# Environmental Field Robotic Simulations

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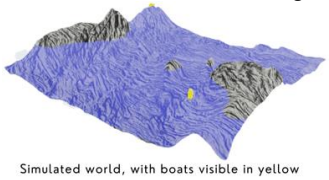
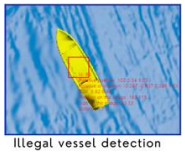
To mitigate escalating environmental challenges, leveraging high-fidelity robotic simulation platform enables realistic modeling and monitoring. Our project evaluates aquatic scenarios using the Webots simulation platform to explore three targeted scenarios, each demonstrating the practical applications and benefits of robotic simulations in marine settings.

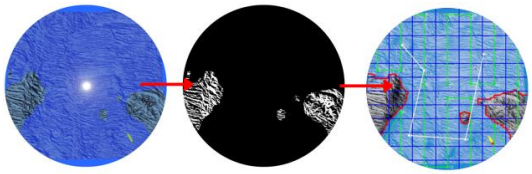


Simulated world, with boats visible in yellow



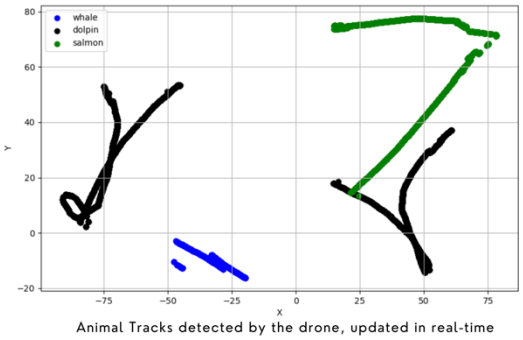
Illegal vessel detection

The first scenario addresses the threat of illegal fishing. For this, an autonomous boat and drone system navigates and computes paths autonomously in the given map. The drone detects vessels and assesses their legality based on their type and location. If there is any mismatch with the Automatic Identification System (AIS), the coast guard is notified. This AIS system is simulated using Webots' supervisor to update in real-time a csv file with vessel information.



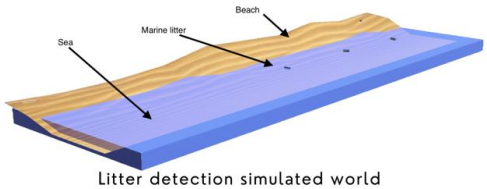
Obstacle detection and waypoint computation

The second scenario, focused on marine wildlife monitoring, implements an automated system to track and analyze the behavior of four simulated species: dolphins, hammerhead sharks, salmons, and whales. Utilizing a personalized flocking algorithm, the system models natural behaviors such as cohesion, separation, and alignment within a dynamic marine environment while also avoiding obstacles. The drone surveys the area, following and recording animal positions, when detected. Simulation limitations in visual recognition under water are addressed by using positional data for recognition. The drone maintains a stable tracking process by focusing on one species at a time, ensuring data integrity, and incorporating boundary stability mechanisms to avoid false detections.




Animal Tracks detected by the drone, updated in real-time

In our final world, we developed a drone-based system for detecting litter along coastlines. This world, simpler in design than previous ones, features a beach and a dynamic sea environment that simulates wave motion affecting litter. The drone, operating autonomously from the beach, captures images at fixed intervals along the coastline. These images are processed in real-time by a controller using OpenCV to detect litter, effectively identifying and plotting the litter's position from the drone's position and orientation. The implementation highlights the capability of drones to quickly cover large, often inaccessible areas and provides a cost-effective, comprehensive solution for coastal litter monitoring.




Litter detection simulated world

These scenarios, designed for both practical application and educational purposes, underscore the potential for improving computer vision models and expanding to multi-drone operations, while showcasing the versatility and effectiveness of drone technology in environmental conservation efforts.