Cartographie magnétique sous-marine des fonds marins pour la recherche de la Cordelière

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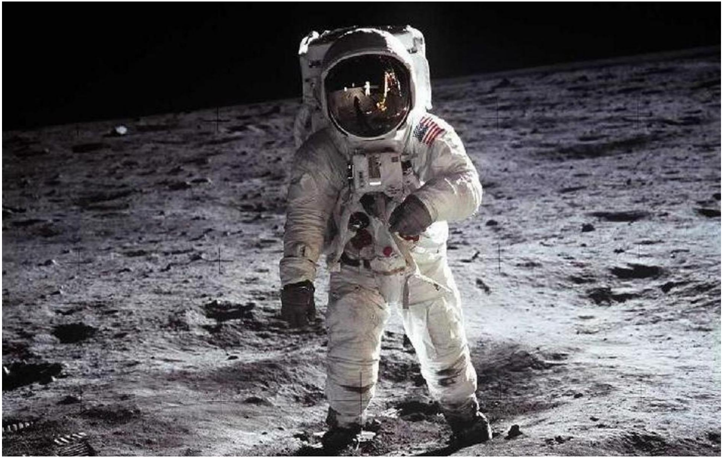
Journée Robotique, Archéologie et Patrimoine
Jeudi 6 février 2020

Marine robots to build maps

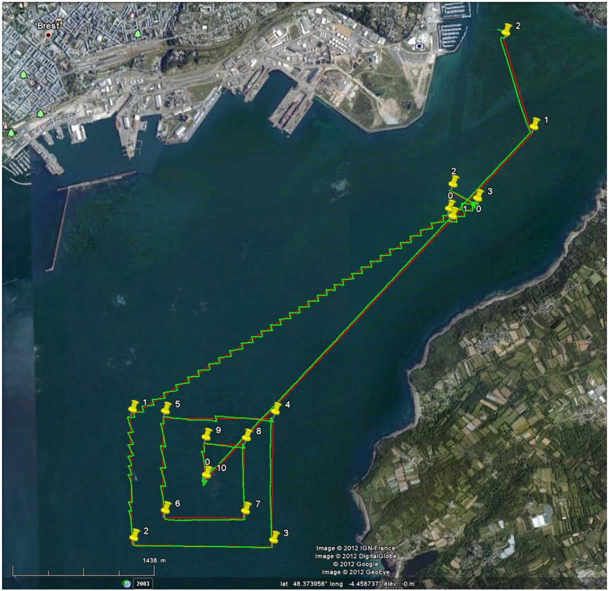
Robots for exploration

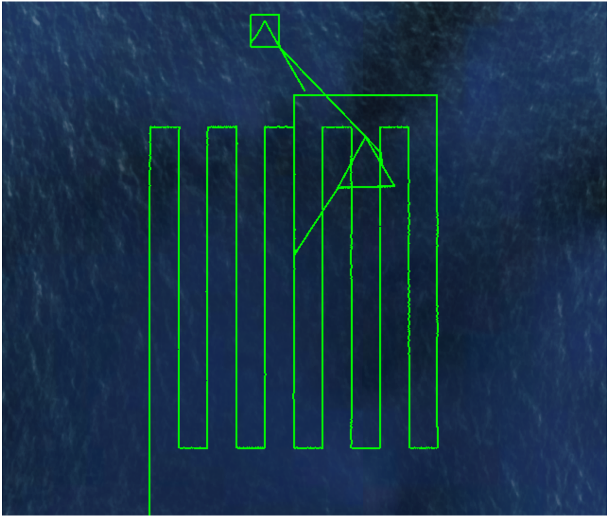


Robots are needed for dirty, dangerous and dull jobs

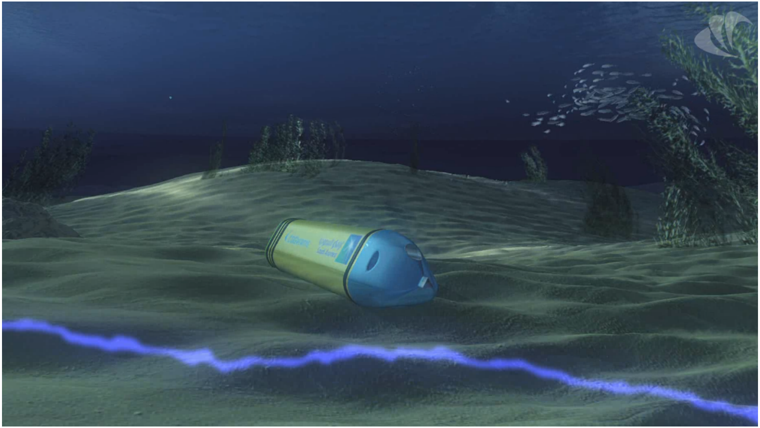
Curiosity

About 3,600 satellites in orbit.
In the ocean, we have gliders, drifting floats.
In the ocean, a robot should be autonomous in energy (persistent autonomy).


Brest
2
1
2
3
0
1
0
1
5
4
9
8
0
10
6
7
2
3
Image © 2012 IGN-France
Image © 2012 DigitalGlobe
© 2012 Google
Image © 2012 GeoEye
1438 m
2003
lat 48.373958° long -4.458737° élév 0 m



Middle of Atlantic ocean, 350 km made by Vaimos, sept. 6-9, 2012.



Youtube

Recherche de la Cordelière

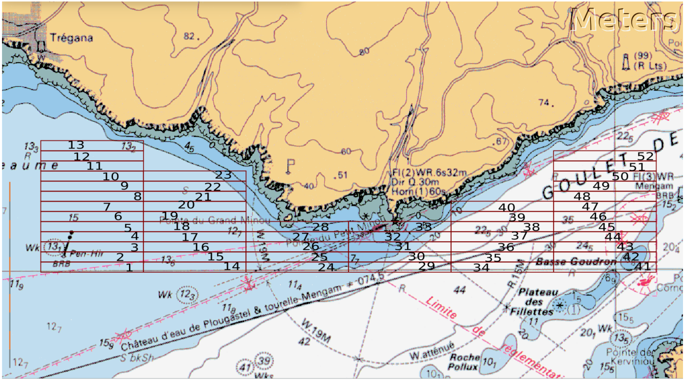
Reconstitution de la bataille

Youtube

Premières recherches avec Boatbot

Youtube

boatbot.html


Meters
Trégana
(99)
(R Lts)
Fl(2)WR.6s32m
Dir Q.30m
Horn(1)60s
Pointe du Grand Minou
GOULET DE
Fl(3)WR
Mengam
BRB
Pen-Hir
Basse Goudron
Plateau
des
Fillettes
Château d'eau de Plougastel & tourelle Mengam 074.5
Limite de réglementat
W atténué
Roche
Pollux
Pointe de
Kervinou
W.19M
R.15M
13
12
11
10
9
8
7
6
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3
2
1
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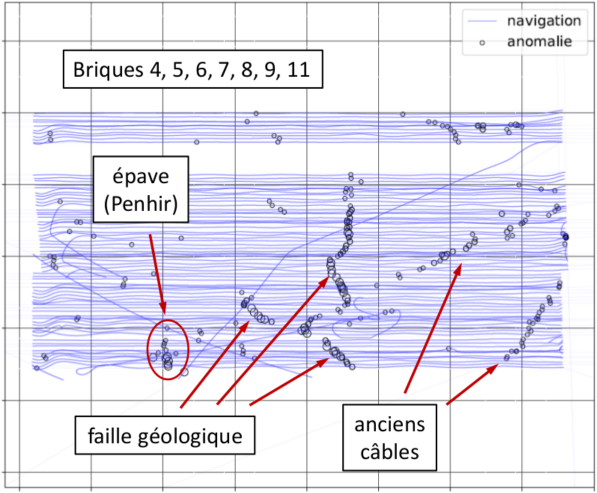
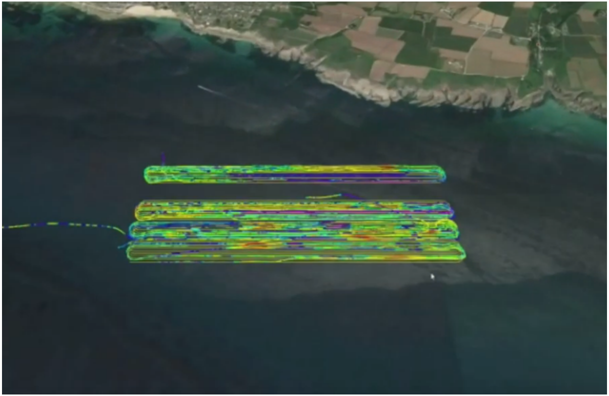
41

Boatbot tracte un magnétomètre

youtu.be/cxVs1fDdm1s



Magnetic map built in 2018



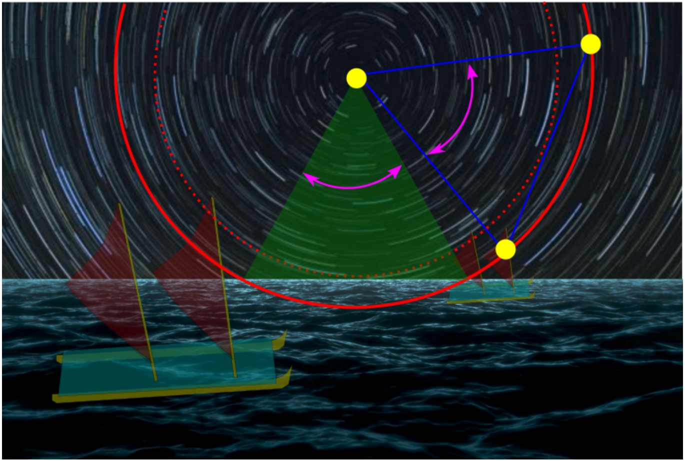
Magnetic map built in 2019

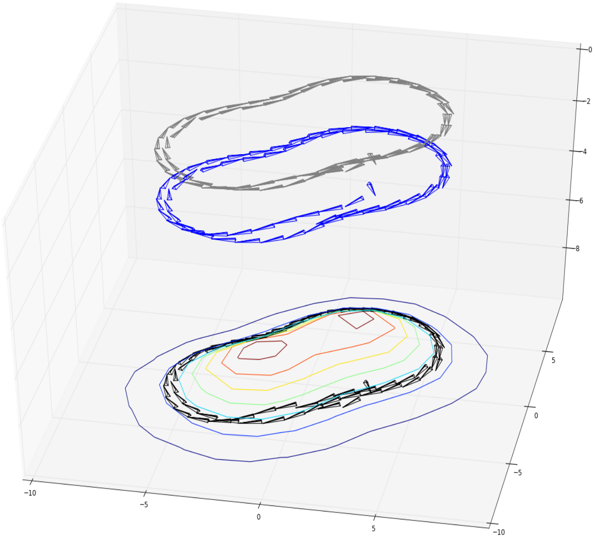
Youtube

All underwater

Submeeting 2018

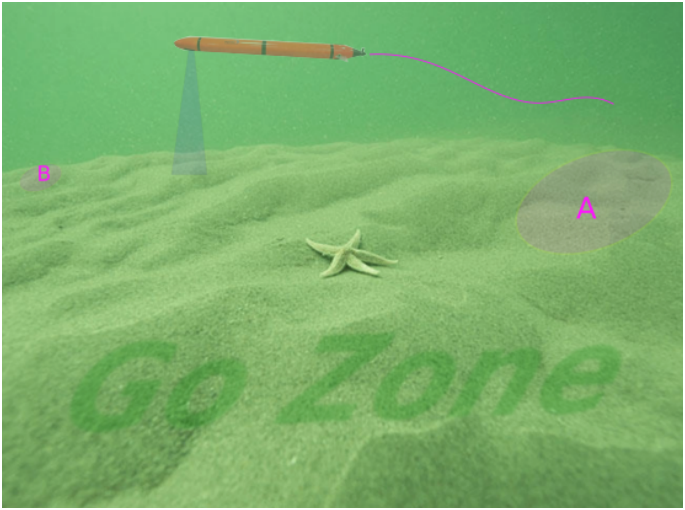
Find the route without GPS, compass and clock





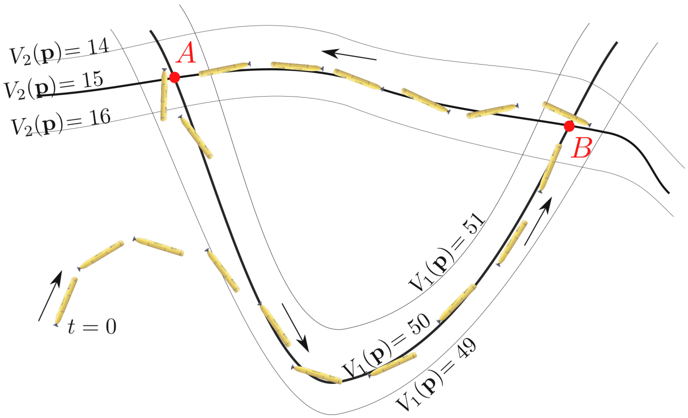
[1]

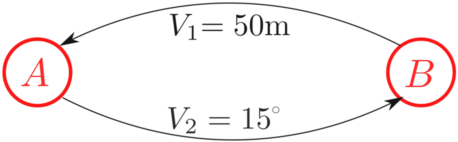
Cycles

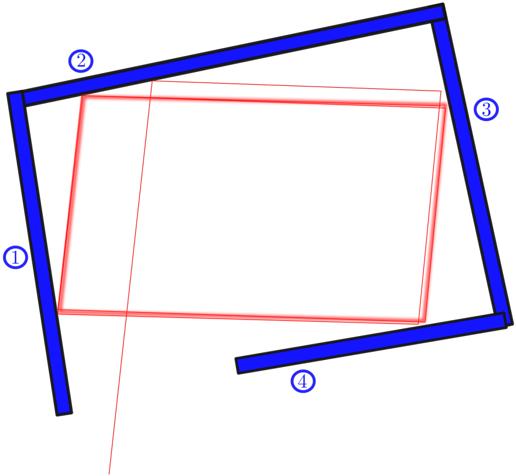

B
A
Go Zone

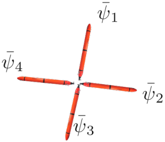
Example of of an underwater automaton that could be followed for navigation

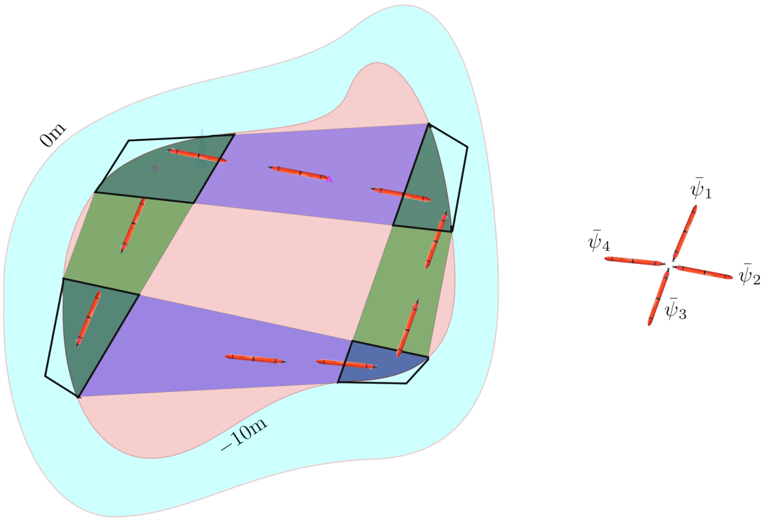
1. Follow the isobath of 50m until the temperature is 15°.
2. Follow the 15° isotherm, until the depth is 50m
3. Go to Step 1

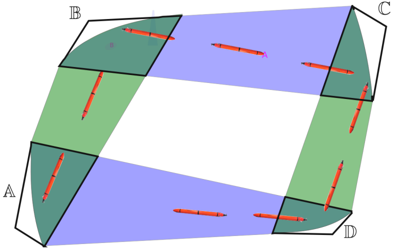

$V_2(\mathbf{p}) = 14$
$V_2(\mathbf{p}) = 15$
$V_2(\mathbf{p}) = 16$
A
B
$t = 0$
$V_1(\mathbf{p}) = 51$
$V_1(\mathbf{p}) = 50$
$V_1(\mathbf{p}) = 49$

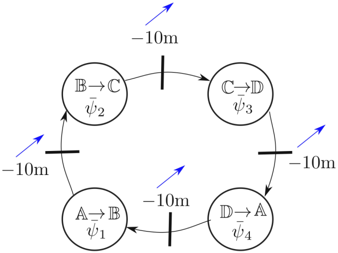

$V_1 = 50\text{m}$
A
B
$V_2 = 15^\circ$

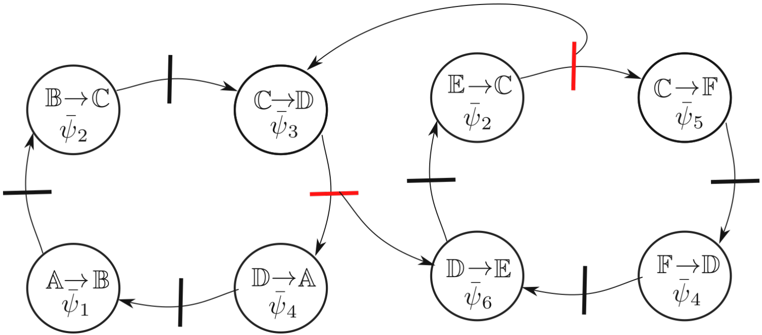

1
2
3
4


$\bar{\psi}_1$
$\bar{\psi}_4$
$\bar{\psi}_2$
$\bar{\psi}_3$

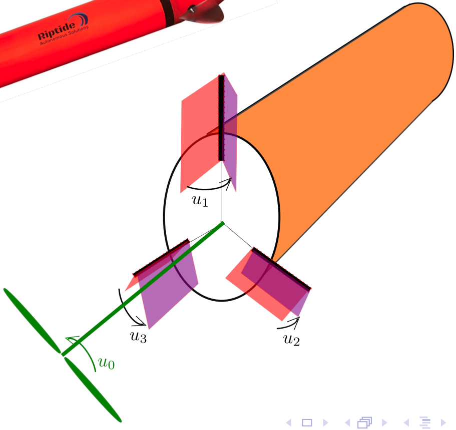

0m
−10m
A
$\bar{\psi}_1$
$\bar{\psi}_2$
$\bar{\psi}_3$
$\bar{\psi}_4$

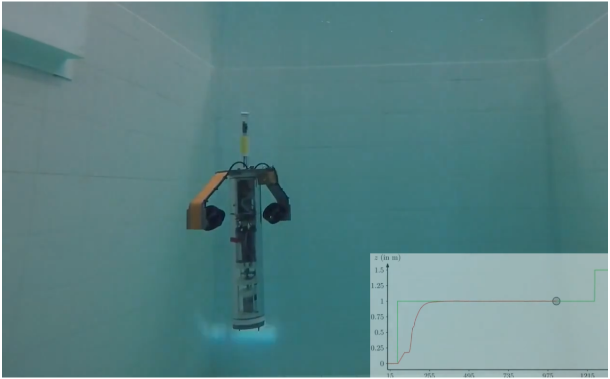

$\mathbb{B}$
$\mathbb{C}$
$\mathbb{A}$
$\mathbb{D}$


$\mathbb{B} \to \mathbb{C}$ $\bar{\psi}_2$
$\mathbb{C} \to \mathbb{D}$ $\bar{\psi}_3$
$\mathbb{A} \to \mathbb{B}$ $\bar{\psi}_1$
$\mathbb{D} \to \mathbb{A}$ $\bar{\psi}_4$
-10m
-10m
-10m
-10m


$\mathbb{B} \to \mathbb{C}$ $\bar{\psi}_2$
$\mathbb{C} \to \mathbb{D}$ $\bar{\psi}_3$
$\mathbb{A} \to \mathbb{B}$ $\bar{\psi}_1$
$\mathbb{D} \to \mathbb{A}$ $\bar{\psi}_4$
$\mathbb{E} \to \mathbb{C}$ $\bar{\psi}_2$
$\mathbb{C} \to \mathbb{F}$ $\bar{\psi}_5$
$\mathbb{D} \to \mathbb{E}$ $\bar{\psi}_6$
$\mathbb{F} \to \mathbb{D}$ $\bar{\psi}_4$


Riptide
Autonomous Solutions

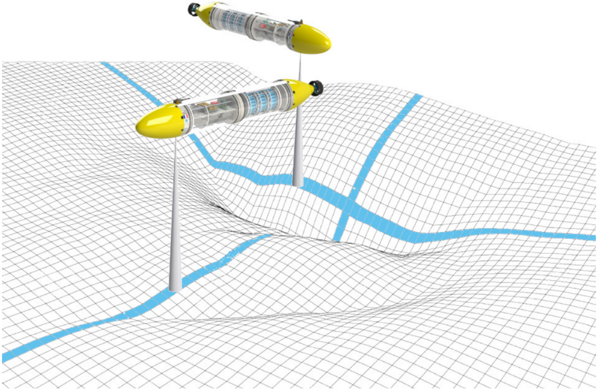

u_1
u_3
u_2
u_0



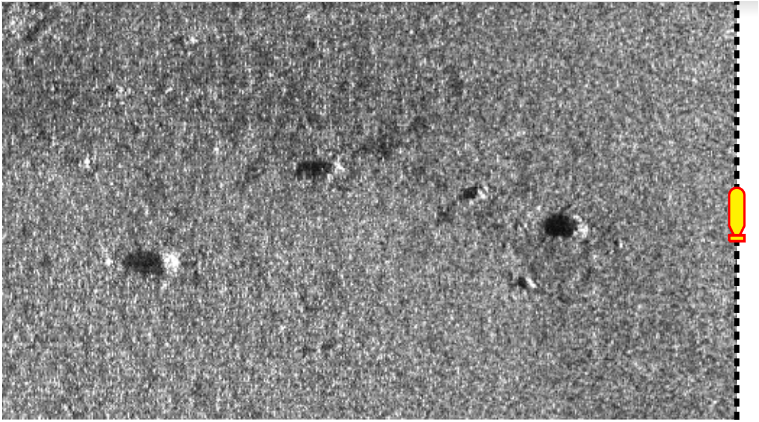
Pseudo-Lagrangian float for building a map of underwater currents [3]

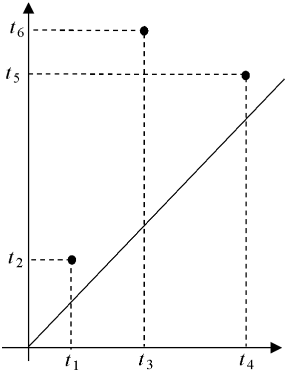
Youtube

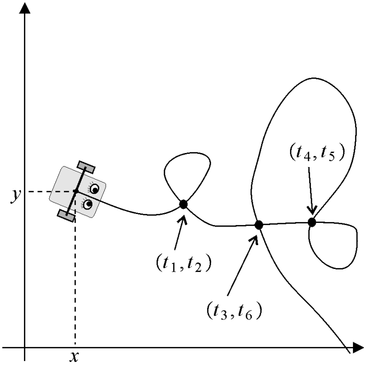
Loops

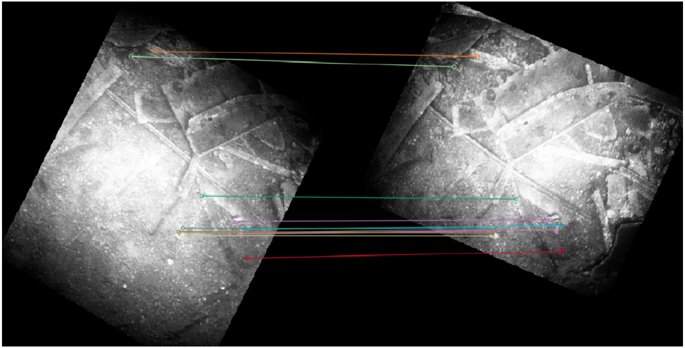


[4]

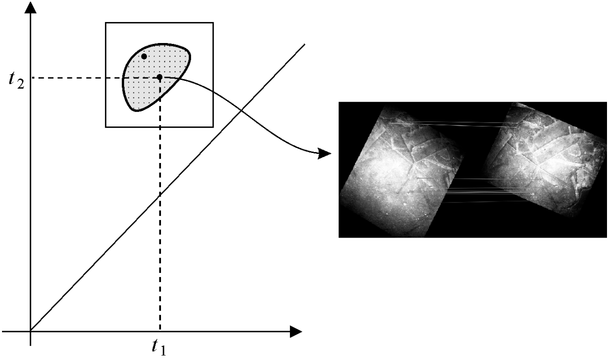


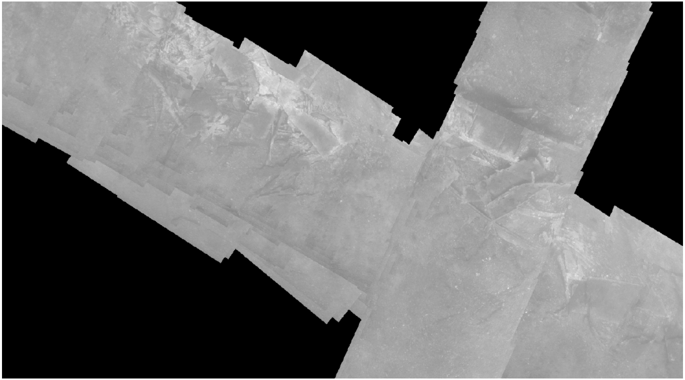

t_6
t_5
t_2
t_1
t_3
t_4


y
x
(t_4, t_5)
(t_1, t_2)
(t_3, t_6)



Are you sure we made a loop ?


t_2
t_1



With M. Laranjeira and S. Tauvry [2]

L. Jaulin.
Isobath Following using an Altimeter as a Unique Exteroceptive Sensor.
In Sophia M. Schillai and Nicholas Townsend, editors, *Robotic Sailing 2018*, pages 105–110, 2018.

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T. Le Mézo, G. Le Maillot, L. Jaulin T. Ropert, A. Ponte, and B. Zerr.
Design and control of a low-cost autonomous profiling float.
In *CFP'19*. Brest, France, June 19-22, 2019.

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