Smart Shipping & Logistics: Perspectives & Challenges

“anticipating the massive introduction of sensing, actuation, computation, and communication technology”

Prof.dr. Rudy Negenborn et al.
R.R.Negenborn@tudelft.nl

Researchlab Autonomous Shipping
Department of Maritime and Transport Technology
Delft University of Technology
\begin{align*}
    x(k+1) &= f(x(k), u(k), d(k)) \\
    y(k+1) &= g(x(k+1)) \\
    u(k) &= c(y(k)) \\
    J(y(k+1), u(k))
\end{align*}

1: Monitor & collect information

2: (Adapt) Model & predict dynamics

3: Control for optimal performance
Port automation for inspiration

Mixed-purpose vehicles can deal with people and freight demand interchangeably.

Integrating people and freight transportation using shared autonomous vehicles with compartments. Beirigo, Schulte, IFAC CTS, 2018
Autonomy leaving the port area

Will AVs really run everywhere?

Dual-mode vehicle routing in mixed autonomous and non-autonomous zone networks

Our world today

Near to distant future

Conventional driving (CD)

Automated driving (AD)

Dual-mode vehicle routing in mixed autonomous and non-autonomous zone networks, Beirigo, Schulte, IEEE ITSC, 2018
- Adaptive control, coordination & health monitoring
- Human-machine intelligence interaction
- Real-time optimization of transport and logistics (e.g. construction materials, mobility solutions)
- Experimental validation using high-fidelity simulations with real-life data and actual vessels (fleet of ~20 vessels)
Multi-disciplinary approaches enabling green and autonomous transport

- on the open oceans
- in crowded port areas
- in inland waterways
- in metropolitan areas
Single Autonomous Vessel

- Sustainability <-> Efficiency <-> Risk avoidance
- Machine Vision & Situational awareness
- Adaptive Predictive Manoeuvring Control
- Predictive Thrust Allocation & Energy Management

Fuel-Efficient Vessel Train Formations


Object manipulation: Multi-Tug Ship Towing

Smart Logistics: Putting things in perspective

Make better use of the capacity of inland fleet and infrastructure, and increase IWT reliability and competitiveness

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Further reading on Autonomous Shipping

Defining autonomy levels: Survey on autonomous surface vessels: Part I – A new detailed definition of autonomy levels

Prototypes and applications: Survey on autonomous surface vessels: Part II – Categorization of 60 prototypes and future applications

Maritime ecosystem: Smart ships and the changing maritime ecosystem

Cooperative control: Survey on cooperative control for waterborne transport

Collision avoidance: Ship collision avoidance methods: State-of-the-art
Further reading on Autonomous Shipping

**Motion control:** [State-of-the-art research on motion control of maritime autonomous surface ships](Journal of Marine Science and Engineering, vol. 7, no. 12, December 2019. Open access).

**Application, technology and infrastructure:** [Autonomous surface vessels in ports: Applications, technology and port infrastructures](In Proceedings of the 9th International Conference on Computational Logistics (ICCL 2018), Vietri sul Mare, Italy, pp. 85-105, October 2018).

**Short-term technology developments:** [Survey on short-term technology developments and readiness levels for autonomous shipping](In Proceedings of the 9th International Conference on Computational Logistics (ICCL 2018), Vietri sul Mare, Italy, pp. 106-123, October 2018).

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V. Reppa, B. Atasoy, V. Garofano, Y. Pang,
A. Coraddu, F. Schulte, et al.

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