WEATHER ROUTING FOR IMPROVING COMFORT ON FERRIES

VIRTUAL BUOYS

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ROUTE OPTIMIZATION BASED ON SHIP MOTIONS

Undesired ship motions are the main cause of wave radiation-induced added resistance (40%) and pose multiple challenges for both passenger and crew comfort, as well as for the safety of the vessel and its cargo. The developed system helps mitigate these issues through the following innovations:

01 A new hydrodynamic model for wave-induced added resistance that improves the accuracy of the current state-of-the-art and eliminates the need for hull form information.

02 New AI models of ship motions in six degrees of freedom that enable route planning based on different criteria.

03 Optimization based on undesired ship motions, allowing route selection using alternative criteria such as accelerations, voyage time, and more.

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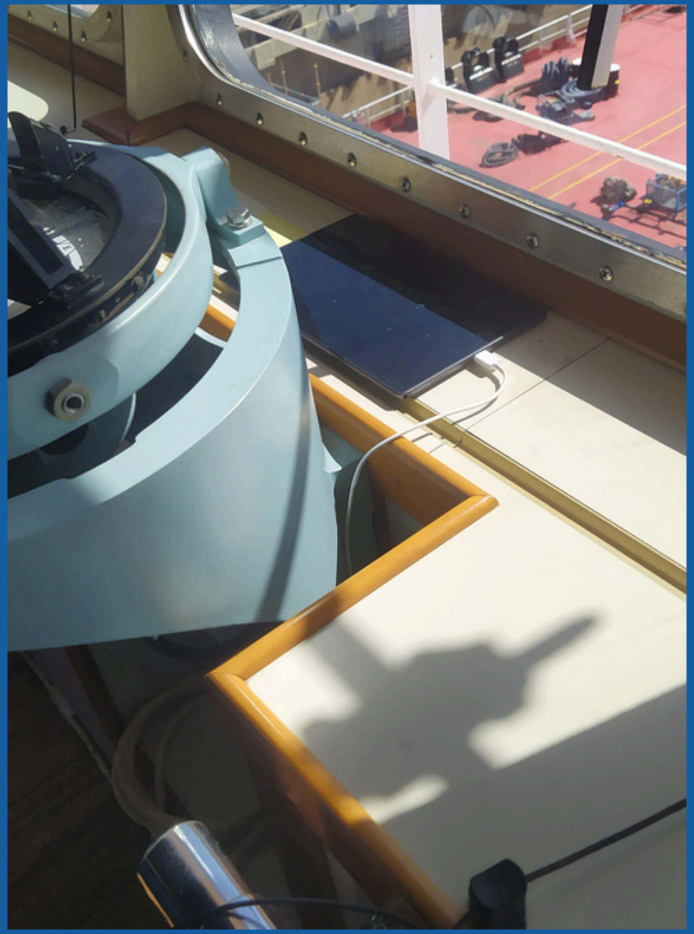
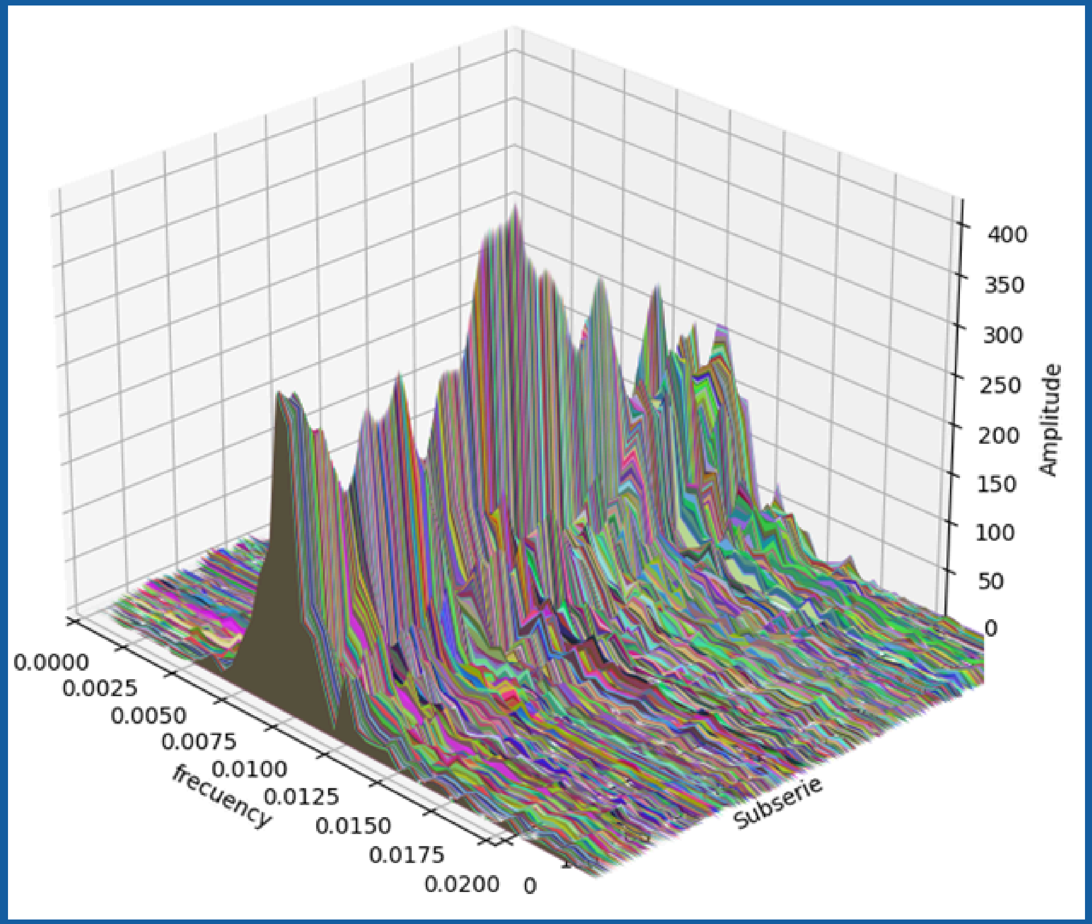
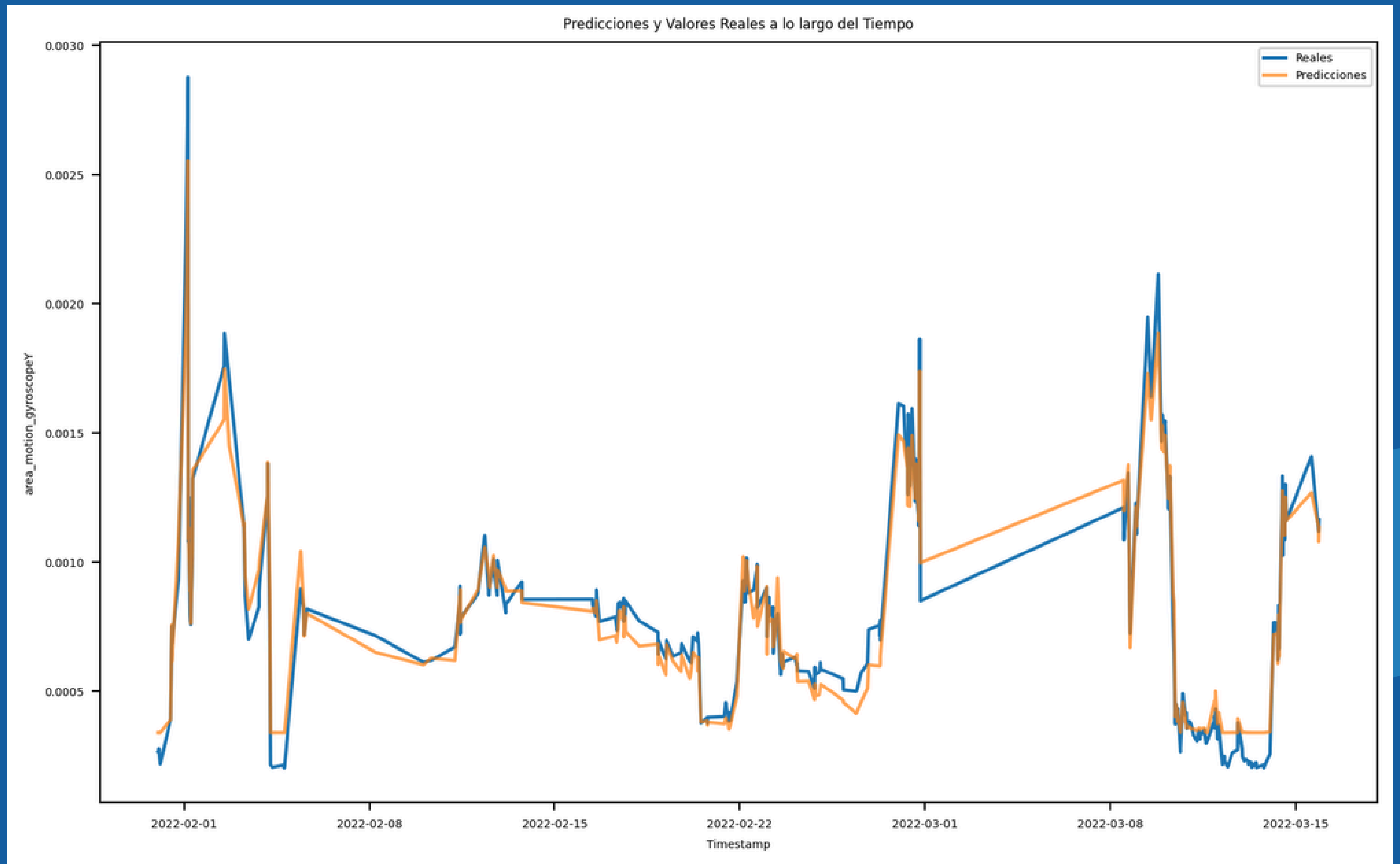
NEW AI MODELS THAT CAPTURE THE SHIP'S DYNAMICS


Onboard tablet



Pitch and roll spectrum



Pitch and roll model

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NEW WAVE-ADDED RESISTANCE MODE

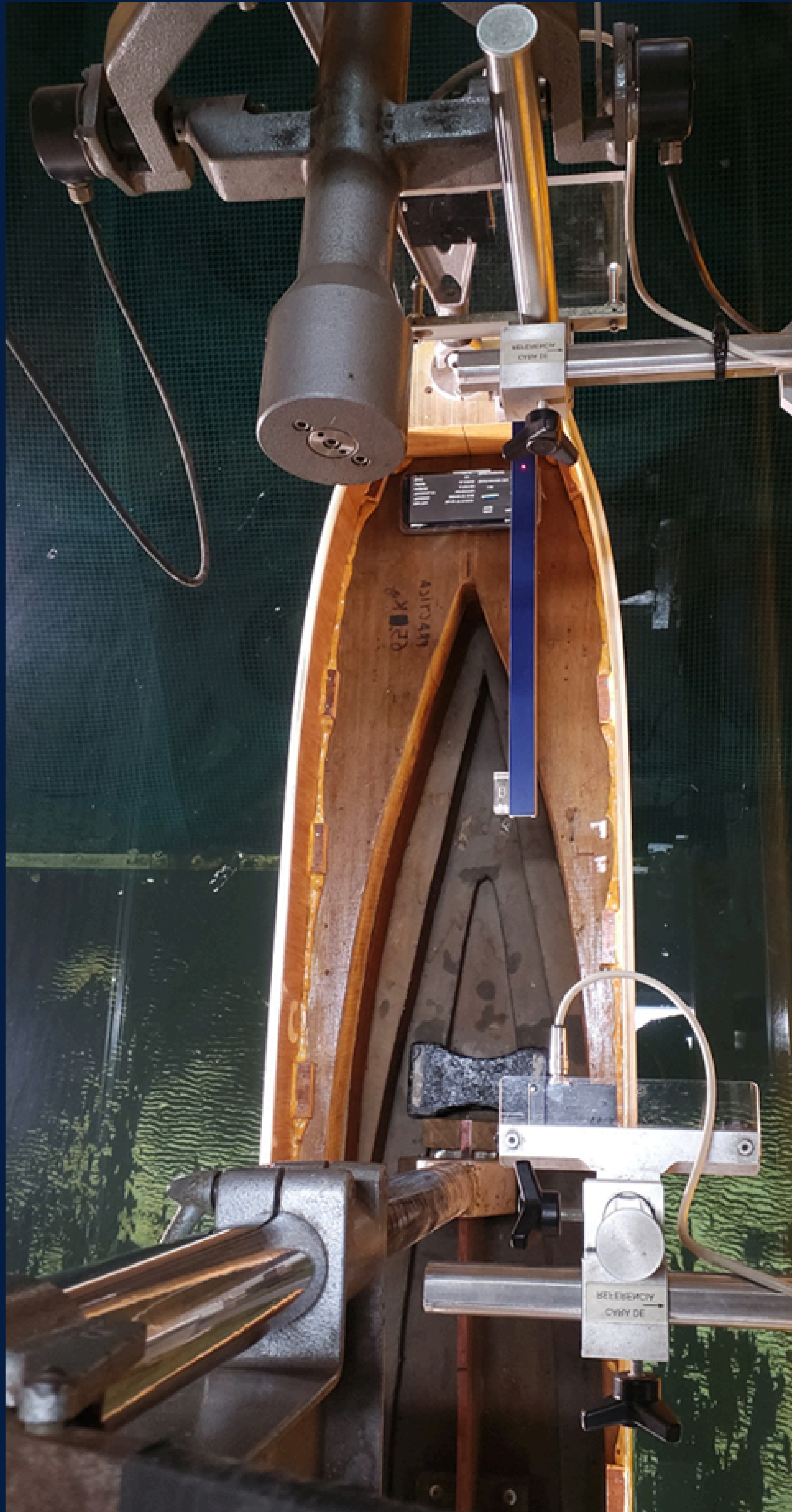
New hydrodynamic model for calculating wave-added resistance (up to 40% of total resistance) based on the ship's pitch and roll motions. The model improves upon the estimates provided by the Gerritsma model, in use since the 1970s, and can be applied to ships operating under real conditions by using onboard gyroscopic data.

01 Capable of generating the ship's RAOs under real operating conditions for all types of waves.

02 Eliminates the need for hull form data, towing tank results, or CFD simulations.

03 Tested in hydrodynamic towing tank.

04 Tested on real ships for over two years.



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MATHEMATICAL MODEL OF SEASICKNESS.

$$G(w_e) = \begin{cases} (w_e/0.7) & w_e < 0.7\,\mathrm{rad/s} \\ 1 & 0.7 < w_e < 1.7\,\mathrm{rad/s} \\ (1.7/w_e)^{2.85} & w_e > 1.7\,\mathrm{rad/s} \end{cases}$$

$$A^2 = \int_0^{\infty} \ddot{s}_3^2(w_e)\, G^2(w_e)\, \mathrm{d}w_e$$

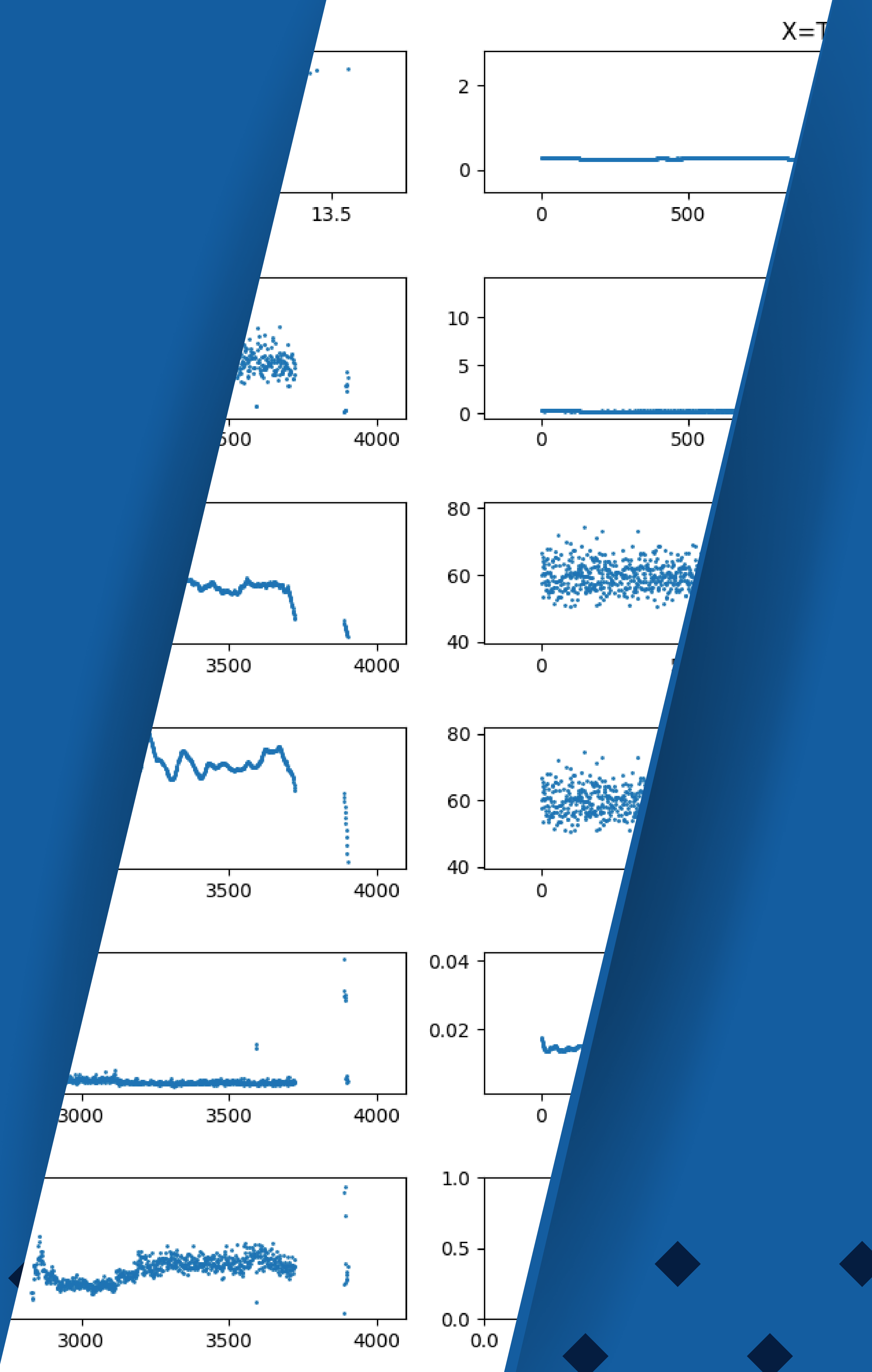
$$\mathrm{MSDV} = pA\sqrt{T}$$

Posture coefficient

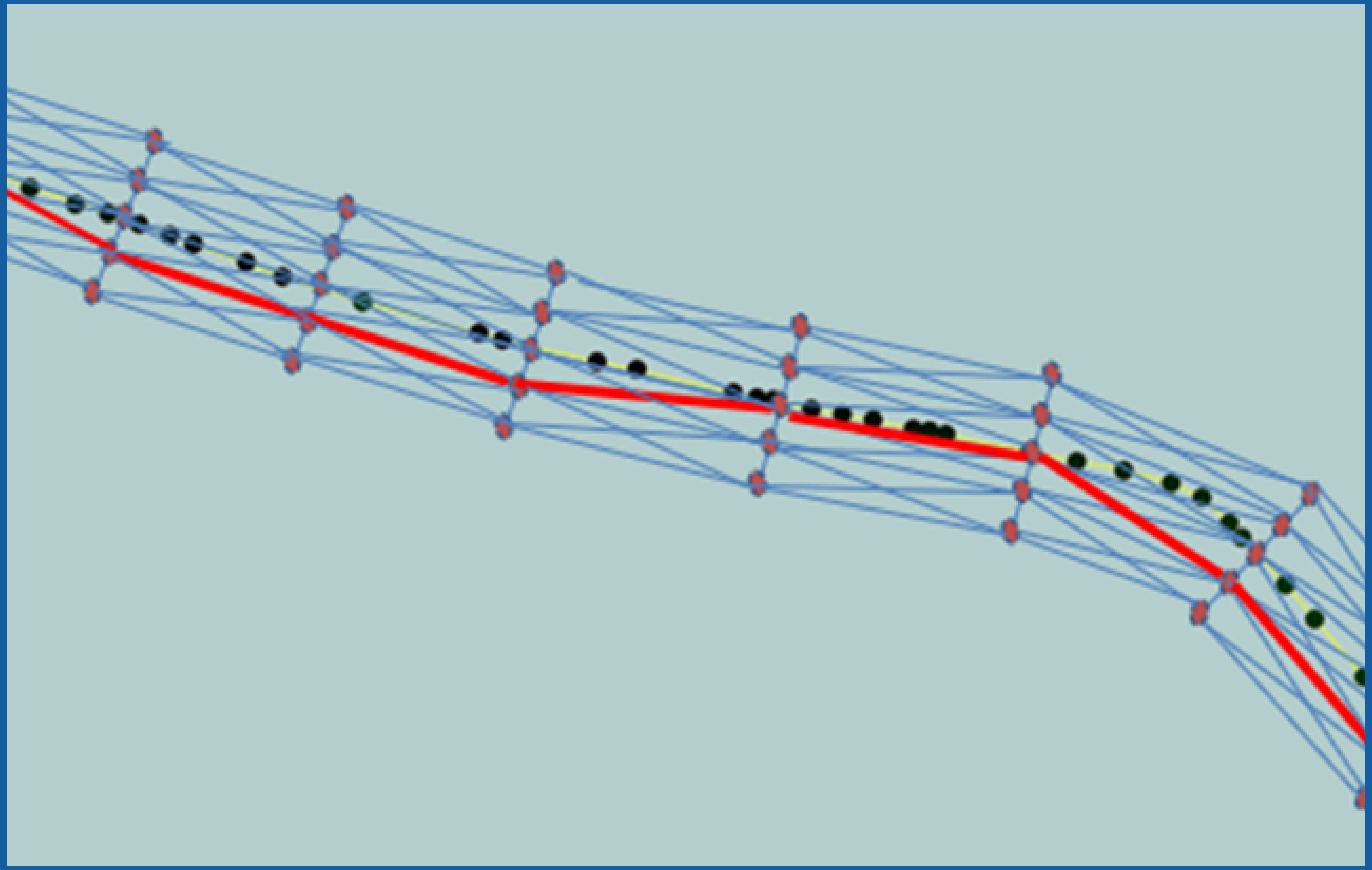
Normal activity inside the ship	Sat	Eating	Laid down	Outside activity
1	[0.6, 1]	[1.5, 2.5]	[0.2, 0.6]	[0.5,1]

$$\mathrm{SPR}(\%) = 100(1 - \mathrm{e}^{0.006(\mathrm{MSDV}-10)})$$

Seasickness prediction in passenger ships at the design stage
F.L. Pérez Arribas, A. López Pinéeiro



NEW MODIFIED DIJKSTRA ALGORITHM.



- Different route selection criteria: minimum distance, minimum fuel consumption, minimum seasickness index.Path priority based on spatially closer data points.

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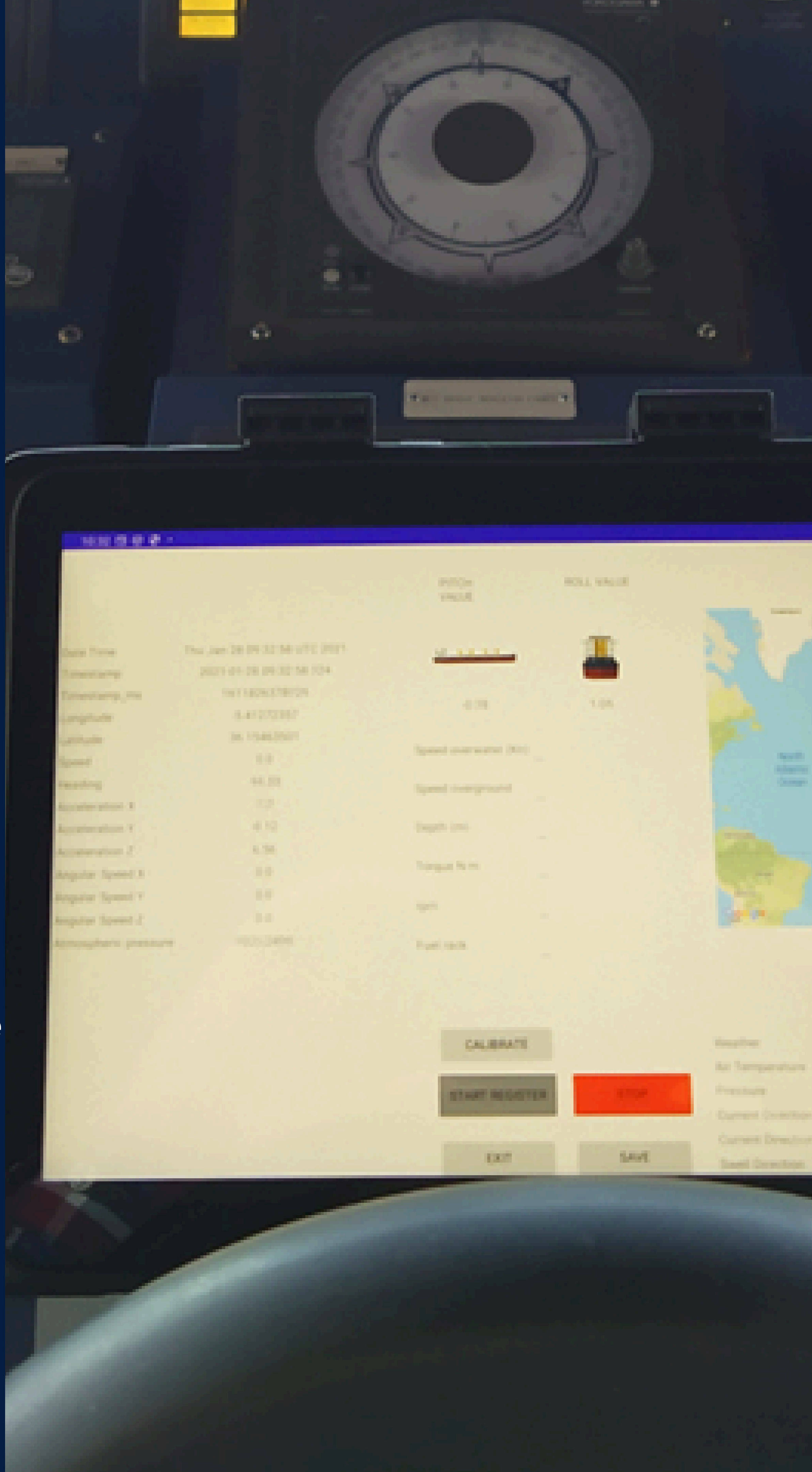
ONBOARD INFRASTRUCTURE.

The only onboard infrastructure used is a tablet equipped with a GPS, accelerometer, gyroscope, and magnetometer. Reference (1) presents a comprehensive study on the characteristics of these devices and their suitability for this type of application.

01 The device must connect to the ship's Wi-Fi network, with the option to transmit data either only while in port or continuously. In both cases, the volume of data transmitted is very low, so it does not affect bandwidth or power consumption. It can be connected either to the ship's technical network or to the passenger network.

02 It should be fixed to one of the tables or consoles on the bridge, as close as possible to the ship's centerline and with GPS signal reception. The wider side should be oriented transversely to the centerline, from port to starboard.

03 The transmitted data is not public and is properly encrypted. Transmission can be configured to occur only while the ship is in port



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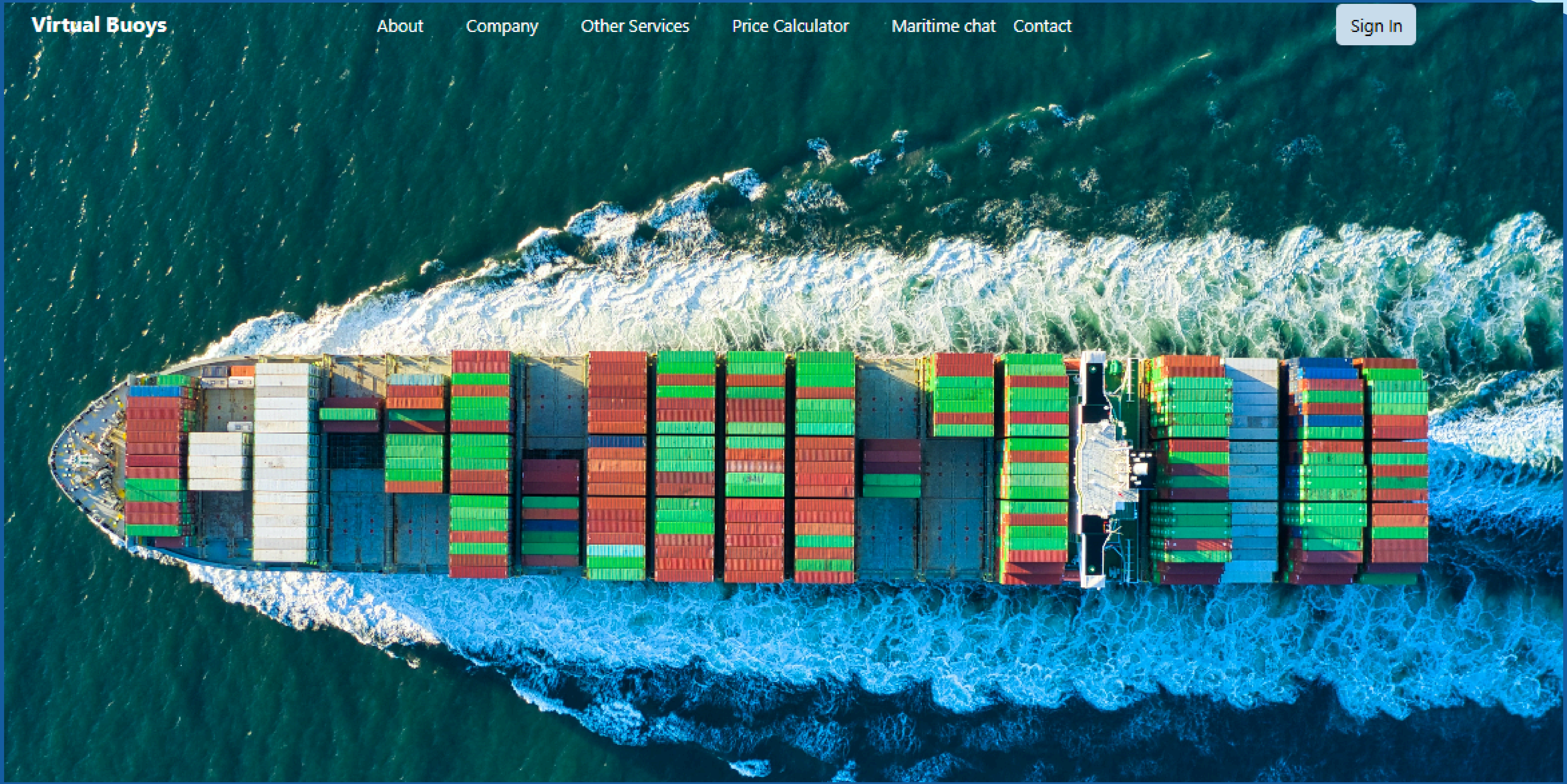
TESTED ONBOARD FOR OVER TWO YEARS ON DIFFERENT SHIPS AND ROUTES.

WEB APP


Virtual Buoys
About
Company
Other Services
Price Calculator
Maritime chat
Contact
Sign In

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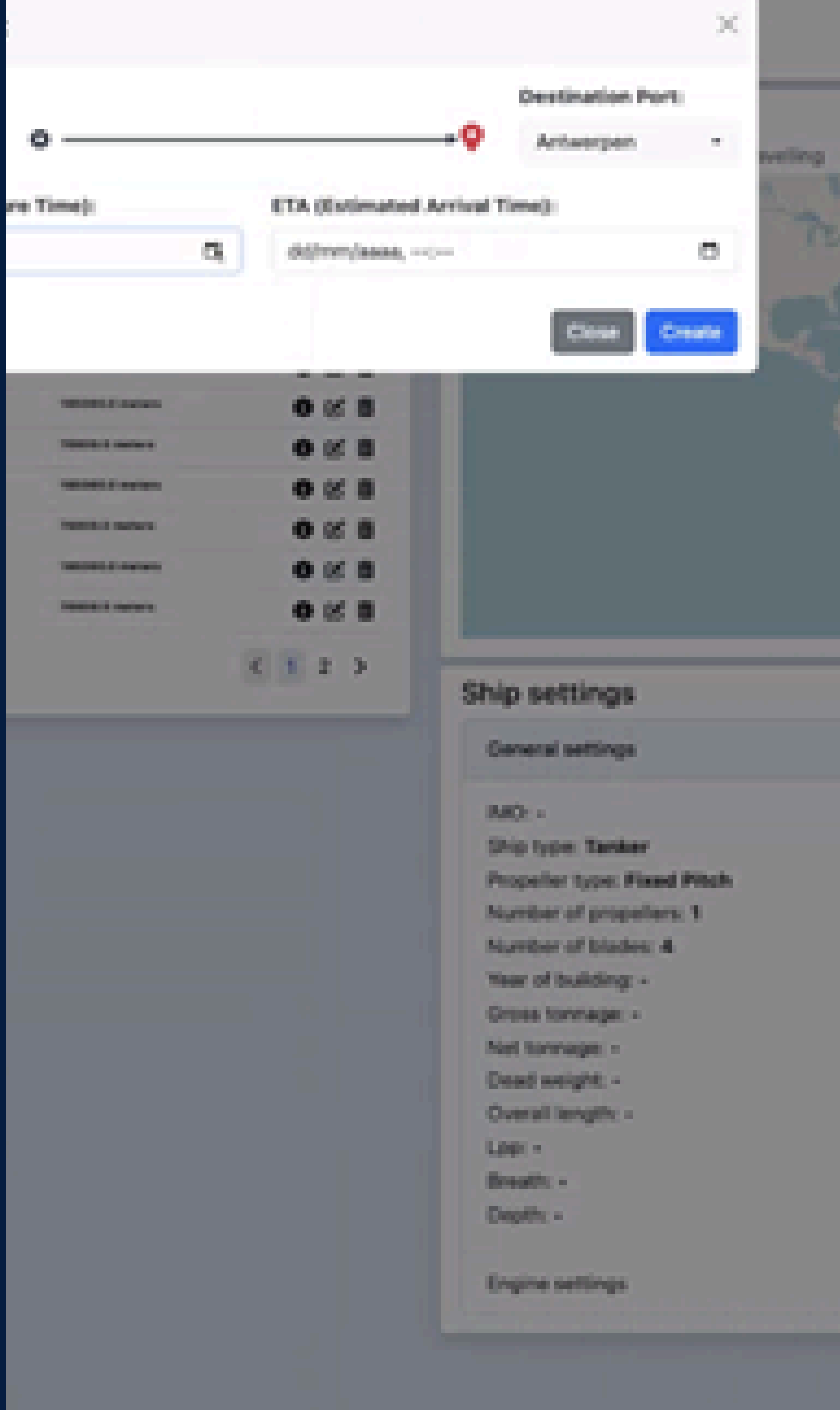
WEB APP

The web application, permanently connected to each vessel, receives data every 5 minutes (in continuous mode) and trains a dedicated AI system tailored to each ship.

01 The application provides optimal routes and speeds based on different criteria—fuel consumption, travel time, transverse or vertical accelerations—customized for each vessel.

02 It offers various visualization tools for the shipowner, the vessel, or the operator—if authorized by the shipowner. Each of these user profiles has its own login credentials.

03 Expandable and scalable platform that will allow the integration of new services in the future, such as cargo management, predictive maintenance, and more.



ROUTES BASED ON DIFFERENT CRITERIA

01	02	03	04
Eco	Comfort	Safe	LNGStabilizer
Fuel consumption reduction.	Reduction of motion on ferries.	Risk reduction in container ships.	Boil-off reduction in LNG vessels.

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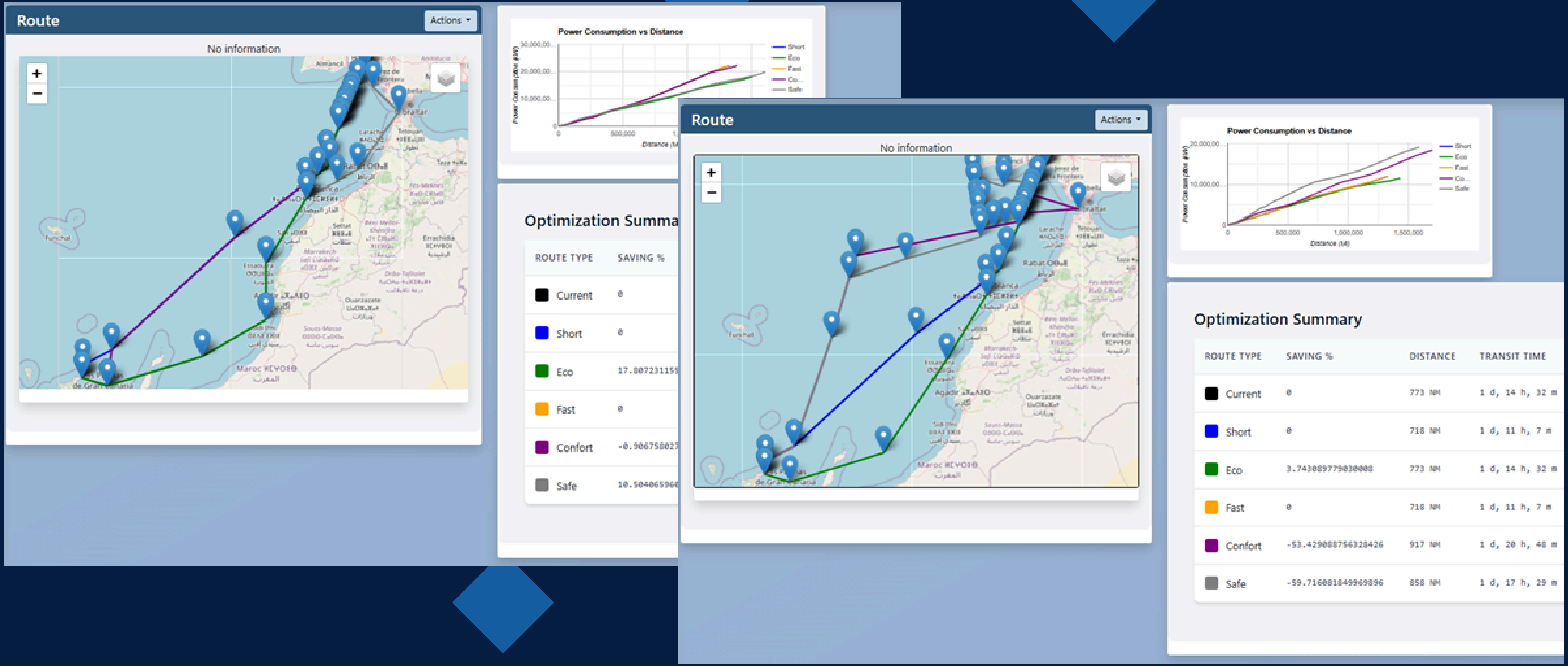
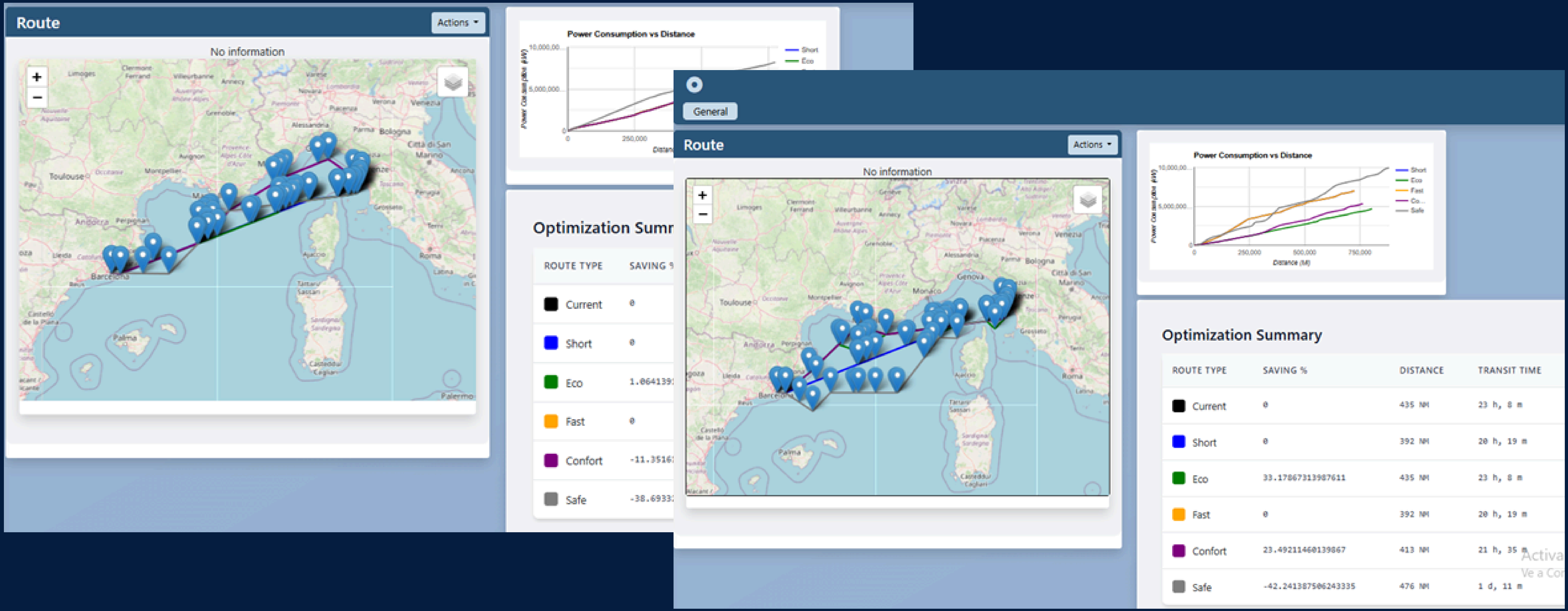
ROUTING



Route
Actions
No information
Power Consumption vs Distance
Short
Eco
Fast
Confort
Safe
Distance (M)
Optimization Summary
ROUTE TYPE
SAVING %
DISTANCE
TRANSIT TIME
Current 0 773 NM 1 d, 14 h, 32 m
Short 0 718 NM 1 d, 11 h, 7 m
Eco 3.743089779030008 773 NM 1 d, 14 h, 32 m
Fast 0 718 NM 1 d, 11 h, 7 m
Confort -53.429088756328426 917 NM 1 d, 20 h, 48 m
Safe -59.716081849969896 858 NM 1 d, 17 h, 29 m

ROUTING


Route
Actions
No information
Power Consumption vs Distance
Optimization Summ
ROUTE TYPE
SAVING %
Current 0
Short 0
Eco 1.064139
Fast 0
Confort -11.3516
Safe -38.6933
General
Route
Actions
No information
Power Consumption vs Distance
Short
Eco
Fast
Safe
Distance (M)
Optimization Summary
ROUTE TYPE | SAVING % | DISTANCE | TRANSIT TIME
Current | 0 | 435 NM | 23 h, 8 m
Short | 0 | 392 NM | 20 h, 19 m
Eco | 33.17867313987611 | 435 NM | 23 h, 8 m
Fast | 0 | 392 NM | 20 h, 19 m
Confort | 23.49211460139867 | 413 NM | 21 h, 35 m
Safe | -42.241387506243335 | 476 NM | 1 d, 11 m

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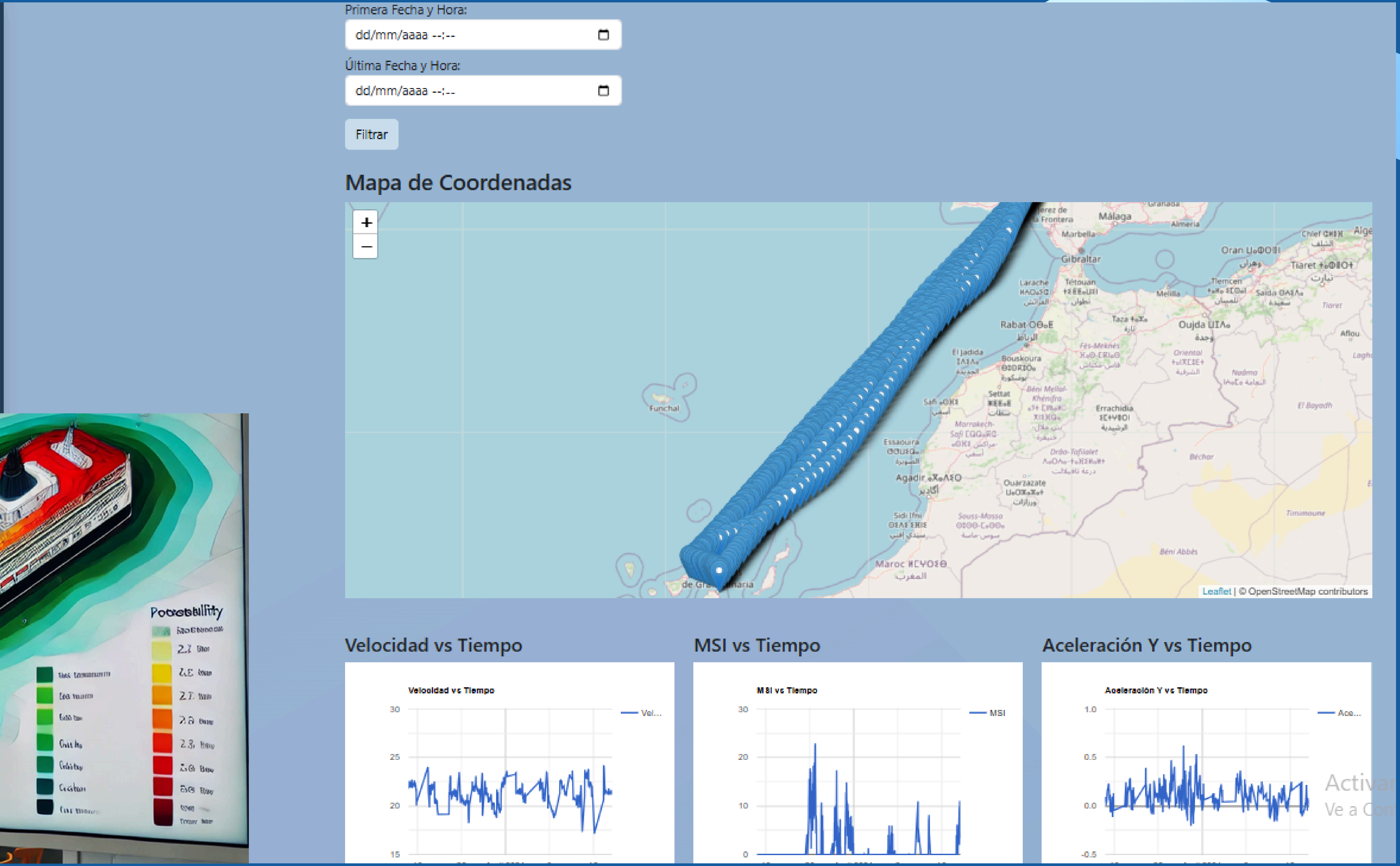
SAILING REPORT



SHIP TYPES

RECOGNIZED BY THE INDUSTRY

Technical and business recognition.

60th Naval Eng. Congress

Honorable mention for our onboard sensorization framework.

61th Naval Eng. Congress

Third prize for our efficiency system based on ship motion measurement.

ActúaUPM 2022

Third prize for Best Business Idea of 2022.

AI laboratory applied to the maritime sector

Objectives

01	02	03
To develop cutting-edge solutions grounded in deep research on artificial intelligence, with applications in the maritime sector, defense, and sustainability.	To provide master's and PhD students in their final years with hands-on experience in industry, research, and entrepreneurship.	To serve as a forum for debate and reflection on the ethical and responsible use of AI.

AI laboratory applied to the maritime sector

Research lines

01
Machine learning

Hamiltonian neural networks for modeling complex physical systems.

02
Geostrategy

Bayesian networks for detecting strategic threats using GDELT data.

03
Defense

Smart buoys for detecting threats to underwater infrastructure.

04
Deep research

Extracting latent information from embeddings in large language models.

ai4seas labs

AI laboratory applied to the maritime sector

Products

PUBLICATIONS

01 “Framework de sensorización y monitorización de datos de navegación”
Autores: Fernando Cañavate Vega, Rocío Lastra Acevedo, Marta Carrera Calzón, Raúl Miguel González
Localización: Ingeniería naval, ISSN 0020-1073, Nº. 1009, 2022, págs. 83-96
Idioma: español
http://cdt.fomento.es/cgi-bin/koha/opac-detail.pl?biblionumber=77934

02 ”Virtual Buoys, sistema de optimización de rutas basado en modelos de IA del movimiento del buque”
Autores: Fernando Cañavete Vega [1] ; Marta Carrera Calzón ; Rocío Lastra Acevedo ; Raúl Miguel González
[1] Universidad Politécnica de Madrid
Localización: Ingeniería naval, ISSN 0020-1073, Nº. 1019, 2023, págs. 7-14

CONCLUSIONS

First route recommendation solution based on the measurement of ship motions, requiring only the installation of a tablet onboard as a sensor. It is based on a new, more accurate hydrodynamic model combined with AI.

01 Fuel and emissions reductions of over 5% across all types and ages of vessels.

02 Non-invasive system that can be used by both shipowners and operators.

03 Plug-and-play installation.

04 Designed by naval engineers and tested both in towing tank and real operating conditions.

05 Different optimization criteria.

For more efficient, cleaner, and safer navigation.

THANK YOU

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