Automated Floating Robot Used for Beach Waste

TEAM 110

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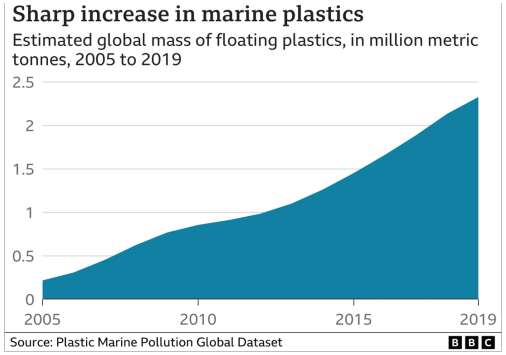
Problem Statement

Plastic waste accumulation in Saudi Arabia's beaches poses a significant threat to marine life, tourism, and the environment. Manual cleanup methods are inefficient and costly.



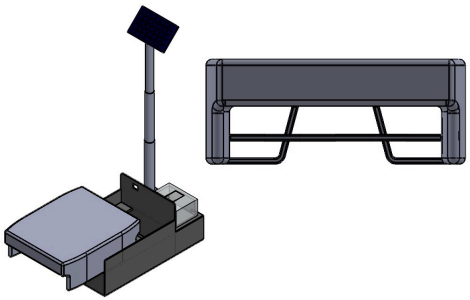
Objective

Design and prototype a clean-powered autonomous floating robot equipped with engineering tools that optimizes power consumption and source, collected plastics and able to detects, collects, and stores plastic waste from coastal waters efficiently, safely, and sustainably.

Prototype Design

Robot Constrains and Specifications

- LiDAR-based SLAM navigation with accuracy ± 0.5m
- SWIR sensor for up to 10 m AI Model plastic classification
- Ultrasonic sensors for up to 10 m obstacle avoidance
- 0.03 m³ sealed waste chamber
- Waterproof design (IP67/IP68)
- Withstand 60°C and 100 kppm salt CX
- Max Robot Density ≤ 0.92 g/cc

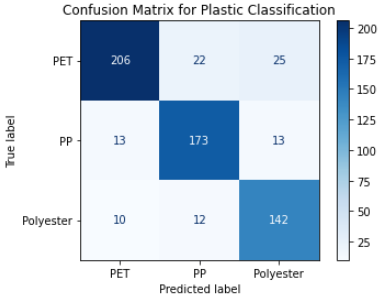


Docking Station Specifications

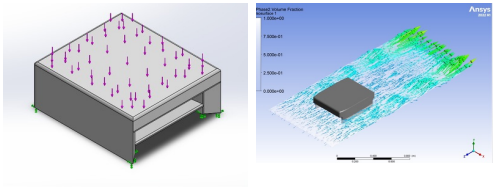
- 500W solar panel with optional AC input
- Solar tracking with 5 min adjustment
- 0.15 m³ waste capacity
- Battery charging and docking platform

Validation

AI Model Plastics Classification:
An AI model was trained on 616 labeled samples of PET, PP, and Polyester to classify plastics using SWIR spectral data (900–2500 nm).



Stress Analysis and Drag Force :
Structural integrity and hydrodynamic efficiency were evaluated using Finite Element Analysis (FEA) and CFD simulations. The hull design achieved a low drag force of 0.215 N and a drag coefficient of 0.0113, ensuring energy-efficient movement. These results guided the final shape to reduce resistance and enhance performance in water.



Route Optimization (TSP):
The robot's path is optimized using a variation of the Traveling Salesman Problem (TSP) to cover the cleaning area efficiently. By combining LiDAR with real-time mapping, the system minimizes redundant movement and ensures full coverage within the defined zone.

Impact

- **Environmental:** Reduces marine plastic, supports Saudi Vision 2030.
- **Economic:** Cuts labor costs, enables recyclable plastic collection.
- **Societal:** Improves coastal cleanliness and marine safety.

Conclusion

The project successfully developed an autonomous, solar-powered robot that detects and collects beach plastic waste with high efficiency, offering a sustainable solution to marine pollution.