Internship offer

Title: 3D Reconstruction of Breasts from Ultrasound images	
Laboratory: LIRIS, CREATIS	**Web site: https://liris.cnrs.fr; https://shaifaliparashar.github.io**
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Details for the subject:

Medical context

Breast cancer is the most common malignancy among women with approximately 58,500 newly diagnosed cases and 12,000 deaths in 2017 in France. The mammography screening program initiated in 2004 led to increased diagnosis of nonpalpable lesions and, accordingly, to an increased need for preoperative localization (POL). POL is required to accurately identify and remove the lesion whenever breast conservative surgery is indicated. The current standard in POL is wire-guided localization, i.e., the placement of a flexible self-retaining wire under ultrasound (US) or stereotactic guidance. The surgeon uses the wire as a guide to locate and remove the tumour. However, this POL technique requires dedicated facilities and is a source of patients' discomfort since it involves an invasive procedure prior to surgery. To partially overcome POL drawbacks, per operative localization of the lesion may have several strengths, particularly regarding preoperative schedule, overall cost and patient's discomfort.

The main objective of this project is to propose an innovative assistance procedure for nonpalpable breast cancer surgery, based on augmented reality (AR). AR, allowing real-time visualisation of nonpalpable tumours, may theoretically overcome most of the limitations of both pre- and per-operative existing localization techniques. It will prevent the need for specific technical facilities, reduce patients' discomfort and avoid repeated imaging acquisitions at the time of tumour removal. However, real time noninvasive tumour tracking and visualisation are particularly challenging in breast surgery: breast is a mobile and deformable organ whose shape changes with the patient's position or histological composition, greatly different from one woman to another.

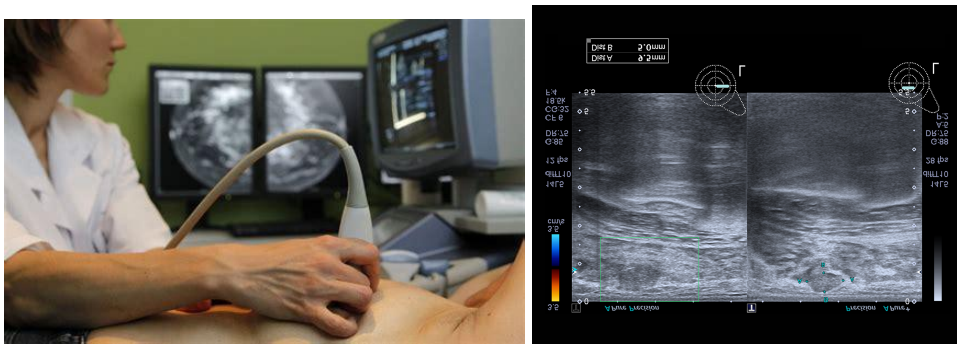

Figure: Ultrasound Imaging setup on Breasts

Main objective

During the exam, the US probe exerts an unknown compression of the breast, thus leading to local and non-homogeneous deformations. The main objective of this PhD thesis is to estimate the tissue deformations of the breast to provide relevant tumour information for 3D visualisation.

Description of the work: We will perform the 3D reconstruction of the breasts by modelling their volumetric deformations using differential geometry. Such a modelling has been proven to be very efficient (in terms of both computation complexity and accuracy) in case of image-based reconstructions [1,2,3]. We will use a single, calibrated RGB camera to capture the surficial deformations of the breasts and propagate through the volume under the guidance of the ultrasound images.

References:
[1] Parashar et al, ICCV 2015. As-rigid-as-possible volumetric shape-from-template.
[2] Parashar et al, CVPR 2020. Local non-rigid structure-from-motion from diffeomorphic mappings.
[3] Parashar et al, TPAMI 2021. Robust Isometric Non-Rigid Structure-from-Motion.