Autonomous tugboats for efficient, eco-friendly and safe port operations

Stefanos Kokkorikos
Co-Founder, Managing Partner
Machine Learning and Industry 4.0 technologies

- Predictive Maintenance
- Energy Management & Optimisation
- Robotic Swarm Intelligence
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
a holistic solution for autonomous vessel towage operations
why Autonomous Tugboats
a step towards the decarbonization of waterborne operations
reduced fuel consumption and GHG emissions
How can we validate this?

Our Key Performance Indicators

- Cost reduction of port operations
- Reduction of docking times
- Reduction of manoeuvring times
- Reduction of human-error accidents in ports
- Engagement of small ports as container terminals
use of enabling technologies
## Autonomous Tugboats

Our approach

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td>Autonomous navigation</td>
<td>e.g. payload, LIDAR, accelerometers, differential GNSS</td>
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<td>Collision avoidance</td>
<td>e.g. swath multi-beam sonar for seabed mapping</td>
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<td>Real-time decisions</td>
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<td>Dynamic environment adaptation</td>
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<td>Collaboration with Auto-Dock and Shore Control Station</td>
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**Target TRL=6**
2 levels of autonomy

MANUAL NAVIGATION WITH DECISION SUPPORT BY THE REMOTE OPERATOR

AUTONOMOUS SWARM OPERATION WITH REMOTE CONTROL CAPABILITY
State of the art
Simulation Environment
Simulation of the whole operating environment & water physics
Virtual port environment
Virtual tugboat
Virtual containership
integrate intelligence into a swarm of autonomous tugboats.
Implement reinforcement learning algorithms
Reinforcement is the way we learn
Our operating scenarios

Phase 1: Preparation of the towing/berthing process
Phase 2: Towing/berthing process
Phase 3: Mooring
Phase 4: Vessel departure
What’s next then?

Integration with shore control station

Collaboration with autonomous mooring system

Validation of the technology in a relevant environment
Thank you for your attention!

Stefanos Kokkorikos
skokkorikos@core-innovation.com