Isobath following using an altimeter

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IRSC 2018, Southampton
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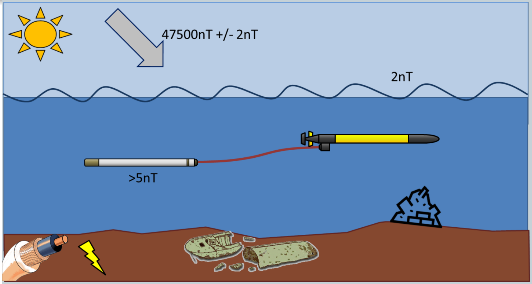
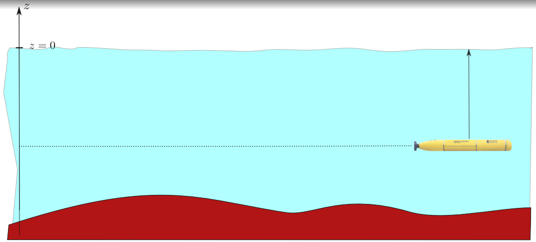
La Cordelière and the Regent

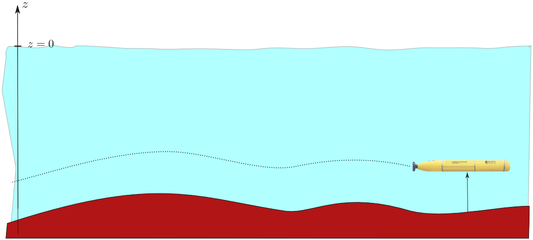
Reconstitution de la bataille

youtu.be/yP4cM1UGrqY



Romain Schwab


z
$z = 0$


z
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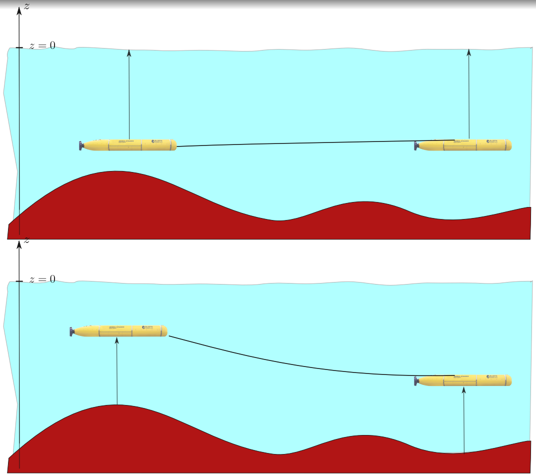
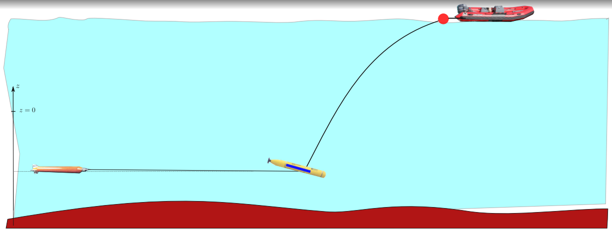
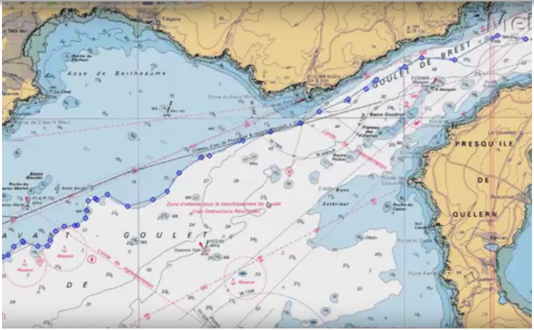

z
$z = 0$
z
$z = 0$


z
z = 0



Tests du 7 juillet

youtu.be/cxVs1fDdm1s

Follow an isobath

Ile des morts experiment


Saint-Renan
Guilers
Bohars
Lambézellec
Le Relecq-Kerhuon
L'Élorn
La Forest-Landerneau
Ploumoguer
Saint-Marc
Brest
Saint-Pierre
Plouzané
Locmaria-Plouzané
Dirinon
Saint-Urbain
Plougastel-Daoulas
Loperhet
Irvillac
Daoulas
Plougonvelin
Roscanvel
Hôpital-Camfrout
Logonna-Daoulas
Landévennec
Lanvéoc
Camaret-sur-Mer
Rosnoën
Crozon
Rue de Dinan
Argol
Telgruc-sur-Mer
Saint-Nic
Plomodiern


Île des Morts
Celtic Sea
ROSCANVEL
Camping Municipal
Route de la Fraternité
Route de Quélern
D355
Le Disloup
Route du Milieu
Route du Ménez
Persuel
Taladec'h
Rostellec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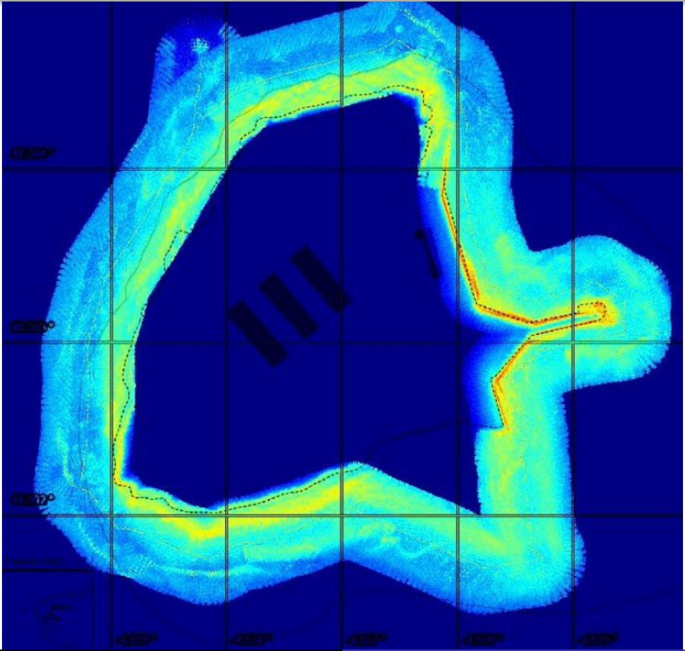
23
50m

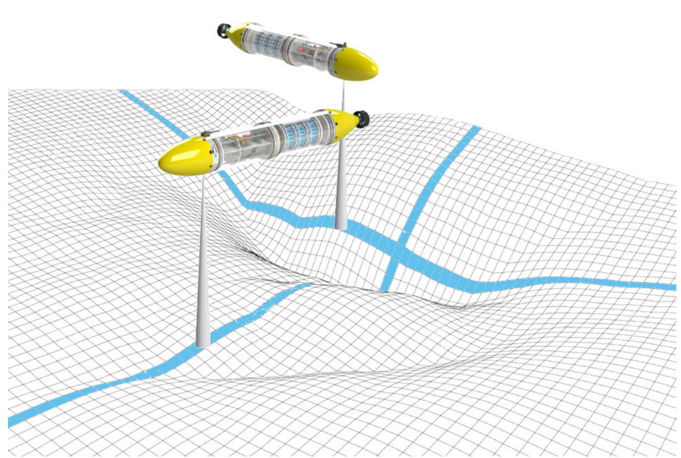


24 juillet 2013

Objective: Follow an isobath with an altimeter, a barometer and a low cost gyroscope.

Exploration

- SLAM paradigm
- Bridge-river paradigm



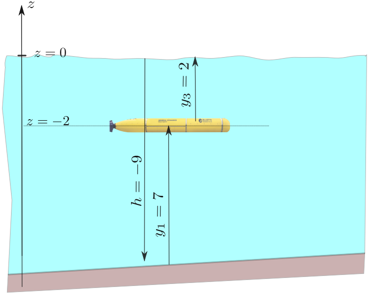
[3]

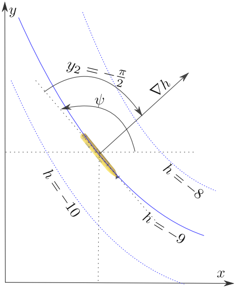
Consider an underwater robot:

$$\begin{cases} \dot{x} &= \cos\psi \\ \dot{y} &= \sin\psi \\ \dot{z} &= u_1 \\ \dot{\psi} &= u_2 \end{cases}$$

The observation function is

$$\left\{\begin{array}{lll} y_1 & = & z - h(x,y) \\ y_2 & = & angle(\nabla h(x,y)) - \psi \\ y_3 & = & -z \end{array}\right.$$



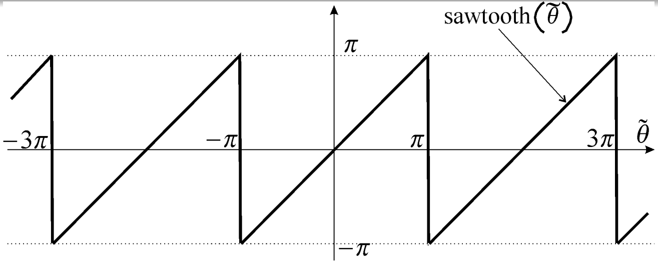


For the control of the depth:

$$u_1 = y_3 - \overline{y}_3$$

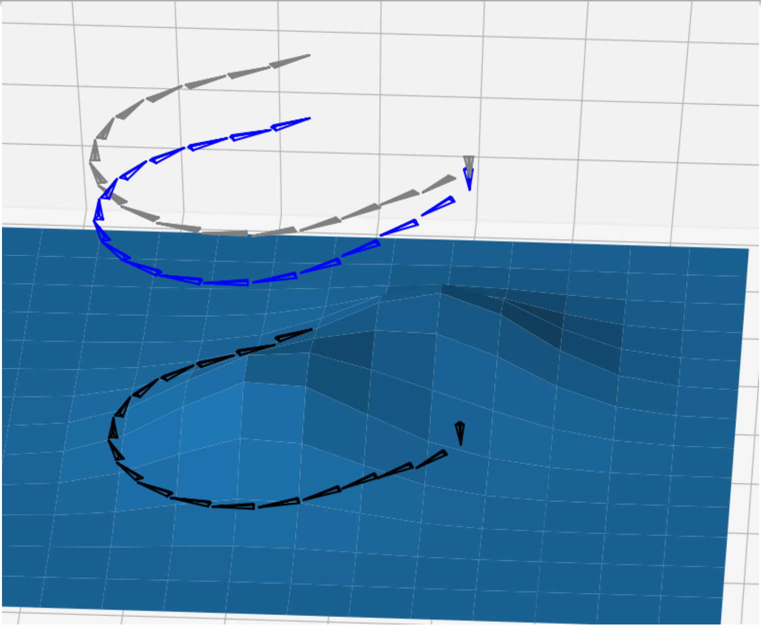
For the heading, we take [1]:

$$\begin{array}{rcl} u_2 & = & \tanh(e_2) + \text{sawtooth}(e_1) \\ & = & -\tanh(h_0 + y_3 + y_1) + \text{sawtooth}(y_2 + \frac{\pi}{2}) \end{array}$$


sawtooth$(\tilde{\theta})$
π
-3π
$-\pi$
π
3π
$\tilde{\theta}$
$-\pi$

The controller is

$$\mathbf{u} = \begin{pmatrix} y_3 - \overline{y}_3 \\ -\tanh(h_0 + y_3 + y_1) + \text{sawtooth}(y_2 + \frac{\pi}{2}) \end{pmatrix}$$



The output $y_2 = angle(\nabla h(x,y)) - \psi$ should thus be estimated [2].
In the robot frame the underneath plane satisfies

$$z_1 = p_1 x_1 + p_2 y_1 + p_3$$

Prediction. We assume the seafloor locally planar. Thus:

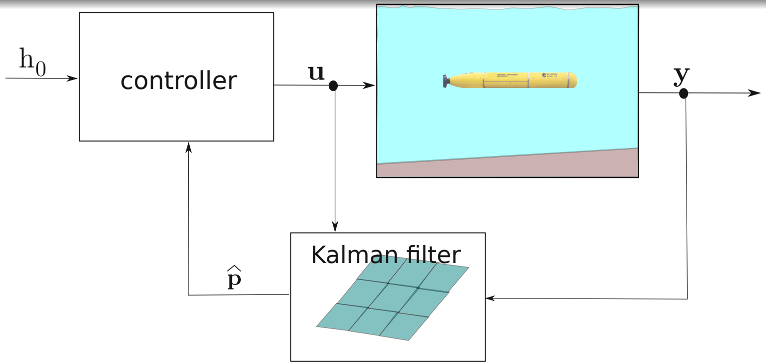
$$\dot{\mathbf{p}} = \begin{pmatrix} 0 & \dot{\psi} & 0 \\ -\dot{\psi} & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix} \mathbf{p}.$$

The prediction for the underneath plane is

$$\mathbf{p}(k+1) = \begin{pmatrix} 1 & dt \cdot u_2(k) & 0 \\ -dt \cdot u_2(k) & 1 & 0 \\ dt & 0 & 1 \end{pmatrix} \mathbf{p}(k) + \alpha(k).$$

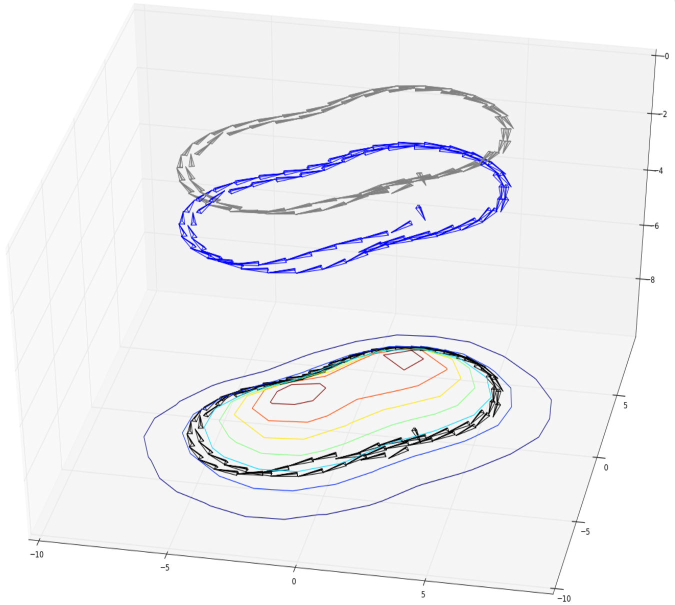
Correction.

$$-y_1 - y_3 = \begin{pmatrix} 0 & 0 & 1 \end{pmatrix} \mathbf{p}(k) + \beta(k).$$


h_0
controller
$\mathbf{u}$
$\mathbf{y}$
Kalman filter
$\hat{\mathbf{p}}$

The controller is thus

$$\mathbf{u} = \begin{pmatrix} y_3 - \bar{y}_3 \\ -\tanh(h_0 - \hat{p}_3) + \mathrm{sawtooth}(\mathrm{atan2}(\hat{p}_2, \hat{p}_1) + \frac{\pi}{2}) \end{pmatrix}.$$


0
2
4
6
8
5
0
−5
−10
−10
−5
0
5

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Automation for Robotics.
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S. Rohou.
Reliable robot localization: a constraint programming approach over dynamical systems.
PhD dissertation, Université de Bretagne Occidentale, ENSTA-Bretagne, France, december 2017.