Virtual Reality Simulators for Unmanned Autonomous Marine Vehicles

ENSTA Bretagne

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	ENSTA Bretagne
Name of the host laboratory / research team	Lab-STICC UMR 6285
Address	ENSTA Bretagne Lab-STICC 2 rue François Verny 29806 Brest Cedex 9
Web site	www.labsticc.fr
Name of the supervisor	Benoît Clément
Function	Deputy Head of Lab-STICC UMR CNRS 6285
Email	benoit.clement@ensta-bretagne.fr
Phone number	+33 (0)2 98 34 89 70

Internship offer

Topic of the internship (title)	Virtual Reality Simulators for Unmanned Autonomous Marine Vehicles			
Proposed dates of the internship*	Start	2021-01-04	End	2021-05-31

* The supervisors have indicated the dates proposed are flexible and are able to be postponed subject to COVID-19 border closures.

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

The use of unmanned autonomous marine vehicles for defence, scientific and commercial applications has grown significantly over recent years with the result that vehicles are becoming increasingly sophisticated and capable of making complex decisions without humans in the loop. Machine learning algorithms are used to implement intelligent processing of sensory information and achieve safe behaviour of autonomous vehicles under known and previously unknown situations, however, the processes by which decisions are reached are difficult to unravel and therefore trust. Testing new algorithms on a vehicle may prove costly and potentially dangerous should the algorithm fail or not behave as predicted. In the case of autonomous marine vehicles, a failure in the vehicle control, planning and guidance systems may result in an unrecoverable vehicle, and as a consequence, considerable financial losses. Simulation is an important research and development tool that can be used to test newly devised control algorithms on a vehicle. Simulation enables algorithms and control schemes to be evaluated in a virtual environment thus reducing potential risks associated with real-world experimentation. Existing simulators such as Gazebo are steadily gaining acceptance in the research community and are being continually developed to enhance the range of platform, actuators and sensor and environment models that can be simulated. Gazebo incorporates physical fidelity to emulate the effects of forces and disturbances within the environment, as well as visual fidelity to emulate textures, illumination and acoustic reflection properties. Gazebo is also tightly integrated with the Robotic Operating System (ROS) enabling algorithms to be tested using the same computational platform as that on the vehicle. Various Gazebo based marine vehicle simulators exist. For autonomous underwater vehicles (AUVs), the uuv simulator package containing existing models of AUVs, is particularly appropriate. It also incorporates customizable models of seabed terrains, and ocean wave and current disturbances. Similarly for unmanned surface vehicles (USVs), the usv_sim_gazebo simulator, contains various models of boats, wind, wave and current disturbances, and terrain. Neither of these simulators, however, include simulation of the hydrodynamic forces, such as waves or ocean currents acting on the vehicle. Any simulation is only in a visual sense and lacks the real behaviour of ocean waves. It is up to the user to include models of underwater vehicle physics in a control script, or to extend the simulator itself. Similarly, the visual fidelity found in Gazebo is relatively simple, however more realistic water motion simulations, terrains and vehicles can be created using the Blender Game Engine, and the models then incorporated into Gazebo. The main work of these internship is to develop high physical/visual fidelity models for the environment using real data. Existing Gazebo wave models are very simple and cyclic and lack the realism needed for ocean waves. One possible solution may be to use the wave models in MSS_hydro to generate dynamic meshes and then incorporate these meshes into Gazebo. The wave models should replicate the physical interaction between wave and vessel and allow simulated measurements using cameras and radar sensors.

Name of industrial partner	Naval Group
Role of the industrial partner in the internship project	Naval Group, Flinders University and ENSTA Bretagne are collaborating on the development of control and guidance algorithms for ASVs and AUVs. The three groups have a range of surface and underwater vehicles and have complementary expertise in maritime autonomy. The development of high-fidelity simulators that can incorporate models of these vehicles, and simulate the hydrodynamic interaction between waves/current and the platforms would be desirable to support the research collaboration between the partners.
Main contact at the French industrial partner	Estelle CHAUVEAU
Email of contact at French industrial partner	estelle.chauveau@naval-group.com
Name of the Australian partner institution	Flinders University
Name of lab/department/team involved in the collaboration at the Australian partner institution	Centre for Maritime Engineering
Main contact in the Australian partner institution	Karl SAMMUT
Function of the main contact in the Australian partner institution	Professor
Email address of the main contact in the Australian partner institution	karl.sammut@flinders.edu.au
Outside of this ongoing collaboration, will applications coming from students of other eligible Australian universities be considered by the hosting institution in France?	Yes

Expected profile of applicant

Level of study	Master, Bachelor with Honours
Discipline	Physics and/or Robotics
Required qualities, knowledge and skills	Required: Programming in Matlab and C++, Control Systems Desirable: programming in Python and ROS

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