SUJETS DES CONTRATS DOCTORAUX 2020

RESSOURCES BIOLOGIQUES ET ENVIRONNEMENT

Effect of dietary peptides on bone development in fish.

Elaboration of thermo-sensible and injectable hydrogels based on marine exopolysaccharides for tissue engineering.

How temperature and nutrition control oysters susceptibility to the Pacific oyster Mortality syndrome?

A MICE for the Gulf of Lions.

Combined effects of spatial hake population structure, environmental and anthropic pressures on Hake fisheries in the Gulf of Lion : a statistical and simulation based approach for the evaluation of the Mediterranean management plan.

MULTITOUT: Reconciling Fisheries Sustainable Yield Objectives with Ecosystem Objectives: Multiple species Reference Points and Methods for Assessing Multiple objectives Management Scenarios

PhD Title: Effect of dietary peptides on bone development in fish.

Thesis supervisor: José Zambonino (RBE/PFOM/ARN) - Jose.Luis.Zambonino.Infante@ifremer.fr
Co-supervisor: Giorgos Koumoundouros (University of Crete)
Unit/Laboratory: PFOM/ARN (Plouzané) and Biology Department (University of Crete)
Doctoral school: EDSML

Summary: Understanding mechanisms behind bone responses to epigenetic trigger may be the missing piece dealing with developmental skeletal deformities in fish species of aquaculture interest. Using special peptides diets, in both a marine (sea bass) and a freshwater (zebrafish) model species at different developmental stages, we will try to decode their developmental patterns though altered nutrition. It is indeed well recognized that short peptides can help reduce the incidence of skeletal deformities in fish. We will implement swimming challenges, combined with histology and molecular biology approaches, to examine the potential links between dietary peptides and skeletogenesis procedures. The study is based on a collaboration with the University of Crete and DIANA-AQUA (feed manufacturer). The subject will generate original data on the control of skeletogenesis processes, and propose a nutritional strategy to reduce the occurrence of bone deformities in fish, a major problem in fish farming.

Key-words: Musculoskeletal development of fish, deformations, dietary peptides, swimming challenge tests, molecular and cellular mechanisms.

Expected profile: The candidate must hold an MSc title and have a good knowledge of fish biology, and more particularly bone morphogenesis and vertebral abnormalities. Experience in the implementation of fish swimming tests would be appreciated. Since this thesis is co-directed by Prof. Giorgos Koumoundouros (Univ Crete), proficiency in English is required. The candidate must also demonstrate good writing skills in English (e.g. publication or report).

PhD Title: Elaboration of thermo-sensible and injectable hydrogels based on marine exopolysaccharides for tissue engineering.

Thesis supervisor: Sylvia Colliec-Jouault (RBE-BRM-LEMMMB) - Sylvia.Colliec.Jouault@ifremer.fr
Co-supervisors: Agata Zykwinska, (RBE/BRM/EM3B); Stéphane Cuenot (UMR 6502 Institut des Matériaux Jean Rouxel (IMN) - CNRS – University of Nantes /PMN)
Unit/Laboratory: BRM/EM3B; IMN/PMN
Doctoral school: EDSML

Summary: Hydrogel is characterized by its three-dimensional highly hydrophilic polymer network stabilized by covalent (chemical gel) and non-covalent (physical gel) cross-linking. Structural properties of hydrogel similar to the extracellular matrix of mammalian connective tissue constitute a key-point for the development of biomaterials for tissue engineering. In this domain, biological and mechanical properties of the hydrogel should mime the matrix of the damaged tissue. The use of biocompatible and biodegradable natural polymers for the development of such matrices appears particularly interesting. In this context, the objective of the thesis is to develop new injectable hydrogels based on exopolysaccharides (EPS) synthesized by marine bacteria. Glycosaminoglycan-mimetic properties of these EPS will allow to elaborate bioactive matrices. By functionalizing the EPS chains, different physical and chemical gels will be obtained. Determination of their mechanical properties will allow to elucidate the relationship between the composition, the structure and the properties.

Key-words: hydrogel, thermo-sensible, injectable, exopolysaccharide, marine bacteria, structure-function relationship.

Expected profile: Physico-chemist of biopolymers; required competences in analytical chemistry, biochemistry and techniques for material characterization.

PhD Title: How temperature and nutrition control oysters susceptibility to the Pacific oyster Mortality syndrome?

Thesis supervisor: Vidal-Dupiol Jérémie (UMR IHPE) - Jeremie.Vidal.Dupiol@ifremer.fr
Co-supervisor: Mitta Guillaume (UMR IHPE)
Unit/Laboratory: UMR IHPE, Montpellier
Doctoral school: ED Gaia Montpellier

Summary: Crassostrea gigas is today the main oyster species exploited in the world. For decades, C. gigas has experienced episodes of mortality, but the phenomenon has worsened considerably since the end of the 2000s. The outbreaks mainly affect juvenile oysters, decimating up to 100% of the juveniles in French oyster farms. In recent years, this disease, which has been named the Pacific Oyster Mortality Syndrome (POMS), has become panzootic and poses a threat to global oyster culture. Recently, a consortium led by our laboratory has deciphered the mechanisms of pathogenesis: infection with the OsHV-1 virus is the first step in the infectious process leading to immunosuppression of the animal, followed by bacteraemia caused by opportunistic pathogenic bacteria. Yet only part of the complexity of this disease has been unraveled. Indeed, this disease is tightly controlled by a series of factors (temperature, age and diet of oysters) and the mechanisms by which these factors control the expression of the disease remained to be elucidated. The aim of this PhD project is to determine how the temperature and diet of oysters control the POMS. To achieve this goal, we will combine experimental approaches in mesoscoms, physiological measures and integrative omics approaches.

Key-words: Pacific Oyster Mortality Syndrome, integrative omics, mesocosm

Expected profile: The candidate will have a Master in Microbiology, Immunology, or physiology and a lab experience in this field. Knowledge in molecular biology and bioinformatics will also be needed and practical experience will be greatly appreciated. As this project is part of a multidisciplinary network, the candidate should be curious of other research fields and have good communications skills.

PhD Title: A MICE for the Gulf of Lions.

Thesis supervisor: Jean-Marc Fromentin (RBE) - Jean.Marc.Fromentin@ifremer.fr
Co-supervisors: Grégoire Certain (RBE-MARBEC-LHM), Sophie Gourguet (RBE-EM), Olivier Thébaud (RBE-EM)
Unit/Laboratory: UMR MARBEC, Ifremer Sète
Doctoral school: ED Gaia Montpellier

Summary: Implementation of the ecosystem approach to fisheries requires specific tools to account for marine socio-ecosystem dynamics while retaining enough simplicity to be of tactical use to management issues. This trade-off is at the core of the design of MICE (Models of Intermediate Complexity for Ecosystem). Today, long time series (25 years) are available for the Gulf of Lions ecosystem. This opens the door for the design of such a model in order to tackle the numerous management challenges issued from the multi-annual european management plan targeting the western mediterranean area. The Gulf of Lions has been highly overharvested since at least two decades by a multi-specific fishing fleet. However, the management measures envisioned at the national level, as a consequence of the management plan (global effort reduction, together with local spatio-temporal closure), are only focusing on one fleet, the demersal trawlers, and one species, hake, at the juvenile stage. Therefore, the main objective of this thesis is to implement a MICE model for the Gulf of Lions to (i) evaluate the consequences of this plan at the scale of the socio-ecosystem, and more broadly to (ii) identify trajectories of sustainable development of these fisheries in a global change context.

Key-words: MICE, Gulf of Lions, Tactical model, Bio-economic model, Stochastic community dynamics, Climate forcing, Sustainable fisheries management.

Expected profile: The applicant should have competences in at least one of the following areas: time series, community dynamics, marine ecology, bio-economy, and modeling. He/she should have some experience with classical programming softwares (R, python, matlab, C++, …) and with code-sharing applications such as GitHub. Any experience with a Mediterranean ecosystem would be appreciated.

PhD Title: Combined effects of spatial hake population structure, environmental and anthropic pressures on Hake fisheries in the Gulf of Lion: a statistical and simulation based approach for the evaluation of the Mediterranean management plan.

Thesis supervisor: Sandrine Vaz (RBE/MARBEC/LHM) - Sandrine.Vaz@ifremer.fr
Co-supervisors: Stéphanie Mahévas (RBE/EMH), Sigrid Lehuta (RBE/EMH), Angélique Jadaud (RBE/MARBEC/LHM)
Unit/Laboratory: RBE/MARBEC/LHM, Sète
Doctoral school: ED Gaia Montpellier

Summary: Since 2009, in the Gulf of Lion, the collapse of small pelagic stocks caused the report of pelagic trawl activity toward demersal fisheries. This increased fishing pressure on demersal species is detrimental to the hake population, which exploitation level already was 12-fold the maximum sustainable yield. In 2018, complementary management measures were proposed (fishing effort reductions and area closures) to ensure a return to MSY before 2020. However to date, the consequences of these management measures are hardly predictable because of the many uncertainties regarding the spatio-temporal dynamics of hake and due to a possible decrease in hake body condition in relation with the environement. The objective of this phD project is to use the ISIS-Fish model, set up for the hake fisherie in the gulf of Lion in order to 1) Integrate and improve the knowledge on hake population dynamics and answer the following questions: Are big, mature individuals spatially dependent on the canyons area? What are the likely movement of the different life stages between the plateau and the canyons? What could be the impact of a change in hake condition on population dynamics? And 2) Understand and evaluate the combined consequences of spatial structuration of hake, environment, fishing exploitation and management on hake population and the fleets havesting the stock.

Key-words: Gulf of Lion Hake, ISIS-Fish model, life cycle modeling, inference, Mediterranean management plan.

Expected profile: Master in fishery sciences or ecological modelling, numerical ecology, statistics, programming skills.

PhD Title: MULTITOUT: Reconciling Fisheries Sustainable Yield Objectives with Ecosystem Objectives: Multiple species Reference Points and Methods for Assessing Multiple objectives Management Scenarios

Thesis supervisor: Stéphanie Mahévas (RBE/EMH) - Stephanie.Mahevas@ifremer.fr
Co-supervisor: Sigrid Lehuta (RBE/EMH)
Unit/Laboratory: RBE-EMH, Nantes
Doctoral school: EDSML

Summary: The Common Fisheries Policy on the one hand and the Marine Strategy Framework Directive on the other hand require that maximum sustainable yields for all species caught and a good ecological status of the marine ecosystem be jointly achieved. The multiplicity of marine uses and the variable spatial and temporal occupation of resources and uses make marine spatial planning an essential tool for achieving these objectives. However, the current fisheries regulatory system remains mainly based on single species management using TACs, which does not guarantee that all these objectives will be achieved jointly in a mixed fishery context. In order to move operationally to an ecosystem-based management approach, it is necessary to develop new multiple species reference points and harvest control rules explicitely accounting for spatial, seasonal and multiple fleets dimensions and environmental constraints. The purpose of this thesis is to 1) develop a theoretical framework for the development of these new multi-species reference points and these new spatial and seasonal control rules, 2) validate it with a fishery simulation model, 3) test it on the demersal mixed fishery in the Bay of Biscay and 4) use it to simulate and assess management scenarios.

Key-words: multi-dimensional indicators, multi-criteria optimization, reference points, management rules, scenarios, spatial and seasonal dynamics, fisheries Bay of Biscay, ISIS-Fish

Expected profile: Master in fisheries or modelling or quantitative ecology or bio-statistics.

DEPARTEMENT OCEANOGRAPHIE ET DYNAMIQUE DES ECOSYSTEMES

Trait-Based Modelling Of Benthic Ecosystem Dynamics.

Sediment dynamics induced by non linear internal solitary waves in the Bay of Biscay.

ANOXITO: Controlling factor and consequence analysis of anoxia and oyster mortality on functioning of the Thau lagoon as part of the global change for sustainable shellfish culture.

Fate and interaction between *Microcystis* and its microbiome in estuary.

Atmospheric CO_2 exchanges over the Charentais Marshes: processes, dynamic and environmental controlling factors.

PhD Title: Trait-Based Modelling Of Benthic Ecosystem Dynamics.

Thesis supervisor: Martin Marzloff (ODE-DYNECO-LEBCO) - Martin.Marzloff@ifremer.fr
Co-supervisors: Fabrice Harrouet (LabSTICC, ENIB); Gireg Desmeulles (LabSTICC-IHSEV, ENIB)
Unit/Laboratory: LEBCO, DYNECO, Brest
Doctoral school: EDSML

Summary: The proposed project will aim at developing an innovative trait-based modelling framework to better understand and predict benthic ecosystem dynamics. Model development will rely on two interconnected components: (1) data-driven inference of the sets of traits and functional groups required to capture overall ecosystem structure and dynamics; and (2) the stepwise development of a trait-based simulation modelling component to capture ecological network and predict ecosystem response to environmental and anthropogenic stressors. This modelling framework will be trained and tested against several large databases of marine seafloor ecosystems (REBENT, Reef Life Survey), as well as species-specific functional traits matrices. A set of trait-based rules will be identified and modelled to project changes in ecosystem structure and dynamics. The framework will be applied and validated across a suite of regional case studies (within Western
Brittany and SE Australia). Simulations of emergent ecological assemblages will provide insights on rewiring of ecological interaction networks under future scenarios, and will also help characterise critical thresholds in ecological dynamics and the risk of shifts to undesirable ecosystem states. We anticipate that the developed framework will in the longer term be applied over larger scales to help predict benthic ecosystem responses under climate change and inform effective ecosystem-based management on the European continental shelf.

Key-words: Ecological Network Inference; Trait-based Modelling; Functional Ecology; Benthic Ecosystem Structure and Dynamics.

Expected profile: The candidate will hold a MSc (or an equivalent degree) in quantitative ecology, statistics, ecological modelling or fisheries science. Required skills include programming with R, experience with Python (or another programming language), knowledge in functional ecology, benthic biodiversity, and research experience in ecological modelling, as well as good spoken and written communication skills (in French and English).

PhD Title: Sediment dynamics induced by non linear internal solitary waves in the Bay of Biscay.

Thesis supervisor: Pascal Lazure (ODE/LOPS) - Pascal.Lazure@ifremer.fr
Co-supervisors: François Dufois (ODE/DYNECO/DHYSED), Lucie Bordois (SHOM – DOPS/STM/REC); Nicole Jones (Oceans Graduate School and UWA Oceans Institute).
Unit/Laboratory: DYNECO/DHYSED, Brest
Doctoral school: EDSML

Summary: Internal waves are ubiquitous oceanic features that can impact the sediment dynamics from the deep ocean to the coasts through a variety of processes. Over the shelf the largest impact occurs when internal waves transition from deep to shallow water, increase in amplitude, become nonlinear and eventually degenerate into trains of internal solitary waves (ISWs). The Bay of Biscay is a hotspot of internal tides and ISWs. Yet, in situ observations of ISWs are relatively scarce over the shelf, and the ISW/sediment interactions have not received much interest. The overarching goal of this PhD proposal is to better understand the potential contribution of the ISWs to the sediment dynamics in the Bay of Biscay, relative to other natural forcing. This will be achieved by analysing historical datasets and data from a new field experiment dedicated to this project. A non-hydrostatic model will be also be implemented in order to extrapolate the results to a larger scale.

Key-words: Sediment dynamics, erosion, solitary waves, internal tide, internal waves, field experiment, Bay of Biscay, continental shelf.

Expected profile: Master degree in physical coastal oceanography, or equivalent. Good knowledge of sediment dynamics processes. Good knowledge of numerical modelling (Fortran language, CROCO or ROMS-like model). Good knowledge of computer programming for environmental data analysis (Matlab, Python). Proficiency in the Linux working environment. Fluent in English.

PhD Title: ANOXITO: Controlling factor and consequence analysis of anoxia and oyster mortality on functioning of the Thau lagoon as part of the global change for sustainable shellfish culture.

Thesis supervisor: Annie Fiandrino (ODE-LITTORAL-LERLR) - Annie.Fiandrino@ifremer.fr
Co-supervisors: Marion Richard (ODE/UL/LER-LR, MARBEC); Beatrice Bec (MARBEC, University of Montpellier)
Unit/Laboratory: MARBEC
Doctoral school: Gaia

Summary: The exceptional climatic conditions of 2018 lead to summer anoxia in the Thau lagoon causing massive mortalities of oysters and mussels (4000 t). A phenomenon of "green water", a stop of growth and oyster mortality were followed at the autumn, impacting shellfish farmers. In this context of ecological, economic and social crisis, the objectives of this thesis will be to analyze the factors and consequences of anoxia and oyster mortalities on the functioning of the Thau lagoon in a context of global change. This subject is original in relation with its problematic, the complementarity of its approaches (observation, experimental ecology, modeling), and the subjects studied (hydrology, biology, ecology, biogeochemistry, modeling), federating the skills of many national and international researchers (DFO, Moncton, Canada). The results, highly anticipated by the scientific community, producers, public policies and local managers, will help to better understand the phenomenon and suggest different management solutions for maintaining the good ecological status of the lagoon and sustainability of shellfish farming. They will be promoted through the publication of articles and international conferences to give to ANOXITO a global dimension.

Key-words: climate change, oxygen, anoxia, oyster, mussel, biogeochemical fluxes, planktonic community structure, modelling

Expected profile: M2 student motivated to do a PhD on the proposed subject. Good knowledge of marine ecology, bivalves, phytoplankton and biogeochemistry. Solid academic file. Enthusiastic about conducting in situ experiments and performing lab tests. Faculty of data processing and statistical analysis. Motivated by modeling. Faculty to write and communicate in English. Rigorous, conscientious, autonomous, appreciating to work in a team and available from 2020-2023.

PhD Title: Fate and interaction between *Microcystis* and its microbiome in estuary.

Thesis supervisor: Zouher AMZIL (ODE/DYNECO/PHYC) - Zouher.Amzil@ifremer.fr
Co-supervisors: Enora BRIAND (ODE/DYNECO/PHYC); Myriam Bormans (UMR CNRS 6553 ECOBIO – University of Rennes 1)
Unit/Laboratory: Phycotoxines, Nantes
Doctoral school: EDSML

Summary: Freshwater cyanobacterial blooms are increasing and may colonize brackish water. Because cyanobacteria are able to produce toxins, they are a major concern to environment and public health. In natural environment, cyanobacteria as *Microcystis* form large mucilaginous colonies with numerous heterotrophic bacteria embedded in the mucilage. This micro-environment, known as phycosphere, is the place of numerous biotic interactions that influence the development of both cyanobacterial and bacterial communities, as well as the production and fate of toxins. The aim of the PhD thesis is to study the impact of a salinity increase on the cyanobacterial diversity, the physicochemical features of the mucilage and the production of specific metabolites (toxins and compatible solutes) and how these changes influence the diversity of the *Microcystis* microbiome and their function in toxins degradation.

Key-words: cyanobacteria, cyanotoxin, microbiome, metabarcoding, microfluidic, risk of contamination

Expected profile: Master 2 specialized in oceanology, marine biology or microbial ecology with potential skills in algal culture, molecular biology, and statistics and with an interest in pluridisciplinarity (microbial ecology, genomic, microfluidic, chemistry). Good written communication skills and fluent in English.

PhD Title: Atmospheric CO_2 exchanges over the Charentais Marshes: processes, dynamic and environmental controlling factors.

Thesis supervisor: Philippe SOUCHU (ODE-LITTORAL-LERMPL) - Philippe.Souchu@ifremer.fr
Co-supervisors: Pierre POLSENAERE (ODE-LITTORAL-LERPC), Aurore REGAUDIE DE GIOUX (ODE-DYNECO-PELAGOS), Laurent ANDRE (BRGM).
Unit/Laboratory: Laboratoire Environnement Ressources Morbihan-Pays de Loire, Nantes
Doctoral school: EDSML

Summary: Marshes generally and tidal marshes particularly bury large amounts of carbon from the atmosphere due to their exceptional primary production and organic matter enriched sediments. Then they represent an essential component of the biological carbon sequestration on earth (Chmura et al. 2003, Kathilankal et al. 2008, Artigas et al. 2015). These systems with both terrestrial and aquatic compartments also export large quantities of carbon to adjacent aquatic systems, the latter being able to behave in turn as a CO2 source to the atmosphere (Odum 1968, Wang and Cai 2004). The objective of this PhD thesis is to study carbon processes, fluxes and relevant environmental factors at the terrestrial-aquatic-atmospheric exchange interfaces in marshes of the Charentais Sounds using in particular the atmospheric Eddy Covariance (EC) technique. This original and innovating micrometeorological technique allows acquiring continuous temporal CO2 flux series at high frequency at both sediment-air and water-air interfaces in a non-invasive way and at the ecosystem scale (Aubinet et al. 2000, Baldocchi 2003, Polsenaere et al. 2012). The results will allow a better understanding of the role insured by these heterogeneous ecosystems in global and regional carbon budgets.

Key-words: marshes, carbon processes and fluxes, spatio-temporal variations, atmospheric Eddy Covariance, exchange interfaces, Charentais Sounds.

Expected profile: MSc degree in coastal/marine biogeochemistry, micrometeorology, biology, ecology.

Skills:

- Spatial and temporal numerical analysis (MATLAB, R and QGIS software)
- Field and team work experience with in situ sensor utilization
- Laboratory experience
- Oral and written communications
- English speaking, reading and writing fluently

RESSOURCES PHYSIQUES ET ECOSYSTEMES DE FOND DE MER

PhD Title: Phylogenetic and functional diversity of uncultivated microbial communities involved in methane cycle.

PhD Title: Experimental characterisation of the turbulence in tidal areas.

PhD Title: Phylogenetic and functional diversity of uncultivated microbial communities involved in methane cycle.

Thesis supervisor: Laurent Toffin (REM-EEP-LMEE) - Laurent.Toffin@ifremer.fr
Co-supervisor: Kai-Uwe Hinrichs (University of Bremen, Organic Geochemistry Group, MARUM)
Unit/Laboratory: REM/EEP/LM2E
Doctoral school: EDSML

Summary: Methanogenesis is a key metabolism in marine organic matter degradation and marine biogas production. Despite the large accumulation of methane in deep marine sediments, known methanogenic lineages represent only a small fraction of *Archaea*, suggesting that undescribed taxa may significantly contribute to the methane sources. Metagenome-Assembled-Genomes (MAG) of microbial genomes by using Metagenomic allow the prediction of potential functions without cultivation. Therefore uncultivated archaeal lineages within *Euryarchaeota* and also non-*Euryarchaeota* (Bathyarchaeota, Vestratearchaeota and Helarchaeota) might be involved in methane cycle, especially by using short- and medium-chain alcanes. However *in vivo* culture incubations are required to demonstrate these predictive metabolims. The thesis project is to identify alternative carbon and energy routes for methanogenesis from marine sediments. Sediment slurries will be amended with ^{13}C-labelled substrates (Stable Isotope Probing) enabling tracking of the carbon flow within microbial biomass and metabolic products through ^{13}C incorporation into nucleic acids and membrane lipids.

Key-words: Incultivated *Archaea*, methanogenesis, metagenomic, lipidomic

Expected profile: Applicants are required to have at least a master degree in microbiology. Good knowledge of molecular and cultural tools is required. The successful candidate will have to carry out fundamental research in microbial ecology. Experienced in bioinformatics and statistics will be greatly appreciated. Applicants are expected to have strong programming skills, the ability to work independently in a team, good writing and oral communication (french and english).

PhD Title: Experimental characterisation of the turbulence in tidal areas.

Thesis supervisor: Grégory Germain (REM/RDT/LCSM) - Gregory.Germain@ifremer.fr
Co-supervisors: Philippe Druault (Sorbonne University, MPIA); Benoît Gaurier (REM-RDT-LCSM).
Unit/Laboratory: LCSM Boulogne/Mer
Doctoral school: EDSPI Lille

Summary: The behavior of marine structures is strongly governed by the turbulence encountered in the environment that conditions the exchange of energies at the micro and macroscopic scales. However, turbulence is still poorly known today, especially in sites where there are strong currents, waves or complex bathymetry. As part of this work, we propose to study turbulence experimentally from the generation of coherent or non-coherent structures to the dissipation of energy.
This work will be carried out in order to:

- Generate experimental databases based on three-dimensional ADV, LDV and PIV measurements of turbulent flows disturbed or not by surface waves and / or obstacles;
- Develop tools and methods for spatio-temporal analysis of the results of 3D flow measurements at high frequencies;
- Analyze turbulence, scale effects and energy transfers within flow governed by tidal currents;
- Evaluate the impact of turbulence on the behavior of marine structures.

Key-words: Turbulence, wave, current, LDV, PIV

Expected profile: The candidate must have knowledge of Fluid Mechanics/ Mechanics with, if possible, instrumental skills and knowledge of traditional data processing tools. Knowledge of numerical simulation tools would be appreciated.

DIRECTION DE LA FLOTTE

Intelligent localisation system for navigation of underwater robot.

PhD Title: Intelligent localisation system for navigation of underwater robot.

Thesis supervisor: Vincent Hugel (COSMER - EA 7398) - vincent.hugel@univ-tln.fr
Co-supervisors: Aurélien Arnaubec (DFO/SM/PRAO); Ricard Marxer (DYNI, LIS UMR 7020 CNRS / AMU / UTLN); Claire Dune (COSMER - EA 7398)
Unit/Laboratory: DFO/SM/PRAO
Doctoral school: University of Toulon, doctoral school 548 - Mer et Sciences

Summary: When deploying an underwater vehicle at great depths, state of the art absolute positioning systems lead to inaccuracies of about 10m. The positioning error can be corrected manually by the end user in post-processing of acoustic and optical images of the seabed. In the case of an autonomous submarine (AUV), the system can (re)locate itself autonomously from the analysis of the data collected by its sensors. In terrestrial robotics, location algorithms are based on the detection of stable geometric primitives anchored on, for example, salient angles of buildings. These algorithms are not very robust in unstructured and changing environments such as underwater environments. It is therefore necessary to consider other more robust descriptors that allow an AUV to efficiently counter the positioning drift from its dead reckoning sensors.

- To what extent can recent advances in artificial intelligence offer interesting solutions for robust semantic segmentation of underwater spaces?

During underwater campaigns, a significant amount of data is acquired by both cameras and sonars. The data could feed into a deep learning system. The problem is the lack of annotation of these data.

- Is it possible to train a deep learning system from poorly annotated data from multi modal sources?

In addition, the acquisition system is an active system: the movements of the AUV, modifications of its lighting, the choice of sensors can improve detection.

- How to control AUV in order to obtain optimal data for terrain segmentation and location discrimination?

Navigation strategy can take into account a priori information on the seabed (existing maps, specific observations, tracking of elements of the relief) in order to optimize the gain of information for robot localization.

Key-words: Underwater navigation, relocalization, AUV, machine learning, underwater imaging, multi-modal data.

Expected profile: Master 2 student in fields comprising artificial intellifence, robotics, signal/image processing or similar. He/She will have solid skills in applied mathematics, simulation techniques in computer programming (especially Python, C/C++, and systems Minux, ROS). Artificial intelligence techniques such as PyTorch or TensorFlow are welcomed, as well as knowledge in signal processing. A solid level in English will be an advantage.