Cycle de Conférences LMIA-LPMT-MIPS 2015-2016
PROJET MIFA Mathématiques pour l'Image, les Formes et Applications

21 avril 2016 à 14h00
Amphithéâtre Schittly – ENSISA-Lumière

TRANSVERSE OSCILLATIONS: A METHOD FOR VECTOR MOTION ESTIMATION IN CARDIOVASCULAR APPLICATIONS

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In medical imaging one is often interested in evaluating or mapping information about the local motion of tissue or blood. This information carries indeed relevant indices about the normal or pathological state of the patient. The aim of this presentation is to give an overview of an ultrasound based vector motion estimation technique called transverse oscillations. This technique has initially been developed by the group of J.A. Jensen at the technical University of Denmark in the 90's for the estimation of two dimensional blood velocities using a linear ultrasound array [Jensen and Munk 98]. It has further been developed and extended to convex and phased arrays as well as 3D and high frame rate imaging.

Transverse oscillations (TO) combine a specific image formation approach and a dedicated motion estimation algorithm. TO has been proposed with the idea of developing ultrasound RF images featuring similar oscillatory characteristics in the transverse direction as in the axial one. Jensen and Munk proposed a particular receive beamforming combining dynamic focusing along with an apodization function where the conventional Gaussian like function is replaced by a function featuring two peaks.

With the same idea of filtering spatially the images, we proposed selecingt the TO present in the images using a spatial filter applied directly to the images obtained with conventional beamforming. The displacement or velocity field is calculated using a combination of phase shifts obtained from multi-dimensional analytic signals. For vessel wall imaging, we have extended the technique to high-frame rate acquisitions in order to image the propagation of the pulse wave along the vessel wall. The high-frame rate approach has also been used for vector flow imaging. TO is an interesting approach for vector motion estimation. There are still some challenges to tackle especially in order to extent the technique to 3D high-frame rate cardiac imaging that is typically involving the transmission of diverging waves.

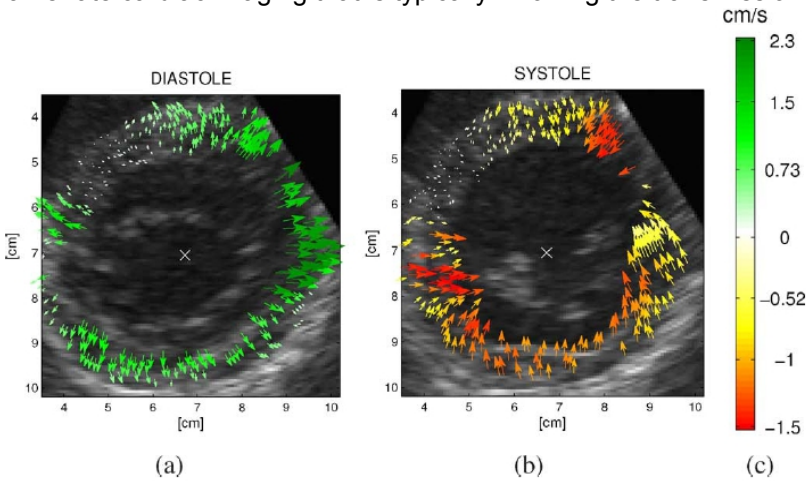

Figure 1 :
Estimated motion fields of the heart obtained with TO images.
One diastolic (a) and one systolic (b) frame of a short axis ultra-realistic simulated sequence. Color encodes the radial velocity component according to the colormap in (c). White cross denotes the left ventricle center.
The estimated motion fields reflects the physiological expansion and contraction of the cardiac muscle in these two phases of the cardiac cycle. [Alessandrini et al. IEEE TMI 2014]

Références :

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