SS 2017-2018, SMT, DISAL-SP120 Project Summary

A Coupled Simulation Tool for Autonomous Underwater Vehicles Engaged in Environmental Monitoring Missions

Théophile Schenker

Professor : Alcherio Martinoli
Assistant(s) : Dr. Alexander Bahr

Hydromea SA is an EPFL spin-off founded in 2014 by Dr. Felix Schill and Dr. Alexan- der Bahr, that aims to bring recent microtechnology and robotics knowledge to the environmental fields. One of its biggest achievements is the development of the Vertex AUV (autonomous underwater vehicle), designed to be deployed in swarms

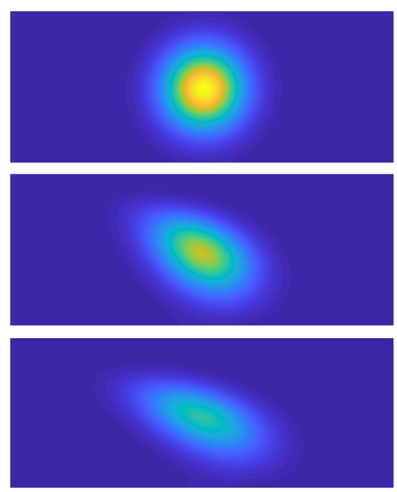
Vertex AUV developped by Hydromea (taken from http://www.hydromea.com/)

As radio waves do not travel well underwater, it is hard to have any control over an AUV once it is underwater. Therefore, a proper simulation solution is very important: a comprehensive and faithful simulator for the vehicle has been developed. However, this simulator is only about the vehicle and does not include any information about the environment. Thus, it is not possible to simulate any environment dependent behavior. The objective of this project is to add this environmental perspective. To achieve this, an existing environmental simulation engine should be linked with the vehicle simulator.

I first had a look at *Meteolakes*, a project that aims to monitor a whole lake (Lake Geneva). This model takes *MeteoSwiss* data (satellite, ground stations) as an input and performs a simulation using *Delft3D* (modeling suite). It is developed and maintained by Theo Baracchini, as a part of his PhD thesis at EPFL (APHYS). Simulation results can be viewed directly online (http://meteolakes.ch/).

However it was not possible to use this model directly to run simulations with the AUV. In order for a swarm to navigate according to a gradient of a parameter, a resolution at least close to a meter is required. In fact, this model focuses on accuracy, compared to the real lake. For testing an environment dependent behavior, high resolution and precision are needed, but the accuracy is less important.

Thus, it was decided to create a realistic but less accurate model, used for simulation only. This model involves a finer grid and runs on top of *Meteolakes*, interpolating the water velocities from it. It is possible to add customs distributions of parameters in it and to simulate their evolution using convection-diffusion equations.



Possible simulation results for a gaussian initial distribution, with advection and diffusion

The system is implemented as a configurable *Python* plugin. The fine grid models can be saved once created, as the simulation results (time evolution of the distributions). Simulations can be performed on-line (at the same time as the AUV navigate) or off-line (at the beginning), or simulation results can be directly loaded. From an external stand point, the AUV query for the different measurements by sending their position with a *GLOBAL_POSITION_INT* message and the results are then returned using *NAMED_VALUE_FLOAT* messages.