Sustainable Robotised Floating System for Collecting Debris from Discharge Basin for Aluminium Industries

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Abstract

This research project describes the design and implementation of a customised Sustainable Floating System (SFS) for collecting debris for an aeration basin that can also be used in coastal areas and rivers. The proposed solution has been designed to address the on-site requirements to clean the aeration basin, considering reliability, efficiency, and sustainability in the design and implementation stages based on the requirements and constraints. The system has two modes of operation: fully autonomous and semi-automatic, with remote control. The floating platform surveys the aeration basin to collect information from the sonar system embedded at the thruster regarding the accumulated precipitation depth and combines it with the positioning data received from the GPS to create a three-dimensional precipitation distribution map that will be used to direct the cleaning process. In addition, a portable floating storage tank could be attached to the system and used to store and transport the collected debris. A collection tank is engaged with the platform through a sliding mechanism that clings to the platform. The system is equipped with a thruster that can be levelled based on the water depth. Besides, it is equipped with GPS and auto-pilot systems to maintain the system's anchoring while conducting the cleaning process. The system is sustainable since a solar power system operates it.

Keywords: Robotised Sustainable Floating System, Aeration Basin, Debris Collection.

1. Introduction

Several methods have been employed for debris collection in industrial discharge aeration basins [1]. These methods range from manual labour to the use of advanced technologies. The manual method involves the use of nets, rakes, or dredging equipment to physically remove debris from the basin [2]. While this approach can be effective for larger debris accumulation, it can be time-consuming and labour-intensive. Automated systems, as an alternative method, have been developed to streamline debris collection processes. Robotics, such as autonomous underwater vehicles or remotely operated vehicles, offer the potential for precise and targeted debris collection, reducing human intervention and improving safety [3]. These automated systems offer advantages in terms of efficiency, accuracy, and reduced labour requirements. Despite the advancements, certain challenges and limitations persist. One significant challenge is the accurate detection and identification of debris accumulation [4]. Another challenge is the management of the collected debris. Disposal and proper treatment of the collected debris pose logistical and environmental concerns. The debris may contain pollutants or hazardous substances that require appropriate handling to minimise environmental impacts.

The integration of emerging technologies like artificial intelligence, machine learning, and robotics can play a significant role in enhancing debris collection [5]. By incorporating machine learning algorithms, debris detection, and classification accuracy can be improved, leading to more efficient collection processes. Furthermore, the utilization of unmanned aerial vehicles (UAVs) or underwater drones equipped with high-resolution cameras and advanced imaging software has shown promise in monitoring and identifying debris accumulation and can provide valuable visual data, facilitating proactive debris management and maintenance planning [6].

2. Feasibility of Designing an Unmanned, Sustainable Floating Platform for Debris Collection

This section explores the feasibility of designing an unmanned, sustainable floating platform, considering various factors including technological advancements, operational considerations, and environmental impact.

2.1. Technological Advancements

Advancements in robotics, sensing technologies, and renewable energy systems have made the development of unmanned floating platforms feasible. Robust and reliable sensors can detect debris efficiently, while sophisticated navigation systems enable precise manoeuvrability. Integration of renewable energy sources provides sustainable power for extended operational periods. These technological advancements support the feasibility of designing an unmanned, sustainable floating platform for debris collection.

2.2. Operational Considerations

The operational feasibility of the platform depends on several factors. Firstly, the platform should be designed to withstand harsh marine conditions, including rough seas, strong currents, and varying weather patterns. Robust materials, corrosion-resistant components, and proper buoyancy systems are essential to ensure operational durability. Secondly, the platform should be able to cover large areas efficiently and autonomously, reducing the need for constant human intervention. Incorporating advanced navigation systems and optimised debris collection mechanisms enhances operational efficiency and feasibility.

2.3. Environmental Impact

Designing an unmanned floating platform for debris collection requires careful consideration of its environmental impact. The platform should be designed to minimise any potential harm to marine ecosystems. This includes selecting eco-friendly materials, implementing mechanisms to prevent the entanglement of marine life, and minimising noise and vibration emissions during operation. Using renewable energy sources contributes to reducing the platform's carbon footprint.

2.4. Cost and Resources

The feasibility of implementing an unmanned floating platform for debris collection also depends on the cost and availability of resources. The design should strike a balance between functionality and cost-effectiveness. Factors such as material costs, technological components, maintenance requirements, and operational expenses need to be carefully assessed. Additionally, the availability of skilled technicians or operators to handle the platform's maintenance and repairs.

discharge aeration basins, ultimately leading to more sustainable and effective wastewater treatment practices.

Figure 8. The developed system was tested in EGA aeration basin site [11].

5. References

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