AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping

D.4.2: Description of the training environment

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List of Acronyms

Abbreviation / acronym	Description
AI	Artificial Intelligence
A.P.	Aft perpendicular of the ship
BL	Base line of the ship
CFD	Computational Fluid Dynamics
CL	Centre line of the ship
D4.2	Deliverable number 2 belonging to WP 4
EC	European Commission
FEA	Finite Element Analysis
FEM	Finite Element Modelling
GMcor	Initial transverse metacentric height corrected for free surface effect
GPU	Graphics processing unit
KEEL	The bottom-most longitudinal structural element on a vessel
KN	Kilo Newton
LCG	Longitudinal center of gravity
ML	Machine learning
MPa	Mega Pascal
MT	Mega tons
O.A.	Overall
RL	Reinforcement learning
RPM	Revolutions per minute
SST	Shear stress transport
STBD	Starboard (right side of a ship when looking forward, towards the bow)
TCG	Transverse center of gravity
VCG	Vertical center of gravity
VOF	Volume of Fluid
WP	Work Package

Executive Summary

The present document is a deliverable of the MOSES project, which is funded by the European Commission's Innovation and Networks Executive Agency (INEA) under the Horizon 2020 research and innovation programme (H2020), reporting part of the outcomes of the activities carried out within the scope of WP4. The current document is connected to Task 4.2 entitled: "Design and Development of training environment". It aims to develop a suitable virtual training environment for autonomous agents (swarm of tugboats) based on the use cases and specifications from WP2.

Existing tugboat operations use manually operated conventional tugboats that assist large vessels for manoeuvring in port. To cross over from the current system to an autonomous tugboat swarm system, various milestones need to be accomplished. Within this document, the milestone of creating and developing a virtual environment, that will enable the training of an autonomous tugboat swarm is reported. This virtual environment is constituted by various objects that represent real-life components, namely water mass, port, containership, and tugboats. To achieve the best possible representation and producing reliable results, the training environment components are introduced with specific characteristics and properties, derived from extensive analyses and simulations. In this way is ensured that the virtual training environment will utilize realistic forces during training of the AI algorithms. For that purpose, a series of hydrodynamic simulations is provided, offering valuable parameters regarding the motion and response analysis of the ship objects. In addition, a Finite Element Structural Analysis is presented, which assesses the structural response and the limits of the components in various operations. The results from this study indicate the maximum allowable approach speed and contact force for the tugboats. Lastly, a validation was processed by defining two categories of test scenarios evaluating respectively the individual behaviour of objects and the interaction between them in the training environment. The results of the first category showcased a good agreement whereas the results of the second a larger disparity led to the conclusion that some adjustments need to be considered.