6th International Conference on Marine sciences and technologies – MITS 09

TUTORIALS

In the framework of the week of conference “MITS 2009”, a series of tutorials will be proposed to attendees.

They cover the main themes selected for that 6th edition of the conference:

- Navigation technologies for safer and cleaner transportation systems.
- Maritime Surveillance and Observation Networks
- Integrated coastal zones management: techniques and methodology for a sustainable exploitation of littoral zones.
- New marine energies
- Climate change: techniques and methods tailored to coastal areas.

They are organised by experts (professionals or researchers) and interest a high level public from private companies, public institutions, research centres, PHD students.

The goal is to provide an in depth knowledge of the state of the art, including the last discoveries in the field of technologies, services or products.

Theme 1: “Shipping in future”

- **Maritime Geographic Information Systems: From monitoring to decision-aided systems**

Speaker: Pr Christophe Claramunt
Organisation: Naval Academy Research Institute
Title: Professor in Computer Science and Director of the
Date:
Duration: 2- 3 hours
Concerned public: Researchers, professors, engineers, industrials, PHD students.

Summary:

Continuous advances in telecommunication; positioning, computing and mobile systems offer new perspectives for the development of maritime information systems. These systems are crucially required for a better management and planning of transportation activities in the maritime domain which is under increasing pressure due to the development of worldwide commercial exchanges and activities. Recent developments include data communication, management, computing and telecommunication architectures and interfaces that offer novel possibilities for real-time exchange and monitoring of maritime transportation and traffic information whose combination with Geographical Information Systems
(GIS) should be of great value. In particular, such systems will be of great interest for maritime authorities, decision-makers and engineers in charge of or involved in maritime transportation and traffic. This tutorial will introduce recent developments in navigation and maritime information systems, several application and research experiments developed in the field where the common ground is the integration of maritime transportation and traffic information within GIS. Through the presentation of recent applications and research experiments in maritime information systems, we will illustrate the potential of GIS for the management of the maritime domain and some of the avenues of research still opened.

Theme 2: Observation and Surveillance networks

- **Microwave Remote Sensing of Sea Surface: Clutter Modelling and target detection**

Speaker: Pr Ali Kenchaf
Organisation: ENSIETA (School of the Armey)
Title: National Engineer
Date:
Duration: 2h30
Concerned public: Researchers, professors, engineers, industrials, PHD students.

Summary

By separating the transmitting and the receiving antennas, and by permitting a study of the received wave polarization, the polarimetric bistatic radars allow to acquire additional information on the illuminated target, compared with the classical monostatic radars. Technological innovations contribute to an easily installation of this new kind of radars on ships, aircraft, and satellites. In this context, the necessity to simulate realistic moving polarimetric bistatic radar in order to develop new target characterization methods is observed. In this context we present the expression of the signal received by this kind of radar in the general case where the transmitter, the target, and the receiver are moving. We model a complete radiolink by taking into account the antennas radiation, the polarimetric behavior of the target, and the influence of the mobiles velocities.

An electromagnetic wave transmitted with a particular polarization is reflected by the target in the receiver direction with a polarization which is generally different from the incident one. This polarization change is modelled by a 2x2 complex matrix called the scattering matrix or the Sinclair matrix which fully characterizes the polarimetric behaviour of the target. The coefficients of this matrix depend on the geometrical and physical features of the target, and are function of time when the transmitter, the target or the receiver are moving. When the illuminated target is the sea surface the scattering matrix coefficients must be calculated.

The problem of developing a model for rough surfaces is very difficult : σ° depends at least upon radar frequency, geometrical and physical parameters, incidence and observation angles, and polarisation. Therefore, it is necessary to restrict the areas of applicability of such models. The Kirchhoff Approximation and the Small Perturbation model for solving the rough surface scattering

problem are limited in their range of validity. The Small Perturbation theory is valid for slightly rough surfaces, and the Kirchhoff approximation is valid for weakly undulating surfaces. In this context, the development of a theoretical two-scale model describing bistatic reflectivity is presented as well as the numerical results computed for the bistatic radar cross-section from rough surfaces especially from the sea surface using the Gaussian Model, the Pierson-Moskowitz and the Elfouhaily spectrum. The scattering coefficients are calculated from the incoherent summation of echoes projected by each surface element. In this case the surface is modelled as having only two average sizes of roughness. This model is compared with the phase perturbation technique, when the surface is Gaussian and to the SSA model for the sea surface in the monostatic, forward and bistatic configurations.

For a complete radiolink, a pulse compression is realized on the transmitted signal by choosing the transmitted waveform as a burst of pulses linearly modulated in frequency. This signal waveform permits to have a good resolution in range and maintaining a resolution in frequency and a detection capability reasonably good.

The temporal expression of the received signal is given introducing the target scattering matrix, the antennas radiation and the dependency with time of the wave propagation delay as a function of the velocities of the transmitter, the target and the receiver.

Simulations are presented in the case where the sea surface is observed by a bistatic radar with a transmitter mounted on an aircraft and a receiver fixed on the ground. The simulations allow to verify that an analysis of the signal received on two orthogonal polarization channels permits to obtain information on the coefficients of the sea surface scattering matrix and then to characterize that surface. Also, we present a set of experimental data describing simultaneous bistatic radar cross section and forward radar cross section measurements of sea clutter taken with a moderately high resolution X-band scatterometer system operating near grazing incidence for both horizontal and vertical polarizations over a range of low grazing bistatic angles. These measured data will be used to examine the applicability of several bistatic reflectivity clutter models.

- **Electromagnetic observation system: techniques and application to maritime scenarios.**

Speaker: Dr Fabrice COMBLET
Organisation: ENSIETA School of the Armey
Title: Associate Professor
Date:

Duration: 1h30
Concerned public: Researchers, professors, engineers, industrials, PHD students.

Summary

Applications for maritime security and safety need to be operational day or night and whatever the weather. Under these conditions, radar systems are particularly suitable and efficient. At the present time, the most used configuration is the monostatic one (i.e., transmitter and receiver are the same antenna). However, stealth radar targets multiplication and the need for more accurate observations imply new radar's configurations and processing developments.
Bistatic configurations should overcome the monostatic limitations. Basically, bistatic radars operate with separated transmitting and receiving antennas. If these systems offer some degrees of freedom, they are also more complex to implement than monostatic ones. However, the potential of bistatic measurements motivates the actual studies.
This tutorial will focus on various methods for monitoring sea using electromagnetic waves in mono and bistatic configurations. First, the methods of remote sensing will be remembered. We will present the main characteristics (performances and limitations) and difficulties caused by the propagation and diffusion of electromagnetic waves on the sea surface. We then interest in imaging radar: SAR and ISAR, for monostatic and bistatic configurations. Finally, we will present the latest works in radar imagery and possible applications in the maritime domain.

A) Environment- Coastal management

- **An example of integrated coastal zone management: the bay of Bourgneuf**

Speaker 1: Hélène Oger
Title: Coastal environment engineer
Speaker 2: Emmanuel Thouard
Title: Directorate of international and european affairs
Organisation: IFREMER (French Research Institute for Exploitation of the Sea)
Duration: 1h15-1h30 + 20-30 min (questions)
Date:
Public concerned: Student, Doctor, researchers

Summary:

Coastal marine resources are fragile as they are needed for many different uses, a situation which can lead to conflicts and wastage. In other words, commercialisation of new marine technologies, in addition to the inherent risks of exploiting natural resources, are highly dependant on other human activities that are putting increasing pressure on the coastal strip. That's why an integrated and sustainable approach is needed.

The **GERRICO project** (global management of marine resources and coastal zone associated risks) presented by Ifremer and the University of Nantes proposes to manage research activities so as to improve knowledge on the exploitation of marine resources in coastal areas along three axes:

1. Technology development of bioproduction and marine resources
2. Identification and analysis of risks from the point of view of sustainability
3. Regulation of access to resources and coastal areas

The 3rd axis will be particularly developed during the tutorial. The originality of this axis is the development of methods capable of taking into account the entire area from the watersheds down to the coastal sea, using a chain of coupled models (physical, biological, economic) to integrate the different activities and a diversity of physical and biophysical forcing factors. The common point driving this approach is water quality, on which depends the optimisation of coastal activities. The implementation of different scenarios and the assessment of their impact should provide a firm basis to help stakeholders for integrated management of the coastal area.

B) Marine bio-resources - biodiversity

- **Chemical risk assessment in food safety**

Speaker: Pr Dominique Parent-Massin
Title: Professor, Head Food toxicology laboratory and Expert in European Food Safety Agencies
Organisation: UBO (University of western Brittany)
Date:
Duration: 1h30
Concerned public: students and researchers in food sciences, professionals in food industry

Summary

The risk is a function of probability of an adverse health effect and the severity of that effect, resulting from a hazard in food. Risk analysis consists of risk assessment, risk management and risk communication. Risk assessment is the process of estimating the likelihood that a particular adverse effect will occur in a population following exposure to a hazard. Risk management is the process of weighing policy alternatives and, if required, selecting and implementing appropriate controls options, including regulatory measures, and subsequent enforcement. Risk communication consists of the interactive exchange of information and opinions concerning risks among risk assessors, risk manager, consumers and other parties interested.
Risk assessment in food toxicology is divided in 4 steps: hazard identification, hazard characterization, intake assessment, risk characterization.
- Hazard identification involves the detection of a potential hazard

following the accidental poisoning of people or animal subsequent to the chemical analysis of foodstuffs. Hazard identification is often done after massive intoxication. In fact, it is very difficult to identify a relationship between increase of incidence of specific pathology and exposure of a population to a toxin via consumption of food.

- The aims of hazard characterization is to identify the toxicological properties related to a specific substance. Dose response assessment is characterized by the establishment of a relationship between ingested amount of the substance and manifestation of adverse health effects. The usual yard-stick for risk assessment of chemicals in food is the Acceptable Daily Intake (ADI) or Tolerable Daily Intake (TDI).

ADI is the amount of a substance, in mg /kg bw which can be ingested on a daily basis during a life time without adverse health effect

- Intakes assessment involves the combination of contamination data (analytical determinations of the levels of a substance in particular food) and food consumption based on results of dietary surveys
- Risk characterization consists of comparing intakes estimated and acceptable or tolerable daily intakes to evaluate the potential health risk on the individual

It is important to distinguish natural contaminants and substances authorized in food such as food additives, pesticides, food packaging, veterinary drugs. In the last case, substances are authorized according to EU or French regulation, after risk assessment based on a specific toxicological dossier. Toxicological studies proposed in the dossier must be performed according to OCDE guidelines. In case of natural contaminants, hazard characterisation is more difficult because toxicological studies are few and often badly documented.

However, in all cases, the objective of hazard characterization is to allocated an ADI or a TDI for natural contaminants. Exposure to the substance or natural contaminant must be evaluated carefully in order to be compared to ADI/TDI. Risk characterization allows to determine if the presence of substance or natural contaminant is a matter of concern or not. In case of genotoxic and cancerogen substances submitted to authorization, they are not authorized. If it is a natural contaminant, the risk assessment is performed according to the threshold of toxicological concern or margin of exposure.

Food safety agencies are in charge of risk assessment. In E. U., European Food Safety Authority (EFSA) is performing risk assessment for food additives, nutrient sources, pesticides, GMO, natural contaminants. EFSA organisation and European approach will be described.

- **Marine biotechnology–marine biodiversity–drugs from the sea**

Speaker: Pr Eric Deslandes
Title:, Vice president
Organisation: IUEM (European Marine University Institute)
Date:
Duration: 1h30
Concerned public: Students: master, doctorate and PHD.

Summary

Drugs from the sea: Marine organisms with novel chemical constituents are excellent sources of new drugs

- **Marine animals, witnesses of climatic and ecological changes**

Speaker: Yves-Marie Paulet,
Title: Director of the European Institute of marine Sciences
Organisation: IUEM
Date:
Duration: 1h00
Concerned public: Post-graduate students, researchers

Summary

During their ontogeny and growth, marine animals record environmental information, continuously and every place where marine life is possible. Some of theses animals produce perennial structures, as shells and bones, which can be compare with record tapes. Recent advances, noticeably in the field of mass spectrometry, allow us to depict the meaning of the structural and chemical signals embedded in theses carbonate structures. These new methods of ecosystem reconstruction are of paramount importance in the context of climate change studies.

- **Biodiversity, physiology and potentials of thermophilic prokaryotes from deep sea hydrothermal vents**

Speaker: Mohamed Jebbar
Title: Professor
Organisation: IUEM (European Institute of marine Sciences)
Date:
Duration: 1h
Concerned public: students

Summary:

The spatio-temporal variations of the main physico-chemical parameters like temperature, pressure, pH and salinity may constraints life in many terrestrial environments. For example, temperature ranges compatible within life have been established and the highest value (113 °C) for the accomplishment of a whole cell cycle was achieved in a hyperthermophilic archaeon *Pyrolobus fumarii*, while the lower limit is about -18 ° C for a microbial population. The combination of several parameters at a time can limit the diversity or even life in different environments. The deep sea hydrothermal vents are extreme environments where occur high temperatures (where the temperature may vary within few centimetres from 2 °C in vicinity of cold sea to more than 400 °C near the hydrothermal fluid) pressure (from 100 to 1100 atm for depths from 1,000 to 11,000 m) high concentrations of metals (Fe, Mg, Mn, S etc..) and gases (CO, CO_2, H_2S, H_2, etc.).

Most of the biosphere is under pressure and the deep biosphere is located below ground and ocean below 1000 m of depth. The pressure is a major parameter in the ocean, since 88% of global ocean volume, has an average depth of 3800 m and an average hydrostatic pressure of 380 atm (38 MPa). In the deep biosphere live the vast majority of prokaryotes, which could represent up to 70% of all cells, and 50% of the primary biomass production. However, although the deep biosphere (underground and Deep Ocean) represents the largest ecosystem on Earth, it is still poorly characterized in terms of living organisms' diversity or cell adaptation to high hydrostatic pressure (HHP) conditions.

Most micro-organisms isolated from deep sea are psychro-piezophiles (Greek piezein: to press), but among them few are strict piezophiles. Since the discovery of black smokers in 1979, several Thermophilic prokaryotes have been isolated from deep sea hydrothermal vents, but only *Thermococcus barophilus* (2) and *Marinitoga piezophila* (1) are piezophiles although not strict. Recently, the first hyperthermophilic and obligately piezophile was isolated, *Pyrococcus* CH1 (3), is an archaeon, isolated from the deepest oceanic hydrothermal vents ever explored. The comparison of 5 strains of thermococcales (*Pyrococcus furiosus*, *P. horikoshii*, *P. abyssi*, *P. glycovorans*,

T. barophilus and *Pyrococcus* CH1) showed a good correlation between the pressure range allowing growth and a depth at which the organism was isolated. The maximum pressure allowing growth of each model was, respectively, 30 MPa for *P. furiosus* (0 m), 40 MPa for *P. horikoshii* (1400 m), *P. abyssi* (2200 m) and *P. glycovorans* (2650 m), 80 MPa for *T. barophilus* (3550 m) and 120 MPa for *Pyrococcus* CH1 (4100 m) (3). Although microorganisms that are adapted or required pressure to achieve a whole cell cycle were isolated, the characterization of piezo-adaptation mechanisms is still in its infancy.
Thermophiles microorganisms display original properties that are of interest to biotechnology. Enzymes and macromolecules of Thermophiles are used in molecular biology, detergent, fine chemical, food processing and biofuels industries. Biopolymers from thermophiles are also of high interest for various fields including cosmetics. Secondary metabolites or extremolytes produced by thermophiles are used for biomolecules stabilization.

C) Renewable Marine Energy

- **Wave energy harnessing: advanced methods for a refined wave climate analysis**

Speaker: Dr Christophe Maisondieu
Title: research engineer
Organisation: IFREMER (French Research Institute for Exploitation of the Sea)
Date:
Duration: 1h30
Concerned public: Engineers, PHD students, industrials

Summary

It is widely accepted nowadays that wave energy represents all over the world a large potential that can be exploited, mostly to produce electricity. Over the last decades, numerous types of wave energy converters were designed and tested based on various concepts. So far, no technology clearly proved better than the
Wave energy converters, whether they are resonant or not can be seen as mechanical systems for which response largely depends on the main characteristics, mostly frequency and direction, of the incoming wave trains.

From one region to another, wave climate can vary largely so that in order to design the most efficient energy converter, one has to take into account a refined and accurate climatology of the exploitation area.
The full frequency-direction information characterizing sea-states is usually given by directional wave spectra which can be obtained either from in-situ measurement or remote sensing or from hind cast models.
We present here an overview of the main concepts of wave energy converters as well as other off-shore energy structures, focusing on their specific characteristics in regard of the marine environment. We then present advanced wave spectra analysis methods such as sea-states partitioning and discuss their interest for an improved design of energy converters. Particularly, we take into account the effects of important parameters such as directionality or frequency spreading and assess their influence on converters efficiency and power extraction rates.

- **Modeling methods and tools for the evaluation of the electrical power potential harnessed by a marine current turbine**

Speaker: Dr Jean-Frédéric Charpentier
Title: Associate Professor
Organisation: Naval Academy France
Date:
Duration: 1h30
Concerned public: Graduate students, researchers, engineers

Summary:

This tutorial deals with how to model a marine current turbine system through the modeling of the resource the rotor, the generator, the converters and the control system. The purposes of the use of such a model are two: performances and dynamic loads evaluation of technologies in different operating conditions and control system development for turbine operation.

First order model is used to predict the resource (marine current behavior). This model can include disturbance linked to swell and turbulence. The Blade Element Momentum (BEM) approach is used for the turbine modeling.
A strategy of speed control of the turbine will be presented which is based on the maximum power point tracking.
Classical Park model are used for the electrical system (generator and drive).

The tutorial will include the presentation of the use of these multi-physical models in a ®matlab/simulink environment. Results will be shown in typical test cases.