# The Design and Prototyping of a Low-Cost & Efficient Ocean Cleanup Robot

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## Project Background

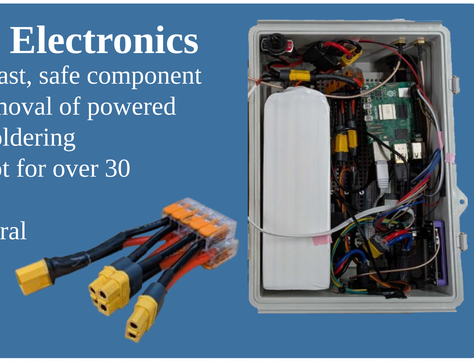
An estimated **11 million tons of plastic waste** entered the oceans last year, joining the **200 million tons** already crowding Earth's waterways, per Ocean Conservancy. This waste poses a **significant health risk** to both humans and marine wildlife. **Existing robotic systems** for combatting plastic waste are **expensive** and require **significant human support**, preventing the kind of large-scale operation needed to combat waste accumulation.

## Project Goals

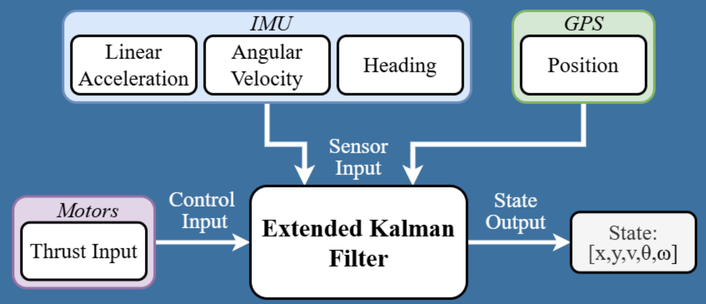
- Collect plastic waste in shorelines, rivers, and lakes
- Support sustained autonomous operation through:
  - Real-time localization
  - Plastic waste detection
  - Durable mechanical and electrical design
- Test robot capabilities in target environments
- Develop cost-effective and reproducible bill-of-materials

## Electronics

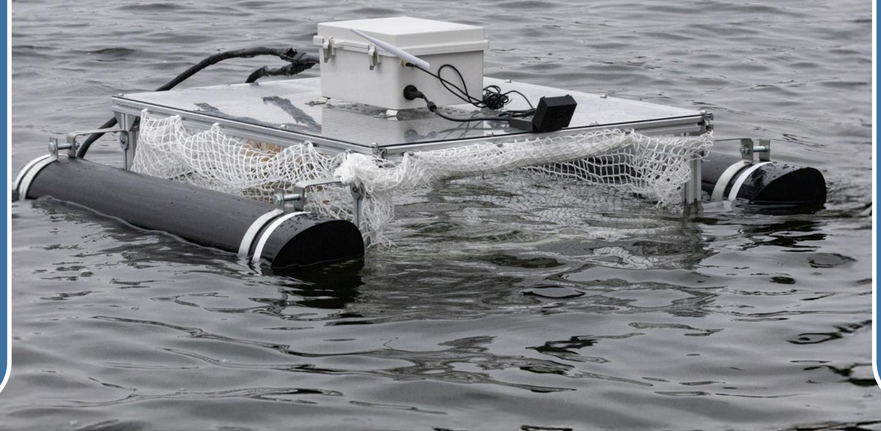
- Power hub allows for fast, safe component swaps and addition/removal of powered components without soldering
- LiPo battery powers bot for over 30 minutes at full speed
- Raspberry Pi 5 for central control and ESP32 for PWM motor control



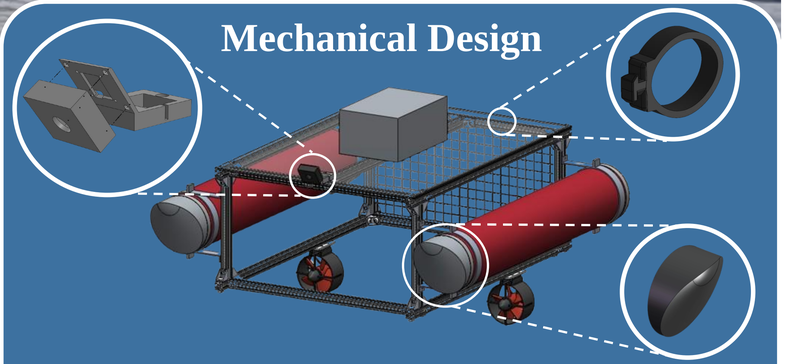
## Localization




- Tracks robot position, linear velocity, heading, and angular velocity
- Creates local coordinate system at initial robot position
- Complementary filter for heading, moving average for all IMU data

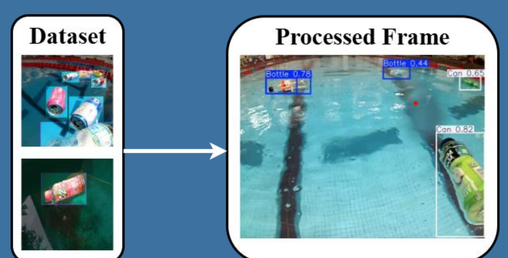


## Mechanical Design



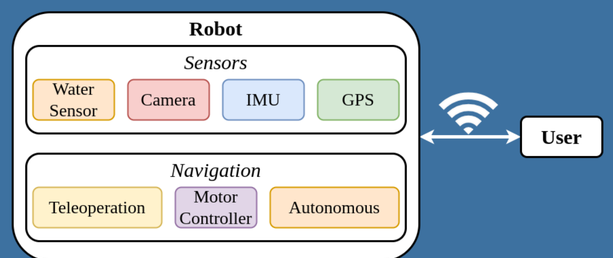
- Inspired by catamaran boats for stability and passive intake system
- Custom wave breakers reduce drag
- Utilized strong and lightweight materials for frame construction
- Plastic waste is collected in a nylon net reinforced with a steel grate

## Waste Detection




- USB camera with 95° field of view, running at 10 fps
- Computer vision using You Only Look Once (YOLO) model
- Detect and classify common plastic wastes items in real-time video

## Control




- Two ROS2 packages to control sensor processing and navigation
- Utilizes PID closed loop control for drift correction
- Communicates to user via wireless router for remote interaction

## Results

- Delivers similar performance to commercial alternatives at a fraction of the cost
- Human operator controlled motion while the robot autonomously prevented drift and estimated current state
- Computer vision model provided information on possible target locations

See our robot in action!