FF4EuroHPC Success Story

HPC-Based Navigation System for Marine Litter Hunting

Organizations

Green Tech Solution s.r.l. is a Start-up focused on the digital integration of ICT, AI and UV. Environmental service relies on AI controlling marine, terrestrial and flying UVs by intelligent algorithms.

University of Naples Parthenope is a public Italian university with a background in the science of navigation, maritime economy, computer science, computer vision, pattern recognition, flight and naval dynamics.

BI-REX is one of the 8 Italian Competence Centres with a specific focus on Big Data, innovation processes, and the adoption of enabling technologies, from a business perspective.

CINECA is the largest Italian supercomputing centre with an HPC environment equipped with cutting-edge technology and highly qualified personnel which cooperates with academia and industrial partners.

End User

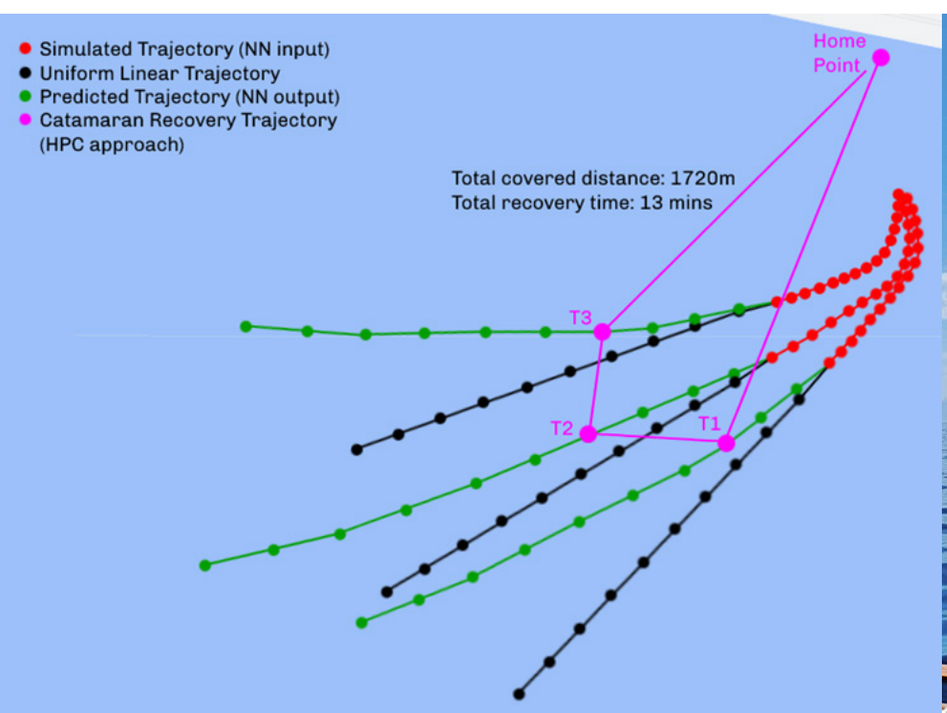
Domain Experts

HPC Centre & Provider

Partner CINECA is part of the NCC Italy.

The Challenge

Marine litter is a problem for the planet, as it damages the environment and generates negative economic, health, and environmental impacts. The most widespread litter is plastic, which accounts for more than 80% of the litter found in the marine environment. Green Tech Solution sets out to automate the collection of marine litter by integrating Neural Networks and Deep Learning logic into its existing approach. The existing solution consisted of the use of an Unmanned Aerial Vehicle (UAV) to monitor the litter. After the litter detection, an algorithm was used to predict the speed and direction of the litter with a spatial accuracy of 20-30 metres and a temporal accuracy of 3-5 minutes. This approach forced the UAV to remain close to the litter before its collection by a catamaran to monitor any possible changes in its position. The existing recovery strategy only focussed on one piece of litter at a time: after the identification of one litter object, this was recovered by a catamaran independently of the other litter objects and their trajectories. This led to long recovery paths and times for the catamaran.



Industry Sector
Environmental

Technology used:
HPC

The Solution

The experiment aimed to overcome the initial service's weaknesses of poor prediction of marine litter trajectories by introducing a new HPC-based approach: Litter Hunter that is able to predict the litter's various trajectories and thus calculate an optimised recovery trajectory in time and space, through the use of two neural networks and a newly developed multi-objective algorithm. The first neural network acquires the aerial images of waste objects (litter) as input, identifies their position, and classifies them in terms of size, materials (PET, PPT, biological) and buoyancy level. A second neural network acquires the trajectories of the observed litter as input and outputs the predicted trajectories of these objects by combining this information with meteorological and oceanographic data. A multi-objective algorithm uses the predicted trajectories to compute the 'best' trajectory to be followed by the catamaran to collect the most litter while minimising recovery time and distance, based on a variety of known constraints such as catamaran battery range and cruising speed or legislative constraints. Litter Hunter also allows larger marine areas to be monitored in a shorter time, enabling the company to reduce operational and management costs.

The Impact

The service now allows an area of 1 km2 to be covered in a single operation and about 100-200 pieces of waste to be collected. Furthermore, as the neural networks improve over the years due to Reinforcement Learning, the system is estimated to allow up to 1,000 floating objects (>25 mm) to be automatically collected per km^2 of the area in a single day of operations (an expected achievement for 2025).

The following are the main identified guidelines of the business strategy of HPC-Based Litter Hunter:

- 4 sales packages (duration min. 1 month / max. 6 months) designed to optimize the cost per contact with the customer (e.g., a multi-month package reduces logistical costs compared to a one-month package).
- Focussing on the investment in drones and boat systems in the 3rd year (reaching 25 available systems) will increase commercial activity.
- Optimization of the services, prices, and fleet management cost will generate a different value proposition in comparison to potential competitors: GTS offers better performance (in terms of object recognition, trajectory prediction and recovery strategy) with lower costs (operational and maintenance).

Maritime municipalities will reduce their cleaning costs by up to 80% using the GTS HPC-based approach. In the medium term, municipalities will benefit from a platform to predict floating waste on a local scale and improve their environmental planning. The Litter Hunter system will reduce working hours (human resources) for litter collection.

The new HPC-Based service will enable the recovery of tonnes of plastic or other materials from the sea for recycling. Continued action over time will enable the redevelopment of areas heavily affected by plastic pollution.

Benefits

- An estimated 60% reduction in energy consumption of vehicle batteries used per km^2 of operation.
- A reduction of 80% in time-to-planning (ca. 3 hours vs ca. 30 minutes per mission), 50% in time-to-recovery (30 minutes vs 15 minutes ca. per mission) and 40% in maintenance costs (€10,000 /year vs €6,000 /year).
- A price for services of €2,000-3,000 per km of road (main competitors are around €7,000).
- Market expansion outside Italy, reaching 2,000 km of EU coastline served (Greece, Spain and Norway) in the next 5-6 years.