SMARTPOL

AUTONOMOUS NETWORK SYSTEM WITH SPECIALIZED AND INTEGRATED MULTI-SENSOR TECHNOLOGY FOR DYNAMIC MONITORING OF MARINE POLLUTION

www.smartpol.info

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SMARTPOL
MONITORING MARINE POLLUTION

Smartpolproject

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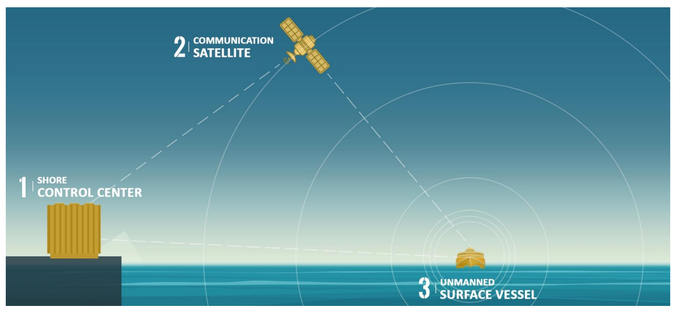
JPI OCEANS

BRIEF DESCRIPTION OF THE PROJECT

SMARTPOL aims to present a novel and compact pollution detection, monitoring and analysis system architecture consisting of hardware and software components in order to monitor marine fields and to detect different types of marine pollution. in sum, integration of different types of sensors (e.g. remote sensing, UAV and USV integrated IoT), development of marine pollution detection algorithms using sensor data and state-of-the-art intelligent system technologies including AI-based image processing, autonomous navigation and smart communication systems will be presented as R&I objectives of the project.



The system will mainly consist of Shore Control Centre (SCC) and unmanned surface vessels (USVs), both equipped with multi-sensor technology and AI based solutions. SMARTPOL will validate the USVs' by monitoring pollutants on specific areas of Turkey, Malta and South Africa. Integration of different types of sensors, development of marine pollution detection algorithm using sensor data and using the state-of-the-art intelligent system technologies including AI, machine learning (ML)-based image processing, autonomous navigation and remote sensing are going to be presented as scientific and technological objectives of the project.

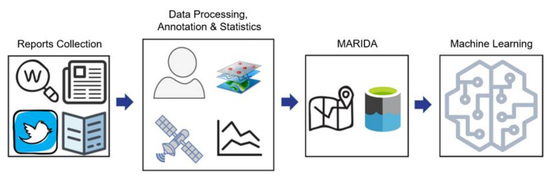
AI & REMOTE SENSING

DATASET (Turkiye)

MARIDA is an open-source dataset consisting of annotated georeferenced polygons/pixels on Sentinel-2 satellite imagery. (https://zenodo.org/records/5151941)

Sea surface features that co-occurred on satellite images were annotated: Ships, Sargassum macroalgae, Foam, Waves and Natural Organic Material (i.e., vegetation and woody), water types (i.e., Clear, Turbid Water and Sediment-Laden Water), Shallow Coastal Waters including benthic habitats, Clouds and Cloud Shadows.

Based on the ground-truth events, the corresponding Sentinel-2 level1C images were acquired from Copernicus Hub for the exact reported dates and locations using a mean time window of 10 days.



Schematic diagram representing the different steps for the construction of Marine Debris Archive-MARIDA

AI MODEL (Turkiye)

The deep learning models have been implemented using Python Keras deep learning library using Tensorflow backend.

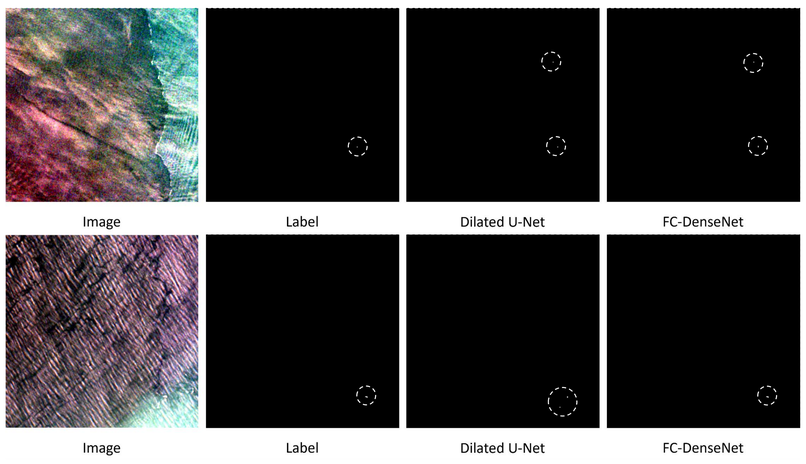
Dilated UNet and Fc-DenseNet Models have been used.

SATELLITE PROCESSING

PRELIMINARY RESULTS (Turkiye)

Accuracy assessment of marine debris segmentation has been realized by using accuracy, intersection over union (IoU).

Dilated UNet achieved 0.6830 IoU score, on the other hand, FC-DenseNet achieved 0.6972. The training process continues iteratively to increase overall accuracy.



Prediction results of the second (top) and third example image

DATASET (Malta)

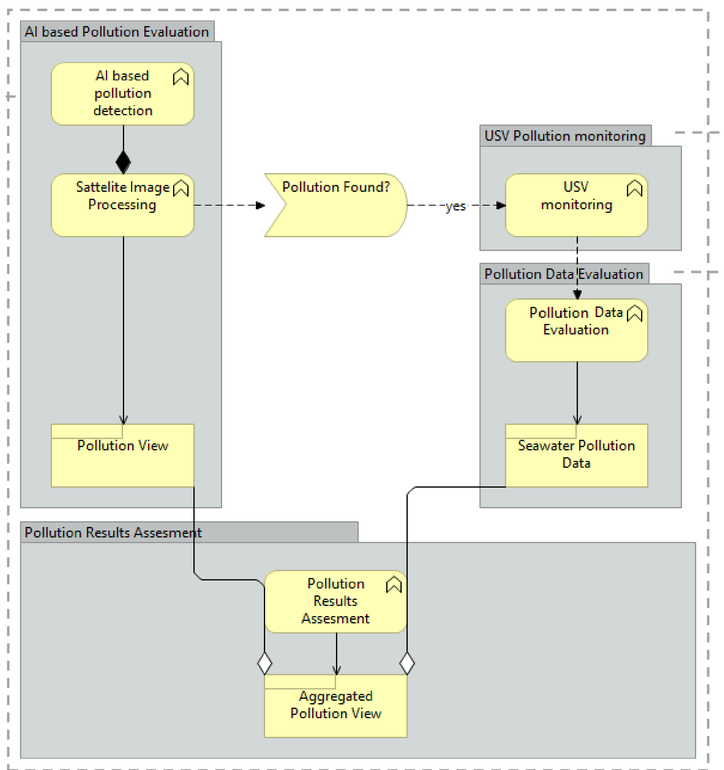
Floating Marine Debris Data by Miguel M. Duarte and Leonardo Azevedo (https://github.com/miguelmendesduarte/Floating-Marine-Debris-Data)
Classes: Water, Plastic, Wood, Seaweed, Pumice, Sea Snot, Sea Foam
Satellite Products: Sentinel-2, KhalifaSat

AI MODEL (Malta)

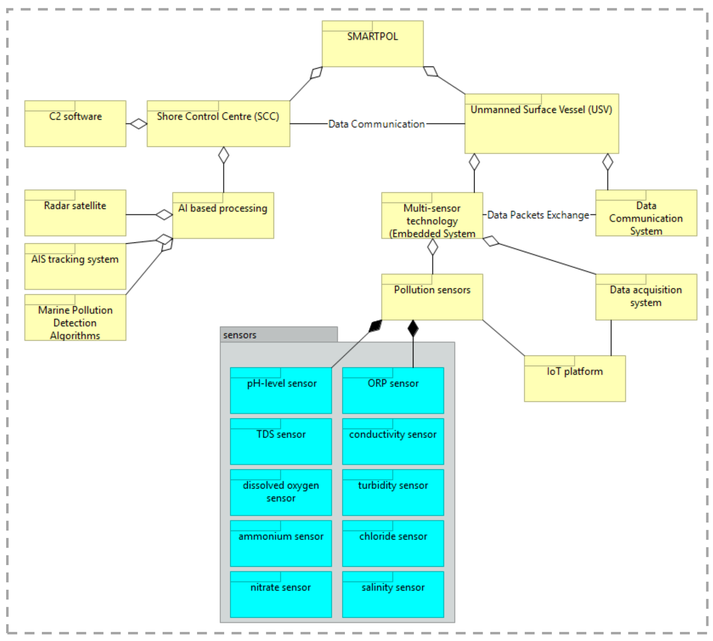
Temporal Convolutional Neural Networks (TempCNNs) was used, a deep learning approach that applies convolutions in the temporal dimension to automatically learn temporal and spectral features. An average F1-Score of 96.8% across all trained classes was achieved, indicating that the model effectively distinguished between all seven classes.

PRELIMINARY RESULTS (Malta)

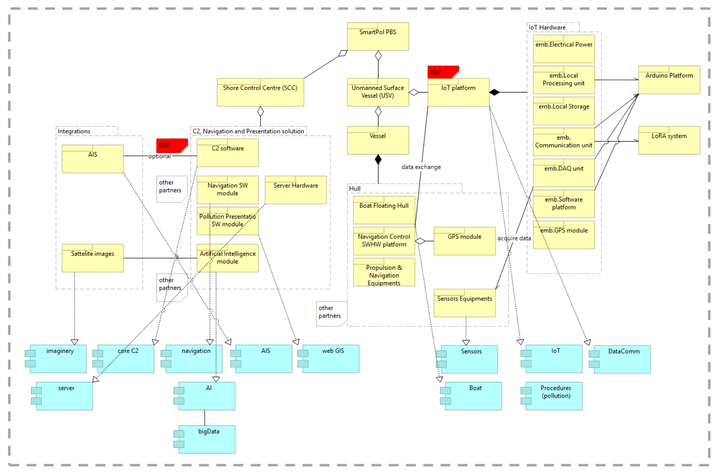
The trained model was tested on a Satellite product for Malta during a period when Sea Snot from fish farms was a notable issue. The model detected other classes, such as plastic, in small beaches where waste is typically concentrated by currents.



BASIC POLLUTION INTERVENTION PROCEDURE



BASIC COMPONENTS OF THE SYSTEM

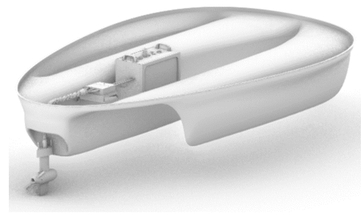


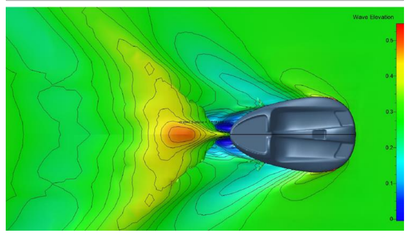
PRELIMINARY DESIGN OF SMART NAVIGATION SYSTEM

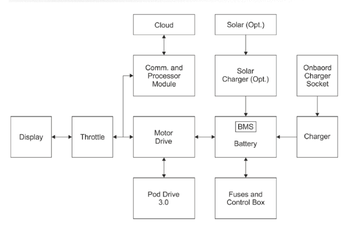
The model demonstrated clear detection of te Sea Snot occurrence (green dots) on the northeast and southeast coasts of Malta.

USV DESIGNS

USV







Design and system diagram of the novel trimaran USV (YTU, Turkiye)

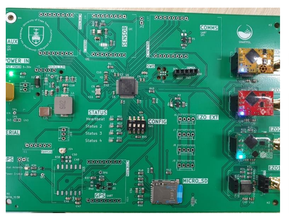
An iterative design process was performed to design a novel trimaran underwater hull form. The main dimensions of the hull:
Displacement: 1050 kg, Length: 3.5m, Width: 2.1m, Draft: 0.4m.

CFD analyzes were carried out for hydrodynamic performance analysis and resistance calculations of the modeled hull form. Total engine power was determined as 3 kW.

USV

Existing USV (UCT, South Africa)

The USV (Subsea Tech Catarob) was used and the implemented sensor rig was fitted to the USV.

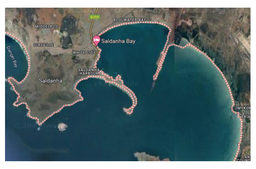


A PCB was designed and manufactured to create a more robust and complete solution. The system is housed in an IP68 rated enclosure with equivalent ratings on all connectors.

PILOT AREAS

Turkiye Pilot Area
(Yalova Marina)

Malta Pilot Area



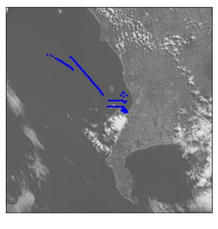
South Africa Pilot Area
(Saldanha Bay)

DATASET (South Africa)

3 datasets with annotations of various marine debris. Two datasets are of Sentinel-2 images and the thirds is from the Planet satellite constellation.
1 dataset with the spectral values of individual Sentinel-2 pixels containing marine debris. Further synthetic pixel data created by a GAN.
1 dataset of Sentinel-2 images with ships identified in the images.
1 dataset of multiple images of the same sight containing a plastic sheet providing the spectral response of plastic over multiple images
Satellite Products: Sentinel-1, Sentinel-2.

PRELIMINARY RESULTS (South Africa)

The aim for this algorithm is to detect oil slicks in Sentinel images allowing for detections of non-oil products. Using automatic identification system (AIS) data, ship locations can be correlated to satellite images.



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