AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping

D.3.4: Control architecture for robotic container handling system

Document Identification			
Status	Final	**Due Date**	Thursday, 30 June 2022
Version	1.0	**Submission Date**	30/06/2022
Related WP	WP3	**Document Reference**	D.3.4
Related Deliverable(s)	D3.3, D3.5	**Dissemination Level**	CO
Lead Participant	MCGR	**Document Type:**	R
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 861678. The content of this document reflects only the authors' view and the Agency is not responsible for any use that may be made of the information it contains.

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Document History			
Version	**Date**	**Change editors**	**Changes**
0.1	28/03/2022	Jonas Renlund	First draft
0.2	23/05/2022	Jonas Renlund/ Tommy Mäkelä	2nd draft
0.3	30/05/2022	Janne Suominen	3rd draft
0.4	22/06/2022	Jonas Renlund Tommy Mäkelä	4th draft (after review)
0.5	23/06/2022	Jonas Renlund Tommy Mäkelä	Final internal review of draft
1.0	28/06/2022	Jonas Renlund	Final version to be submitted

Quality Control		
Role	**Who (Partner short name)**	**Approval Date**
Deliverable leader	MCGR	23/06/2022
Quality manager	NTUA	25/06/2022
Project Coordinator	NTUA	30/06/2022

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List of Acronyms

Abbreviation / acronym	Description
EC	European Commission
3D	3 dimensional
3DWI	3D world interpreter
AC	Alternating current
AEGIS	Advanced, efficient and green intermodal system
ARC	Active rotation control
CAN open	communication protocol and device profile specification for embedded systems used in automation
CC3000	Crane operation system
CCU	Crane control unit
C-How	Virtual reality software
D1.1	Deliverable number 1 belonging to WP 1
DSS	Deep sea shipping
GLE	Wire luffing onboard electric crane
HARA	Hazard and risk analysis
IMU	Inertial Measurement Unit
IOSS	Intelligent Operator Support System
IP	Internet protocol
ISO	International organisation for standardisation
LIDAR	Light detecting and ranging
LMS	Lifting and machinery system
MOSES	AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping
OCR	Container identification number
PC	Personal computer
R&D	Research and development
RCHS	Robotic Container Handling System
RGB	Red green blue

Abbreviation / acronym	Description
SCC	Shore control centre
SSI	Synchronous serial interface
SSS	Short se shipping
SWL	Safe working load
TRL	Technology readiness level
VCOP	Voyage/Container optimisation platform
VFD	Variable frequency drive
WP	Work Package

Executive Summary

The EC supports the development of short sea and inland waterway transportation to reduce road congestion and offer more environmentally friendly transportation networks. The MOSES project has expressed the ambition to design innovative feeder vessels to serve the purpose. The development of MOSES innovations is concentrated on two geographical areas in the Mediterranean region, namely the Greek use case and the Spanish use case. These use cases are described in detail on *"D2.2. MOSES Use Cases and scenarios "*. To increase the possibilities for expanding container supply chain to ports where the infrastructure is not supporting lifting containers from/to vessel, the feeder vessel will be outfitted with a robotic container-handling system that is autonomous, i.e., self-sufficient in terms of (un)loading containerised cargo.

Because the on-board robotic crane will be able to operate autonomously, i.e. does not need an onsite or on-board crane driver, it is a key innovation for enabling a short-sea container supply chain completely independent from small port infrastructure. In short, the robotic container handling system will be designed as a fully self-supporting system that does not need any local help except for a quay for berthing and for placing the containers, while maintaining safety of operations.

Together with partners like BROMMA and TNO, MacGregor's contribution in MOSES are:

- Develop and demonstrate, to TRL5, a Robotic Container Handling System (RCHS) capable of handling standard containers
- Shore Control interfaces to landside infrastructure and vessel loading computer
- Creating a 3D-world model, including sensor suite, for the robotic container handling system
- Virtual reality assisted remote supervisory control of the robotic container handling system

This document is the MOSES deliverable D3.4, "Control architecture for robotic container handling system", and the fourth deliverable in Work Package 3 of the project. The deliverable is closely connected to "*D.3.3: 3D world model for Container Handling System*" and *"D3.5: Remote supervisory control for robotic container handling system*". The content of these three deliverables are forming together the Robotic container handling system. Having said that, the objective of this deliverable

is to further describe, how the information flow of data for autonomous quay operations for container handling is arranged for the onboard robotic crane.

In order to fulfil this goal, the control architecture is designed to be modular. It consists of the following components: i) Crane control unit (CCU), which is responsible for data-processing for autonomous operations, ii) Crane Control unit (CC3000), responsible of giving crane its commands as it would do in case of manual operations, iii) Onboard control unit, responsible of collecting the data from various crane systems and also act as a link between the system and outside world, iv) Bromma spreader and built in cameras, v) 3D-world interpreter (3DWI), vi) crane sensors (jib top camera and LIDAR scanner), vii) VFD drive system and cabin display. All of this is connected to the shore control centre through MacGregor gateway device, so that it can be monitored within IOSS (Intelligent Operator Support System)

This document describes the current crane system and the additional crane functions required by the MOSES project, which will be used during the demonstration. Requirements are specified in the *"D2.4: Specifications and requirements for MOSES innovations".* In addition, the document will also describe the requirements for control architecture of the electromechanical crane system from a practical point of view so that the reasoning of the technical details can be understood.

In the architectural description, the connections towards 3D-world interpreter and remote-control systems are described but not in detail, as they are described in deliverables D3.3 and D3.5 respectively.