OCEAN ROBOT CLEANER (ORCA)

Group 5 - Tam Le, Zain Ali, Sai Rohan Kakarlapudi, Om Goyal

Scenario Description

After a successful MVP demo of ORCA - an autonomous robot designed to collect trash from bodies of water - this second scenario introduces several improvements and advanced features that are built on top of the MVP. Users will now have access to a fleet of ORCA robots at their disposal. After multiple cleanup sessions, maintaining operational efficiency is crucial. Our web-based interface provides real-time analytics on motor status, sensor performance, debris compartment integrity, and battery health. Based on this data, users can schedule preventive maintenance, including filter replacements, sensor cleaning, and software updates.

Advanced Features and Improvements

After deployment of the robots, the users can also utilize these new advanced features and improvements.

Targeted Cleanup Missions

Users can designate high-debris areas using historical data or real-time satellite feeds. ORCA robots prioritize these hotspots, dynamically adjusting routes in coordination with other units for efficient coverage.

Adaptive Navigation

Using machine learning and ultrasonic sensor data, ORCA detects unusual surface conditions and water currents, autonomously rerouting to avoid obstacles like algae blooms and restricted zones.

Extended Mission Duration

To maximize efficiency, ORCA robots can use floating recharging stations or mid-mission battery docking at designated checkpoints, ensuring continuous operation.

Collaborative Multi-Robot Coordination

The user interface provides real-time tracking of cleaning progress. If an area is cleared faster or needs more assistance, robots are dynamically reassigned for optimal coverage.

Fleet Expansion & GPS Integration

We plan to develop another ORCA robot for larger coverage and conduct rigorous testing under varying environmental conditions. Integration of GPS modules will enable live tracking of each robot's location.

Maintenance Operations

After each mission, ORCA robots return to base or a floating service station for routine maintenance:

- **Filter Cleaning/Replacement** – Maintain debris-trapping efficiency.
- **Hull Inspection** – Check for cracks or biofouling accumulation.
- **Software Updates** – Install new navigation optimizations and bug fixes.
  If hardware issues arise (e.g., battery degradation or sensor misalignment), the system flags them for immediate attention, allowing swift redeployment without restarting the mission plan.

Data & Reporting

ORCA streams mission data to a centralized database, generating reports on:

- **Maintenance Logs** – Track replaced parts, cleaning schedules, and software updates.
- **Debris Concentration Analysis** – Heat maps of collected waste for pollution tracking.
- **Adaptive Navigation Adjustments** – Records of route changes due to real-time conditions.
- **Resource Efficiency Stats** – Battery usage, cleaning speed, and downtime metrics.

Environmental agencies and researchers use this data to optimize deployment strategies, forecast maintenance needs, and monitor long-term pollution trends.

Outcome

By integrating real-time analytics, advanced navigation, and scheduled maintenance, we enhance ORCA's efficiency, reduce downtime, and ensure scalable, data-driven ocean cleanup efforts. Our system extends the robots' lifespan and strengthens their role in combating water pollution.