Post-doctoral fellowship
Motion estimation in echocardiography using deep learning

Creatis laboratory

This project will be carried out in the team "Images and Models" of the CREATIS lab (Villeurbanne – Lyon). Creatis is a biomedical imaging research laboratory, with about 200 persons, whose main areas of excellence and international influence are linked to two fundamental problems: *i)* identification of major health issues that can be addressed by imaging; *ii)* the identification of theoretical barriers in biomedical imaging related to signal and image processing, modelling and numerical simulation.

Postdoc overview

Cardiovascular diseases remain the leading cause of the death in western countries and account for 30% of all global deaths corresponding to 17 million deaths per year. These numbers illustrate the extreme needs of improving the different techniques for diagnosis and treatment follow-up of patients with heart disease. Echocardiographic imaging takes a leading role to diagnose heart disease thanks to its bedside applicability, time efficiency and low cost compared with other modalities such as magnetic resonance imaging (MRI). In this context, a multitude of advanced acquisitions and post-processing methodologies have been proposed in echocardiography over the last decades. The current limitations clearly reside in the high variability of most of the measurements derived from ultrasound images, due to limited spatio-temporal resolution and the presence of many artefacts (*e.g.* shadows, reverberation, and signal dropout). Strong efforts thus remain to be done to make the analysis of echocardiographic images more robust and accurate.

Scientific context

The objective of this project is to significantly improve the performance (robustness and accuracy) of state-of-the-art methods for motion estimation in echocardiography. In particular, one of the main limitations in this field concerns the speckle decorrelation over the cardiac cycle. Indeed, most of the current algorithms consider that locally the speckle (which can be seen as texture information) corresponds to a signature of the tissue that could be tracked over time to estimate the real motion of the underlying structures. Unfortunately, it is known that apart for translation displacements, any motion induces modifications in the speckle structure which limits the performance of the current tracking algorithms.

Goal and tasks

The goal of this post-doctoral project is to design a dedicated deep learning architecture to learn to recover the true motion of cardiac structures under speckle decorrelation. Several architectures and strategies dedicated to motion estimation should be investigated. Based on the strong experience of our team in simulation [1] [2] [3], ultra-realistic simulations of echocardiography sequences will be used as reference databases in order to feed the different deep learning solutions. Figure 1 provides an example of such realistic simulations of 3D echocardiography. Clinical databases of real patients (already in place) will also be used for validation.

Context around the project

This study is part of a wider project on deep learning for echocardiography analysis in collaboration with the University of Sherbrooke, Canada (Prof. Pierre-Marc Jodoin). The postdoc will thus be integrated inside an international team (between France and Canada) and will also benefit from:

- ultra-realistic and clinical databases for the training, testing and validation phases of the learning process (the corresponding database are already in place) ;
- existing codes of deep learning methods already deployed for echocardiography image analysis;
- hardware materials (gpu card, 500 Gb of memory system) dedicated to the deployment of deep learning solutions for the training on big data.

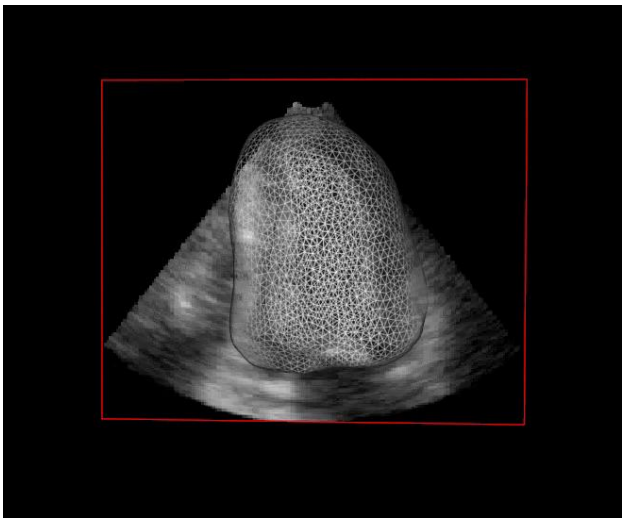

Figure 1: Illustration of a realistic simulation of 3D echocardiographic sequence.

Profile

- Experience: the candidate must hold a PhD in artificial intelligence or in digital imagery and during he/she had to develop machine learning models
- Languages: English required, French optional
- Strong motivation and interest in multidisciplinary research.

Salary: 2050 euros per month.
Duration: 1 year postdoc, can start immediately.
Contact: Interested applicants are required to send a cover letter + CV + reference letters at the following email address: olivier.bernard@creatis.insa-lyon.fr

Reference

[1] Y. Zhou, S. Giffard-Roisin, M. De Craene, S. Camarasu-Pop, J. D'hooge, M. Alessandrini, D. Friboulet, M. Sermesant and O. Bernard, « A Framework for the Generation of Realistic Synthetic Cardiac Ultrasound and

Magnetic Resonance Imaging Sequences from the same Virtual Patients », IEEE Transactions on Medical Imaging, accepted, 2017.

[2] M. Alessandrini, M. De Creane, O. Bernard, S. Giffard-Roisin, P. Allain, I. Waechter-Stehle, J. Weese, E. Saloux, H. Delingette, M. Sermesant and J. D'hooge, « A Pipeline for the Generation of Realistic 3D Synthetic Echocardiographic Sequences: Methodology and Open-access Database », IEEE Transactions on Medical Imaging, vol. 34, p. 1436-1451, 2015.

[3] M. De Craene, S. Marchesseau, B. Heyde, H. Gao, M. Alessandrini, O. Bernard, G. Piella, A. R. Porras, L. Tautz, A. Hennemuth, A. Prakosa, H. Liebgott, P. Allain, S. Makram Ebeid, H. Delingette, M. Sermesant, J. D'hooge and E. Saloux, « 3D Strain Assessment in Ultrasound (Straus): A synthetic comparison of five tracking methodologies », IEEE Transactions on Medical Imaging, vol. PP, 2013.