



Automated inland shipping - *The challenges on the inland waterways*

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KU Leuven, IMP research group

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Outline

Where?

KU Leuven, Campus Group T

Why?

Societal-Economic motivation

Who?

IMP research group

Which?

H2020

EFRO

TETRA

Miscellaneous

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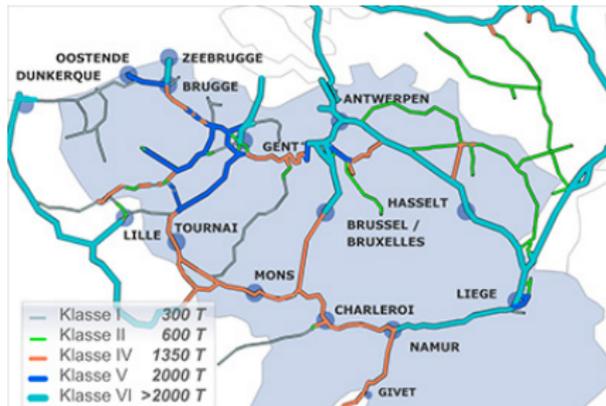
Miscellaneous

Central location of KU Leuven

Heart of Europe, and Belgium



60 % European purchasing power within 500 km range



Dense inland waterway network

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Inland cargo transport (Belgium)

Saturated roads and fairly empty inland waterways



- Cheap
- Flexible

Economic



- Sustainable
- Decoupling freight and traffic

Societal

Transported inland cargo (tonne-kilometre)

- 80 % road
- 15 % water
- 5 % rail

GOOD REASONS FOR WATERWAY TRANSPORTATION

Even the smallest Péniche can load the capacity of 14 trucks. Plus: Five liters of fuel last 500 kilometers per ton in a ship compared to only 100 kilometers per ton in a truck

Spits - Péniche:

length 38.50 m/width 5.05 m/draft 2.20 m/loading capacity 350 t



Tank ship:

length 110 m/width 11.40 m/draft 3.50 m/loading capacity 3,000 t



Container ship:

length 110 m/width 11.40 m/draft 3 m/loading capacity 200 TEU*

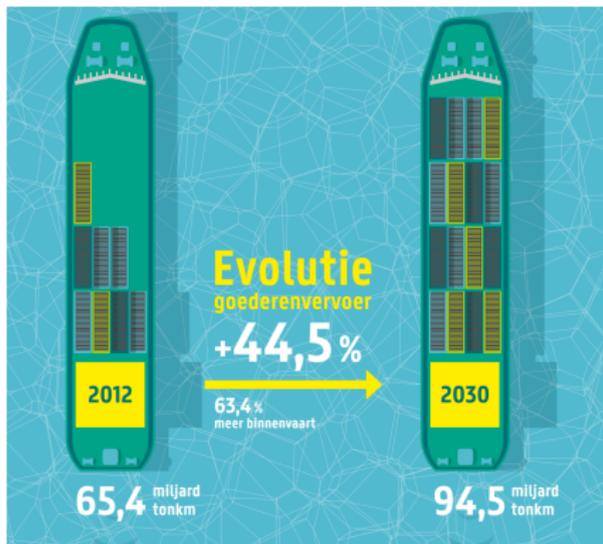


Push convoy (with 4 barges):

length 193 m/width 22.80 m/draft 2.50/ 3.70 m/loading capacity 11,000 t

* TEU=Twenty-foot Equivalent Unit Source: INE

Expected cargo growth in Europe



- Total cargo growth (tkm):
+ 44.50% 2030
- Water inland cargo wanted growth (tkm):
+ 62.40%
- - Outflow of inland ships, and shippers

Waterway investments in the past



(a) Gent 1791



(b) Gent now

- 1561 canal Brussel-Rupel
- 1561 Sassevaart
- 1623 canal Gent-Brugge

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Intelligent Mobile Platforms research group

Interdisciplinary research: **Intelligent Mobile Platforms (IMP)**

- Aerodynamics and hydrodynamics
- **Autonomous inland shipping**
- Indoor localization
- Mobility for health
- Mobile quality control

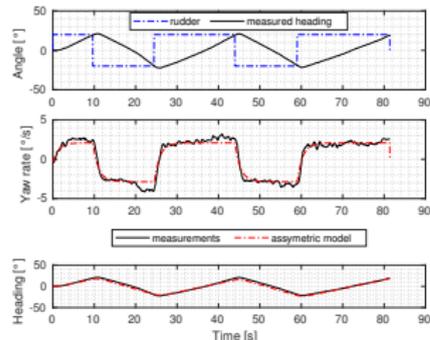
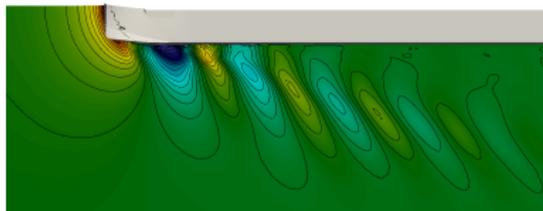
Professors: M. Vanierschot, P. Slaets, G. Waeyenbergh

Researchers: G. Peeters, A. Eggers, G. Oigus , R. Amsters, P. Geenen , T. Catoor , A. Junaid, S. Roy, M. Kotzé, P. Demissie, B. Filtjens

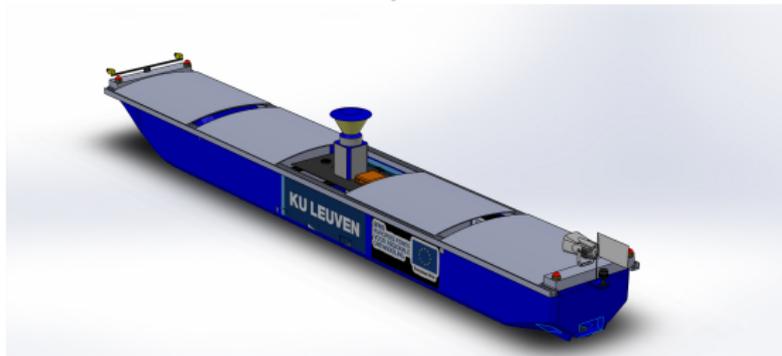
<https://www.mech.kuleuven.be/en/pma/research/robotics/research/applications/imp>

IMP - Autonomous inland shipping

Identification & Motion control



Localisation & Perception



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H2020: Hull to hull navigation (EGNSS H2H)

Close proximity navigation: vessel - vessel and vessel - object

Inland goals:

- Single handed sailing
- Single handed lock passing
- Single handed docking

Partners:

- Kongsberg Seatex
- SINTEF Ocean
- SINTEF Digital
- Mampaey Offshore International
- KU Leuven

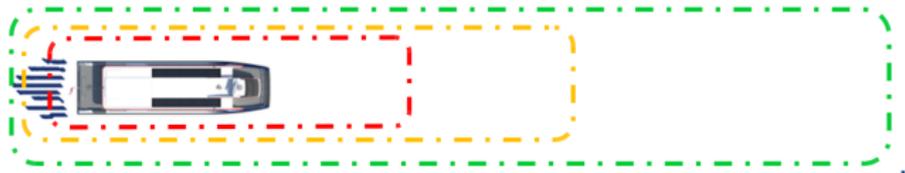
H2H: Proximity Zones

Changing proximity zones due to vessel dynamics, sensor and map accuracy.

E.g. low speed and/or inertia, smaller proximity zones



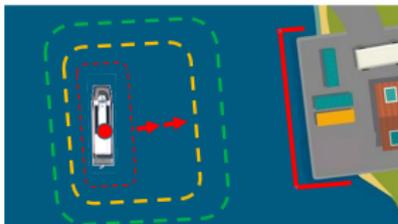
Whereas a higher speed and/or inertia results in a larger proximity zone.



H2H: e.g. single handed docking

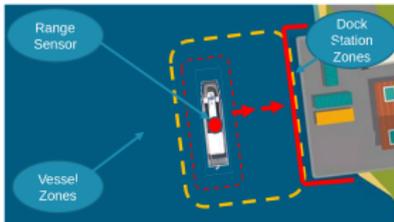
I. Approach

- GNSS and INS sensors



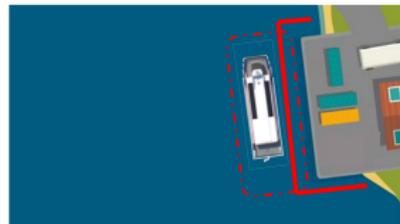
II. Docking

- GNSS and INS sensors
- Additional range sensors



III. Contact

- GNSS and INS sensors
- Additional range sensors
- Quayside sensors, and actuators



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EFRO: "Autonoom varen in de Westhoek"

Real life demonstration of the state-of-the-art equipment:

- Technical design
- Legal design
- Pilot demonstrations



AGENTSCHAP
INNOVEREN &
ONDERNEMEN



EFRO
EUROPEES FONDS
VOOR REGIONALE
ONTWIKKELING



West-Vlaanderen,
ondernemen op **hoog niveau**

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TETRA: Ad Usum Navigatum

Two years, test case for SLAM on mobile platforms using multiple sensor systems.

- Leuze RSL 430-S
- 2D safety laser scanner
- Max range 50 m
- Robust
- Clean data



- SICK LMS200
- 2D laser scanner
- Max range 80 m
- Robust
- Clean data



- Pepperl & Fuchs OMD10M-R2000-B23-V1V1D
- 2D laser scanner
- Max range 60 m
- 4 laser beams
- Compact



- Microsoft Kinect
- Stereo camera
- Max distance 4,5 m
- Range of 42° x 57°



- Ensensio N35-602-16-IR
- Stereo camera
- Max distance 3 m
- Range of 58° x 52°



- Microsoft Kinect V2
- Time of Flight camera
- Max distance 4,5 m
- Range of 70° x 60°



- XSENS Mt-G-710
- IMU (internal measurement unit)
 - Gyroscopes
 - Accelerometers
 - Magnetometer
 - Barometer



- Sensor fusion algorithm

- IMU (internal measurement unit)
 - Gyroscopes
 - Accelerometers
 - Magnetometer
 - Barometer
 - Humidity
 - Temperature



- Variense VMU930
- IMU (internal measurement unit)
 - Gyroscopes
 - Accelerometers
 - Temperature

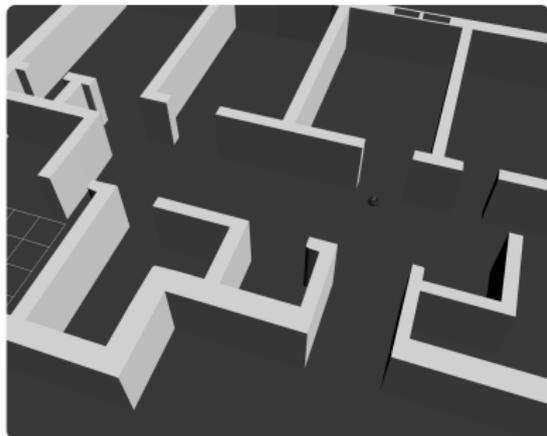


TETRA: Ad Usum Navigatium

Web simulator

KU LEUVEN Welcome All to Robot Web Simulator v0.1

ROS Server is connected



Robot Speed: 90%



Homepage Intelligent Mobile Platforms Contact us Log Out

Navigation Position Error in XY



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Miscellaneous projects

- GIP projects (integrated projects):
 - Development benchmark motion control
 - Development crane for small containers
 - Development small cargo vessel
 - Development passive and active markers for mooring
- Ecorace Challenge:



- Master theses