Helios Challenge : Build an ocean current map from navigation data of an autonomous boat

https://www.ensta-bretagne.fr/jaulin/helios.html

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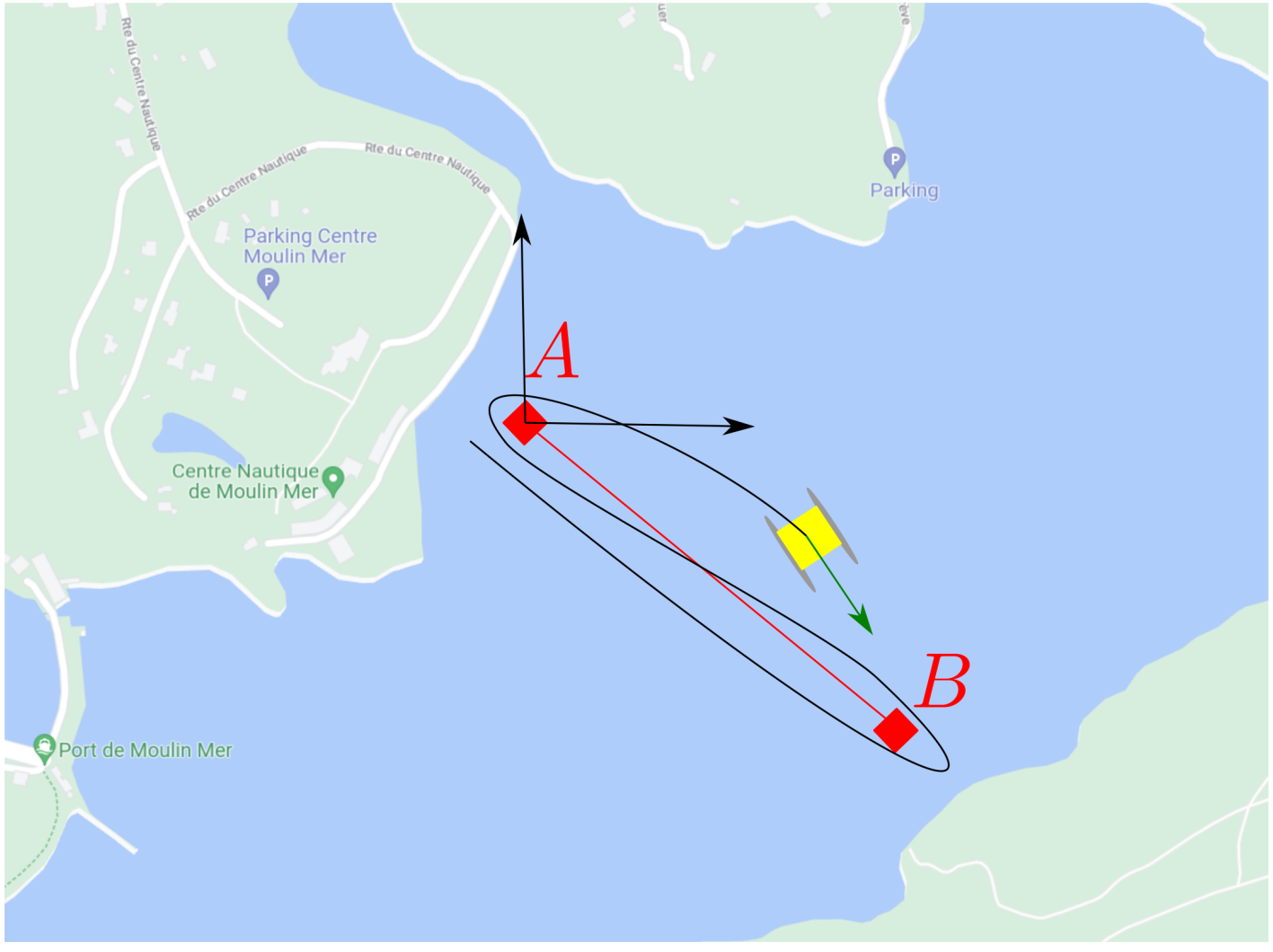
Séminaire IA&Océan, Moulin Mer

1. Helios


Rte du Centre Nautique
Rte du Centre Nautique
Rte du Centre Nautique
Parking Centre
Moulin Mer
Parking
Centre Nautique
de Moulin Mer
Port de Moulin Mer
A
B

Distance from A to B : 350 m.

$$\begin{array}{lll} A: & \ell_x^A = 48.31810947946432 & \ell_y^A = -4.282106814960749 \\ B: & \ell_x^B = 48.31616169236366 & \ell_y^B = -4.278512654938928 \end{array}$$

The local frame that will be taken is centered in A and is defined by

$$\begin{aligned} x &= \rho \cdot \cos \ell_y \cdot \left(\ell_x - \ell_x^A\right) \\ y &= \rho \cdot \left(\ell_y - \ell_y^A\right) \end{aligned}$$

where $\rho = 6378000m$.

Helios performs loops from A to B for several hours and returns a file (.csv) with

1. The time t (UTC, in sec)
2. The coordinate of the robot :(ℓ_y, ℓ_x) lat-long,
3. The heading ψ with respect to the North
4. The values u_L, u_R for the two propellers

- All videos, photos, data will be shared and made public on the Web.
- They can be used by anybody for publications, communication, etc.

2. Model

You can take your own model, but we propose the following:

$$\begin{cases} \dot{x} &= v \cdot \cos\psi + c_1 \\ \dot{y} &= v \cdot \sin\psi + c_2 \end{cases}$$

where c_1, c_2 correspond to the coordinates of the current velocity vector $\mathbf{c}$.
The wind is neglected in this model.

- The variable v is the unmeasured longitudinal speed of Helios with respect to the water.
- We know that v it linked to the voltage delivered to the propellers, but we have no model for this.
- The current varies smoothly on the time t and the space x, y.
- The current is periodic $T = 12:25\text{h}$.

Ellipsoidal model for the current:
It might be assumed that at a given position the current satisfies

$$\begin{pmatrix} c_1 \\ c_2 \end{pmatrix} = \begin{pmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{pmatrix} \cdot \begin{pmatrix} a_1 & 0 \\ 0 & a_2 \end{pmatrix} \cdot \begin{pmatrix} \cos(\frac{2\pi t}{T} + \varphi) \\ \sin(\frac{2\pi t}{T} + \varphi) \end{pmatrix}$$

with $a_1 > a_2$.

3. Ground truth

Different methods:

- Lagrangian
- Eulerian

Future: SWAM approach

- AUV following a pinger
- Camera + flying drone
- Immersed buoys
- Cooperative localization and mapping