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Design of River Surface Cleaning "ECOBOT"

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Abstract - The increasing pollution and excessive weed growth in rivers pose serious threats to aquatic ecosystems and water quality. This project presents the design of a river surface cleaning and weed-cutting Ecobot aimed at addressing these environmental issues through a sustainable and efficient solution. The robot is equipped with a conveyor mechanism for collecting floating waste and a rotating cutter system for trimming aquatic weeds. Powered by a solar-based energy system, the Ecobot promotes eco-friendly operation while reducing dependence on conventional power sources. The design focuses on lightweight materials and flexibility, ensuring easy maneuverability in water. This multifunctional robot offers a practical approach to maintaining clean water bodies, supporting long-term environmental conservation.

***Key Words*:** River Pollution , Sea Weed , Robot Technology , Environmental management , aquatic ecosystem

1.INTRODUCTION

Rivers are vital lifelines of our environment, supporting diverse aquatic ecosystems, supplying water for domestic and industrial use, and maintaining ecological balance. However, increasing human activities have led to severe pollution in these water bodies. Careless disposal of waste such as plastics, bottles, wrappers, and industrial debris has resulted in the accumulation of garbage on the river surface. This human-made waste not only pollutes the water but also poses a serious threat to aquatic life. Many species mistakenly consume plastic waste, which can lead to injury, poisoning, or death. Moreover, the presence of garbage in rivers reduces oxygen levels, disrupts the food chain, and contributes to the degradation of aquatic habitats.

In addition to pollution, the uncontrolled growth of aquatic weeds, especially invasive species like water hyacinth, further worsens the condition of river ecosystems. These weeds form thick mats on the water surface, blocking sunlight from reaching submerged plants and reducing oxygen levels in the water. This creates a suffocating environment for fish and other aquatic organisms, negatively impacting biodiversity. Dense weed growth also hampers water flow, clogs irrigation channels, and interferes with fishing and boating activities.

To address these pressing environmental issues, our project titled **"Design of River Surface Cleaning Ecobot"** proposes an innovative and eco-friendly solution. The Ecobot is a solar-powered, semi-automatic robot designed to collect floating waste and cut surface weeds effectively. It uses a conveyor mechanism for waste collection and a motorized cutter to manage weed overgrowth, offering a sustainable approach to river maintenance. With its lightweight and flexible design, the Ecobot aims to reduce manual effort, support environmental conservation, and contribute to cleaner, healthier river ecosystems.

2. LITERATURE REVIEW

The water pollution is very important problem in rivers, ponds and water bodies near Godavari River at Nashik. Due to increase in water pollution in the form to waste debris; it is hampering the life of aquatic animal and make their life in danger. India is holy country & during lots of festival like Ganesh Visarjan, Navratri Durga puja & mainly Siahnsthkumbhmela there is lots of water pollution of Godavari River at Nashik. Similarly sometimes the aquatic animal tends to eats surface waste debris considering it as a food; which ultimately cause the death of animals. Due to polluted water many skin diseases to human kind are observed. So that to reduce the water pollution we are trying to make river cleanup machine. "River cleanup machine" a machine which involves the removing the waste debris from water surface and safely dispose from the water body. The river cleanup machine works on hydropower to extract waste water debris, plastics & garbage from Godavari river at Nashik. Explained that the motive of the project is to automate the sewage cleaning process in drainage. A machine consisting of a chain and sprocket and driven by a motor is made use of in the cleaning process. When the motor runs, the chain starts to circulate and it makes the lifter to

move upwards. The waste material is lifted by lifter teeth and stored in a collector bin. Once the collecting bin is full, the waste material is removed from the bin manually. Fabricated a river cleaning machine which makes of a turbine driven alternator to produce electricity. When water flowing in the river falls on turbine the turbine begins to rotate. The alternator generates electricity. This drives the vertical conveyor belt and horizontal conveyor belt through timing chains and sprockets. With the help of spur gears both the conveyor belts are connected with each other.

3. METHEDOLOGY

Objective Definition: The main objective is to design a solar-powered floating robot that collects waste from water surfaces using a conveyor belt mechanism.

Design Concept: The robot includes two photovoltaic (PV) cells for power generation, a conveyor belt for collecting debris, propellers or wheels for movement, and a buoyant structure to keep it afloat.

Material Selection: Selected materials include 1.5 W PV cells, buoyant pontoons, a mesh conveyor belt, and an aluminum or stainless-steel frame to ensure durability and corrosion resistance.

Working Principle: Solar energy powers the motors that drive the conveyor belt and the movement system. The conveyor belt collects floating debris from the water surface.

Prototype Development: The frame is assembled first, followed by the installation of the conveyor belt, solar panels, and motors. Each component is tested individually before final assembly.

Testing and Evaluation: The prototype is tested for power efficiency, movement, and debris collection. Based on the results, design adjustments are made to improve performance.

Optimization and final Implementation: After refining the design through testing, the optimized Ecobot is deployed in the target water body. Results and performance are documented for future enhancements.

4. CALCULATION

4.1.Blades: The cutting resistance (R) has been considered proportional to the cutting area, measured in the motion plane of the blade.

Infinitesimal value for the single blade cutter bar.

$$R = E \times \frac{da}{dx}$$

da = effective area moved by the blade dx=infinitesimal displacement

From this formula we calculated the resistance and from this we are finalizing this dimension

1. Dimension -44cm*0.5cm

a.Length – 44cm

b.Width - 0.5 cm

2. Number of cutters - 4

Material – stainless steel

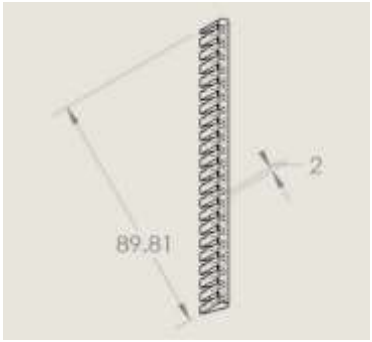

Fig.4.1

4.2.Conveyor belt: Here we have used the aluminium net for conveyor belt cause pores in it will easily pick up the trash and move it towards collecting tray and store it in. The dimension of the conveyor belt is as follows:

1. Dimension -56*30 cm

a.Length -56 cm

b.Width – 30cm

2.Number of rollers - 2

3.Material – PUC Pipe , net

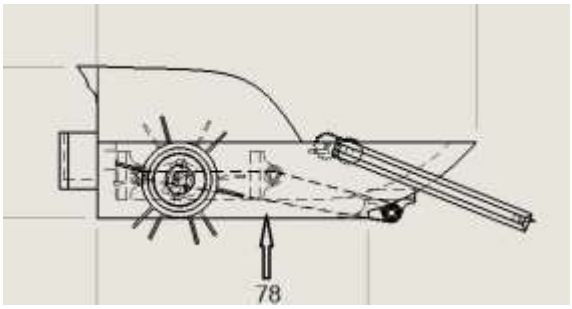

Fig.4.2

4.3.Propeller : The drive shaft is a rod or tube used to carry rotation from the gear motor. Propellers are used to

give a direction to the vehicle. Its made up of fiber on which metal plates are fixed externally. propeller was made by using the toy car wheels. Impeller was made by using the metal sheet with the help of following dimension and material:

1.Radius- 12 cm

2.Impeller Blade length- 8 cm

3.Number of impeller- 6

4.Materials – a) for propeller-plastice

b) for impeller-cast iron (SAE20)

Torque (t) = F*R = D/ 2

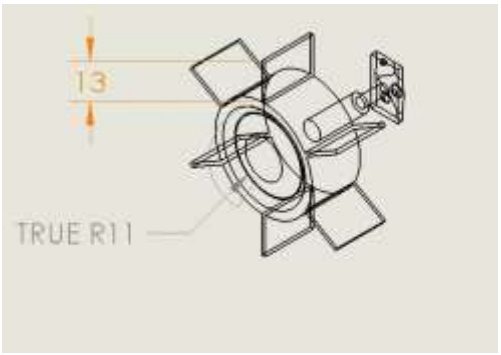

Fig.4.3

4.4.Body: The body of the boat is made up of fiber sheets as they are less in weight. It will protect the boat from drawining. For balancing the boat the center of gravity is calculated by the formula given below:

$$\text{Center of gravity} = \frac{m1g1x + m2g2x}{M1g1 + m2g1x}$$

5.PROPOSED DESIGN

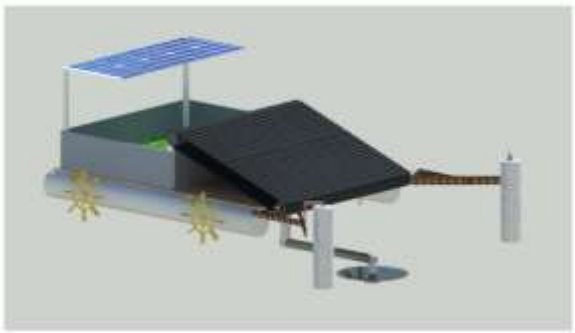

Fig.5.1

Following figure 5.1 shows the proposed compact and reliable design of Ecobot on AutoCAD.

6.TESTING AND RESULT

The EcoBot performed effectively in collecting floating waste using a mesh conveyor system and cutting aquatic weeds with stainless-steel rotary blades. While it handled light to moderate waste loads efficiently, finer mesh is needed for small debris. The weed-cutting mechanism worked well but occasionally got tangled, suggesting the need for a self-cleaning feature. The flotation system ensured stability, although minor tilting occurred due to uneven waste distribution. Navigation was smooth in still water, but flowing water affected movement; this can be improved with higher RPM motors or AI-based navigation. The 10W solar panel adequately charged the 12V battery under sunlight, but performance dropped in low-light conditions, highlighting the need for a more powerful or hybrid power system. Overall, the EcoBot reliably performed its cleaning and weed-cutting tasks with scope for enhancements in stability, power efficiency, and system resilience.

Fig.6.1 Floating Ecobot

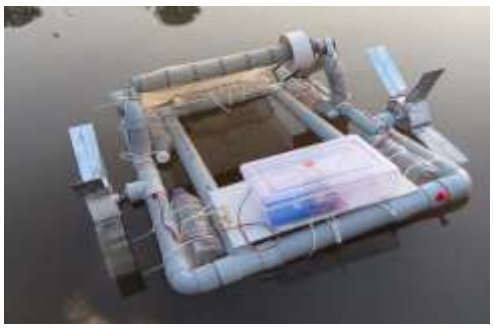

Fig.6.2 ECOBOT

7.CONCLUSION

In conclusion, the EcoBot demonstrates a practical and eco-friendly solution for cleaning river surfaces and cutting aquatic weeds. Its solar-powered system, efficient waste collection mechanism, and effective weed-cutting blade make it suitable for real-world environmental

applications. While the robot performs well in controlled conditions, minor improvements in mesh design, power capacity, and navigation can enhance its efficiency and reliability. With further optimization, the EcoBot has strong potential to contribute significantly to water body maintenance and environmental conservation efforts.

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