# INSTRUMENTATION VIEWPOINT

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# MARTECH 25

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**The acceptance of the articles presented depends on their scientific quality and their adaptation to magazine's editorial line.**

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| **Session 5.2<br>Application case studies of remote sensing and videometry.<br>16:40 – 18:20<br>(Full talks)<br>Chairs:<br>Jesus García Lafuente (CTIMA - UMA). Pau Luque (UIB)** | **Combining in-situ measurements and video imagery to capture wave drivers on the Bilbao coast: Implications on ML for coastal morphodynamic assessment**<br>Manuel Viñes Recasens. UNIVERSITAT POLITÈCNICA DE CATALUNYA |
| | **Advancing Coastal Hazard Management: the multi-scale coastal hazards solutions of Atlantic Sense**<br>Luis Pedro Almeida. +ATLANTIC |
| | **Advanced AI Strategies for Coastal Analysis: A Case Study at Las Canteras Beach in Gran Canaria**<br>Fernando Sanfiel. UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA |
| | **Monitoring Morphological Changes Using DIY Bathymetric Devices combined with satellite images**<br>Benjamí Calvillo. UNIVERSITAT POLITÈCNICA DE CATALUNYA |
| | **Continuous-Wave Radar for Ocean Wave Measurement From Coastal Beaches**<br>Pau Luque. IMEDEA (UIB-CSIC) |

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|---|---|
| **18:20 - 19:00** | CLOSING OF THE CONFERENCE & BRANKA AWARD |

# POSTER SESSION 1

*"ADCP SUSPENDED SEDIMENT TRANSPORT MONITORING USING ACOUSTIC PARTICLE RADIUS"*
**Cristobal Molina. NORTEK GROUP**

*"TOWARDS VISUAL-ACOUSTIC POSE CONTROL FOR NET CAGE INSPECTION: REALISTIC SIMULATION APPROACH"*
**Andrea Pino Jarque. UNIVERSITAT JAUME I**

*"ADVANCEMENTS IN POP-UP BUOY TECHNOLOGY FOR ENHANCING SEAFLOOR DATA COLLECTION: INSIGHTS FROM A YEAR OF TRIALS"*
**Matias Carandell Widmer. UNIVERSITAT POLITÈCNICA DE CATALUNYA**

*"ENGINEERING AND OPTIMIZATION OF AN ADVANCED MARINE SAMPLER FOR PRECISE LABORATORY ANALYSIS OF WATER SAMPLES"*
**Ana Albenza Alonso. UNIVERSIDAD POLITÉCNICA DE CARTAGENA**

*"COMPACT LOW-COST SENSOR FOR MICROPLASTICS DETECTION AND CLASSIFICATION IN MARINE AND AQUATIC ENVIRONMENTS"*
**Silvia Merlino. CNR-ISMAR**

*"USE OF SLAG TO DEVELOP 3D PRINTING MORTARS MIXTURES FOR ARTIFICIAL REEFS"*
**Virginia Mendizabal. UNIVERSITAT POLITÈCNICA DE CATALUNYA**

*"AN ACCESSIBLE I-AUV FOR RESEARCH AND TEACHING OF UNDERWATER ROBOTICS"*
**Alaaeddine El Masri El Chaarani. UNIVERSITAT DE GIRONA**

*"TOWARDS THE DESIGN OF A SENSORIZED HYBRID END EFFECTOR FOR UNDERWATER OPERATIONS"*
**Andrea Pino Jarque. UNIVERSITAT JAUME I**

# ID07 ADVANCED AI STRATEGIES FOR COASTAL ANALYSIS: A CASE STUDY AT LAS CANTERAS BEACH IN GRAN CANARIA

Fernando Sanfiel-Reyes[6], Jonay Suárez-Ramírez[7], Miguel Alemán-Flores[8] and Nelson Monzón[9]

## Abstract

We propose a semantic segmentation model to analyze coastal dynamics. Using advanced AI techniques, precise segmentation masks are generated, overcoming challenges like changing weather conditions, glare, or shadows. A diverse dataset ensures adaptability, classifying features such as waves, sand, foam, and static infrastructures at the pixel level. This enables detailed analysis of interactions between marine elements and coastal structures, and can lead to measurements such as wave period, crucial for predicting overtopping events and identifying abnormal sea behavior. Experiments at Las Canteras Beach in Gran Canaria, a location where our model was not trained, yet it still performed well, demonstrate its effectiveness. This research illustrates AI's potential in advancing coastal management and environmental monitoring.

**Keywords - Coastal Dynamic, Deep Learning, Semantic Segmentation.**

## SEMANTIC SEGMENTATION FOR COASTAL ANALYSIS

Conserving the coastal environment is essential due to its influence on activities like tourism or maritime safety. In this sense, the proper use of coastal infrastructures underscores the need for sustainable management strategies. Video recordings of coastal scenes help study these environments and understand tidal and wave patterns. AI and neural network-based methods have revolutionized the computer vision literature. By leveraging AI, we can extract detailed information from images of maritime scenarios, improving our understanding of these complex systems. This enables the prediction of temporal phenomena, such as wave overtopping, and enhances our ability to assess and mitigate the impact of coastal dynamics on surrounding areas.

We propose a semantic segmentation model specifically trained for coastal analysis. This strategy recognizes regions within an image and classifies the pixels into a specific semantic category. Our previous work in [1] identified the most suitable methods for these environments, targeting areas of interest such as sea, sand, rocks or piers, while measuring model precision and computational cost. Our goal here is to generate segmentation masks where each pixel is assigned a class identifier, allowing the mask to be overlaid on the original image to delineate objects at the pixel level.

The training of our model is based on a detailed comparative study of state-of-the-art strategies conducted in [2] as part of the collaboration between the R&D company Qualitas Artificial Intelligence and Science and the University of Las Palmas de Gran Canaria. A robust dataset was developed, incorporating numerous labeled examples, and addressing the challenges of coastal dynamics, such as the inclusion of the "Foam" class for analyzing wave-breaking events. Extensive effort was dedicated to collect and label images from diverse coastal and port environments under varying weather conditions and at different times of the day, enhancing the model's precision across diverse scenarios and unfamiliar locations. Our experiments in [1, 2] show that using Mask2Former [3] as the head and Swin-B [4] as the backbone of our neural network architecture yields the best results, so that they form the framework for our proposal.

## EXPERIMENTAL RESULTS AT LAS CANTERAS BEACH

The accuracy and robustness of the segmentation masks provided by our model are illustrated in Figures 1 and 2 (the color scheme that labels the different regions is included at the bottom). Notice that no images from Las Canteras Beach were included during training and validation, which demonstrates the generalizability of the proposed model.

Fig. 1 illustrates wave overtopping with two frames from a video captured at the seafront promenade of Las Canteras Beach. The segmentation can accurately capture the dynamic behavior of the wave at each instant. If we know the region of the image where overtopping is likely to occur, the masks will describe the wave behavior at each moment, allowing us to predict how close we are to overtopping or to determine whether it has already occurred. Fig. 2 shows an example of the method's performance under challenging conditions, including a case where sunlight directly hits the camera lens. Even in these situations, the method accurately distinguishes the different regions.

The model's segmentation masks facilitate near-real-time calculations, such as measuring wave period, predicting overtopping events, and detecting anomalous sea behaviors. Our future work aims to differentiate between wet and dry sand, providing insights into tidal behaviors and impact on terrestrial areas. These advancements help detect deviations from typical tidal patterns, offering essential tools for environmental monitoring and coastal management.

## Acknowledgements

This work is the result of the collaboration between the company Qualitas Artificial Intelligence & Science and the University of Las Palmas de Gran Canaria, within the framework of the research contract C2024/54 signed between the company and The Canarian Science and Technology Park Foundation of the ULPGC. It has also been supported by Vicepresidencia Primera, Consejería de Vicepresidencia Primera y de Obras Públicas, Infraestructuras, Transporte y Movilidad from Cabildo de Gran Canaria, through the project of reference Resolution ``DETECCIÓN PRECISA IA".

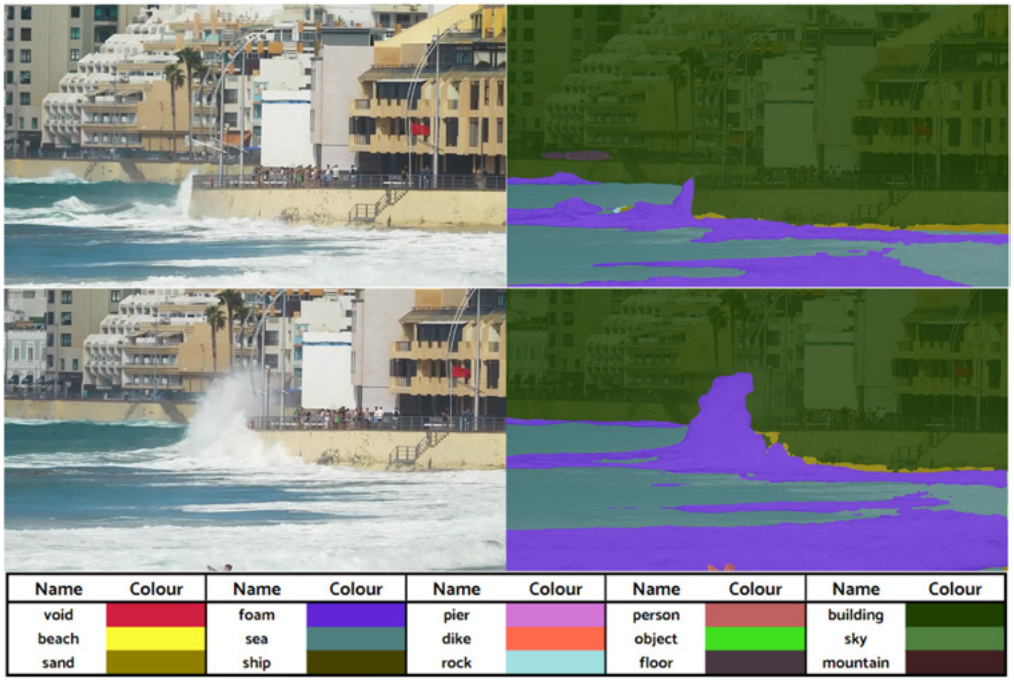


*Fig 1. Two frames of a video where a wave overpasses the beach seafront. The mask accurately describes the wave's impact.*

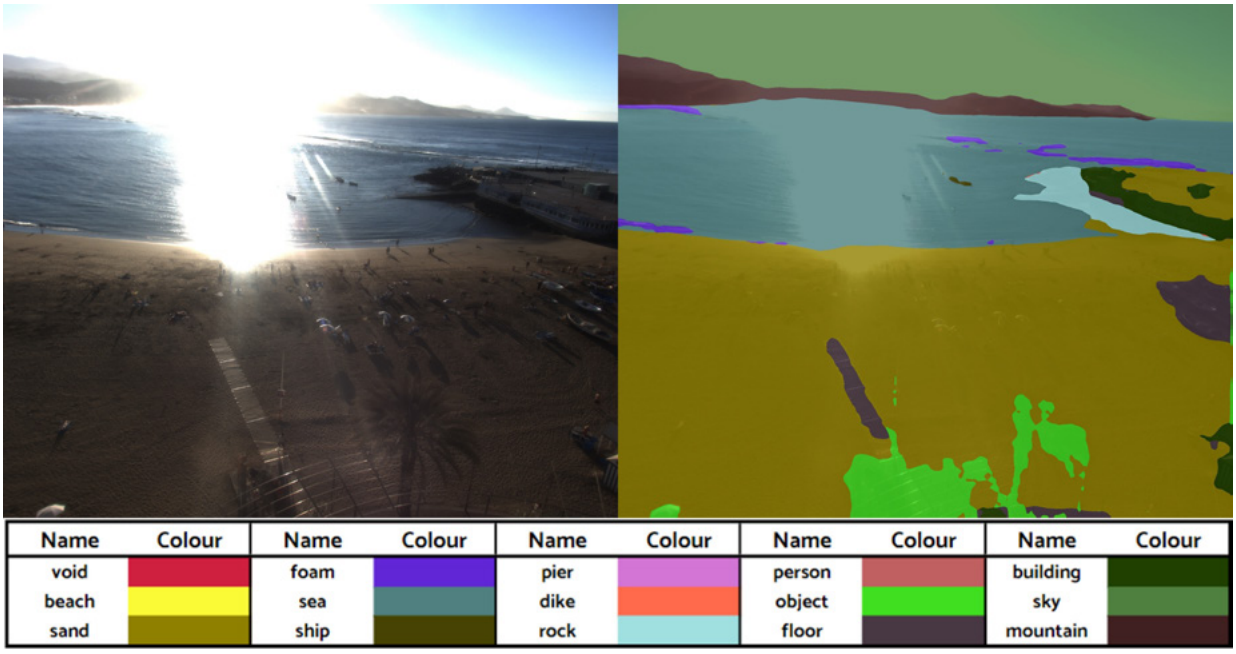


*Fig 2. Original image and inference obtained by our model in a scene with very poor lighting conditions.*

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