The MOSES Project

Automated and autonomous technologies for modal shift to Short Sea Shipping

Nikolaos P. Ventikos
Associate Professor, NTUA

Konstantinos Louzis
PhD Candidate, Research Engineer, NTUA

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Facts about the MOSES project

- **Project Title:** AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping
- **Duration:** 01.07.2020 - 30.06.2023 (36 months) – to be extended
- **Budget:** 8 million €
- **Consortium:** 17 Partners
The EU container supply chain

Maritime transport is efficient and green, mainly due to economies of scale!

The EU aims at shifting cargo from land-based transportation to more environmentally friendly modes.

To increase the share of SSS in the container supply chain:
- Feeder routes must reach more destination ports.
- Feeder vessels must carry less cargo cost effectively.
MOSES ambition/main objective

Significantly **enhance the SSS component** of the European container supply chain!

- **5%** Minimum decrease of end-to-end costs for container transport with feeder services
- **15%** Increase of feeder traffic between large terminals and small ports
- **10%** Modal shift to Short Sea Shipping in designated areas
MOSES Innovations:
1. MOSES AutoDock (MOSES Autonomous tugboats + AutoMoor)
2. MOSES Recharging Station
3. Innovative Feeder Vessel
4. Robotic container-handling system
5. MOSES matchmaking platform
**Objective:**
Decongest truck transport traffic in Valencia port and connect two Sagunto and Gandia satellite ports

- The feeder would be competitive to existing cargo transport options if **40% of the maximum estimated demand** is captured.
- Feeder service with a frequency of **three weekly services**, with geared ships.
- The expected cost-effective capacity of the vessel is **600-700 TEUs**.
“Eastern MED-Greece” use case

Objective:
Decongest Piraeus container terminal and integrate small Greek ports into the container supply chain

- The feeder would be competitive to existing cargo transport options if 80% of the maximum estimated demand is captured.
- At least two weekly services in each port.
- The expected cost-effective capacity of the vessel is 300-400 TEUs.

The 7 island ports represent 87% of the total general cargo traffic (based on 2019 data)
Autonomous tugboats | State of the art

- RECOTUG (remote control test)
- Robert Allan RAMORA (remotely controlled concept)
- IntelliTug (decision support, autonomous nav. test)
- POSH Harvest (autonomous nav. test)
- Seamachines Nellie Bly (autonomous nav. test)
- Kotug (autonomous nav. test)
AutoDock | Design and MOSES scope

- Architecture
- Artificial Intelligence for autonomous manoeuvring
- Requirements for fail-safe operation

Feasibility study with the assumption the autonomous tugboats are electric (battery or hybrid)

Adapted AutoMoor prototype

- Functional design
- Requirements for information exchanges - human interface

AutoDock | Design and MOSES scope
AutoDock | Autonomous Tugboat Swarm

Architecture

Artificial Intelligence

The “agents” have learned to manoeuvre the large vessel in a similar way as in a real tugboat operation!
AutoDock | Automated Mooring System

Prototype innovations:
- Small-scale
- Surge motion control
- Energy harvesting
- Communication with tugboats
AutoDock | Shore Tugboat Control Station

Monitoring of autonomous towing with transfer of a tug control in the event of an alarm

- STCS
- Meteorologic Service
- VTS
- Tagboat Swarm

Monitoring and alarm generation schemes:
- Weather data
- Maritime traffic data
- Tag sensor data

Alarm on tug X: Give control to the captain
AutoDock | Pilot Demonstration

Candidate locations at Faaborg port
Innovative Feeder | Design and MOSES scope

- Concept design for use cases and green operation, cost analyses
- Safety related to innovative features
- Demonstration of port-to-port autonomous operation through simulation (model integration problem)

Intelligent Operator Support System (IOSS) for autonomous cargo handling operations

- Sensor suite for 3D world model
- Hardware for crane control
Innovative Feeder | Concept designs

**Spanish concept**
- 670 TEU
- 5kn service speed
- 85 nm range

**Greek concept I, II**
- 180 TEU
- 10 kn service speed
- 266 nm range

**Innovations:**
- Sustainable propulsion (Hybrid methanol ICE + batteries, Full electric)
- Azimuth thrusters for enhanced manoeuvrability
- Automated cargo-handling, as first step towards higher autonomy
9 High risk events / system component

Cargo space:
- Onboard crane impedes port cranes → Slower cargo handling
- Water accumulation in cargo hold (open top design) → Stability degradation, damage to cargo

Accommodation:
- Mustering process takes too long
- Limited visual monitoring of the cargo space → Fire, cargo shift/loss not detected

Fuel/Energy storage:
- Methanol leakage
- Batteries overheating

Engine/Propulsion machinery:
- Hybrid configuration operation & maintenance
- Generator fails due to load variations in extreme weather
- Design speed too specific

* Hazards apply for all three concept designs
The objective is to demonstrate a fully autonomous round-trip by combining different vessel control models!

The simulation showcases fully automated vessel control from the port of Mykonos to the container terminal in Piraeus!

- Different models are used for:
  - way-point/track following,
  - Dynamic Positioning (DP) while manoeuvring,
  - docking
- A state machine is used for changing between mission phases
Intelligent Operator Support System (IOSS):
It uses AI to solve issues caused by another AI!

Remote supervisory control
- Enabling local situation awareness
- Robot self awareness in problem detection
- Control Intelligence
- Dynamic task allocation (One-to-many)
- Risk assessment for problem solving

Human-robot collaboration
- 3D world representation
- Anomaly detection
MOSES experience and key take-aways

• Competitiveness depends on the container transport demand captured by the feeder
• The hybrid power solution is estimated to have 10% lower operating costs compared to battery electric

• Reinforcement learning produces tugboat movements similar to manually operated tugboats
• Knowing the tugboat position accurately (< 1m) and comm. with automated mooring are crucial factors
• Human-in-the-loop seems to be the way for safety critical operations
NAIADIES III Impact Map

**shifting freight to water**
- Innovative feeder designed to be competitive to RoRo chain and independent from small port infrastructure (cargo, mooring)
- Matchmaking platform optimises SSS alternative for stakeholders

**more attractive jobs**
- Intelligent Operator Support System (IOSS) enabling safe and cost-effective (1-many) remote crane operations

**pathway to zero emission fleet**
- Innovative Feeder designed for zero-emissions operation
- Required infrastructure for recharging fully electric tugboats

**smart waterways**
- Autonomous port-to-port operation of Innovative Feeder
- Fully automated tugboat operation (manoeuvring)
Thank you for your attention!

Konstantinos Louzis, NTUA
klouzis@mail.ntua.gr

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