An IoT- Integrated Double Disc Type Oil Skimmer with pH Detection

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Abstract - The release of oil into the marine ecosystem has severe detrimental effects, exemplified by a significant incident in 2017 at Chennai near Ennore that originated from the refinery of Chennai Petroleum Corporation Ltd (CPCL) leaked into Kosasthalaiyar River up to 20 square kilometers into the sea, so the biodiverse Ennore creek and the bay of Bengal thereby polluting ecosystem and rendering waters unfit for fishing. To effectively address the recovery of floating oil in dynamic water bodies, we propose a smart oil skimmer featuring a dual circular disc mechanism, coupled with a user-controlled smartphone-based IoT system for data monitoring and control. This IOT enables remote control of the system from any location through a server, contributing to efficient operation.

Keywords-Oil leakage, Marine ecosystem, pH sensor.

I INTRODUCTION

Water pollution is the contamination of water bodies, such as lakes, rivers, oceans, and groundwater, by harmful substances. These contaminants can include pollutants from various sources like industrial discharges, agricultural runoff, urban sewage, and oil spills. Historical data from ITOPF shows 5.86 million tons of oil lost in the last 50 years due to tanker incidents. Skimmer systems, including vessel type and steam-driven ejector type, address oil spills in dynamic water bodies, find applications in oil spill response, oily water treatment, and remove oil from coolants and hydrous portion washers. Crucial parameters like humidity, moisture, and temperature assess the friendliness of an environment. In our research, we utilized IoT to remotely control an oil skimmer worldwide, requiring minimal manpower and time, easily managed through a server. As oil spills introduce hydrocarbons, the pH sensor integrated into the skimmer disc tracks variations in water chemistry. This data helps in understanding the extent of contamination and enables swift response measures. The interaction between oil and oxygen, leading to oxidation reactions and the formation of by-products, can be monitored dynamically through the pH sensor.

II LITERATURE SURVEY

Oil spills are a significant environmental concern, with detrimental effects on ecosystems, human health, and economies. Effective oil spill remediation techniques are essential to mitigate these impacts. One widely employed method for removing oil from water surfaces is the use of oil skimmers. Oil skimmers are mechanical devices designed to collect oil from water surfaces, thereby facilitating its removal and disposal. Among various types of oil skimmers, the double disc type has garnered attention due to its efficiency and versatility in different environmental conditions.

The efficacy of traditional oil skimmers, including drum skimmers and weir skimmers, has been well-documented in the literature. Drum skimmers, for instance, utilize rotating drums to collect oil from water surfaces, while weir skimmers rely on gravity to skim oil from the water surface. However, these conventional skimmers often face challenges in terms of scalability, maneuverability, and adaptability to varying oil spill scenarios.

A study by Smith Et al. (2019) investigated the integration of IoT technology into oil skimmers for enhanced oil spill response. The researchers developed a prototype IoT-enabled oil skimmer equipped with sensors to monitor oil concentration, water quality parameters, and environmental conditions in real time. The IoT platform facilitated remote monitoring and control of the skimmer, allowing operators to optimize skimming operations and minimize environmental impacts.

III HARDWARE IMPLEMENTATION

A. ESP32 CONTROLLER

The ESP32 is a family of low-cost, low-power System-on-a-Chip (SoC) microcontrollers that also have a dual-core CPU, Wi-Fi, and Bluetooth wireless connectivity. It can be used either as a standalone chip or as a comprehensive development board. There are two variants of this board, one with 30 GPIOs and the other with 36 GPIOs. In terms of wireless connectivity, the ESP32 supports Wi-Fi with a data rate of 150.0 Mbps using HT40 technology. It also supports both Bluetooth Low Energy (BLE) and Bluetooth Classic protocols. Ten silica Xtensa dual-core 32-bit LX6 CPU, operating at 160 or 240 MHz, powers the ESP32. It features 520 KB of static random-access memory and 448 KB of read-only memory (ROM). Furthermore, the ESP32 is compatible with the Arduino IDE, allowing programmers to use the familiar Arduino core to develop and program applications for the ESP32 microcontroller

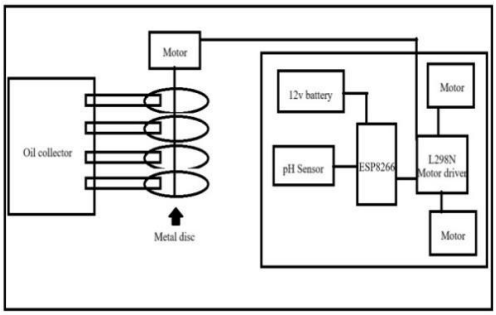

Fig 1. Block diagram of the hardware module

B. L298N MOTOR DRIVERS

A high-power motor driver module, the L298N Motor Driver Module may be used to operate both DC and stepper motors. A78M05 5V regulator and an L298 motor driver IC make up this module. The L298N Module can direct and speed-control up to 4 DC motors or 2 DC motors.L298N 2A is the driver model. 46V is the maximum motor supply voltage. 0-36 mA for logical current. The maximum power is 25W.

C. MQ2 GAS SENSOR

MQ2 Sensors are electronic gas gauges that can be used to identify a specific gas, such as hydrogen, Methane, CO (carbon monoxide), and LPG (liquid petroleum gas) are all detected using MQ2 Devices. Additionally, the digital pins on this module make it easier to use a microprocessor or an ESP32. The pin will be high if the output surpasses the threshold and low if the output is below the threshold. The measurement range for this instrument is 200ppm–1000ppm [9] [12].

D.THRUSTER

Oil spillage poses significant environmental hazards, necessitating efficient cleanup operations. Thruster systems play a vital role in the maneuverability and effectiveness of oil skimmers, enabling precise control and targeted collection of oil contaminants. This paper examines the design principles and considerations specific to thruster systems for oil skimmer applications. It delves into the key factors influencing thruster selection, such as propulsion type, thrust output, power requirements, and maneuverability. Additionally, practical implementation strategies and case studies are discussed, highlighting the integration of thruster systems into oil skimmer platforms for effective oil spill response.

E. TEMPERATURE SENSOR

Temperature sensing is fundamental across various industries, ranging from electronics to environmental monitoring. The efficiency and accuracy of temperature sensors are critical for ensuring optimal performance in applications such as industrial processes, healthcare, and climate monitoring. This paper presents a comprehensive review of the design principles, working mechanisms, and performance analysis of temperature sensors. It explores various types of temperature sensing technologies, including thermocouples, resistance temperature detectors (RTDs), thermistors, infrared sensors, and semiconductor-based sensors. Additionally, considerations for sensor selection, calibration, and optimization are discussed, along with recent advancements and future directions in temperature sensing technology.

F. pH SENSOR

pH sensing technology plays a pivotal role in a multitude of fields, ranging from environmental monitoring to biomedical applications. Accurate and reliable pH measurement is essential for ensuring the quality and safety of various processes and products. This paper provides an in-depth analysis of the working principles, design considerations, and performance characteristics of pH sensors. It explores different types of pH sensors, including glass electrode sensors, ion-selective field-effect transistors (ISFETs), and optical sensors, elucidating their underlying mechanisms and operational principles. Additionally, considerations for sensor selection, calibration, and optimization are discussed, along with recent advancements and future directions in pH sensing technology.

G. BLYNK CLOUD

The Blynk Library manages communication, cloud-based device authentication, and command processing between the Blynk app, the cloud, and the hardware. Whether you are beginning from scratch or incorporating Blynk into an already project, it is incredibly versatile. In mobile apps, control tools for the application and value displays for presenting Sensor values are provided by #C++ (Arduino).

H. 12 VOLT BATTERY

This is a rechargeable lead-acid battery, which is commonly referred to as a sealed or maintenance-free battery. It consists of multiple lead-acid cells connected in series within a single container. Each lead-acid cell contains two lead plates immersed in an electrolyte solution of sulphuric acid. This battery is designed to be used in any position or orientation without the risk of spillage. The battery cover is constructed using polypropylene material, protecting against impacts in challenging conditions. Furthermore, this battery does not require any water refilling during its entire lifespan.

IV Hardware Implementation

In the project titled An IoT-Integrated Double Disc Type Oil Skimmer with pH Detection, the ESP32-CAMmodule can play a crucial role in providing visual monitoring capabilities. Here is how the ESP32-CAM can be utilized in this project:

Fig 2. Real-time implementation of an IoT integrated Double Disc type oil skimmer module

This model is designed to remove oil, grease, and other floating contaminants from water surfaces. It typically consists of a mechanism to collect the oil from the water's surface, such as a belt, tube, or disk, which is then separated from the water. Oil skimmers are commonly used in industrial settings, wastewater treatment plants, oil spill cleanup efforts, and various other applications where removing oil from water is necessary for environmental or process reasons. The pH sensor then detects the pH level of the water to remove the oil content. In this project, the main component is the Oil Skimming disc. This disc is mounted on the shaft the

shaft one end is connected to the DC motor 12V. The power supply for the motor is 12 V battery. The scraper is provided in front of the disc to remove the oil from the disc and the oil is collected to the collecting tank. Teflon or activated carbon for separator systems of roller and with pH Sensor inserted to detect the pH of the water.

A. MECHANISUM OF OIL SKIMMER

Oil spills pose significant environmental threats, necessitating efficient cleanup strategies. Oil skimmers play a crucial role in the removal of oil contaminants from water surfaces, employing various mechanisms to achieve effective separation. This paper provides a comprehensive analysis of the mechanisms and operation of oil skimmers, elucidating the principles behind their design and functionality. It explores different types of oil skimmers, including weir skimmers; drum skimmers, belt skimmers, and disc skimmers, highlighting their unique features and applications. Additionally, considerations for skimmer selection, deployment, and optimization are discussed, along with case studies and advancements in oil skimming technology.

Fig 3. Top view of the disc-type oil skimmer in hardware setup

B. SPECIFICATION OF DISC TYPE OIL SKIMMER

This oil separator can be used in the navy to collect the oil in the sea if any oil spill occurs. This oil separator can be used in industries where oil is a major material used and leakage of oil occurs regularly. Marine applications: Offshore plants like ONGC and oil collecting stations like Bombay have High Lower Maintenance costs. Marine and Port Operations: Oil skimmers equipped with pH sensors can be deployed in ports and harbors to prevent oil pollution by efficiently removing oil from water surfaces, thereby protecting marine ecosystems Industrial Wastewater Treatment: In industries where oil contamination is common, such as manufacturing, machining, or food processing, integrating pH detection into oil skimmers ensures effective removal of oil from wastewater before discharge.

Oil and grease are always on the water's surface. They do not mix with water. Separation is based on surface tension, specific gravity, and viscosity. The “oil and grease skimmer unit has a special purpose Disc, which is rotated by mechanical means such that it just touches the surface of the water the oil and grease particles stick to the Disc material and travel with the Disc up to scrapping arrangement where scrapping of oil and grease occurs and oil grease are collected. This unit mainly consists of a rectangular frame. In the first stage of the unit the top surface of the frame motor and gearbox of fitted. The ¼ H.P. induction motor is used having 40r.p.m. At the bottom of the frame driven shaft is placed in the tightening arrangement. This arrangement is provided for the movement of the shaft as per the requirement. One drum each is fitted on the two shafts with the help of the boss. On these drums, the main oil-removing Disc is placed. With the help of a tightening arrangement, the Disc is sufficiently tightened so that it will not slip. The main advantage for the adjustment of the unit as per the level of water flow. In the same sense 2nd stage of the unit is formed and its upper shaft with a drum is driven by an intermediate chain drive. On one side of the frame, a scrapping arrangement is attached which removes the oil and grease from the surface of the Disc. The removed oil and grease is carried through the collector pipe to the barrel. When the unit is switched on, the motor starts, which is coupled to the gearbox. The motion of the motor shaft is given to the gearbox, which reduces the speed. This reduced speed is given to the driver shaft through a sprocket. The upper shaft is rotated, because the drums revolve at about at because of these drums revolve and Disc is revolving at about 15 to 16 rpm. The Disc is immersed in water oil and grease is stacked to the Disc material which so carried with the Disc up to the scrapping arrangement. Here scrapping of oil and grease occurs and oil and grease are collected in the barrel through the collector pipe. The Disc after scrapping arrangement, here scrapping of oil and grease occurs and oil and grease are collected in a barrel through a collector pipe. The Disc after scrapping again goes the downward in water channel. This cycle is repeated continuously.

C. Programming IoT Device

Write code to program the IoT device for data transmission. Include routines for pH sensor readings and information on oil skimming activity. Implement error handling and security measures. Data Logging and Storage: Set up a system for logging and storing data received from the pH sensor and oil skimmer. Consider cloud storage options for easy accessibility and analysis. Ensure a stable and reliable power supply for both the skimmer and IoT components. Consider using rechargeable batteries or solar panels depending on the project location and requirements. Conduct thorough testing of the oil skimmer, pH sensor, and IoT connectivity. Calibrate the pH sensor to ensure accurate readings. Address any issues with the skimming mechanism. Blynk Library uses a proprietary binary protocol. Every message consists of 2 parts.

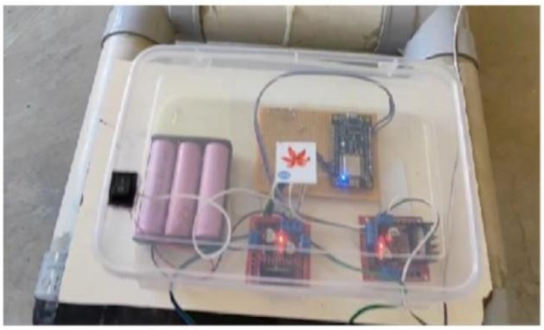

Fig 4. The thruster module with the motor driver

CONCLUSION

The IoT-based oil skimming project has demonstrated its effectiveness in efficiently removing oil from water surfaces. By integrating sensor technology and real-time monitoring, the system enhances environmental sustainability, providing a proactive approach to oil spill management. The project aligns with the principles of the Internet of Things (IoT) and contributes to a cleaner and more ecologically responsible solution for maintaining water quality in various settings. Integrating chemistry-oriented ideas into oil skimming projects can lead to more sophisticated and effective solutions for addressing oil pollution in various environments. In the future, we can develop biologically non-harmful mannered chemical strategies and applications to remove the oil from water.

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