Research Opportunity at Institut Fresnel
Internship and/or PhD Study Program in
PhotoAcoustic Tomography (PAT) of biological tissues in the Frequency Domain (FD)

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Applications are invited for an **internship** program in **PhotoAcoustic Tomography (PAT)** at the Institut Fresnel, University of Aix-Marseille, France. The internship will commence in the Spring of 2016 and, according to funding possibilities, can be extended by mutual agreement into a full-time PhD study program in October of 2016. Persons with a combination of experimental and theoretical skills and a strong physical background are particularly encouraged to apply.

Keywords : Multiphysics, Photoacoustic, Optical and ultrasound instrumentation, forward and inverse problems modelling.

Background

PhotoAcoustic Tomography (PAT) is a multiple wave tomographic imaging technique. It consists in illuminating the tissue with a pulsed laser source. Because of the presence of absorbing heterogeneities within the tissue (high vascularisation of the tissues, neoangiogenis of the tumors, …), light is locally absorbed and dissipated into heat, microdilatations appear and give birth to an acoustic wave that propagates through the tissue and can be measured with conventional ultrasonic transducers. Hence, in visible to near infrared wavelength range, it potentially offers the possibility to couple high sensitivity to a wide variety of chromophores (haemoglobin, oxygen consumption, glucose, fat, water, …) brought by the optical illumination and high spatial resolution thanks to the acoustic detection. Initially, the technique was exploited in a complete passive mode: the sample was probed with the optical illumination distributed as homogeneously as possible at the surface of the tissue to optimise the heating volume. The primary inverse problem sought at reconstructing the heating function from the acoustic pressure that indeed depends on the absorption coefficient but also on the scattering properties of the medium. By using a pattern of multiple illuminations, the probing becomes active as the medium is probed under different views, and the quantitative reconstructions of the spatial distribution of both the optical absorption and the scattering coefficients can finally be obtained.

Research program

In this internship, alternative ways of achieving the reconstruction of these optical parameters will be considered. Another type of time varying source of illumination will be exploited. It consists in using a continuous laser source modulated in intensity, at a given frequency (1-100 MHz).
The different steps of the project will be:

- Perform experiments with this new approach on tissue mimicking phantoms;
- Understand and adapt existing numerical (FEM: Finite Element Method) or semi-analytical codes solving the forward multiwave coupled problem; Run a number of realistic simulations;
- Understand and adapt existing inversion codes; Proceed to reconstruction of the optical parameters based on synthetic noisy data;
- Proceed to reconstructions of the optical parameters based on experimental data.

Qualifications:

This internship covers a wide range of disciplines, persons with a combination of experimental and theoretical skills and a strong computational background are particularly encouraged to apply. The candidate should have special interest for experiments in both optics and acoustics, and should have a strong background in physics, applied math, or signal/image processing, and technical computing, and an interest in biomedical applications. Experience of or interest in working in a multi-disciplinary environment is a plus.

The insternship will last for 6 months, an allowance of ~550 euros/month will be granted.