Thesis Topic:
Cardiac Function Assessment from Cardiac Motion Analysis

This thesis focuses on the analysis of the cardiac electrical and mechanical function for patients suffering from heart failure. An expected outcome of this work is a set of computational tools that may help a clinician in understanding, diagnosing and treating patients suffering from **cardiac motion asynchrony** a specific aspect of heart failure.

More precisely, the application of this thesis work should cover the different stages of the clinical practice from diagnosis to therapy:

- **Diagnosis** : detection and characterization of asynchronous motion
- **Therapy guidance** : guidance of the implantation of pacing leads and real-time evaluation of the cardiac function,
- **Therapy follow-up**: optimization of the excitation parameters of the pacing leads.

To reach those objectives, we propose a two steps approach. First, the contraction and relaxation times at each point of the myocardium should be estimated from time series of cardiac images. To improve the robustness of this estimation, it is important to use a priori information about the motion and structure of the heart such as the cardiac fiber architecture. The observation of the cardiac motion should consist of 3D+T image modalities such as cine MRI or 3D echocardiography.

In a second step, isochrone maps providing the time at which the mechanical wave reaches a given point in the myocardium will be built and analysed. For such objective, a simplified model of the cardiac electrophysiology, mechanics and their coupling may be used to improve the interpretation of isochrone maps and to estimate local parameters (such as the velocity) of the mechanical propagation.

This information will be exploited clinically in terms of diagnosis, therapy guidance and follow-up for one or two specific pathologies.

Thesis Context :

This thesis will be carried out in partnership with the MEDISYS group of Philips HealthCare that is well connected with different clinical sites. Those sites will provide the required clinical data and relevant clinical advice. The MEDISYS group expertise also includes the segmentation of 2D, 3D et 4D ultrasound images, segmentation of the right and left ventricles from cine-MR images, segmentation of scars from late enhancement MRI, motion estimation from Tissue Doppler Imaging and the parametric representation of cardiac motion.

The Asclepios team of INRIA is well known for the development of image segmentation algorithms based on surface or volumetric meshes, image registration algorithms and the geometrical and physiological modelling of the heart. Asclepios is strongly involved in the action CardioSense3D dedicated to the electromechanical modelling of the heart.

Requirements

- Master degree in computer science or applied mathematics,
- Good knowledge of software engineering (unix and windows), and C++ development,
- Fluent in English (written and spoken).
- Knowledge of medical imaging and cardiac physiology appreciated.

Practical nformation

The thesis will start in September 2008 for a period of 3 years and will take place mainly in the Asclepios team at INRIA Sophia-Antipolis located 20 km from Nice. A 6 months period in the MEDISYS group of Philips HealthCare in Suresnes (near Paris) and at the university hospital of Caen (Normandy) is required during the first year of the thesis.

Contact :

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