# Design and Fabrication of a Wi-Fi Controlled Oil Cleaning Robot Using Esp32

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**ABSTRACT -** The oil contamination on the surface of the water, resulting from industrial activities, running machines, and accidental spillage, is a potential threat to the environment and ecology. Conventional methods for oil spill cleanup are often costly, labor-intensive, and less effective for small water bodies such as ponds, lakes, and industrial wastewater tanks. This paper discusses the design and development of a Wi-Fi-controlled oil cleaning robot for effective removal of floating oil layers on the surface of the water. A Wi-Fi-controlled oil cleaning robot is designed and developed for effective removal of floating oil layers on the surface of the water. This is achieved by using an IoT-enabled robotic system, where the system uses an ESP32 microcontroller and the Blynk IoT application for effective wireless monitoring and control. A lightweight floating chassis is designed for effective movement on the surface of the water, and an oleophilic pad is attached at the rear end for effective collection of oil contaminants on the surface of the water. Experimental results show the reliable wireless monitoring and control, stable movement, low power consumption, and effective oil removal capability of the designed and developed Wi-Fi-controlled oil cleaning robot.

*Key Words***:** Oil Spill Remediation, IoT Robotics, ESP32 Microcontroller, Water Surface Cleaning Robot, Wireless Control, Environmental Cleanup.

## 1.INTRODUCTION

The pollution of water by oil contamination is a critical issue in the field of water pollution due to the rapid growth of industries and transportation, as well as the leakage of oil into water. The presence of oil on the surface of the water reduces the availability of oxygen in the water. The oil spill cleanup techniques are not suitable for water bodies due to the high cost of the equipment and the complexity of the operation. However, the recent advancements in the field of robots and the development of the Internet of Things (IoT) technology have enabled the development of intelligent water pollution monitoring and cleaning systems. The robots are capable of operating in the water without the presence of humans. This helps to maintain the quality of the water. Therefore, the main objective of the present work Is to develop a Wi-Fi-controlled oil cleaning robot using the ESP32 microcontroller and the Blynk IoT platform. The proposed system is a floating robot capable of operating on the surface of the water and absorbing the oil from the surface of the water. The proposed system is a cost-effective and eco-friendly solution for the cleanup of oil spill in water.

LIST OF COMPONENTS

| PARAMETER | SPECIFICATION |
|---|---|
| Microcontroller | ESP32 |
| Control Method | Wifi (BLYNK IOT APP) |
| Propulsion | DC Motor |
| Power supply | 12V Li-ion Battey |
| Cleaning Mechanism | Polypropylene Absorbent pad |
| Application area | Ponds, lakes ETP Tank |

**Table:** 1

## 2. BACKGROUND

Traditionally, oil spill management techniques have employed three main strategies:

1. Mechanical recovery techniques using skimmers and booms
2. Chemical dispersion techniques
3. Biological and absorbent oil removal techniques

The use of mechanical techniques is effective but involves substantial capital costs and operating expenses. Chemical techniques pose the risk of secondary environmental pollution, while biological techniques involve long processing times. Absorbent oil removal has

been identified as an environmentally friendly option due to its simplicity, reusability, and environmental compatibility.

Simultaneously, advances in embedded electronics and wireless communication have led to the development of IoT-based robotic systems that allow for remote monitoring and control. Microcontrollers such as ESP32 offer the advantage of integrating Wi-Fi communication and processing capabilities within a small package, which is advantageous for mobile robotic applications.

Currently, existing water cleaning robots are mainly designed for removing solid wastes or for environmental sensing instead of oil cleaning. In addition, most of the robots are not user-controlled in real-time or cost-effective. As a result, there is a need for a system that incorporates:

- IoT-based remote navigation,
- Stable floating mobility,
- Energy efficiency,
- And oil cleaning capability.

The proposed project is intended to fulfill this need by designing a light-weight robot that is capable of active oil cleaning through absorption.

## 3. LITERATURE SURVEY

The rapid escalation of water pollution levels caused by industrial waste and oil spillage has encouraged the design and development of automated and intelligent water surface cleaning systems. Recent research has emphasized robotic devices, IoT-based solutions, and oil cleaning solutions to ensure environmental sustainability.Water cleaning robots based on IoT solutions have attracted considerable research interest due to their ability to offer remote monitoring and control solutions. Kumar et al. [1] have presented an IoT-based water cleaning robot with the ability to remove floating materials using wireless communication and embedded controllers. Sharma et al. [2] have presented a smart water surface cleaning system based on remote control and automated collection of waste materials. Although these solutions have shown promise, they have only considered cleaning solid materials and have not considered oil cleaning solutions. Traditionally, oil spill remediating techniques include mechanical methods such as oil spill skimmers, dispersants, and large autonomous surface vehicles (ASVs). Fingas in his paper "Analysis of Autonomous Oil Spill Recovery Systems" discussed various autonomous oil spill recovery systems and their

effectiveness in water environments. Nevertheless, the high costs of deploying these systems are a major hindrance to their usage in small water bodies. In a previous paper, Dave and Ghaly in "Oil Spill Recovery Techniques" discussed various techniques of oil spill recovery and concluded that oil spill recovery techniques based on absorption are environmentally friendly and reduce secondary contaminants in water environments. Advances in microcontrollers and embedded systems have led to efficient control of robots using small microcontrollers. ESP32 is a microcontroller that offers Wi-Fi capabilities and is efficient in real-time applications, as discussed in ESP32. Patel et al. in their paper "Smartphone-based Robot Control Using Blynk IoT Platform" demonstrated the effectiveness of smartphone-based control of robots. Furthermore, [7] introduced autonomous surface vehicles for oceanographic data collection, with emphasis on reliability and extended operational capability. Singh et al. [8] introduced an affordable autonomous boat for water quality monitoring. Nevertheless, the emphasis of the introduced system was on the monitoring aspect, with no emphasis on oil cleaning. Material-based oil cleaning has been widely studied to enhance the oil cleaning efficiency. Xue et al. [9] presented various oil-absorbing materials, with high oil selectivity achieved with polymer-based materials. Moreover, the use of eco-friendly oil sorbents has been further studied, with improved reusability and environmental compatibility compared to traditional oil cleaning methods, as presented in [10].

However, the existing literature lacks the integration of the IoT-based remote control, robotic movement, and oil absorption-based oil cleaning in one affordable and efficient system for localized oil cleaning in ponds, lakes, and industrial water tanks. The introduced oil cleaning robot with Wi-Fi control has filled the existing gap in the literature, with the emphasis on the integration of ESP32-based remote control, stable floating movement, and oil absorption-based oil cleaning in one efficient and environment-friendly framework.
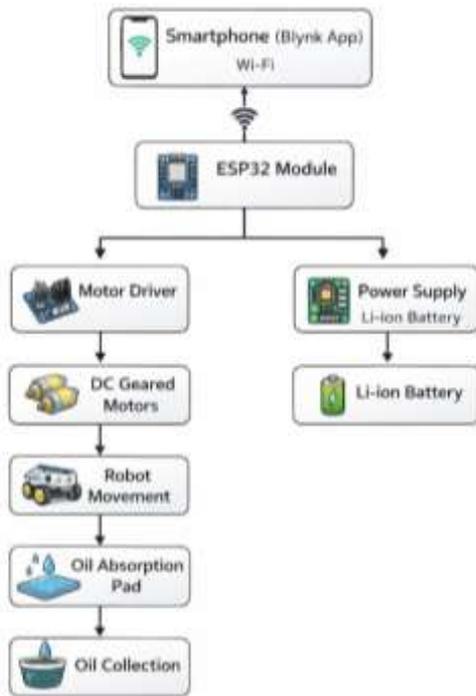
## 4. BLOCK DIAGRAM



**Fig-1:** Block diagram

## 5. WORKING PRINCIPLE

The working principle of the proposed system is based on the concept of wireless robotic mobility and selective oil absorption.

1. ESP32 module is connected to a Wi-Fi network and communicates with the Blynk cloud server.

2. The commands are sent through the mobile application.

3. The control commands are processed by the ESP32 microcontroller.

4. The motor driver is used to activate the respective DC motors for robotic mobility on the water surface.

5. As the robot moves on the water surface, the oil comes into contact with the floating absorbent pad.

6. The floating pad is designed to absorb the oil and repel the water.

7. The absorbed oil is stored in the absorbent pad for future disposal.

## 6. METHODOLOGY

The proposed oil cleaning robot was created through an integrated design approach that incorporates IoT technology and robotic systems with floating capabilities and oil absorption. The lightweight buoyant body was created to ensure stability and ease of movement on water surfaces. The ESP32 microcontroller was used as the brain of the system to control all processes through wireless communication using the Blynk IoT platform. DC motors were used to facilitate directional movement through a motor driver module. The system was powered by a rechargeable battery to ensure portability and ease of use. An oil absorption pad was placed on the rear surface to absorb oil during movement.

## 7. RESULT AND DISCUSSION

The robot floated steadily with minimal tilt during operation. Wireless communication using ESP32 and the Blynk platform exhibited good real-time response with zero latency. The absorbent pad successfully collected the oil using multiple passes over the contaminated areas, thereby reducing the concentration of oil.

The robot was able to run continuously using battery power with low power consumption, proving the feasibility of using ESP32 in a portable environmental robot. Compared with existing methods of oil cleanup, the proposed method provides a lower-cost solution with ease of deployment and safety.



**Fig -2:** Side view 1

**Fig -3:** Side view 2



**Fig-4:** Top view

## 8. CONCLUSION

This research work has discussed the design and development of a Wi-Fi-controlled oil cleaning robot intended for water surface remediation. The integration of IoT technology for control purposes and absorption-based oil collection has been shown to be efficient and eco-friendly for oil spill cleanup on water surfaces. The experimental result has shown promising capabilities for efficient oil cleanup on water surfaces.

## 9. FUTURE SCOPE

The future scope of this project is as follows:

- The project can be improved to include features such as:
- Autonomous navigation using sensors and GPS technology
- Oil spill detection using vision or hydrocarbon sensors
- Solar power-based energy system
- Auto-replacement mechanism for absorbent material

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