INTERNSHIP PROPOSAL

Subject: RECURSIVE ESTIMATION OF OCEAN WAVE SPECTRA

***Company*: IFP Energies nouvelles**

***Supervisors:* Alexis Mérigaud (alexis.merigaud@ifpen.fr) and Paolino Tona (paolino.tona@ifpen.fr), Digital Science and Technology Division**

***Workplace:* IFPEN Rueil-Malmaison (near Paris) or IFPEN Solaize (near Lyon)[1]**

***Duration:* 5 – 5,5 months in 2022**

***Internship allowance:* about 1050 € gross / month**

Description

In a path to decarbonisation of the energy mix, oceans offer a tremendous potential for renewable energy production: offshore wind, tides, waves, temperature and salinity gradients... But the sea is also a demanding environment, that puts equipment and structures to a severe challenge. In particular, waves are both a potential source of energy, and a considerable threat, that determines the feasibility or not of many operations at sea. Ocean waves manifest themselves in very diverse forms, and thus constitute a rich subject of study from a scientific point of view, in fields as varied as hydrodynamics, applied mathematics, statistical physics or oceanography. From a phenomenological point of view, waves are governed by the laws of fluid mechanics, which can be modelled in a classical, deterministic way, using differential equations. However, the waves that we can observe around us on board a ship are the result of so many small contributions, that we cannot describe the wave field in a deterministic way, and we therefore resort to a probabilistic description in the form of a stochastic process (or more generally a random field).

IFP Energies nouvelles (IFPEN) is interested in the real-time monitoring and control of offshore systems, such as ships, floating wind turbines or wave energy converters, in operating conditions or during installation or maintenance operations. In this context, it is essential to estimate in real time the surrounding sea state, i.e. the wave spectrum, which describes the distribution of wave energy in frequency and propagation direction. The estimation of the spectrum can be done using sensors, such as navigation radars or the inertial unit which measures the movements of the floating device.

Traditional approaches to spectrum estimation are performed at regular intervals, based on sequences of measurements lasting a few tens of minutes. In this internship, we propose to explore an innovative approach for continuous spectrum estimation, based on a recursive method: the differences observed in real time, between on the one hand the sensor measurements, and on the other hand those expected given the current spectrum estimation, will be used to continuously correct the spectrum estimation, in the manner of an adaptive Kalman filter. Such an approach aims at making spectrum estimation more up-to-date and robust, while proposing a novel connection between control theory and oceanography.

This internship topic will provide an in-depth understanding of the nature of ocean waves, and will be an opportunity to learn interesting concepts in statistics and control.

[1] The centre is served by public transport (Lyon-Feyzin shuttle bus then GE2 bus line).

Student profile

- Engineering MSc student in his/her last year (preparing a MSc thesis.
- Excellent background in control and/or statistical physics and/or applied mathematics.
- The candidate shall be proactive.
- Ability to read scientific publications in English, to understand the state of the art on the subject.
- The project could eventually lead to a PhD on the themes of estimation, modelling and numerical simulation of sea states, as well as real-time wave prediction.

How to apply

To apply, please send your CV and cover letter to the internship supervisors Alexis Mérigaud (alexis.merigaud@ifpen.fr) and Paolino Tona (paolino.tona@ifpen.fr).