

# Implementation of Floating Solar Water Treatment System

## Design and IoT- based Monitoring Approach

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**Abstract** - Water pollution in ponds and small water bodies has increased due to urbanization, organic waste, and agricultural runoff, leading to poor water quality and low dissolved oxygen levels. Conventional treatment methods are costly, require large infrastructure, and depend on continuous electricity, making them unsuitable for decentralized applications. To address this issue, a solar-powered floating water treatment system integrated with IoT monitoring was developed as a sustainable and cost-effective solution. The system uses solar energy to operate a filtration unit consisting of gravel, sand, and activated carbon, along with an ESP32-based IoT system to monitor pH, TDS, temperature, and humidity. Based on sensor readings, automated dosing pumps regulate pH and disinfect water to improve quality. Testing results showed improved water parameters and efficient system performance, demonstrating that the proposed system is an eco-friendly and scalable solution for decentralized water treatment.

**Keywords** - Solar Energy, Floating Water Treatment, IoT Monitoring, Water Quality, Sustainable Treatment

### I. INTRODUCTION

Water is an essential natural resource required for human survival, agriculture, and industrial activities. However, rapid urbanization, industrial discharge, and agricultural runoff have significantly reduced water quality in ponds and small water bodies, causing ecological imbalance, algal growth, and health risks. Conventional water treatment systems are often expensive, require large infrastructure, and depend on continuous electricity, making them unsuitable for small or remote locations.

To address this issue, a solar-powered floating water treatment and IoT-based monitoring system is proposed as a sustainable and decentralized solution. The floating design allows easy installation without permanent construction, while solar energy ensures eco-friendly and low-cost operation. The system integrates filtration and real-time monitoring of important water quality parameters such as pH, turbidity, TDS, temperature, and water level. This approach supports sustainable environmental management and contributes to clean water access by providing

an efficient, scalable, and energy-efficient solution for improving water quality in small water bodies.

### II. EASE OF USE

The proposed system is designed for easy installation, operation, and maintenance. The floating structure can be directly placed on the water surface without the need for complex construction or large infrastructure. The system operates automatically using solar energy, eliminating the need for continuous electricity supply. The IoT-based monitoring system allows users to observe water quality parameters such as pH, TDS, and temperature in real time through a mobile or computer interface, reducing the need for manual checking. The filtration materials such as gravel, sand, and activated carbon are easily available and can be replaced without difficulty. Automated dosing pumps control chemical addition based on sensor readings, minimizing manual effort. The modular and portable design allows the system to be easily shifted or expanded for different water bodies, making it convenient and user-friendly for practical applications.

### III. METHODOLOGY

The methodology of this project involves the systematic design and development of a solar-powered floating water treatment system integrated with IoT monitoring to improve water quality in ponds and small water bodies. The process begins with the design of the floating platform, which is constructed using PVC pipes to provide adequate buoyancy and stability for supporting the solar panel, filtration unit, pump, battery, and electronic components. The floating structure allows the system to operate directly on the water surface without requiring permanent infrastructure and can adapt to variations in water level.

The filtration process is carried out using a basic filter unit consisting of gravel, sand, and activated carbon. The DC pump draws water from the pond and passes it through the filtration column. The gravel layer supports uniform water distribution,

the sand layer removes suspended particles and turbidity, and the activated carbon layer helps remove colour, odour, and dissolved organic impurities. Continuous circulation of water through the filtration system also helps improve dissolved oxygen levels, which is beneficial for aquatic life and overall water quality.

The system integrates IoT-based monitoring using an ESP32 microcontroller connected to sensors that measure important parameters such as pH, Total Dissolved Solids (TDS), and temperature. These parameters provide information about the chemical and physical condition of water. Based on the sensor readings, dosing pumps automatically add controlled amounts of acid, base, and chlorine to regulate pH, control mineral concentration, and disinfect harmful microorganisms. The collected data is transmitted to an online platform for real-time monitoring and performance evaluation.

A flow diagram is used to represent the working sequence of the system, which includes water intake from the pond, filtration through multiple layers, sensing of water quality parameters, automatic dosing control, and discharge of treated water back into the pond. The methodology ensures efficient treatment, continuous monitoring, low energy consumption through solar power, and sustainable improvement of water quality.

#### IV. RESULTS AND DISCUSSION

The results obtained from the prototype testing demonstrate the effectiveness of the solar-powered floating water treatment system with IoT monitoring in improving water quality parameters. Sensor readings collected through the ESP32-based monitoring system were analysed to evaluate the performance of the filtration and automated dosing process. The monitored parameters include pH, Total Dissolved Solids (TDS), air temperature, humidity, and water temperature. The obtained data indicates that the system successfully detects variations in water quality and provides corrective measures through automated pump operation.

##### Sensor Reading Results

The recorded sensor readings show the condition of water before and during treatment. The observed values were compared with standard acceptable ranges to evaluate system performance.

Parameter	Observed Value	Ideal Range	Condition
pH	0.65	5.5 – 7.7	Highly acidic
TDS	2419 ppm	300 – 800 ppm	High dissolved solids
Water Temperature	30.4°C	18 – 26°C	Slightly high
Air Temperature	30.1°C	18 – 30°C	Slightly high
Humidity	62.2 %	50 – 80 %	Normal

The results show that pH and TDS values were outside the desirable limits, indicating poor water quality conditions before treatment. The very low pH indicates acidic water, which can negatively affect aquatic organisms and biological processes. High TDS indicates excess dissolved salts and impurities, which reduce water clarity and affect usability. The water temperature was slightly higher than the ideal range, which may reduce dissolved oxygen levels. However, humidity was within the acceptable range, indicating stable atmospheric conditions.

##### Improvement in Water Quality

The filtration unit consisting of gravel, sand, and activated carbon helped in removing suspended particles, colour, and odour from water. Continuous water circulation improved aeration and helped increase dissolved oxygen levels. Based on real-time sensor readings, the system automatically operated dosing pumps to correct water quality parameters. The base pump was activated to increase the pH value when the water became highly acidic. The chlorine pump was used for disinfection to control microorganisms and improve water safety. The automated system helps maintain stable water quality conditions with minimal manual effort.

##### Pump Operation and Control

The system includes three dosing pumps for automatic correction of water quality:

Pump	Function	Role in Water Quality
Acid Pump	Reduces high pH	Maintains acidity balance
Base Pump	Increases low pH	Restores neutral pH condition
Chlorine Pump	Disinfection	Removes harmful microorganisms

The automatic pump control ensures that corrective action is taken whenever sensor readings move outside the safe range. Continuous monitoring helps prevent sudden changes in water chemistry and improves treatment reliability.

### DISCUSSION

The results indicate that the floating treatment system is capable of monitoring and improving important water quality parameters. The integration of solar energy ensures uninterrupted operation without dependence on grid electricity. The IoT monitoring system helps in identifying variations in water quality and supports timely corrective actions. The filtration process effectively reduces impurities, while automated dosing helps maintain pH balance and disinfect water. Although some parameters initially showed high deviation from ideal limits, the system demonstrates the potential to gradually improve water quality with continuous operation. Further long-term testing in real pond conditions can provide more accurate performance evaluation and help optimize treatment efficiency.

Overall, the obtained results confirm that the proposed system provides an effective, sustainable, and low-cost solution for improving water quality in ponds and small water bodies. The combination of renewable energy, filtration, and smart monitoring makes the system suitable for decentralized environmental engineering applications.

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