony: Saving Concurrent Transmissions from Harsh RF Interference. DSP-based RF waveform aggregation for next generation mobile front-hauling.[4]

CHAPTER NO 3

METHODOLOGY / PROPOSED SOLUTION

CHAPTER3

METHODOLOGY / PROPOSED SOLUTION

3.1 PROPOSED SOLUTION

The main goal of our system is that real time monitoring water quality (pH, Turbidity, and TDS), the proposed system uses three sensors which are pH, turbidity, TDS, microcontroller unit as the main processing module and one data transmission module. The microcontroller unit is a significant part of the system developed for water quality measurement because The Arduino Mega consumes low power, and it is a small size, where the size is a good use for a crucial point-of- sale technology criterion.

The most important function of the system is to ensure that the data collected fromthe sensor reflects the actual aquatic scenario and the data are transmitted and delivered as a display of information in the LCD screen of RC and serial monitor and sent to pre-identified key users in a timely manner. It is suitable in a large aquatic area. and it can measure and store information in a database in a real-time scenario. this is in order to provide a platform that allows fast information dissemination and quick formulation of an appropriate and immediate response. when timely report reaches the key user, for example, that user can immediately identify abrupt changes in the values of monitored water quality parameters, and thus can give them enough lead time for possible implementation of activities to minimize if not eradicate risks and damages. The system was designed to provide the data collection and storage, Power management for longer measurement periods and Maintenance interface for administrators etc.

- **Modules:**

Module 1: Sensors Testing & Study.

Module 2: Integration with Remote Control (RC) System.

Module 3: Manufacturing RC Boat & Remote Control.

3.2 SYSTEM ARCHITECTURE

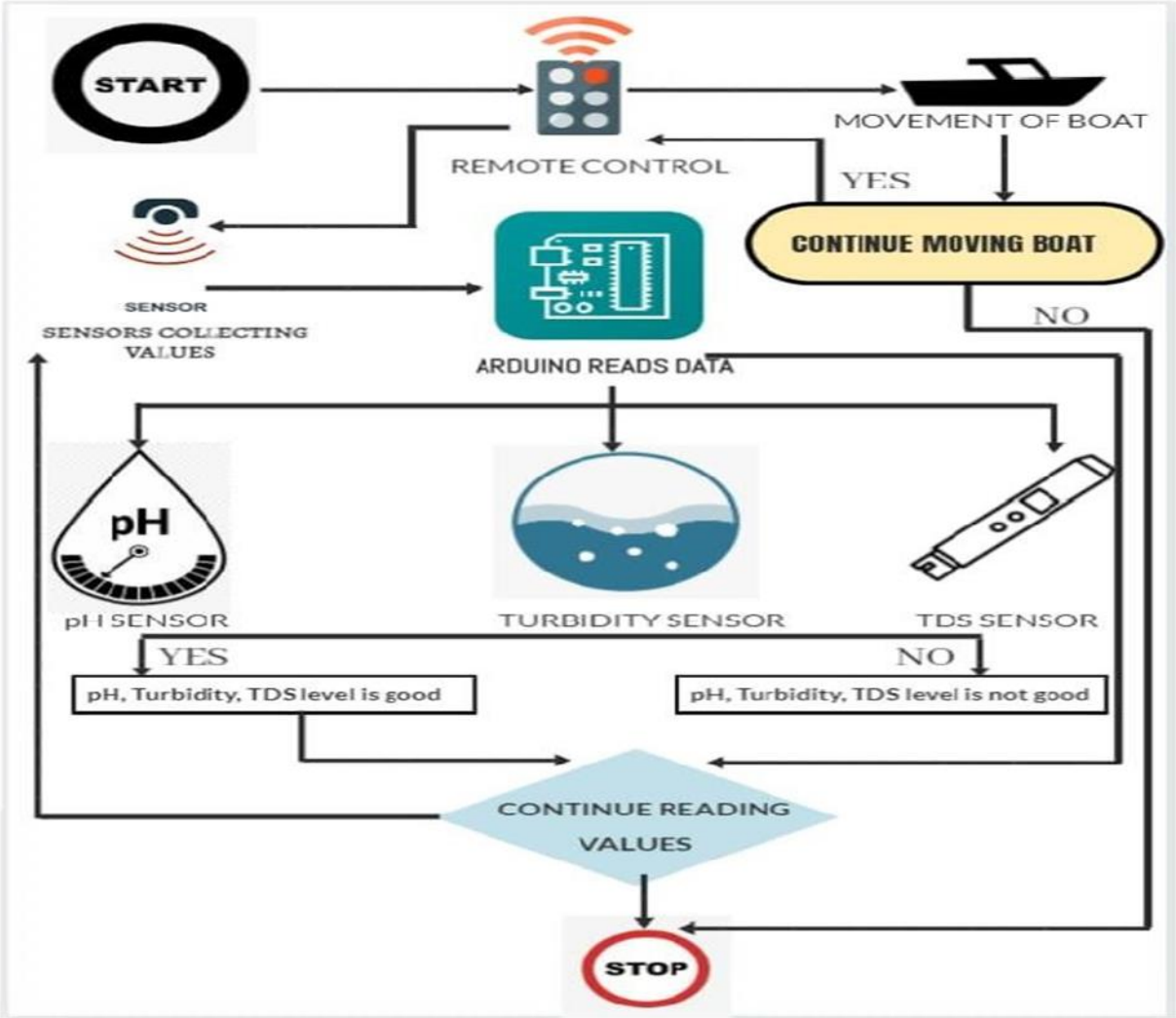

Fig. 3.1: System Architecture

The major focus of this system is real time monitoring of water quality. You will get overviewof system prototype above (Fig 3.1). The best thing of the system which make it different from other system is the overall system is operating through the Remote Control (RC). The most important function of the system is to ensure that the data collected from the sensor reflects the actual aquatic scenario and the data are transmitted and delivered as a display of information in the web and sent to pre- identified key users in a timely manner. Here the architecture provides the complete view of the system and its usage in the perfect manner.

3.3 SYSTEM FLOWCHART

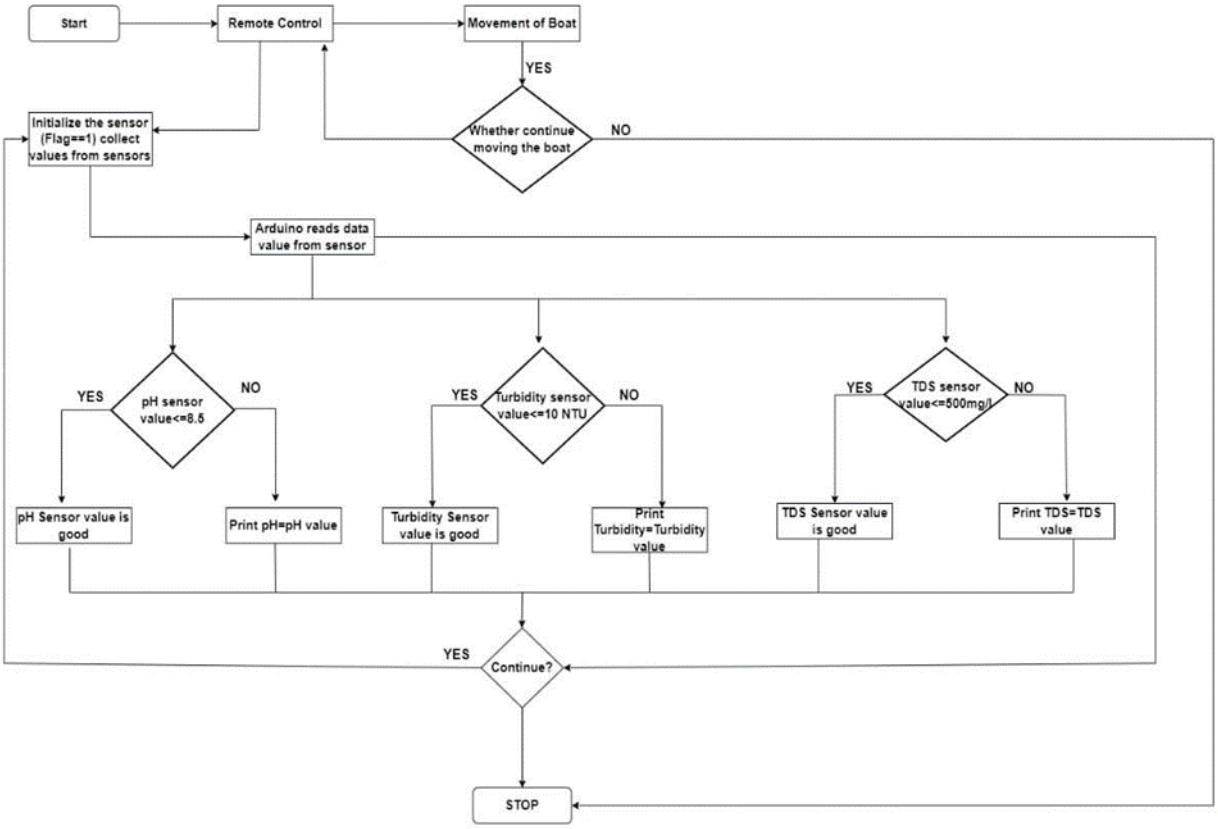

Fig. 3.2: Flowchart

Above we have shown the flow of our system. In this first Initialized a sensor with the help of Remote control, all the data will be collected from sensor and then send to Arduino. Arduino reads the data and get the data for checking water parameters (pH, Turbidity and TDS). If the data values are in standard range, then it displays pH, Turbidity and TDS level is good on LCD screen of RC. If the data values are not in standard level, then it displays the values of the pH, Turbidity and TDS sensors. And the same result is updated in the Serial monitor.

CHAPTER NO 4

TOOLS/PLATFORMS

CHAPTER 4

TOOLS/PLATFORM

4.1 SOFTWARE REQUIREMENT

1. **Operating System**: Windows 7 or Higher
2. **Training Environment**: Arduino IDE, GitHub
3. **Languages**: C, C++
4. **Designing Tool**: Draw.io, Star UML, Circuit-diagram.org/editor
5. **Libraries Used**: TinyGPSPlus.h, SoftwareSerial.h, LiquidCrystal.h, SPI.h, nRF24L01.h, RF24.h
6. **Testing Tool**: Arduino Serial Monitor

1. OPERATING SYSTEM:

Any Operating System (preferably windows 7 or higher) which is having architecture of 32-bitor higher is supported. We have used Windows 10 64- bit.

2. TRAINING/DEVELOPMENT ENVIRONMENT:

- **Arduino IDE:**

Arduino IDE is an open-source tool that makes it possible for users to write as well as uploadcode to a work environment in real-time. Since the written code will be moved to the cloud, it's frequently used by those who need an additional level of redundancy. Arduino IDE offers full compatibility to any Arduino-based software board. The software can easily be deployed in any Linux, Mac, or Windows operating systems. Most of its parts are written within JavaScript for seamless compilation and editing. While the tool's main aim is based on code writing, it offers several noteworthy functionalities. For instance, Arduino IDE lets users share important project information tocompany stakeholders. Users are given the freedom to make internal layouts and schematic modifications when needed.

- **GitHub:**

GitHub is a Git repository hosting service that provides a web-based graphical interface. It isthe world's largest coding community. Putting a code or a project into GitHub brings it increased, widespread exposure. Programmers can find source codes in many different languages and use the command-line interface, Git, to make and keep track of any changes.

Features:

- **Easy Project Management:** GitHub is a place where project managers and developers cometogether to coordinate, track, and update their work so that project share transparent and stay on schedule.
- **Increased Safety with Packages:** Packages can be published privately, within the team, or publicly to the open-source community. The packages can be used or reused by downloadingthem from GitHub.
- **Effective Team Management:** GitHub helps all the team members stay on the same page and organized. Moderation tools like Issue and Pull Request Locking help the team to focus on the code.
- **Improved Code Writing:** Pull requests help the organizations to review, develop, and propose new code. Team members can discuss any implementations and proposals through these before changing the source code.
- **Increased Code Safety:** GitHub uses dedicated tools to identify and analyze vulnerabilities to the code that other tools tend to miss. Development teams everywhere work together to secure the software supply chain, from start to finish.
- **Easy Code Hosting**: All the code and documentation are in one place. There are millions of repositories on GitHub, and each repository has its own tools to help you host and release code.

3. LANGUAGES:

- **C:**

C is a procedural programming language. It was initially developed by Dennis Ritchie in the year 1972. It was mainly developed as a system programming language to write an operating system. The main features of C language include low-level access to memory, a simple set of keywords, and a clean style, these features make C language suitable for system programming's like an operating system or compiler development. C# is intended to be suitable for writing applications for both hosted and embedded systems, ranging from the very large that use.

Features:

Procedural Language, Fast and Efficient**,** Modularity**,** Statically Type**,** General-Purpose Language**,** Rich set of built-in Operators**,** Libraries with rich Functions**,** Middle-Level Language**,** Portability**,** Easy to Extend.

- **C++**

C++ is a high-level object-oriented programming language that helps programmers write fast,portable programs. C++ provides rich library support in the form of Standard Template Library (STL).

Features:

- **Object-oriented**: C++ is an object-oriented programming language. This means that the focuseson "objects" and manipulations around these objects. Information about how these manipulations work is abstracted out from the consumer of the object.
- **Rich library support**: Through C++ Standard Template Library (STL) many functions are available that help in quickly writing code. For instance, there are standard libraries for various containers like sets, maps, hash tables, etc.
- **Speed:** C++ is the preferred choice when latency is a critical metric. The compilation, as wellas the execution time of a C++ program, is much faster than most other general purpose programming languages.

- **Compiled**: A C++ code has to be first compiled into low-level code and then executed, unlikeinterpreted programming languages where no compilation is needed.
- **Pointer Support**: C++ also supports pointers which are widely used in programming and areoften not available in several programming languages.

4. DESIGNING TOOLS:

- **Star UML**

Star UML is an open-source software modeling tool that supports the UML (Unified Modeling Language) framework for system and software modeling. It is based on UML version 1.4, provides eleven different types of diagrams and it accepts UML2.0 notation. It actively supports the MDA (Model Driven Architecture) approach by supporting the UML profile concept and allowing to generate code for multiple languages.

Features:

- Multiple platform support.
- Model-driven development.
- Drag & Drop Interface.
- Third Party Integration

- **Draw.io**

Draw.io is an open-source technology stack for building diagramming applications, and the world's most widely used browser-based end-user diagramming application.

- **Circuit-diagram.org/editor**

A free, user-friendly program for making electronic circuit diagrams.

4.2 HARDWARE REQUIREMENT

Hardware: NRF24L01, Arduino Mega, NEO-6M GPS, Turbidity Sensor with Module, Analog PH Sensor Kit, TDS Sensor kit, Arduino UNO R3 SMD Atmega328P Board

1. **NRF24L01**: The NRF24L01 module is the latest in RF modules. This module uses the 2.4GHz transceiver from Nordic Semiconductor, the NRF24L01+. This transceiver IC operates in the 2.4GHz band and has many new features. Take all the coolness of the 2.4GHz NRF24L01+PA+LNA SMA Wireless Transceiver Antenna and add some extra pipelines, buffers, and an auto-retransmit feature –very nice. This board features a reverse polarized SMA connector for maximum RF range. And there is PA and LNA circuit on board, with the external antenna it can reach long distance than the one without these parts. This module comeswith the 2.4G antenna (2DB), with 250Kbps transmission ration open air it can reach the 800-1K meters communication distance.

Features:

- It uses 2.4GHz global open ISM band, with license free.
- Transmit power is greater than +20 dBm.
- Support six-channel data reception.
- 2Mbit/s speed makes high-quality VoIP possible.
- Multi-frequency points: 125 frequency points meet the needs of multi-point communicationsand frequency hopping.
- Low cost: integrated with high-speed signal processing parts associated with RF protocol,such as: automatically re-send lost packets and generate acknowledge signal.
- SPI interface facilitates the communication with MCU I/O port.
- Facilitate the development for customers, without development RF part.
- Software programming is fully compatible with NRF24L01 modules.

Fig: NRF24L01 2.4GHz PA+LNA SMA Wireless Transceiver Module with Antenna

2. **Arduino Mega 2560 R3 Board - Clone Model:** The Arduino Mega 2560 R3 is an open-source precise microcontroller board Successor to the Arduino Mega based on the ATmega2560 SMD chip. The Mega 2560 R3 also adds SDA and SCL pins next to the AREF. In addition, there are two new pins placed near the RESET pin. One is the IOREF that allow the shields to adapt to the voltage provided from the board. The other is a not connected and is reserved for future purposes. The Mega 2560 R3 works with all existing shields but can adapt to new shields which use these additional pins. This Board has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

Fig: Arduino Mega 2560 R3 Board - Clone Model

3. **NEO-6M GPS Module:** This is a complete GPS module that is based on the NEO-6M. Thisunit uses the latest technology to give the best possible positioning information and includes a larger built-in 25 x 25 mm active GPS antenna with a UART TTL socket. A battery is also included so that you can obtain a GPS lock faster. This is an updated GPS module that can beused with ardupilot mega v2. This GPS module gives the best possible position information, allowing for better performance with your Ardupilot or other Multirotor control platform. The NEO-6M GPS engine on this board is a quite good one, with the high precision binary output.It has also high sensitivity for indoor applications. NEO-6M GPS Module has a battery for power backup and EEPROM for storing configuration settings. The antenna is connected to the module through a ufl cable which allows for flexibility in mounting the GPS such that theantenna will always see the sky for best performance. This makes it powerful to use with carsand other mobile applications. The GPS module has serial TTL output, it has four pins: TX, RX, VCC, and GND. You can download the u-center software for configuring the GPS and changing the settings and much more.

Features:

- 5Hz position update rate.
- Operating temperature range: -40 TO 85°CUART TTL socket.
- EEPROM to save configuration settings.
- Rechargeable battery for Backup.
- The cold start time of 38 s and Hot start time of 1 s.
- Supply voltage: 3.3 V.
- Configurable from 4800 Baud to 115200 Baud rates. (Default 9600).
- Super Sense ® Indoor GPS: -162 dBm tracking sensitivity.
- Support SBAS (WAAS, EGNOS, MSAS, GAGAN) Separated 18X18mm GPS antenna.

Fig: NEO-6M GPS Module

4. **Turbidity Sensor Module:** This is a Turbidity Sensor with Module, an electronic monitoring module specially developed to work with microcontroller platforms Arduino, Raspberry Pi, PIC, ARM, AVR, among others. It is very efficient, the Arduino Turbidity Sensor can detect and verify the quality of the water, making the turbidity measurement, where it is possible to verify the results by means of digital or analog signal next to the corresponding pins in the accompanying electronic module. The Turbidity Sensor emits at its end an infrared light, imperceptible to human vision, capable of detecting particles that are suspended in water, measuring the light transmittance and the dispersion rate, which changes according to the Amount of TSS (Total Suspended Solids), increasing the turbidity of the liquid whenever levels increase.

Features:

- Compatible with Arduino, Raspberry Pi, AVR, PIC, etc.
- Measures turbidity of water in rivers.
- Detects and verifies water quality.
- Digital and analog output.
- Able to detect particles that are suspended in water.
- Trim pot for sensitivity adjustment.
- Ideal monitoring of water turbidity in rivers, streams, lakes, water boxes, catchment andresearch sites, laboratories, tanks with liquids.

Fig: Turbidity Sensor Module

5. **pH Sensor Module:** This pH Sensor is a scientific instrument used to indicate whether a solution is acidic or alkaline in nature. The sensor kit can detect the pH levels between 0 and14pH. This pH sensor kit can be used in testing the nature of the soil and water quality.

Fig: pH Sensor Module

6. **TDS Sensor Kit:** TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids are dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids are dissolved in water, and the less clean the water is. Therefore, the TDS value can beused as one reference point for reflecting the cleanliness of water. A TDS pen is a widely used piece of equipment to measure TDS value. The price is affordable, and it is easy to use, however commonly it is not able to transmit data to a control system for online monitoring ofwater quality. In general, professional instruments have accuracy and can send data to the control system, but the price is high for the ordinary person. To this end, we have launched an analog TDS sensor kit which is compatible with Arduino, plug and play, and is easy to use Matching with Arduino controller, you can build a TDS detector easily to measure the TDS value of liquid without needing to purchase expensive equipment.

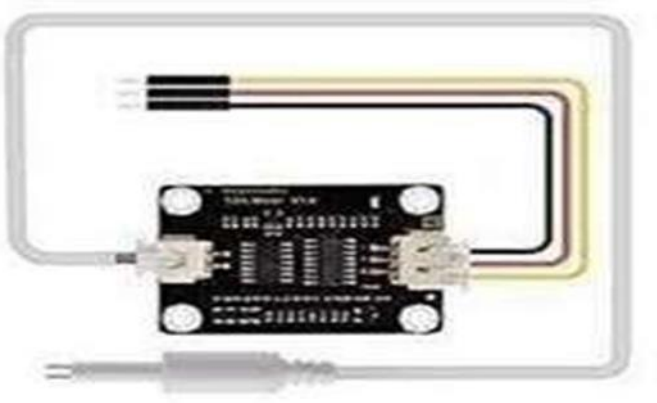

Fig: TDS Sensor Kit

7. **Arduino UNO R3 SMD Atmega328P Board:** Arduino UNO R3 SMD is the open-source Embedded Development board launched by Arduino based on Atmega328 SMD Package Microcontroller. Because Atmel is moving more and more of their production capacity to surface mount ICs, the DIP packaged ATmega is becoming more and more difficult to get. To keep up with demand, we now offer the Arduino Uno R3 with an SMD ATmega. The board is identical to the PTH version of the Uno, but you won't be able to remove the ATmega without some hot air. This change shouldn't affect most users.

Fig: Arduino UNO R3 SMD Atmega328P Board

CHAPTER NO 5

DESIGN & IMPLEMENTATION

CHAPTER 5

DESIGN & IMPLEMENTATION

5.1 SYSTEM DESIGN

5.1.1. USE-CASE DIAGRAM

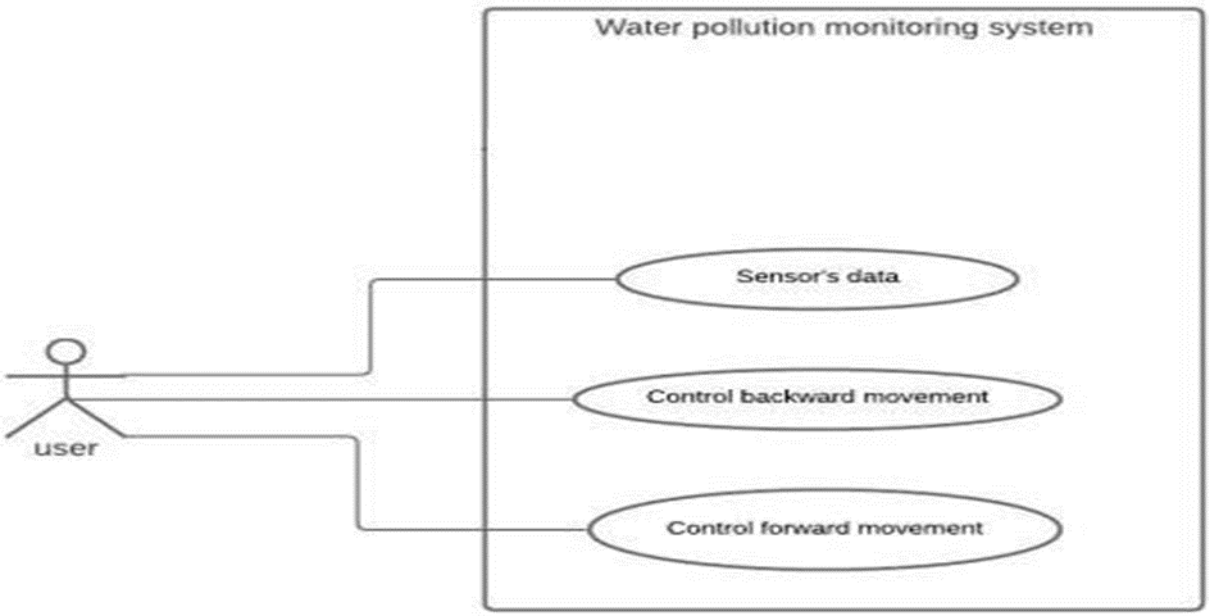

Fig. - 5.1.1: Use-Case Diagram

The above diagram represents the use case which shows graphical representation of user's interaction with the system. This consists of user as an actor. User has access to all the modules. The system comprises of TDS sensor, turbidity sensor, pH sensor and microcontroller. This data is displayon LCD screen.

5.1.2CIRCUIT DIAGRAM

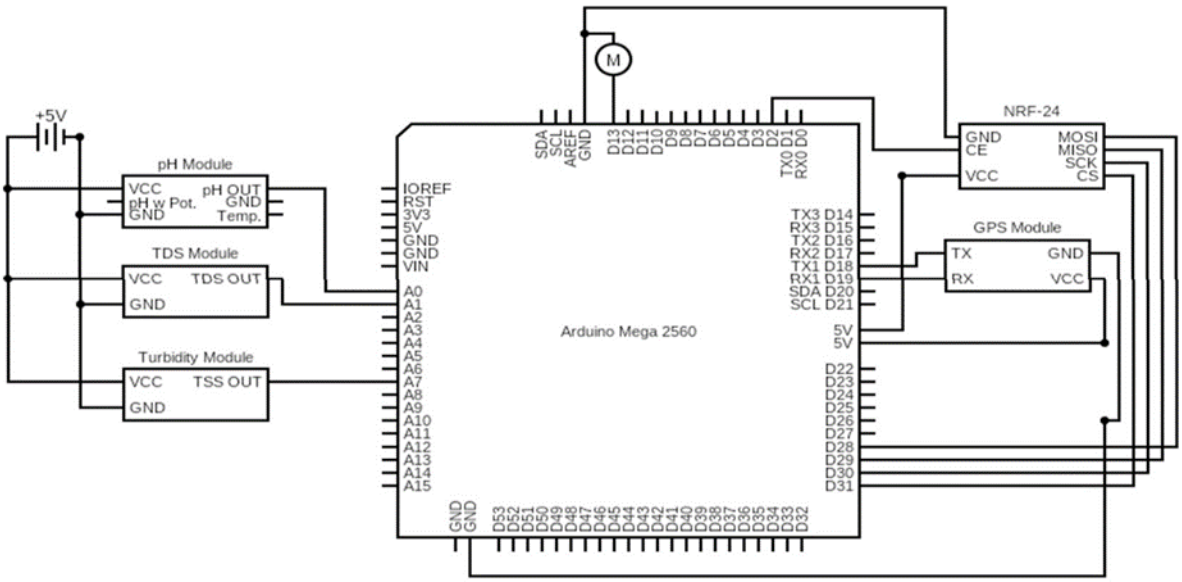

Fig. - 5.1.2: RC-Boat Circuit Diagram

This is the Circuit diagram for RC-Boat, the whole design of the system is based mainly on Arduino. There is basically two parts included, the first one is software and second one is hardware. The hardware part has sensors i.e., pH module, TDS module and turbidity module which help to measure the real time values, another one is Arduino Mega 2560, The Arduino Mega 2560 is a microcontroller board based on the AT mega 2560. Next is the NRF-24L01 module. It is basically a wireless transceiver, which is used to send and receive data by using radio waves. GPS Module is used to capture the geographical location.

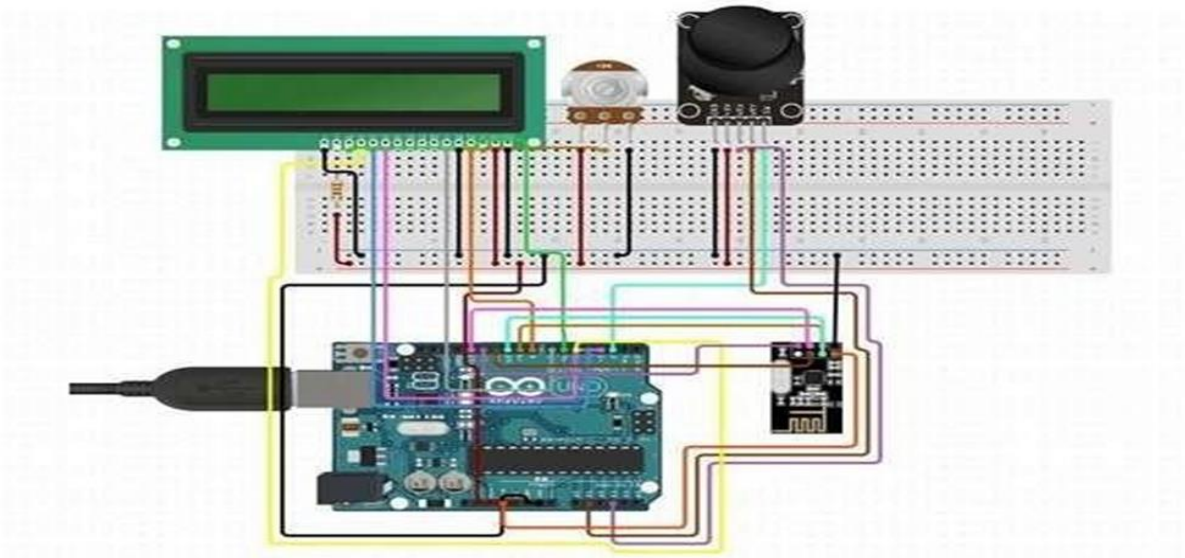

Fig: -5.1.3: Remote control device Diagram

The above diagram is for Remote control device, here we used Arduino atmega328 converts the analog values to digital one and LCD shows the displays output from sensors. LCD Screen is an electronic display module. A 16*2 means it can display16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5*7-pixel matrix. This is used to display Result of water quality**.** Potentiometer is used to adjust the brightness of LCD screen. A potentiometer is a simple knob that provides a variable resistance, which we can read into the Arduino board as an analog value.

5.1.3 SEQUENCE DIAGRAM

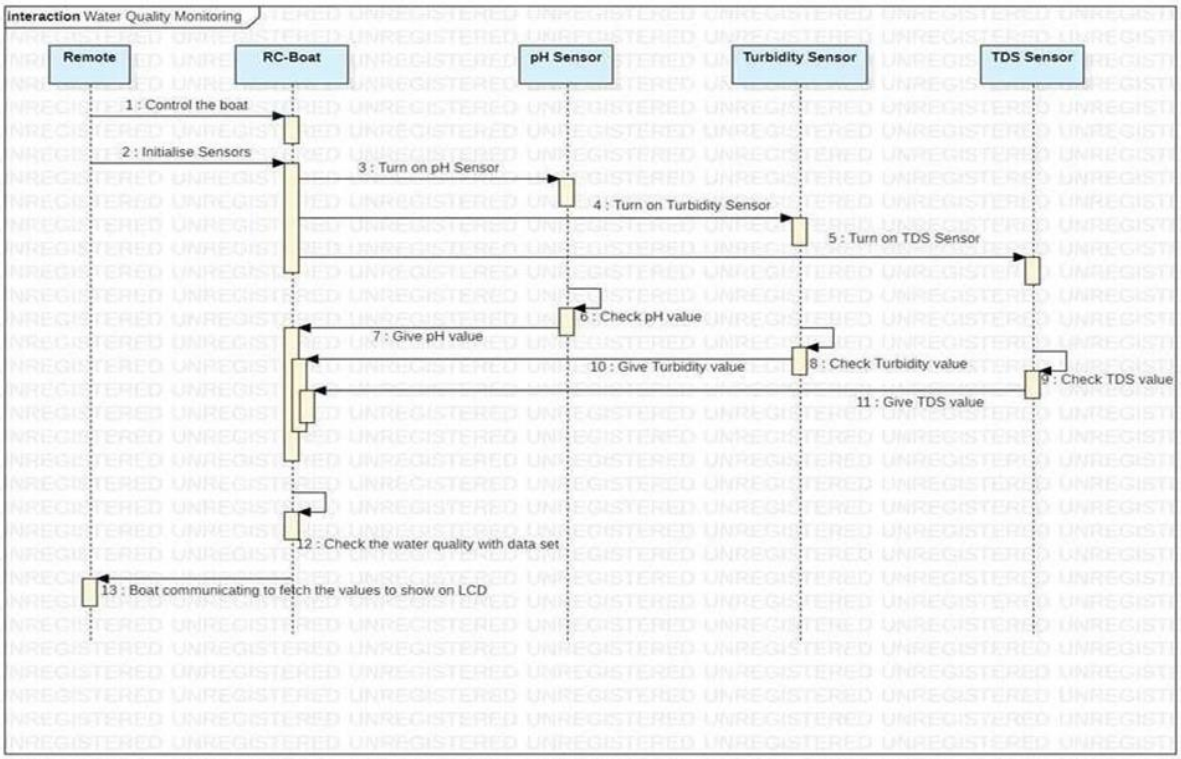

Fig. - 5.1.4: Sequence Diagram

The above represent the sequence diagram which shows the interaction between different Objects how and in what order they are working. Sequence diagrams help us validate and visualize several system events for predicting and analyzing how the system will behave. when the user starts the sensors with the help of Remote Control, sensors will begin to collect the values, then the Arduino reads these collected values of the sensors i.e. (pH, TDS, and Turbidity). then values are compared with the standard readings. If the values differed, then the system will be communicating with Remote control to fetch the data result display on LCD screen. And, data values stored in a file. If values are not differed then it displays the water quality i.e., pH, TDS and Turbidity level is good. And same result also shows on serial monitor of Arduino.

5.2 IMPLEMENTED MODULES

- **Module 1: Sensors Testing & Study.**

  We have used different sensors like pH, TDS, Turbidity.

  pH sensor which is a very important indicator of water quality.

TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids are dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids are dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one reference point for reflecting the cleanliness of water.

Turbidity sensors measure the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's turbidity level (and cloudiness or haziness) increases.

- **Module 2: Integration with Remote Control (RC) System.**

  Integration of Module 1 with NEO-6M GPS Module.

In this the GPS receivers use the information and tri lateration to calculate a user's exact location. Essentially, the GPS receiver measures the distance and the amount of time it takes to receive a transmitted signal. To calculate your latitude and longitude, a GPS receiver must be locked on to a signal. Generally, a GPS receiver will track, but that depends on the time of day.

- **Module 3: Manufacturing RC Boat & Remote Control.**

  Integration of Module 1 and 2 and sending all the data to Receiver Module.

In this the transmitter is sending message to the receiver. Those messages are being displayedin receiver's serial monitor and LCD screen. It works very well when the receiver and transmitter are close to each other. If you separate the too far apart, you may lose the communication.

5.3 SAMPLE CODE

```
int sensorPin = A3;     // Turbidity


float calibration = 25.20;         //change this value to calibrate const int analogInPin =
A1;      // pH
int sensorValue = 0; unsigned long int avgValue; float b;
int buf[10],temp;


#define TdsSensorPin A0       // TDS
#define VREF 5.0       // analog reference voltage(Volt) of the ADC #define SCOUNT
30 // sum of sample point
int analogBuffer[SCOUNT]; // store the analog value in the array, read from ADC int
analogBufferTemp[SCOUNT];
int analogBufferIndex = 0,copyIndex = 0;
float averageVoltage = 0,tdsValue = 0,temperature = 25;
int getMedianNum(int bArray[], int iFilterLen)         //Special Function for TDS
{
int bTab[iFilterLen];
for (byte i = 0; i<iFilterLen; i++) bTab[i] = bArray[i];
int i, j, bTemp;
for (j = 0; j < iFilterLen - 1; j++)
{
for (i = 0; i < iFilterLen - j - 1; i++)
{
if (bTab[i] > bTab[i + 1])
{
bTemp = bTab[i];
bTab[i] = bTab[i + 1];
 bTab[i + 1] = bTemp;
```

```
}
                    }
                    }
                    if ((iFilterLen & 1) > 0)
                    bTemp =
                    bTab[(iFilterLen
                    - 1) / 2];else
                    bTemp = (bTab[iFilterLen / 2] +
                    bTab[iFilterLen / 2 - 1]) / 2;return bTemp;
          }

          void setup()
          {
          // put your setup code here, to run once:
          Serial.begin(9600);
          pinMode(TdsSensorPi
          n,INPUT); // TDS

          }

          void loop() {
          // put your main code here, to run repeatedly:

          int sensorValue = analogRead(sensorPin);
          // Serial.println(sensorValue);
          int turbidity =
          map(sensorValue, 0, 640, 100,
          0);Serial.print("Turbidity
          Value : ");
          Serial.println(turbidity);
          delay(100);
          ////////////////////////////////////////////////////////////////////////////////////////////////////
          ///////////////
```

```
for(int i=0;i<10;i++)
{
buf[i]=analogRead(analogInPin); delay(30);
}
for(int i=0;i<9;i++)
{
for(int j=i+1;j<10;j++)
{
if(buf[i]>buf[j])
{
temp=buf[i]; buf[i]=buf[j]; buf[j]=temp;
}
}
}
avgValue=0; for(int i=2;i<8;i++) avgValue+=buf[i];
float pHVol=(float)avgValue*5.0/1024/6;
float phValue = -5.70 * pHVol + calibration;
Serial.print("pH Value = "); Serial.println(phValue);
delay(500);
////////////////////////////////////////////////////////////////////////////////////////////////////
///////////////


static unsigned long analogSampleTimepoint = millis();
 if(millis()-analogSampleTimepoint > 40U)
//every 40 milliseconds,read the analog value from the ADC
{
analogSampleTimepoint = millis();
analogBuffer[analogBufferIndex] = analogRead(TdsSensorPin);
//read the analog value and store into the buffer analogBufferIndex++;
if(analogBufferIndex == SCOUNT) analogBufferIndex = 0;
```

```
}
static unsigned long printTimepoint = millis(); if(millis()-printTimepoint >
800U)
{
printTimepoint = millis();
for(copyIndex=0;copyIndex<SCOUNT;copyIndex++)
analogBufferTemp[copyIndex]= analogBuffer[copyIndex];
averageVoltage = getMedianNum(analogBufferTemp,SCOUNT) *
(float)VREF / 1024.0;
// read the analog value more stable by the median filtering algorithm, and
convert to voltage value
float compensationCoefficient=1.0+0.02*(temperature-25.0);
//temperature compensation formula: fFinalResult(25^C) =
fFinalResult(current)/(1.0+0.02*(fTP-25.0));
float compensationVolatge=averageVoltage/compensationCoefficient;
//temperature compensation
tdsValue=(133.42*compensationVolatge*compensationVolatge*compensa
tio
nVolatge - 255.86*compensationVolatge*compensationVolatge +
857.39*compensationVolatge)*0.5;
//convert voltage value to tds value
//Serial.print("voltage:"); L;kjl;//Serial.print(averageVoltage,2);
//Serial.print("V "); Serial.print("TDS Value:"); Serial.print(tdsValue,0);
Serial.println("ppm");
}
////////////////////////////////////////////////////////////////////////////////////////////////////
////////// delay(5000);
}
```

CHAPTER NO 6

TESTING, RESULTS & DISCUSSION

CHAPTER 6

RESULTS & DISCUSSION

6.1 TESTING

6.1.1 TYPES OF TESTING

Manual Testing

Manual testing includes testing a software manually, i.e., without using any automated tool or any script. In this type, the tester takes over the role of an end-user and tests the software to identify any unexpected behavior or bug. There are different stages for manual testing such as unit testing, integration testing, system testing, and user acceptance.

Testers use test plans, test cases, or test scenarios to test a software to ensure the completeness of testing. Manual testing also includes exploratory testing, as testers explore the software to identify errors in it.

Following are the testing techniques that are performed manually during the test life cycle:

- Acceptance Testing
- White Box Testing
- Black Box Testing
- Unit Testing
- System Testing
- Integration Testing

6.1.2 LEVELS OF TESTING

There are four levels of testing: Unit, Integration, System and Acceptance.

1. **Unit Testing:** A level of the software testing process where individual units/components ofa software/system are tested. The purpose is to validate that each unit of the software performsas designed.

2. **Integration Testing**: A level of the software testing process where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units.

3. **System Testing:** A level of the software testing process where a complete, integrated system/software is tested. The purpose of this test is to evaluate the system's compliance withthe specified requirements.

4. **Acceptance Testing**: A level of the software testing process where a system is tested for acceptability. The purpose of this test is to evaluate the system's compliance with the business requirements and assess whether it is acceptable for delivery.

6.1.3 TESTING REPORT

Project:	Development of Water Pollution Monitoring System					
Module:	1					
Prepared By:	Mr. Himanshu Saha					
	Ms. Namrata Thakre					
	Ms. Natasha Ramtekkar					
	Ms. Shweta Lanjewar					
	Ms. Vijayalaxmi Yelchalwar					
Sr. No.	**TEST CASE ID**	**TEST OBJECTIVE**	**STEPS**	**EXPECTED RESULT**	**ACTUAL RESULT**	**STATUS**
1	TC_PH_SENSOR_MODULE-1	To check & sensor Calibarations	1. Make Proper connections 2. Observe the Test Values 3. Calculate Calibration	To get Min. & Max. Values	Min. Value = 0 Max. Value = 640	Pass
2	TC_TDS_SENSOR_MODULE-1	To check & sensor Calibarations	1. Make Proper connections 2. Observe the Test Values 3. Calculate Calibration	Range: 0 ~ 1000ppm	150 ppm	Pass
3	TC_TSS_SENSOR_MODULE-1	To check & sensor Calibarations	1. Make Proper connections 2. Observe the Test Values 3. Calculate Calibration	To get the Lag Value	Lag Value: -11.2	Pass
4	TC-1_PH_SENSOR_MODULE-1	Observe Values in clean Water	1. Make Proper connections 2. Observe the Test Values	Range: 5 ~ 13	11.5	Pass
5	TC-1_TDS_SENSOR_MODULE-1	Observe Values in clean Water	1. Make Proper connections 2. Observe the Test Values	Below 250ppm	0ppm	Pass
6	TC-1_TSS_SENSOR_MODULE-1	Observe Values in clean Water	1. Make Proper connections 2. Observe the Test Values	Range: 0 ~ 100	58	Pass
7	TC-2_PH_SENSOR_MODULE-1	Observe Values in Contiminated Water	1. Make Proper connections 2. Observe the Test Values	Range: 7 ~ 14	13.43	Pass
8	TC-2_TDS_SENSOR_MODULE-1	Observe Values in Contiminated Water	1. Make Proper connections 2. Observe the Test Values	Range: 250 ~ 500	357ppm	Pass
9	TC-2_TSS_SENSOR_MODULE-1	Observe Values in Contiminated Water	1. Make Proper connections 2. Observe the Test Values	Range: 0 ~ 100	32	Pass

Project:	Development of Water Pollution Monitoring System					
Module:	2					
Prepared By:	Mr. Himanshu Saha					
	Ms. Namrata Thakre					
	Ms. Natasha Ramtekkar					
	Ms. Shweta Lanjewar					
	Ms. Vijayalaxmi Yelchalwar					
Sr. No.	**TEST CASE ID**	**TEST OBJECTIVE**	**STEPS**	**EXPECTED RESULT**	**ACTUAL RESULT**	**STATUS**
10	TC_GPS_SENSOR_MODULE-2	Observe the values of GPS Sensor	1. Make Proper connections 2. Observe the Test Values	Lat. : 21.195206 Long. : 79.070205	Lat. : 21.195206 Long. : 79.070205	Pass
11	TC_TRAN_SENSOR_MODULE-2	To check if transmitter working properly	1. Make Proper connections 2. Observe the Test Values	Sent: Hello World	Sent: Hello World	Pass

Project:	Development of Water Pollution Monitoring System					
Module:	3					
Prepared By:	Mr. Himanshu Saha					
	Ms. Namrata Thakre					
	Ms. Natasha Ramtekkar					
	Ms. Shweta Lanjewar					
	Ms. Vijayalaxmi Yelchalwar					
Sr. No.	**TEST CASE ID**	**TEST OBJECTIVE**	**STEPS**	**EXPECTED RESULT**	**ACTUAL RESULT**	**STATUS**
12	TC_RECV_SENSOR_MODULE-3	To check if reciver working properly	1. Make Proper connections 2. Observe the Test Values	Recived: Hello World	Recived: Hello World	Pass
13	TC_INTEGRATION_MODULE-3	To check the final working of the system	1. Make Proper connections 2. Observe the Test Values	Sent: S 10,H 7.2,T 53 La:21.19Lo:79.07	Recived: S 10,H 7.2,T 53 La:21.19Lo:79.07	Pass

6.2 RESULTS AND DISCUSSIONS

Fig 6.1.1: -Circuit

The above snapshot shows that integrated circuit of module 1

Fig 6.1.2: - Circuit with impurities

Fig 6.1.3: -Circuit without impurities

The above snapshot is the result of water quality testing. In the First diagram, we have checkedthe sample of contaminated water, and in second snapshot we have checked normal water. From this we have get the result is that, in normal water the values of the sensors are in normal range, that means no impurities present in water and in contaminated water some impurities are present.

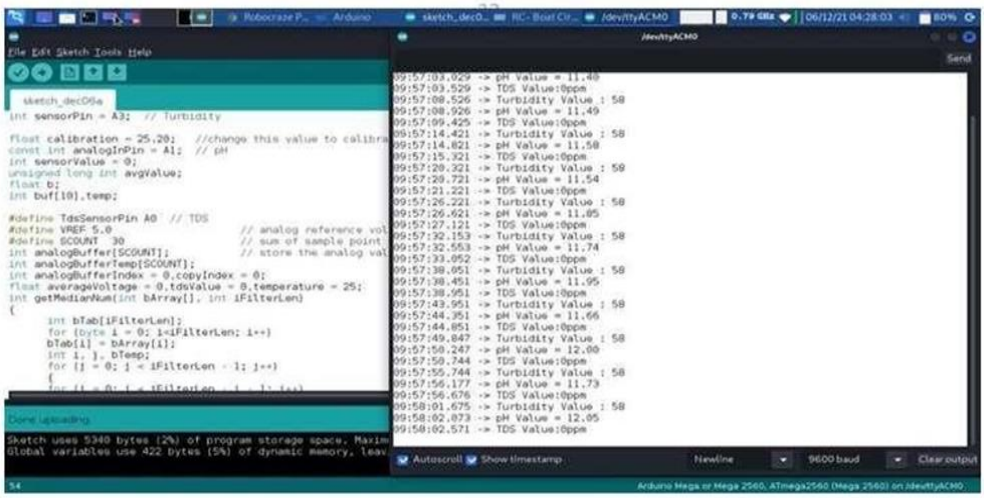

Fig 6.1.4: -Arduino Serial Monitor values without impurities

The above snapshot is shows that normal water parameter values on Serial Monitor. The result of normal water parameters i.e., pH, TDS and Turbidity sensors values is display on Serial Monitor. With the help of above result we can analyze that all the values of sensors are in standard level that means water is pure, no Impurities are present in water.

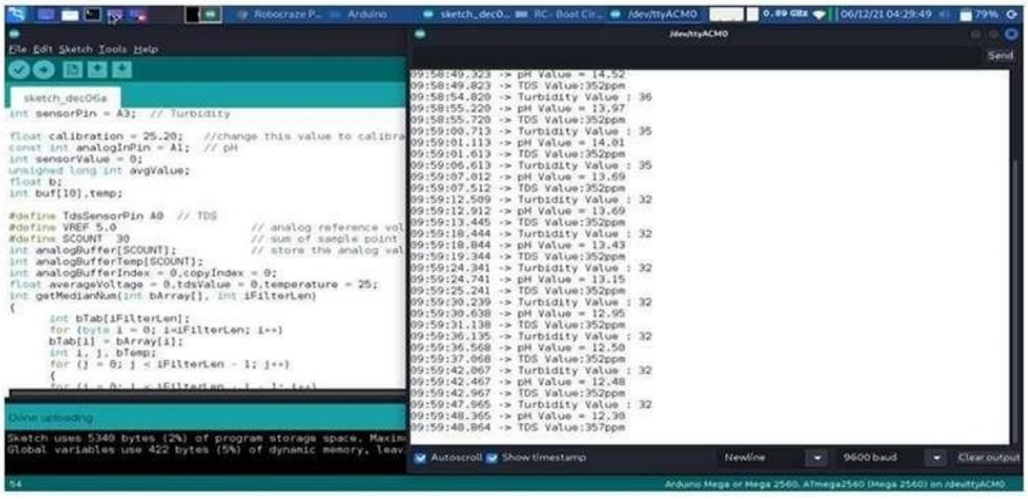

Fig 6.1.5: -Arduino Serial Monitor values with impurities

The above snapshot of Serial monitor is shows that the result of contaminated water. In contaminated water the values of water parameters i.e., pH, TDS and Turbidity sensors is display on Serial Monitor. With the help of above result we can analyze that the sensors values are not in standard range, that means water is impure and some quantities of Impurities are present in water.

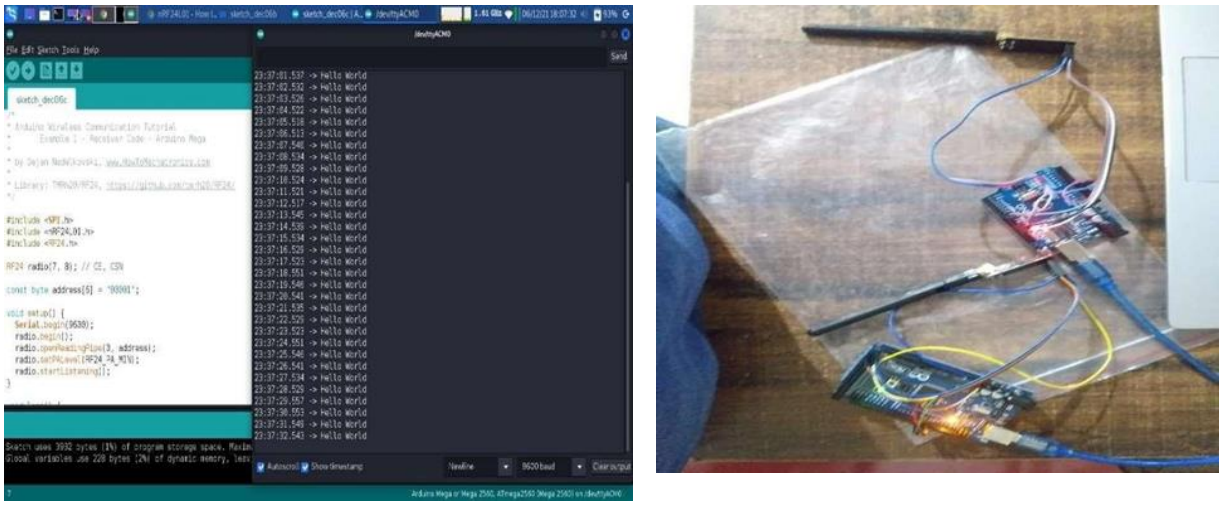

Fig 6.1.6: - Arduino serial Monitor (Transmitter and Receiver Module)

The above snapshot of Serial monitor shows the working/testing of Transmitter and Receiver Module.

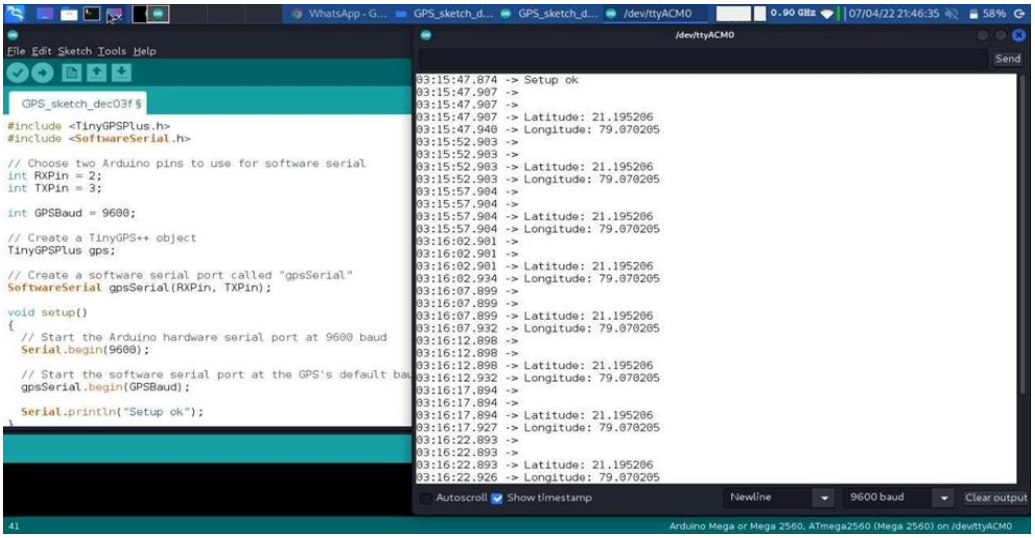

Fig 6.1.7: - Arduino serial Monitor (GPS Module)

The above snapshot of Serial monitor shows the values of latitude and longitude from GPSModule.

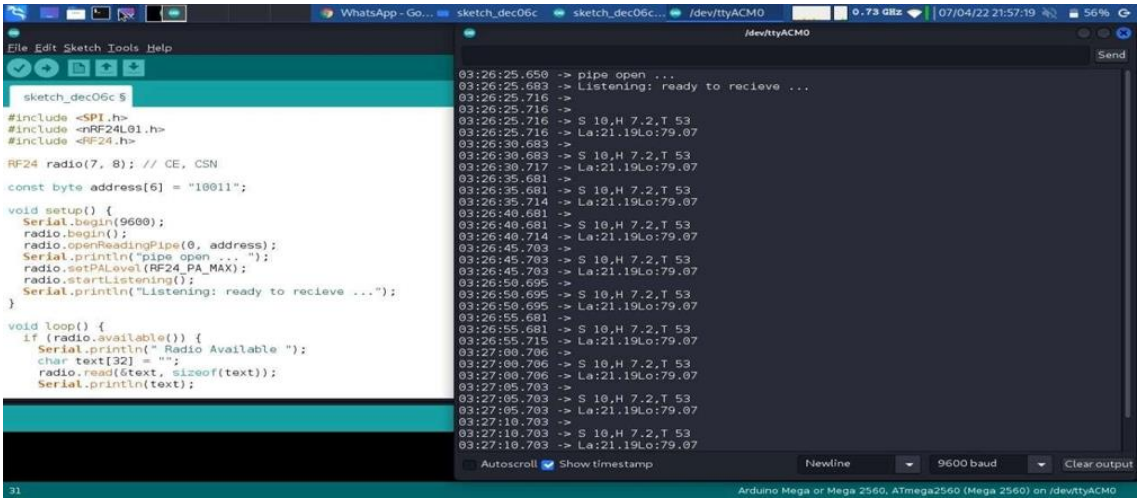

Fig 6.1.8: - Arduino serial Monitor (Receiver Module)

The above snapshot of Serial monitor shows the Receiver Module, receiving values of TDS,pH and Turbidity along with the GPS Module.

CHAPTER NO 7

ADVANTAGES AND APPLICATIONS

CHAPTER 7

ADVANTAGES AND APPLICATIONS

7.1 ADVANTAGES

1. Ease and convenience of usage:

- Modern smart water monitoring systems analyses data continually and instantly alert users to changes in the system, giving peace of mind and reducing the need for unreliable and expensive sampling.
- Smart systems are also designed to be easy-to-use, allowing easy access of all the data in oneplace, accessible via any internet enabled device.

2. Instantaneous data:

- Without a smart water monitoring system, sampling is the main way for water quality checksthat take place.
- The problem with sampling is that results can take weeks to come back, by which timeconditions may have changed.
- Using real-time monitoring, instant data allows pre-cursors to potential issues (such ascorrosion) to be flagged up and immediately be addressed before major issues occur.
- The ability to make real-time decisions during critical moments can be vital in preventingexpensive repairs and breakdown.

3. Improved accuracy of measurements:

- If sampling is the sole way that water quality is checked, there is unfortunately always the prospect of human error.
- Results are open to interpretation and represent a snapshot in time, rather than a full picture of several days or weeks.
- With advanced water monitoring technology, highly accurate measurements allow building managers, FMs and maintenance teams to detect and gather more data, including dissolved oxygen – a pre-cursor to all types of corrosion.

4. Cost saving:

- Water network operators can use pressure monitoring to find leaks in pipes and avoidamins break.
- Pressure monitoring can also be used to ensure that only the minimum pressurizationissued in the delivery network.
- Reducing unnecessary pump station operation through pressure optimization can reduceenergy and save money.
- IoT-based remote monitoring solutions are also substantially cheaper to acquire thantheir predecessors.
- Legacy monitoring cabinets cost upward of $30,000 per unit. Modern, IoT-based solutionscan be purchased for a fraction of that.

7.2 APPLICATIONS

1. It can used to survey the pollution levels of Large Water bodies.
2. It can be used to enumerate the water pollution levels near the industrial area as an alert system for high pollution levels.

CHAPTER NO 8

CONCLUSION & FURTHER SCOPE

CHAPTER 8

CONCLUSION

8.1 CONCLUSION

We have **designed** a water pollution monitoring system and completed its development. The current manual method for monitoring of the water quality is Money, Time consuming and labor intensive. We have identified and applied **engineering knowledge** to **analyze** the **societal problem** of water pollution. We have investigated the available application to find out the new solutions and updates. As there are various resources available but still no progress. So, we have used **modern tools** to implement our project. So, we have identified water quality factors such as (pH, Turbidity and TDS). This system provides real time monitoring of water quality. We have used hardware is NRF24L01, Arduino Mega, NEO-6M GPS, Turbidity Sensor with Module, Analog PH Sensor Kit & TDS Sensor kit. During this Project tenure we have applied **professional ethics** and understood the importance of **teamwork** and **communication** while **project development and management.** This solution can be developed at generalized level for multiple sectors for **life-long learning**.

8.2 FURTHER SCOPE

1. This system can be deployed for large water bodies.
2. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural pollution and so on.
3. More parameters of water and environment can also be tested by connecting multiple sub-system to this system.

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APPENDIX I

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN SCIENCE, COMMUNICATION AND TECHNOLOGY

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Survey Paper on Development of Water Pollution Monitoring System

IN IJARSCT, VOLUME 2, ISSUE 1, JANUARY 2022

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APPENDIX II

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Survey Paper on Development of Water Pollution Monitoring System

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Abstract: *Water pollution is one of the biggest threats to our surroundings. To supply good quality of water it is important to monitor the quality of water. So, we are designing a cheap and time consuming water pollution monitoring system. The system comprises of different sensors which is used to measure the physical and chemical parameters of the water. The parameters such as temperature, pH, turbidity, TDS sensor of the water can be measured. The measured values from the sensors are provided to Arduino, it reads the data and provide the results. Finally, the sensor data gets appended in the file and can also be viewed on Arduino serial monitor.*

Keywords: pH Sensor, Turbidity Sensor, TDS Sensor, Arduino Model

I. INTRODUCTION

Quality of drinking water plays a vital role in the health of animals and human beings. Rivers, lakes, ponds are major sources available for drinking water. Irrigation, fishery and energy production organizations are highly relied on water quality. Therefore, the quality of water of rivers and lakes ought to be kept at a certain level. But still, many of the people don't get plenty and clean drinking water and also the fact that government's responsibility to guarantee that clean water is conveyed to its citizens. Hence it is necessary to monitor the quality of water which will be utilized for consumption. Monitoring is characterized as the collection of data at set locations and at standard interims in order to provide the information which may be used to direct the current conditions, build-up trends, etc.

Water quality is affected by both point and non- point sources of pollution, which include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Other sources of water contamination include floods and droughts and due to lack of awareness and education among users. The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment sanitation, storage and disposal are critical elements to maintain the quality of water resources.

Conventional water quality checking methods include sampling and laboratory techniques. These strategies are however not cost effective and time consuming which eventually leads to delayed in detection of impurities and reaction to those contaminants in water. So, there should be more efficient and productive checking strategies to monitor the quality of water.

So, we have designed a solution for easy water quality checking of water bodies with ease. We will design Remote Control (RC) boat which will help to measure the pH level and turbidity level. This will further help us to maintain the water clean. This project is remote-operated and controlled by an RC remote. Thus, this will help to maintain the water quality.

1.1 Goals or Objectives

- To study, water quality and importance of water quality monitoring.
- To develop a system with Ease and convenience of usage.
- To improve data collection system in survey of water quality for large water bodies.

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II. Literature Survey

2.1 Research Papers

Wong Jung et al., 2021 -Water is a quintessential element for the survival of mankind. Its variety of uses means that it is always in a constant state of demand. The supply of water most primarily comes from large reservoirs of water such as lakes, streams, and the ocean itself. As such, it is good practice to monitor its quality to ensure it is fit for human consumption. Current water quality monitoring is often carried out in traditional labs but is time consuming and prone to inaccuracies. Therefore, this paper aims to investigate the feasibility of implementing an Arduino- based sensor system for water quality monitoring. A simple prototype consisting of a micro-controller and multiple attached sensors was employed to conduct weekly onsite tests at multiple daily intervals. It was found that the system works reliably but is reliant on human assistance and prone to data inaccuracies. The system however, provides a solid foundation for future expansion works of the same category to elevate the system to being Internet of Things (IoT) friendly.[1]

S.Geeta et al., 2017 - Smart solutions for water quality monitoring are gaining importance with advancement in communication technology. This paper presents a detailed overview of recent works carried out in the field of smart water quality monitoring. Also, a power efficient, simpler solution for in-pipe water quality monitoring based on Internet of Things technology is presented. The model developed is used for testing water samples and the data uploaded over the Internet are analyzed. The system also provides an alert to a remote user, when there is a deviation of water quality parameters from the predefined set of standard values.[2]

Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.[3]

Omar Faruq et al., 2017 - A water quality monitoring system based on micro-controllers for people living in Bangladesh's outskirts, where safe drinking water is not available, is provided in this paper. The device has been designed with a high degree of accuracy and is sensitive to several water parameters such as temperature, turbidity and hydrogen potential. (pH) displayed on the LCD monitor. Finally, in this paper, each of the parameter values is compared with the predefined equipment, and sensor values and error are calculated.[4]

NPS pollution encompasses a wide range of sources that are not subject to Federal or often state Regulation. The scope of the problem expands as a result of Population growth and land use changes. Even as waters are restored, others are Identified as impaired as a result of development pressures and other factors such as recent assessment of existing water quality problems. The vast extent and continuous nature of NPS pollution is a daunting challenge. That requires problems be addressed through a variety of approaches using Multiple funding sources. Although not the entire remedy, §319 funding is an Essential part of the solution to the costly challenges of NPS pollution—it is A critical source of support for NPS management programs and for watershed Projects. State NPS programs typically leverage other programs and funding Sources to achieve water quality improvements. This report highlights some of the many accomplishments of the NPS Program and describes how the program has evolved and is addressing a variety of water quality problems around the country. In the years to come, NPS practitioners at the federal, state, tribal and local levels will continue to work hard together to ensure clean, safe water is available for people, plants and animals—not an easy task by any means. It will take hard work and time to accomplish all that needs to be done.[5]

2.2 Websites

This article talks about water pollution in Brunei. High levels of water pollution in the Brunei River have been traced to wastewater treatment plants, industrial discharge, and polluted streams. Point and non-point pollution sources – including residential, industrial and agricultural outlets – are currently the main sources of pollution in Brunei River. The country is considering taking steps to address the water problem, including introducing legislation to improve watershed protection and manage pollution. The country has built reservoirs and dams to help prevent seawater intrusion and manage its river flow, utilized hydro-logical data network with technological advances, secured

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international cooperation from countries like Singapore and improved water quality monitoring. Furthermore, the country has had initial success in adapting to the threats of climate change. [6]

This explains about turbidity and water in detail. Turbidity makes water cloudy or opaque. High concentration of particulate matter affects light penetration and ecological productivity, recreational values, and habitat quality, and cause lakes to fill in faster. In streams, increased sedimentation can occur, which can result in harm to habitat areas for fish and other aquatic life. Particles also provide attachment places for other pollutants, notably metals and bacteria. For this reason, turbidity readings can be used as an indicator of potential pollution in a water body. Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent health concern. Turbidity can provide food and shelter for pathogens.[7]

This article explains about water pollution in detail. Categorist of water pollution such as groundwater, surface water, ocean water, point water etc. Used water is wastewater. It comes from us sinks, showers, and toilets (think sewage) and from commercial, industrial, and agricultural activities (Think metals, solvents, and toxic sludge). Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment. It's generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and medicine.[8]

This paper consists of topic like balanced electro absorption modulated RF photonic link. Graphene and MWCNT thick films: preparation and RF electrical properties study. A broadband outlook on flexible and textile RF energy harvesting and wireless power transfer: from near-field to 5G. Designs and Simulations of Millimeter Wave On-chip Single Turn Inductors for 0.13 µm RF CMOS Process Technology. Harmony: Saving Concurrent Transmissions from Harsh RF Interference. DSP-based RF waveform aggregation for next generation mobile front-hauling.[9]

III. Proposed Work

3.1 Flow of the System

The system is designed and implemented with its main goal of monitoring water quality (pH, Turbidity, and TDS) with the consideration that the system:

1. It is suitable in a large aquatic area/ Water Bodies.
2. It can measure and store information in a real-time scenario.
3. It can be remote-operated to move it to a certain place from where it can collect relevant data.

The most important function of the system is to ensure that the data collected from the sensor reflects the actual aquatic/Water Quality scenario and the data are transmitted and delivered as a display of information to the User on Remote Control [Fig. 3]. This is in order to provide a platform that allows fast information dissemination and quick formulation of an appropriate and immediate response. When timely report reaches the key user, for example, that user can immediately identify abrupt changes in the values of monitored water quality parameters, and thus can give them enough lead time for possible implementation of activities to minimize if not eradicate risks and damages. Therefore, the system was designed to provide the following:

1. Data collection and storage.
2. A RC system which will move on the water surface to collect relevant data.
3. Control interface for administrators. The overview of the system is depicted in Fig. 1, Fig. 2 and Fig. 3.

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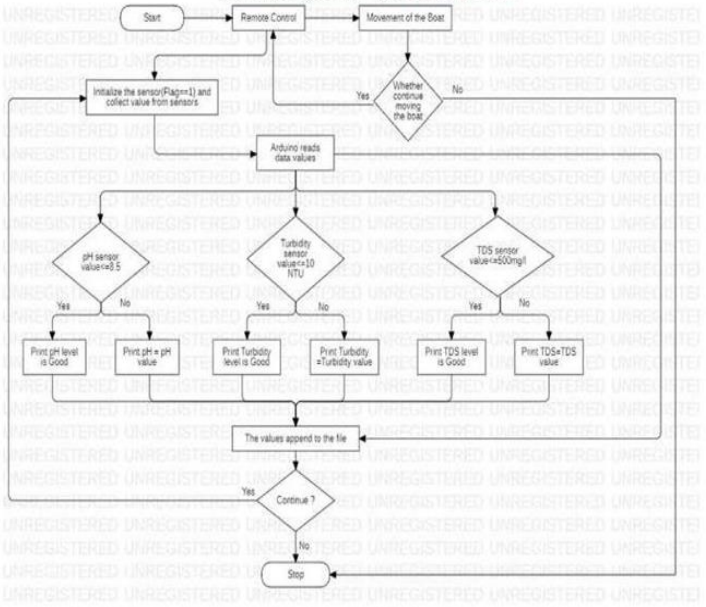

Figure 1: Flowchart for water pollution monitoring system.

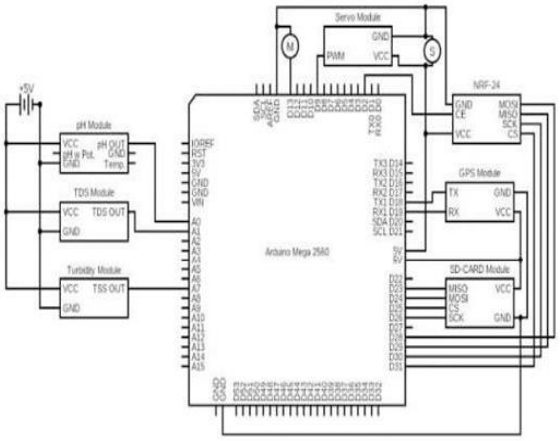

Figure 2: RC Boat Circuit.

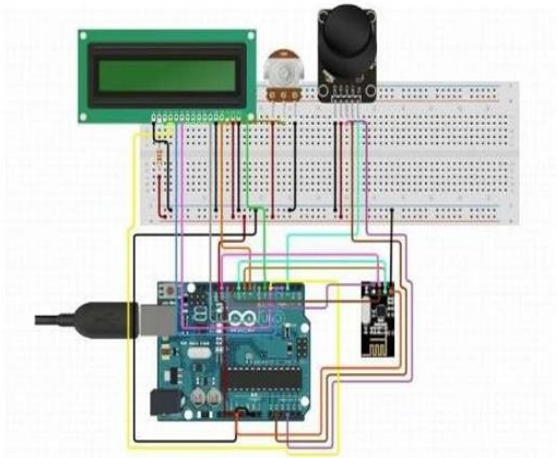

Figure 3: RC Device Circuit.

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IV. Conclusion

This survey helps in developing an approach for water pollution monitoring system. It has helped to explore the various approach that has been previously developed like, The current manual method for monitoring of the water quality which is Money & Time consuming and labour intensive. This survey helps in developing an approach for making the devices more relevant and convenient. Monitoring of real time quality of Water from Large water bodies, it makes use of pH, turbidity and TDS sensor with Arduino-based microcontroller. The system can monitor water quality automatically and it is low in cost and require minimum 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 hydrological, air pollution, industrial and agricultural pollution and so on. It has widespread application and extension value.

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APPENDIX III

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Water pollution is one of the biggest threats to our surroundings. To supply good quality of water it is important to monitor the quality of water. So, we are designing a cheap and time-consuming water pollution monitoring system. The system comprises of different sensors which is used to measure the physical and chemical parameters of the water. The parameters such as temperature, pH, turbidity, TDS sensor of the water can be measured. The measured values from the sensors are provided to Arduino, it reads the data and provide the results. Finally, the sensor data gets appended in the file and can also be viewed on Arduino serial monitor.

Keywords: pH sensor, Turbidity sensor, TDS sensor, Arduino model

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APPENDIX IV

Instruction Manual

on

“Development of Water Pollution Monitoring System”

Submitted By

Ms. Namrata Thakre

Ms. Shweta Lanjewar

Ms. Natasha Ramtekkar

Mr. Himanshu Saha

Ms. Vijayalaxmi Yelchalwar

Under the Guidance of

Ms. Snehal P. Dongre

Department of Information Technology

S. B. Jain Institute of Technology Management

and Research Nagpur

2021-2022

1.Abstract

Water pollution is one of the biggest threats to our surroundings. To supply good quality of water it is important to monitor the quality of water. So, we are designing a cheap and time-saving water pollution monitoring system. The system comprises of different sensors which is used to measure the physical and chemical parameters of the water. The parameters such as temperature, pH, turbidity, TDS sensor of the water can be measured. The measured values from the sensors are provided to Arduino, it reads the data and provide the results. Finally, the sensor data gets appended in the file and can also be viewed on Arduino serial monitor.

2.Modules Implemented

- **Module 1: Sensors Testing & Study.**

We have used different sensors like pH, TDS, Turbidity. pH sensor which is a very important indicator of water quality.

TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids are dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids are dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one reference point for reflecting the cleanliness of water.

Turbidity sensors measure the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's turbidity level (and cloudiness or haziness) increases.

- **Module 2: Integration with Remote Control (RC) System.**

Integration of Module 1 with NEO-6M GPS Module.

In this the GPS receivers use the information and trilateration to calculate a user's exact location. Essentially, the GPS receiver measures the distance and the amount of time it takes to receive a transmitted signal. To calculate your latitude and longitude, a GPS receiver must be locked on to a signal. Generally, a GPS receiver will track, but that depends on the time of day.

- **Module 3: Manufacturing RC Boat & Remote Control.**

Integration of Module 1 and 2 and sending all the data to Receiver Module.

In this the transmitter is sending message to the receiver. Those messages are being displayed in receiver's serial monitor and LCD screen. It works very well when the receiver and transmitter are close to each other. If you separate the too far apart, you may lose the communication.

3.Software and Hardware Requirement

3.1Software Requirement

Technology: -

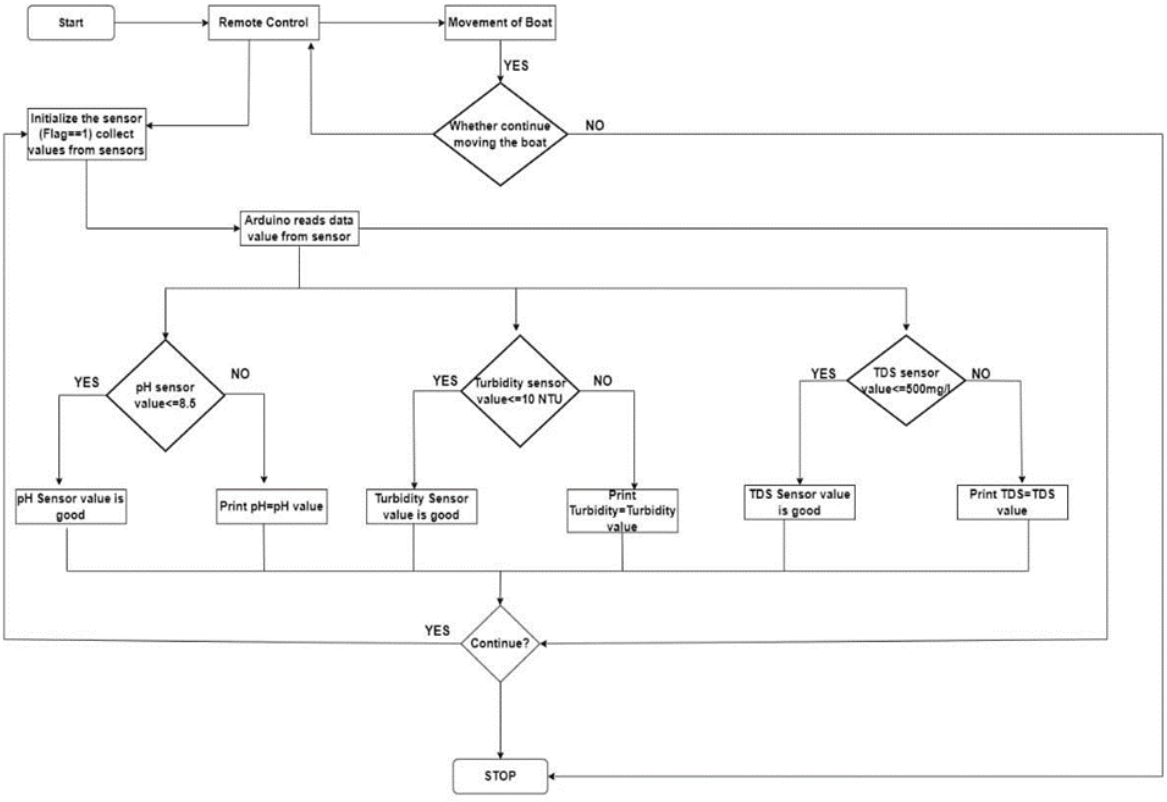
1. **Operating System**: Windows 7 or Higher
2. **Training Environment**: Arduino IDE, GitHub
3. **Languages**: C, C++
4. **Designing Tool**: Draw.io, Star UML, Circuit-diagram.org/editor
5. **Libraries Used**: TinyGPSPlus.h, SoftwareSerial.h, LiquidCrystal.h, SPI.h,nRF24L01.h, RF24.h
6. **Testing Tool**: Arduino Serial Monitor

3.2 Hardware Requirement

Hardware: NRF24L01, Arduino Mega, NEO-6M GPS, Turbidity Sensor with Module, Analog PH Sensor Kit, TDS Sensor kit, Arduino UNO R3 SMD Atmega328P Board.

Sr. No.	Name of Component	Quality	Price
1.	16x2 (1602) Character Blue Backlight LCDDisplay	1	Rs.115.00
2.	USB A To B Cable – Cable for Arduino –Blue Color	2	Rs.40.00
3.	NRF24L01 2.4GHz PA+LNA SMA Wireless Transceiver Module	2	Rs.356.00
4.	Arduino Mega 2560 R3 Board – Clone Model	1	Rs. 975.00
5.	DS18B20 Waterproof Temperature SensorProbe	1	Rs.74.00
6.	NEO-6M GPS Module	1	Rs.320.00
7.	Arduino UNO R3 SMD Atmega328P Board –Clone Compatible Model	1	Rs.385.00
8.	2x20 Pin 2.54mm Pitch Male Berg Strip –Break Away Header - Straight	1	Rs.18.00
9.	4x6 cm Double Sided Universal PCBPrototype Board	2	Rs.68.00
10.	Turbidity Sensor with Module	1	Rs.675.00
11.	Robocraze PH Sensor Module	1	Rs.1,999.00
12.	CentIoT - TDS Meter V1.0 module	1	Rs.1,310.00
		TOTAL	Rs 6,335.00

3.2.1 Flowchart



3.2.2 Circuit Diagram of Components

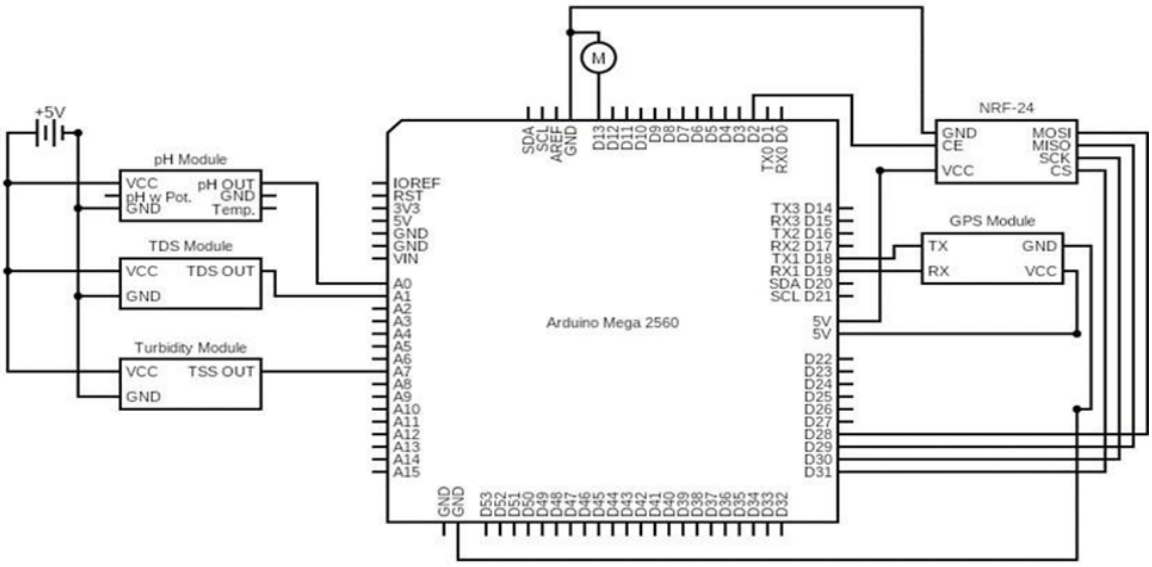


Fig. - RC-Boat Circuit Diagram

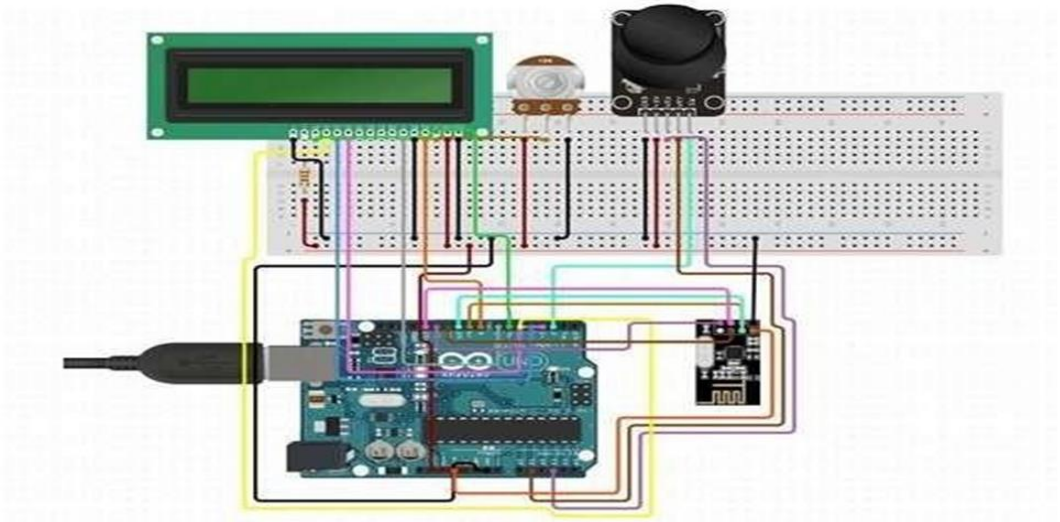


Fig: -Remote control device Diagram

3.2.3 Steps to Connect Components

1. **pH Sensor: -** Connect equipment according to the graphic, that is, the pH electrode is connected to the BNC connector on the pH meter board and then use the connection lines,the pH meter board is connected to the analog port 1 of the Arduino controller. When the Arduino controller gets power, you will see the blue LED on board is on.
2. **TDS Sensor: -** The connection of TDS Sensor with Arduino is simple.

Connect the VCC to Arduino 5V & GND to GND. Connect its Analog pin to any analog pin of Arduino. Inmy case, I used Analog pin A0 of Arduino.

3. **Turbidity Sensor:** - Connect the VCC of the Turbidity Sensor with Arduino 5V, GNDto GND & Analog Output to Arduino A2 pin.
4. **GPS Module:** - GND is the Ground pin and needs to be connected to GND pin on the Arduino; Tx pin is used for serial communication and connect it to Digital pin 2; Rx pin isused for serial communication and connect it to Digital pin 3; VCC supplies power for themodule, directly connect it to the 5V pin on the Arduino.
5. **Radio Module:** -
    a) **Transmitter Module:** - In this Transmitter Module, Connect the NRF24L01 modules to the Arduino Mega board. All connections are done on Digital pins. Now, Connect VCC to 3.3V, GND to GND, CSN to 8, CE to 7, SCK to 52, MOSIto 51, MISO to 50.
    b) **Receiver Module:** - In this Receiver Module, Connect the NRF24L01 modules tothe Arduino Uno board. All connections are done on Digital pins. Now, Connect VCC to 3.3V, GND to GND, CSN to 8, CE to 7, SCK to 13, MOSI to 11, MISO to12.

4.Steps to Run the Project

1. Connect all the sensors along with GPS and radio module and LCD.
2. Opening the Arduino platform.
3. Selecting board and port for the Arduino.
4. Uploading the sketch to Arduino.
5. Opening of serial monitor and checking the result.
6. Data can also be seen on the LCD Screen.

5. Future Scope

1. This system can be deployed for large water bodies.

2. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural pollution and so on.

3. More parameters of water and environment can also be tested by connecting multiple sub-systems to this system.

6.Limitations

The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment sanitation, storage and disposal are critical elements to maintain the quality of water resources.

Real time water monitoring has following applications:

- **Domestic water:** intended for human consumption for drinking and cooking purposes. Traditional water monitoring systems are not considered efficient due to unavailability of real time water quality information, delayed detection of contaminants and not cost-effective solution.

- **Lake and Sea water applications:** For these, distributed wireless sensor networks are required to monitor the parameters over a larger area and send the data monitored to a centralized controller using wireless communication.

- **Aquaculture:** Requires water quality monitoring and forecasting for healthy growth of aquatic creatures. Measurement of DO is important here as this parameter determines whether a species can survive in the said water source.

- Water which is to be used for Agricultural irrigation should contain low sodium content.

- Drinking water distribution system.

- **Water and Air quality:** pH of the water is most important factor; it measures how acidic or basic the water is. Water with a pH of 11 or higher can cause irritation to the eyes, skin, or mucous membrane. Acidic water (pH 4 and below) can also cause irritation due to its corrosion effect. Turbidity refers to concentration of suspended particles in water. Conductivity gives an indication of number of impurities in the water, the cleaner the water, less conductive it is.

7. Achievement Details

Sr. No	Title	Event Name / JournalName/ Conference	Date	Remark
1	Development of WaterPollution Monitoring System	International Journal of Advanced Research In Science, Communication And Technology (IJARSCT)	01/01/22	Participated
2	Development of WaterPollution Monitoring System	International Conference on Tech Trends In Science & Engineering (ICTTSE)	25/02/22	Participated