K. K. WAGH INSTITUTE OF ENGINEERING EDUCATION & RESEARCH, NASHIK.

MINI PROJECT REPORT

On

"Water Pollution Monitoring RC Boat"

Submitted by

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Department of Electronics & Telecommunication Engineering

YEAR 2023-2024

K. K. WAGH INSTITUTE OF ENGINEERING EDUCATION AND RESEARCH, Nashik

Department of Electronics and Telecommunication Engineering

Mini-Project Completion Certificate

This is to certify that the project work titled **"Water Pollution Monitoring RC Boat"**, has been successfully completed during the academic year of 2023-2024 by the following students:

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This project conforms to the standards laid down by SPPU and has been completed in satisfactory manner as a partial fulfillment for the Bachelor degree in Electronics & Telecommunication Engineering, SPPU.

Prof. M. V. Marathe	**Dr. D. M. Chandwadkar**	**Dr. K.N. Nandurkar**
Project Guide	**H.O.D.**	**Principal**

ACKNOWLEDGMENT

We would like to thank our Head of Department, **Prof. Dr. D. M. Chandwadkar** for all the guidance and help provided us for this project. We express our humble gratitude for being with us and for all the help needed.

We would extend deep gratitude towards **Prof. Dr. S. A. Patil (Ugale)** for guidance and selection of our project. Madam has given us very important guide lines that helped us for strengthening the objective of our project.

Finally, we would like to express our sincere gratitude towards **Prof. M. V. Marathe** for helping us to complete our project.

Name of student

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3. Ketan Patil

ABSTRACT

Smart solutions for water pollution 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 pollution 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 pre-defined set of standard values. This device will surf on the water bodies and will provide the required measurement data for the given parameters and will also self-analyses and inform us accordingly. The solution is kept to be minimalistic yet a fully-fledged device for a given task. This solution has a lot of scope and practical implementation and can also help in curb the water pollution. Using the given detailed approach, methodology and fabrication anyone can produce, assemble and launch this device.

CONTENTS

INTRODUCTION

The quality of our water bodies is vital for both environmental health and human well-being. However, assessing water quality effectively across large or hard-to-reach areas can be challenging. In response to this need, innovative approaches combining technology and environmental monitoring have emerged. One such promising method involves utilizing remotely controlled (RC) boats equipped with specialized sensors.

This project aims to leverage the capabilities of an RC boat outfitted with Temperature and turbidity sensors to monitor and assess water quality in real-time. Turbidity indicates the cloudiness or haziness caused by suspended particles in the water.

The deployment of an RC boat for water quality monitoring offers several advantages. By accessing remote or difficult-to-reach areas, this approach enables comprehensive data collection that would otherwise be impractical. Furthermore, real-time monitoring facilitates prompt identification of water quality issues, supporting timely interventions to protect aquatic ecosystems and public health.

In this project, we will explore the design, implementation, and operational aspects of an RC boat equipped with TDS and turbidity sensors. By combining engineering ingenuity with environmental science, this initiative contributes to the advancement of sustainable water management practices.

LITERATURE SURVEY

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.

Jayti Bhatt, Jignesh Patoliya entitled “Real Time Water Quality Monitoring System”. This paper describes to ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists some sensors which measure the water quality parameter such as turbidity, temperature. The measured values from the sensors are processed by microcontroller and these processed values are transmitted remotely to the core controller that isESP32i Finally, sensors data can view on internet browser application using cloud computing.

Michal Lom, Ondrej Pribyl, Miroslav Svitek entitled “Industry 4.0 as a Part of Smart Cities”. This paper describes the conjunction of the Smart City Initiative and the concept of Industry 4.0. The term smart city has been a phenomenon of the last years, which is very inflected especially since 2008 when the world was hit by the financial crisis.

SYSTEM DETAILS

System details for a water quality monitoring RC boat equipped with TDS (Total Dissolved Solids) and turbidity sensors, we'll outline the components, design considerations, and operational aspects of such a project.

3.1 PROJECT SPECIFICATIONS

1. RC Boat Platform:

Selection: Choose a suitable RC boat based on size, weight capacity, maneuverability, and battery life. opt for a platform that can accommodate sensor mounting and electronics.

Power System: Use rechargeable batteries with sufficient capacity to support prolonged operation of the boat and sensor systems.

2. Sensor Integration:

a) Temperature Sensor Specifications

Sensor Type: Select a temperature sensor suitable for water applications, capable of providing accurate readings over a range of temperatures.

Measurement Range: The sensor should cover the expected temperature range of the water body (e.g., -10°C to 50°C).

Accuracy and Resolution: High accuracy and resolution are essential for precise temperature monitoring.

Response Time: Choose a sensor with a quick response time to capture rapid temperature fluctuations.

Waterproofing: Ensure the sensor is waterproof and can withstand immersion in water without compromising performance.

b) Turbidity Sensor:

- Type: Choose a turbidity sensor capable of measuring suspended solids or particles in water.
- Calibration: Calibrate the turbidity sensor to account for variations in water clarity and environmental conditions.
- Placement: Mount the turbidity sensor in a location that minimizes interference from boat movement and ambient light.

3. Control and Communication:

- **Remote Control**: Implement a reliable remote-control system to navigate the boat on the water surface.
- **Data Transmission:** Use wireless communication Bluetooth to transmit sensor data in real-time to a base station or monitoring device onshore.

4. Microcontroller: Incorporate a microcontroller ATMEGA328P to interface with the sensors and manage data acquisition.

- **Data Logging:** Develop a data logging system to record Temperature and turbidity measurements along with mapping water quality variations.
- **Algorithm:** Implement data processing algorithms to analyze sensor readings and detect anomalies or trends in water quality parameters.

5. Environmental Considerations:

- **Water Conditions**: Account for variations in water temperature, salinity, and clarity that may affect sensor performance.
- **Weatherproofing:** Ensure all electronic components and sensors are adequately sealed to protect against water ingress

6. Project Objectives and Outcomes:

- **Monitoring Goals:** Define specific water quality parameters to monitor (e.g., TDS levels, turbidity) and establish monitoring locations.
- **Data Analysis**: Plan for data visualization and analysis to derive insights into water quality trends and potential environmental impacts.

7. Field Testing and Validation:

- **Prototype Testing:** Conduct field tests to evaluate the performance and reliability of the RC boat system under different environmental conditions.
- **Iterative Improvement:** Use feedback from testing to refine the system design and optimize sensor integration.

3.2 BLOCK DIAGRAM

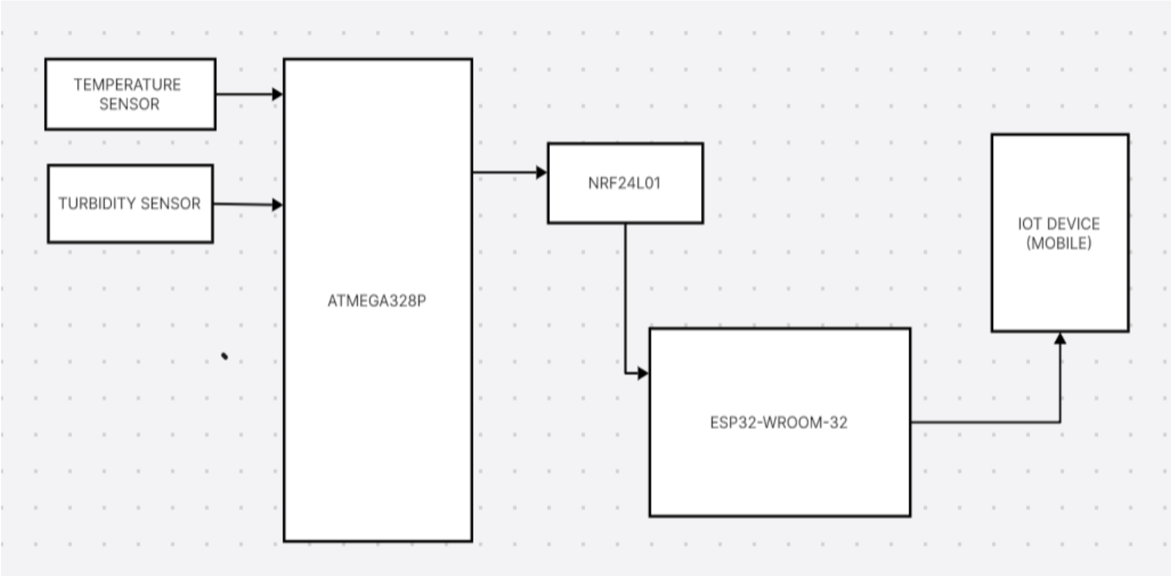


Figure 1 Block Diagram

3.3 DESCRIPTION OF BLOCKS

1. Sensors

a) Temperature Sensor

The temperature sensor should cover the expected range of water temperatures encountered during monitoring activities. Typical ranges could be from -10°C to 50°C or broader, depending on the water body and environmental conditions. The sensor should provide high accuracy (within ±0.5°C or better) and fine resolution to capture subtle changes in water temperature. This level of precision is crucial for reliable data collection and analysis. A fast response time is essential for capturing rapid temperature fluctuations in the water. Ideally, the sensor should respond quickly to changes, ensuring real-time monitoring capabilities.

b) Turbidity Sensor:

A turbidity sensor measures the cloudiness or haziness of a fluid caused by suspended particles. Turbidity in water is caused by the presence of clay, silt, organic matter, algae, and other microscopic particles that scatter or absorb light. The turbidity sensor quantifies this optical property to assess water clarity. Turbidity sensors utilize light scattering or absorption principles to measure the presence of suspended particles.

A light source emits a beam of light into the water sample. Particles in the water scatter or absorb the light. The sensor detects the amount of light that is scattered or absorbed by the suspended particles. Turbidity is typically reported in Nephelometric Turbidity Units (NTU) based on the intensity of light detected by the sensor.

2. Microcontroller

The ATMEGA328P microcontroller can serve several essential functions in a water quality monitoring RC boat project, particularly for interfacing with sensors, controlling actuators, and processing data. Here are some key functions and capabilities of the ATMEGA328P in this context:

a) Sensor Interface:

- The ATMEGA328P can interface with TDS and turbidity sensors using analog-to-digital converters (ADC).
- Analog sensor outputs (e.g., from TDS and turbidity sensors) can be read by the microcontroller's ADC channels.
- The microcontroller can process these analog readings and convert them into digital values for further analysis.

b) Communication:

- Enable communication between the ATMEGA328P and other components (sensors, GPS module, wireless transceiver) using serial communication protocols (UART, SPI, I2C).
- Transmit sensor data wirelessly to a remote monitoring station or display unit for real-time visualization.

c) Power Management:

- Implement power management routines to optimize battery usage and monitor voltage levels.
- Control sleep modes and power-saving features to extend operational duration during field missions.

3. NRFL24L01

- The NRF24L01 wireless transceiver module significantly enhances the capabilities of our water quality monitoring RC boat system by facilitating reliable and efficient communication between the boat and the base station.
- This integration is critical for enabling remote, real-time monitoring of turbidity and temperature levels in water bodies, thereby contributing to improved environmental management and ecosystem health. The successful implementation of this technology underscores its potential for future applications in aquatic monitoring and research.

4. **ESP32 Module**

- With WIFI functionality, the ESP32 module can wirelessly transmit water quality data to a remote monitoring station or a mobile device.
- Bluetooth connectivity allows for flexible data retrieval without physical tethering, enhancing the mobility of the RC boat.

5. **Mobile**

- Display TDS and turbidity readings graphically on the mobile app for easy interpretation.
- Generate customizable reports and visualizations that can be shared or exported from the

HARDWARE DESIGN

4.1 DESIGN BLOCKS AND COMPONENTS:

1. **Turbidity Sensor (Optical Turbidity Sensor):**

Figure 2 Turbidity sensor

- **Requirement**: Measure water turbidity accurately.
- **Design Considerations:** Select an optical turbidity sensor for precise measurements.
- **Ensure sensor** compatibility with water conditions (e.g., clarity, particle size).
- **Options**: TSD-10 Turbidity Sensor, TURB-SENSE Optical Turbidity Sensor, etc.
- **Selected Option**: TURB-SENSE Optical Turbidity Sensor.
- **Justification**: Provides accurate turbidity readings. Suitable for water quality monitoring applications.

2. **Temperature Sensor:**

Figure 3 Temperature sensor

- **Requirement**: Measure water temperature.
- **Design Considerations:** Select a waterproof temperature sensor suitable for by aquatic environments.
- **Options:** DS18B20 Waterproof Temperature Sensor, DHT22 Digital Temperature and Humidity Sensor, etc.
- **Selected Option**: DS18B20 Waterproof Temperature Sensor.
- **Justification**: a. Waterproof and accurate temperature measurements.
  b. Compatible with digital communication protocols.

3. **ESP32 (Wi-Fi Module):**

Figure 4 ESP32 Dev Kit

- **Requirement**: Enable wireless data transmission for remote monitoring.
- **Design Considerations:**
  a. Choose a Wi-Fi module with sufficient range and data transfer capabilities.
  b. Ensure compatibility with the microcontroller and communication protocols.
- **Options**: ESP32-WROOM-32, ESP32-WROVER, etc.
- **Selected Option:** ESP32-WROOM-32.
- **Justification**: **a.** Powerful and versatile Wi-Fi module.
  b. Supports various communication interfaces (Wi-Fi)

4. **ATmega328P Microcontroller:**

Figure 5 ATmega328P

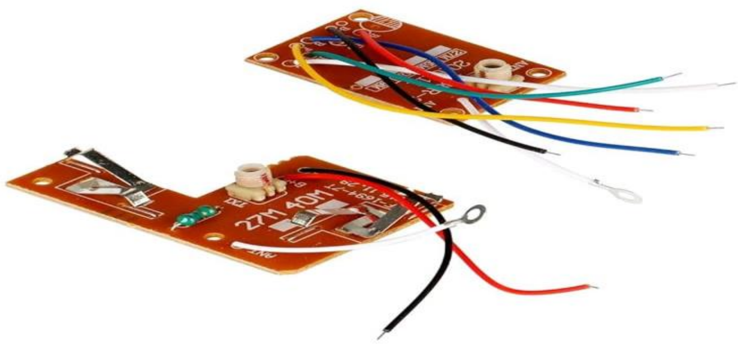
- **Requirement**: Control sensors, process data, and manage communication.
- **Design Considerations:**

  a. Select a microcontroller with sufficient I/O pins, memory, and processing power.

  b. Ensure compatibility with Arduino IDE for ease of programming.
- **Options**: Arduino Uno (ATmega328P), Arduino Nano, etc.
- **Selected Option**: ATmega328P
- **Justification**: **a.** Well-suited for sensor interfacing and data processing.

  b. Compatible with a wide range of sensors and peripherals.

5. **Super Debug 4CH 27MHZ Remote Tx and Rx Board**



- **Requirement**: Control Boat and its Motor.
- **Design Considerations:** Select Transmitter that is Cost effective and has very high reliability.
- **Options**: RF 533MHz Tx Rx, NRF24L01
- **Selected Option**: Super Debug 4CH 27MHZ Remote Tx and Rx Board
- **Justification**: **a.** Cost effective and has very high reliability.

  b. Easily Available.

4.2 SOFTWARE

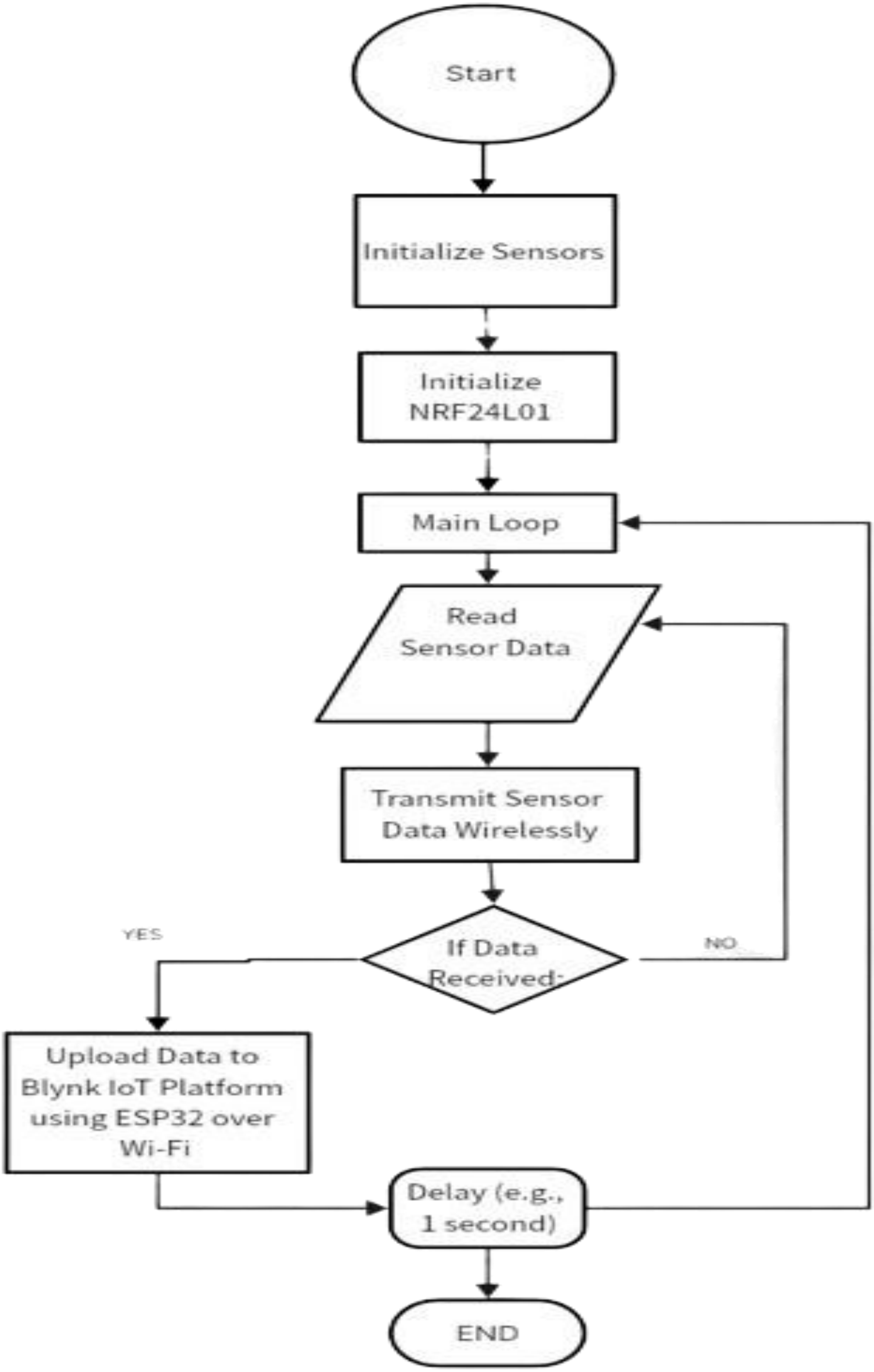


Figure 6 Flowchart

4.3 ALGORITHM

1. **Initialization:** Set up the sensors and wireless communication modules.
2. **Main Loop**: Implement a continuous loop for monitoring and data transmission.
3. **Read Sensor Data:** Obtain sensor readings from Turbidity, and Temperature sensors.
4. **Transmit Sensor Data:** Send sensor data wirelessly using NRF24L01.
5. **Check for Data Reception:** Monitor for incoming data on the ESP32.
6. **Data Reception Check:** Process and store received data if data is successfully received.
7. **Upload Data to Blynk:** Transmit processed data to the Blynk IoT platform for visualization.
8. **Update Blynk App:** Display sensor readings on the Blynk app interface.
9. **Delay:** Introduce a delay between loop iterations to control the loop frequency.
10. **End Loop Condition:** Check for specific conditions to determine whether to exit the main loop.

4.4 PCB DESIGN

1. PCB Layout

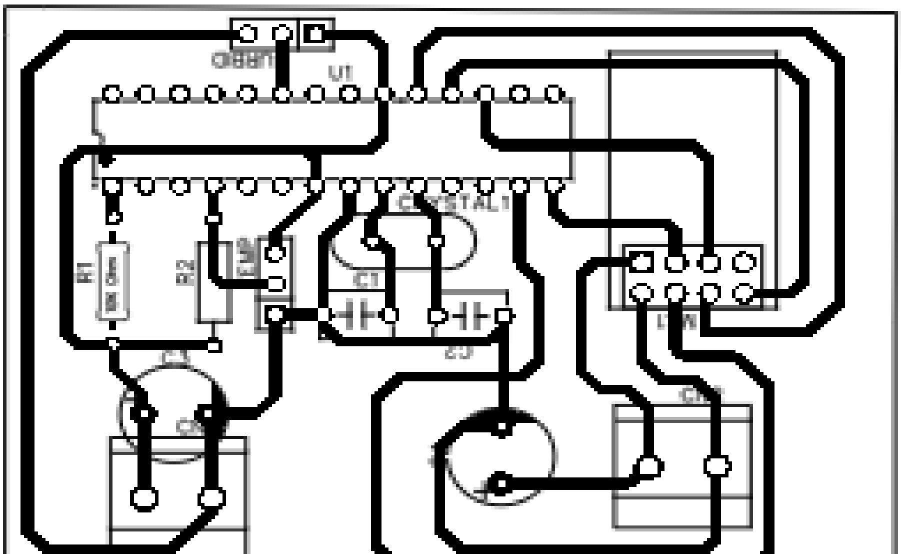


Figure 7 Transmitter PCB Layout

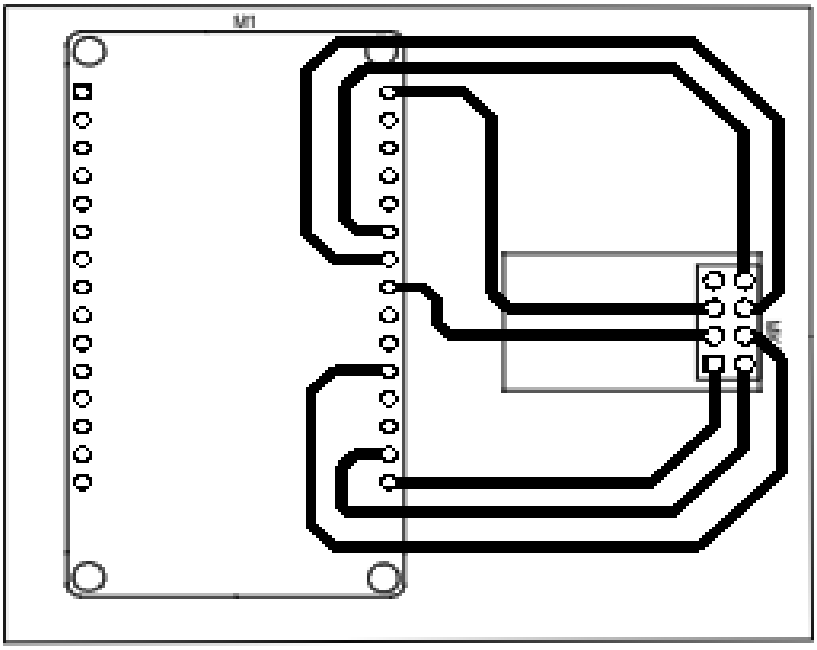


Figure 8 Receiver PCB Layout

2. **PCB Schematics**

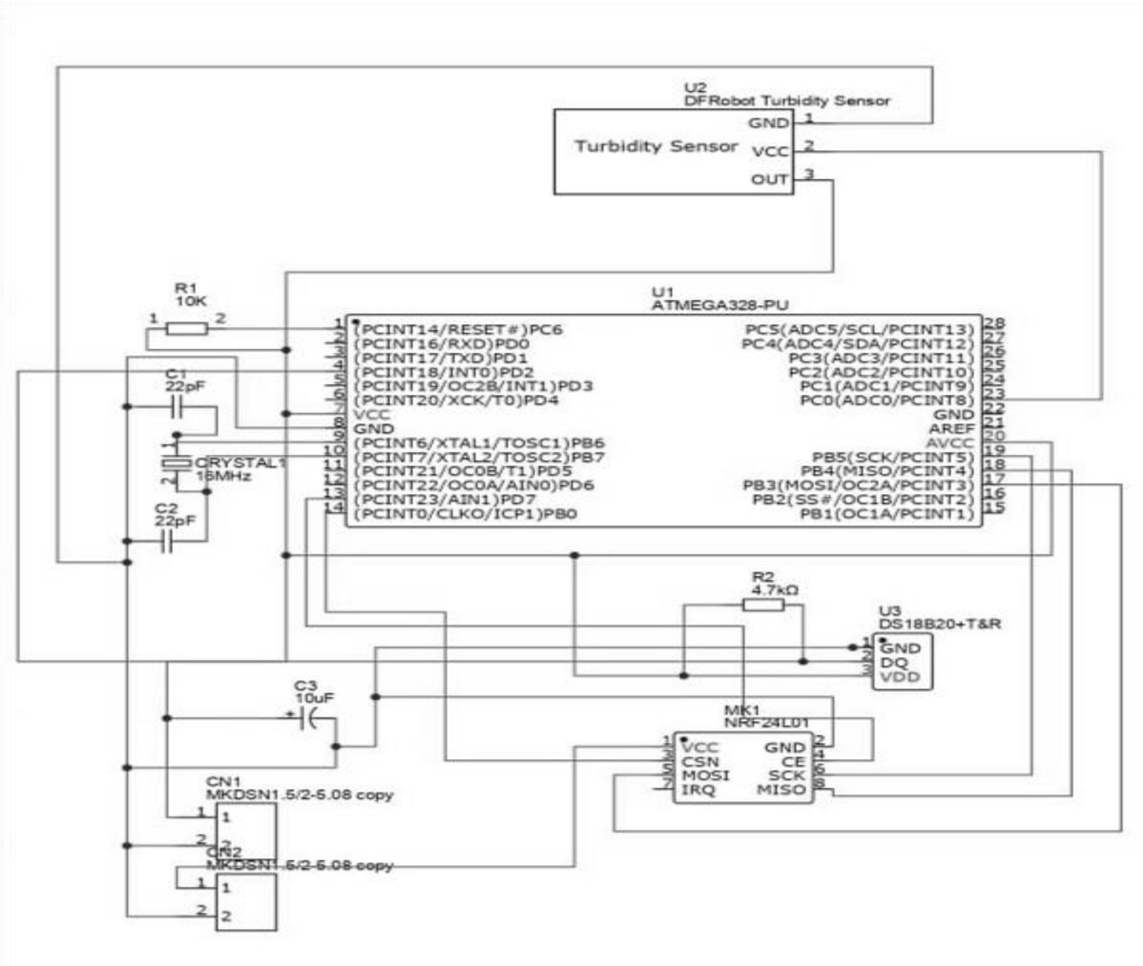


Figure 9 Transmitter PCB Schematics

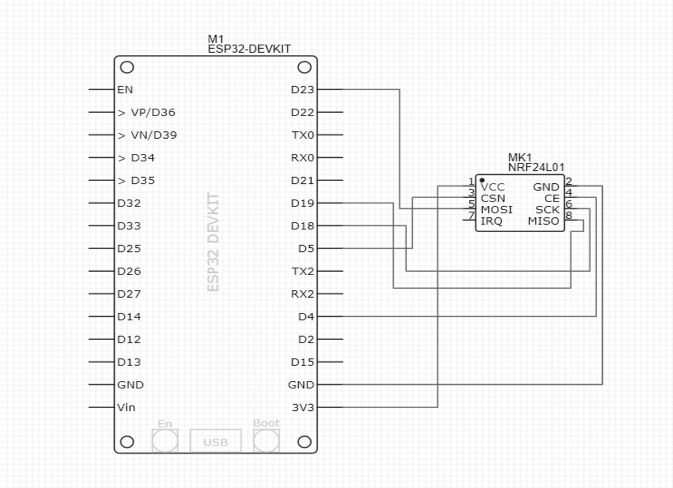


Figure 10 Receiver PCB Schematics

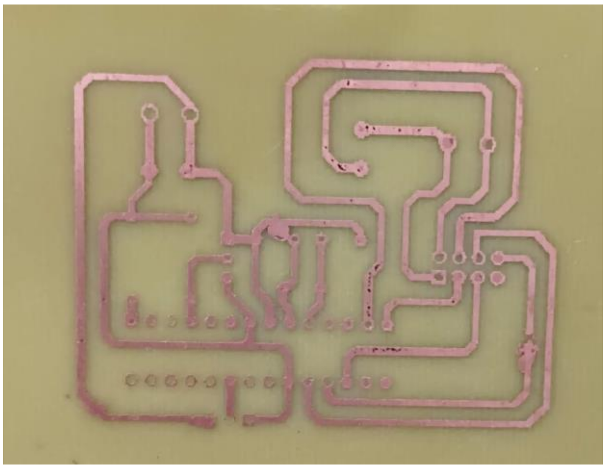


Figure 11 PCB

4.5 ENCLOSURE DESIGN

Figure 12 Enclosure

TESTING

Testing for water pollution and monitoring it as part of a project involves using a range of sensors and equipment to collect data on various water quality parameters. These parameters help determine the level of pollution in the water body and assess its impact on the environment and aquatic life.

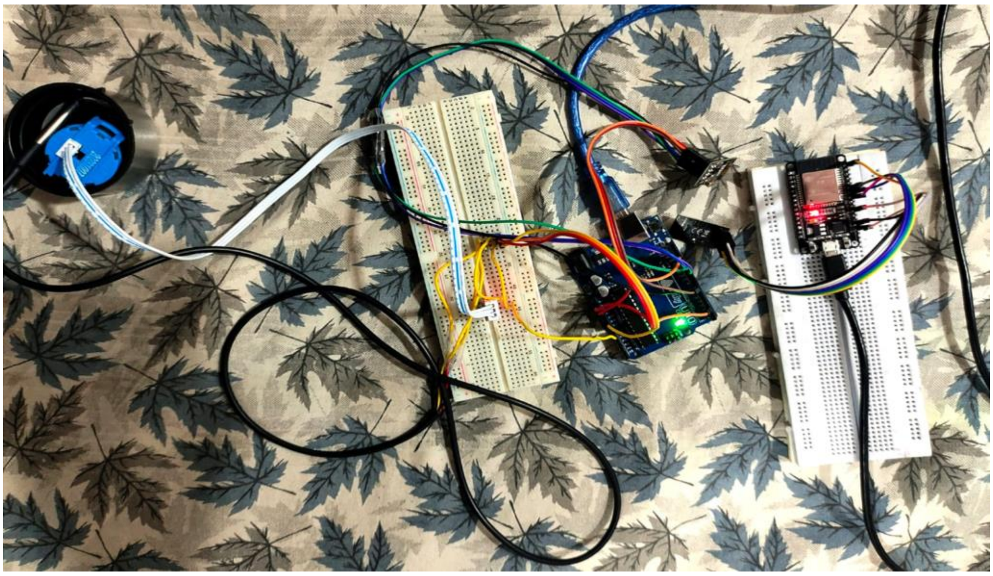


Figure 13 Bread Board Testing

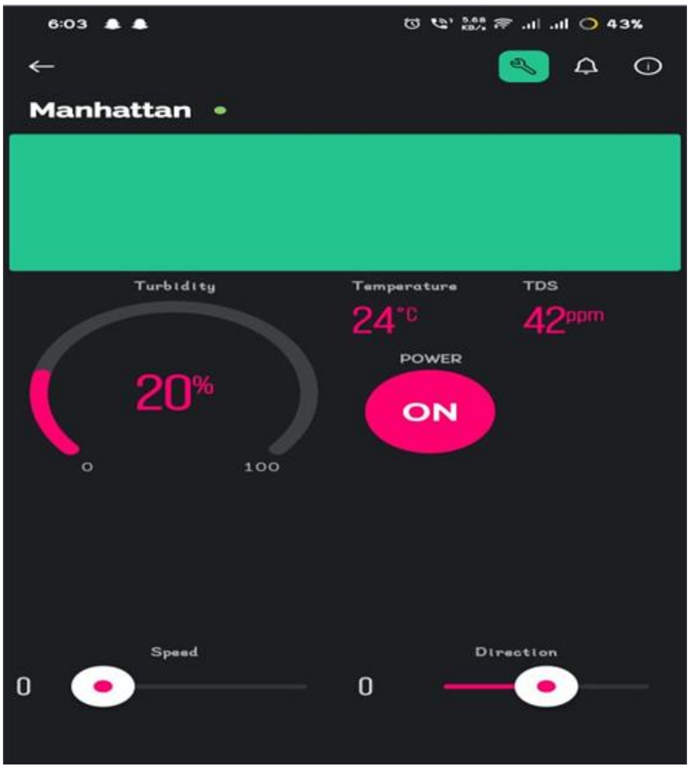


Figure 14 Blynk App

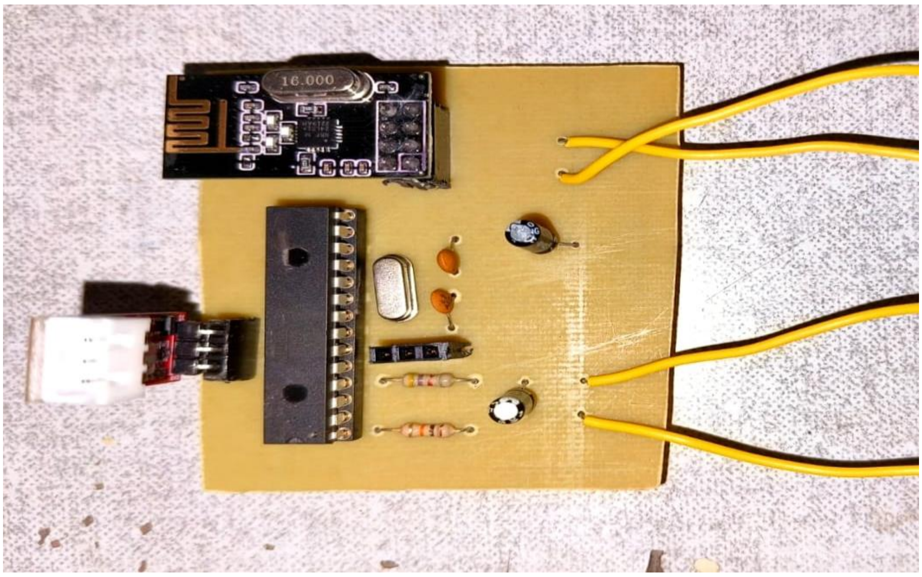


Figure 15 PCB Testing

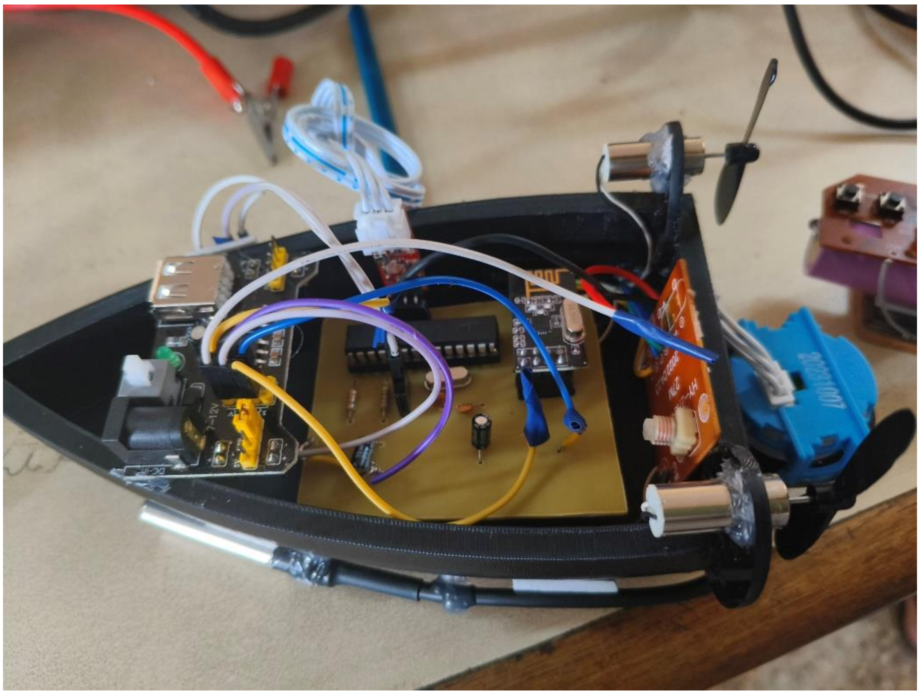


Figure 16 Final Testing

RESULT

We measured the temperature of normal water which came out close to the room temperature. This test was carried out first so that the reading could later be used for the comparison between other samples of water. The sensor was cleaned and then inserted in hot water and later dipped in cold water to gather the readings respectively.

Type of Water	Degree C of water
Hot Water	72.01
Cold Water	2.46
Normal Water	27.15

Type of Water	% of Clean Water
Drinking Water	97.13
Dirty Water	60.17

ADVANTAGES

- **Environmental Monitoring:** RC boats equipped with water quality sensors can be deployed in bodies of water to monitor various parameters such as pH levels, dissolved oxygen, turbidity, and temperature. This capability allows for real-time data collection in remote or challenging locations, contributing to better environmental monitoring and management.
- **Efficient Sampling:** Instead of traditional methods that require manual sampling or large vessels, RC boats can navigate specific areas efficiently, collecting water samples and conducting measurements. This efficiency reduces costs and labor associated with water quality assessments.
- **Remote Operation**: RC boats can access areas that are difficult for humans to reach, such as deep waters or hazardous locations. This capability enhances safety and enables the collection of data from otherwise inaccessible sites.
- **Real-Time Analysis:** By integrating sensors with RC boats, water quality data can be transmitted in real-time to a base station or control center. This immediate feedback allows for rapid decision-making and timely interventions in case of water quality issues.
- **Low Environmental** Impact: Unlike larger vessels, RC boats typically have minimal environmental impact. They are lightweight and maneuverable, minimizing disturbance to aquatic ecosystems during operation.
- **Educational Purposes**: RC boats can be used as educational tools to teach students about water quality monitoring and environmental science. They offer a hands-on approach to learning about water ecosystems and the impact of human activities on them.
- **Cost-Effective**: Compared to larger boats or aircraft used for similar purposes, RC boats are generally more affordable to acquire, operate, and maintain. This cost-effectiveness expands the accessibility of water quality monitoring to smaller organizations or communities.

APPLICATION

Integrating water quality monitoring into an RC boat can serve various practical applications, particularly in environments where water quality assessment is important for environmental monitoring, research, or specific tasks. Here are several potential applications for an RC boat equipped with water quality monitoring capabilities:

1. Environmental Research and Monitoring

Water Sampling: The RC boat can navigate water bodies to collect real-time data on parameters like turbidity, TDS, and temperature, providing researchers with valuable insights into water quality trends and variations.

2. Ecosystem Monitoring: Assessing water quality can aid in monitoring the health of aquatic ecosystems, identifying pollution sources, or understanding the impact of natural events (e.g., floods, algae blooms).

3. Pollution Detection and Surveillance

Industrial and Urban Areas: Use the RC boat to survey areas impacted by industrial discharges or urban runoff, detecting changes in water quality and potential pollutants.

4. Emergency Response: Rapid deployment of the RC boat during environmental emergencies (e.g., chemical spills) to assess water contamination levels remotely.

5. Aquatic Resource Management

Fisheries and Aquaculture: Monitor water quality parameters in aquaculture operations to optimize conditions for fish or shellfish growth and health. Water Treatment Facilities: Assess water quality before and after treatment processes to ensure compliance with standards and optimize treatment efficiency.

6. Water Recreation Safety: Ensure safe conditions for recreational activities (e.g., swimming, boating) by monitoring water quality in real-time. Tourism Industry: Provide tourists with educational experiences by demonstrating water quality monitoring techniques and discussing local environmental issues.

5. Educational Outreach and STEM Programs

Schools and Educational Programs: Use the RC boat as an educational tool to teach students about water quality, environmental science, and technology.

CONCLUSION

Water Pollution is a major threat to any country, as it affects health, economy and spoils bio-diversity. In this work, causes and effects of water pollution are presented, as well as a comprehensive review of different methods of water quality monitoring and an efficient IoT based method for water quality monitoring has been discussed. Although there have been. Many excellent smart water quality monitoring systems, still the research area remains challenging. This work presents a review of the recent works carried out by the researchers in order to make water quality monitoring systems smart, low powered and highly efficient such that monitoring will be continuous and alerts/notifications will be sent to their concerned authorities for further processing. The developed model is cost effective and simple to use (flexible). Three water samples are tested and based on the results, the water can be classified whether it is drinkable or not. As a future directive, the suggestion is to use the latest sensors for detecting various other parameters of quality, use wireless communication standards for better communication and IoT to make a better system for water quality monitoring and the water resources can be made safe by immediate response.

FUTURE SCOPE

Expanding the capabilities and future scope of your water quality monitoring RC boat project can involve several interesting additions and improvements. Here are some ideas to enhance and extend your project:

1. Data Logging and Storage

Implement data logging capabilities to record sensor readings over time. You can use an SD card module with the ATmega328P to save data periodically. This will allow you to analyze trends in water quality and identify patterns.

2. Wireless Communication

Incorporate wireless communication modules like Bluetooth (HC-05/HC-06) or LoRa (SX1278/SX1276) to enable remote monitoring and control of the RC boat. This allows you to receive real-time sensor data on a smartphone or computer.

3. GPS Integration

Integrate a GPS module to track the location of the RC boat while collecting water quality data. This adds geographical context to the collected data, enabling mapping and spatial analysis.

4. Automated Sampling

Implement an automated sampling mechanism using a peristaltic pump or a robotic arm. This allows the RC boat to collect water samples at specific locations or depths for detailed analysis.

5. Water Quality Analysis

Integrate advanced sensors for additional water quality parameters such as pH, dissolved oxygen, conductivity, or specific ions (e.g., nitrate, phosphate). This provides a more comprehensive assessment of water conditions.

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BILL OF MATERIAL

Sr No.	Component	Quantity	Price
1	Atmega328p	1	220
2	ESP32	1	500
3	NRF24L01	2	300
4	Turbidity sensor	1	700
5	DS18B20	1	80
6	Crystal Oscillator 16MHz	1	20
7	Bread Board	1	100
8	Connecting wire	1	50
9	Capacitor, Resistor	1	30
10	PCB	1	200
11	3D Print	1	300
12	Tx-Rx Module	1	300
	Total		**2800**