

Autonomous submarine exploration by a group of robots

L. Jaulin

Cité des congrès de Nantes, June 03, 2022
Capteurs communicants pour le génie océanique



Ancestral method of navigation

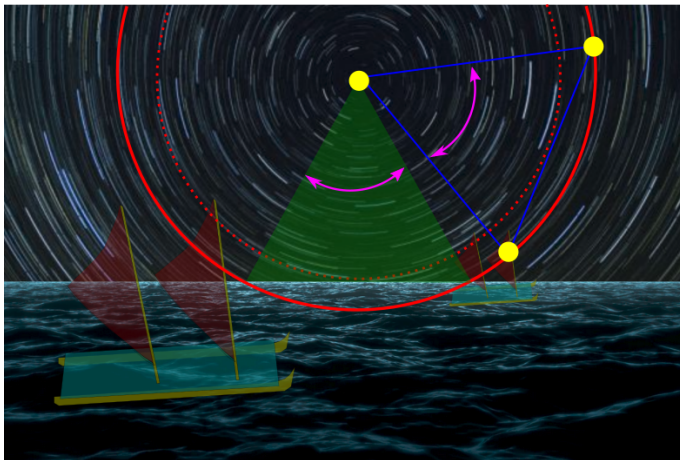


[Submeeting 2018](#)

Polynesian navigation

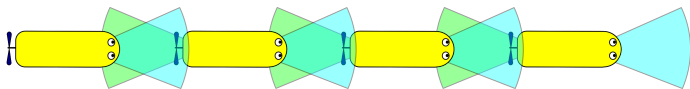


Find the route without GPS, compass and clocks with *wa'a kaulua*[?]

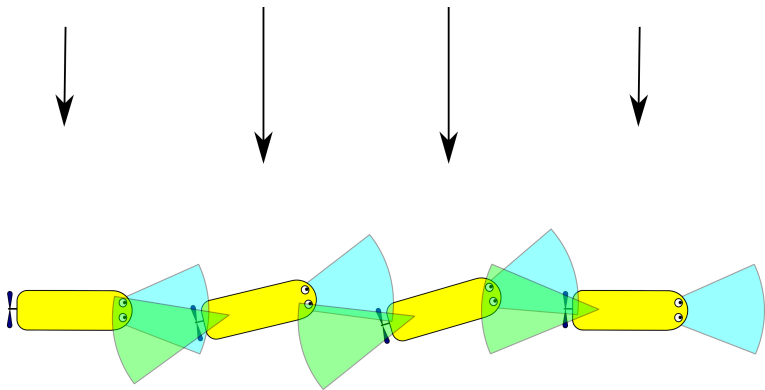




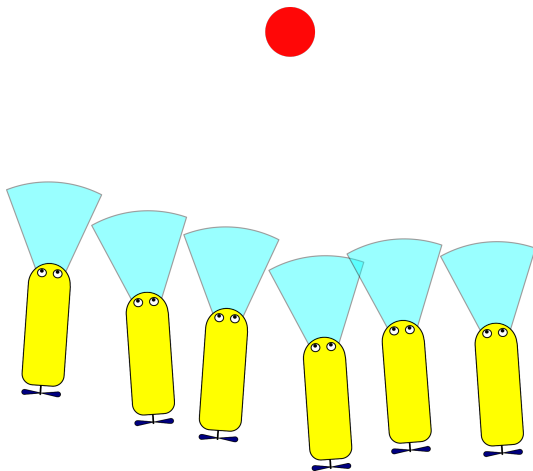
Alignment to keep the heading in case of clouds



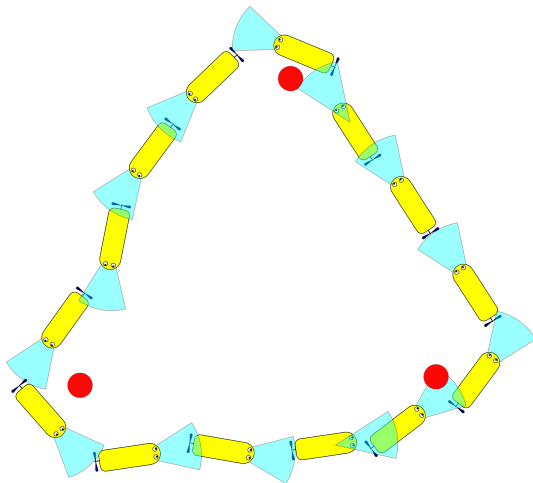
More inertia, more predictable



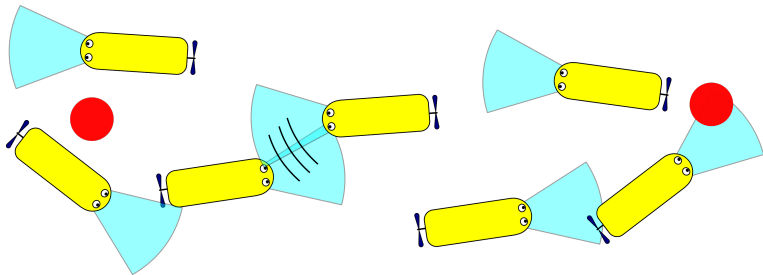
Internal deformations provide information



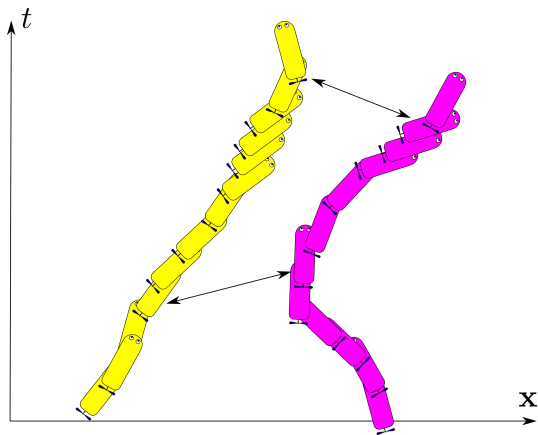
Explore further



Virtual chain: localization $\leftrightarrow$ proprioception

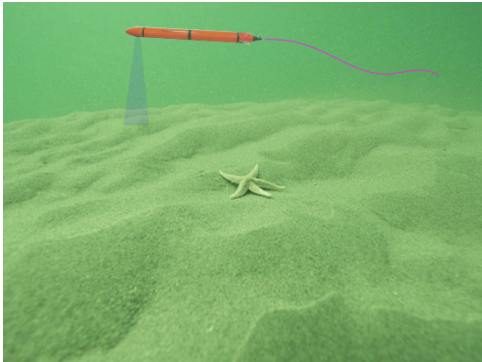


With communication we can do more

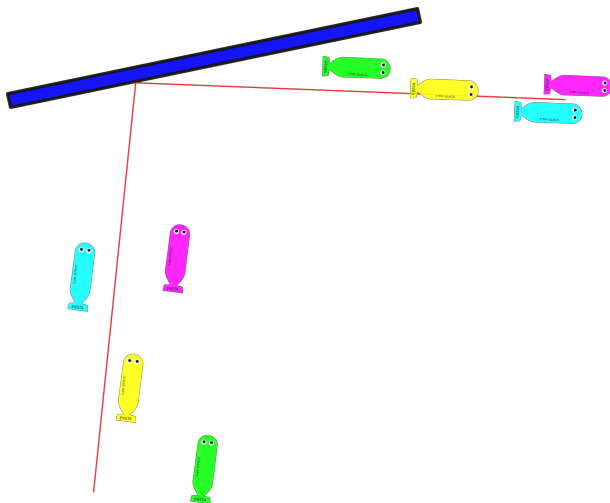


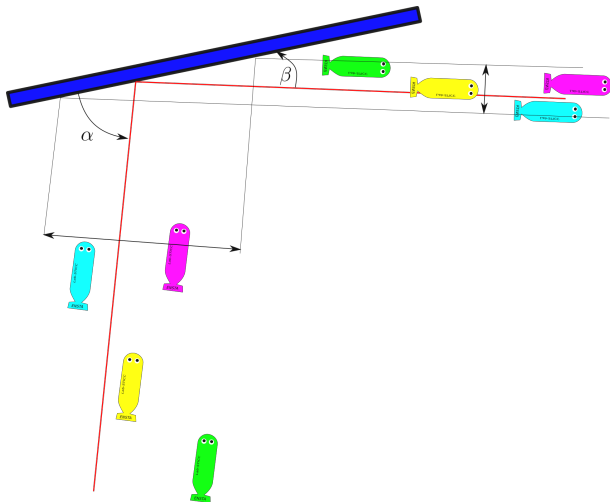
Perception of others rigidifies the evolution of the group

Stable cycles



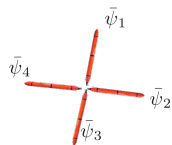
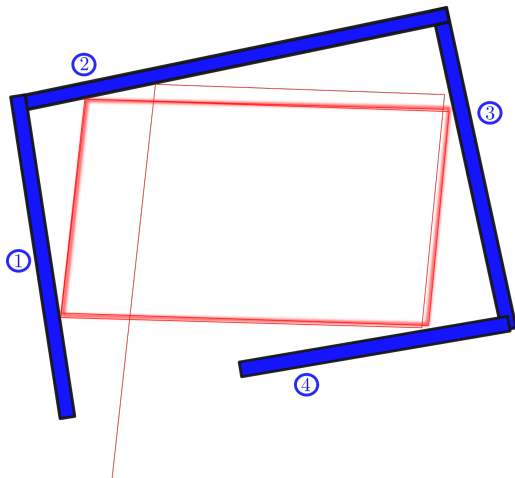
No route exist

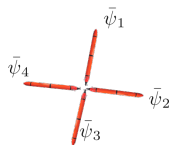
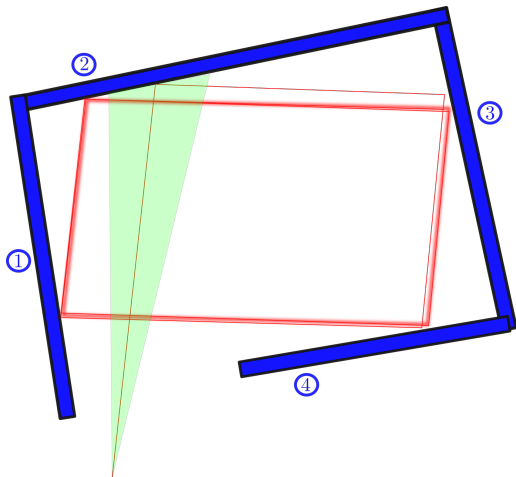


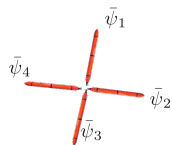
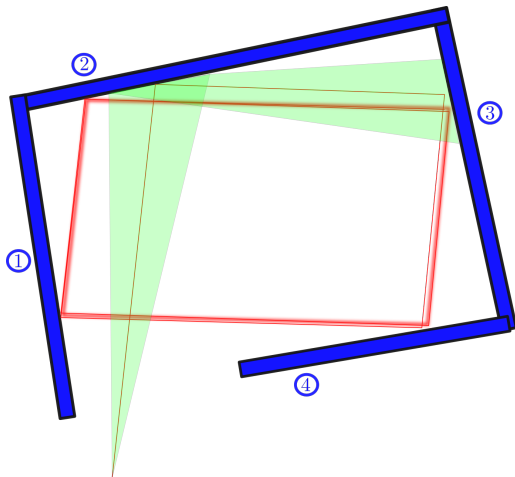


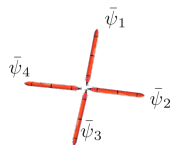
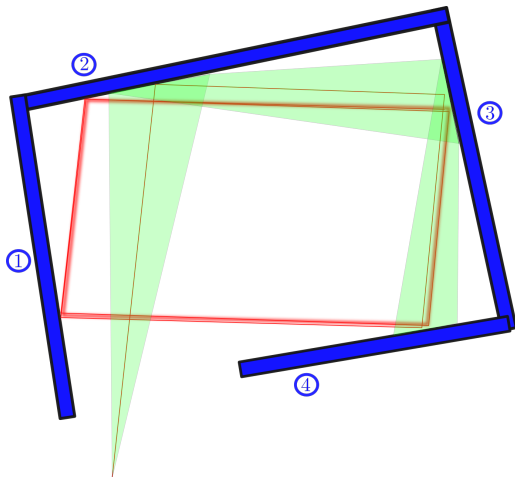
A cycle is stable if

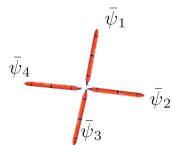
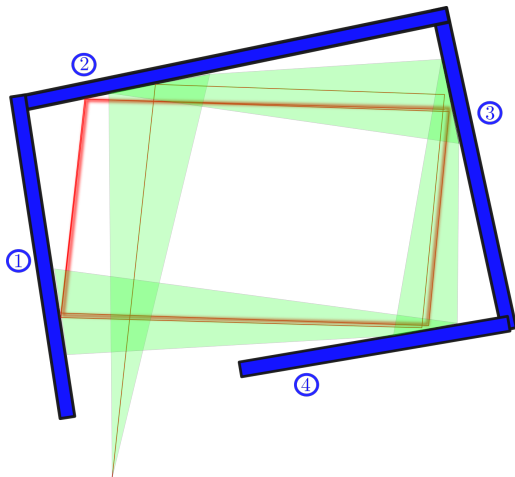
$$\prod_i \frac{\sin \beta_i}{\sin \alpha_i} < 1$$

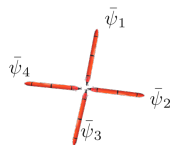
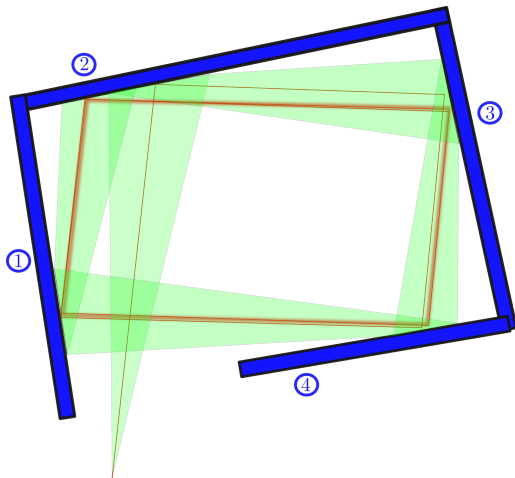


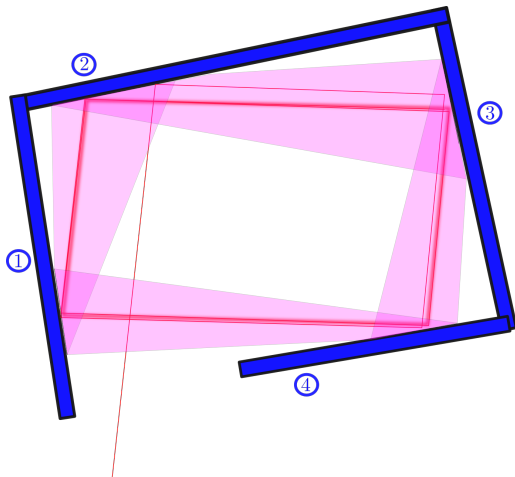




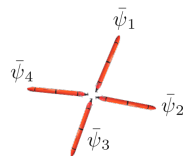
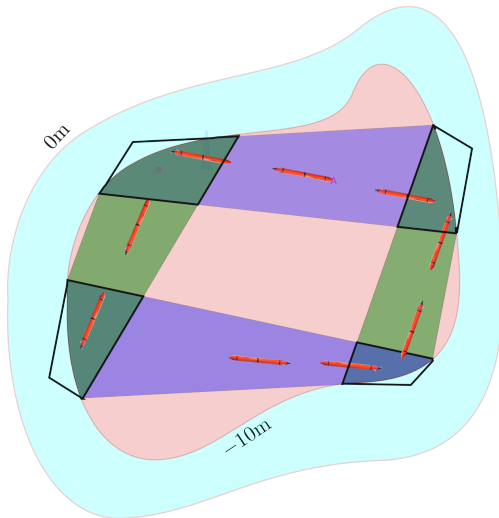


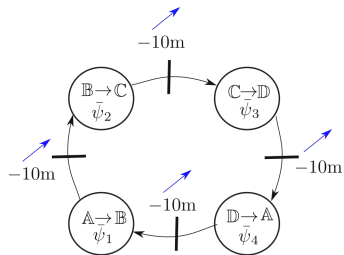
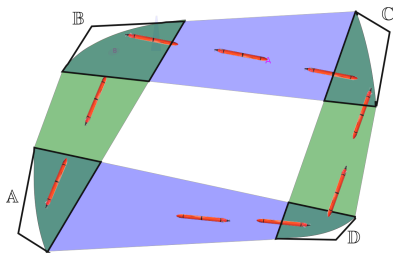


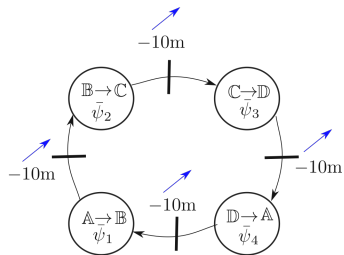
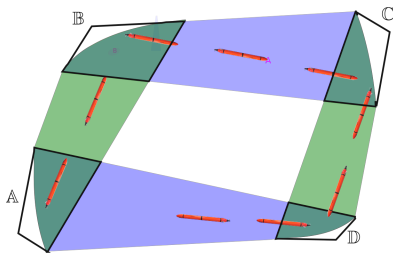


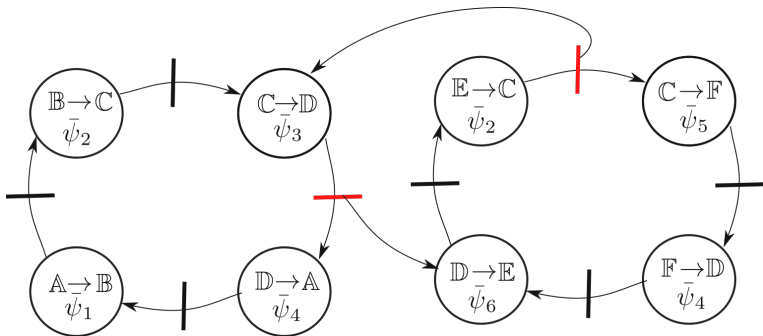


<https://youtu.be/TsvEUGa-XAs?t=73>







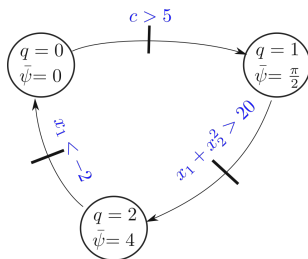


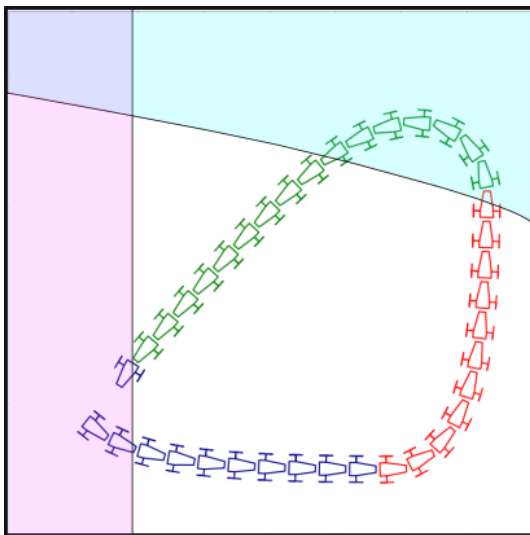
Test-case

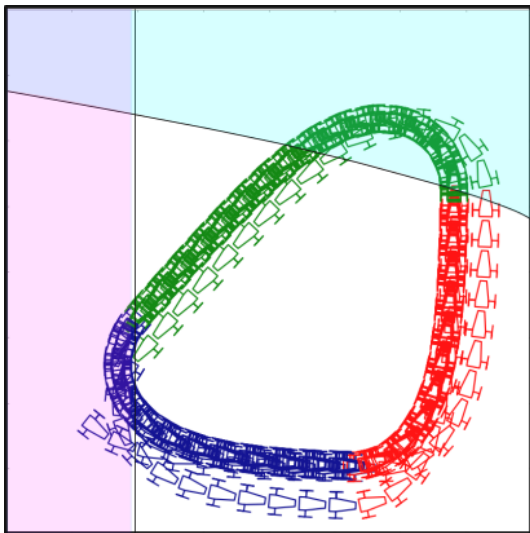
Consider the robot

$$\begin{cases} \dot{x}_1 = \cos x_3 \\ \dot{x}_2 = \sin x_3 \\ \dot{x}_3 = u \end{cases}$$

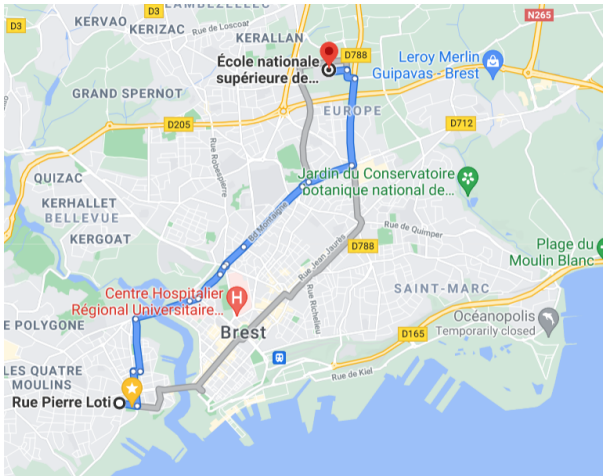
with the heading control $u = \sin(\bar{\psi} - x_3)$.



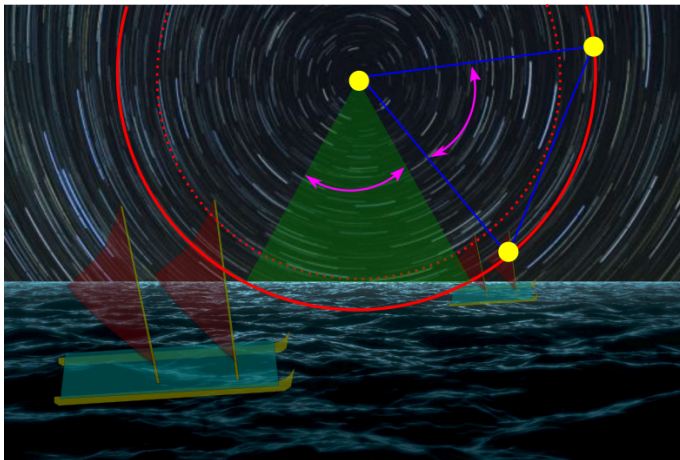


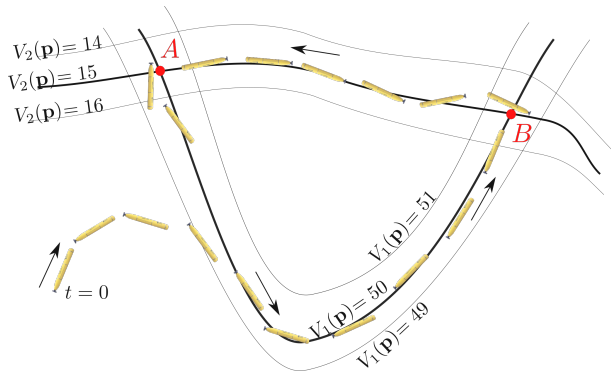


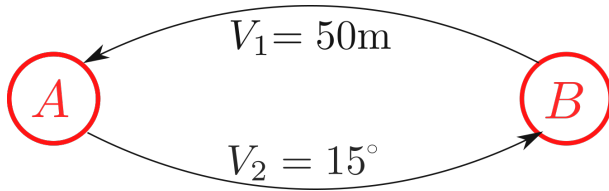
Metric maps ? Topological
maps ? Other ?



Modern navigation







- [1] L. Jaulin (2019). Naviguer comme les polynésiens, Interstices.
- [2] A. Bourgois, A. Chaabouni, A. Rauh and L. Jaulin (2021).
Proving the stability of navigation cycles, SCAN'2020
- [3] J. Damers, L. Jaulin, S. Rohou. Lie symmetries applied to
interval integration, Automatica (accepted).

This work has partially been supported by Kopadia and DGA