Deep learning-based motion compensation of myocardial perfusion MRI

Background

Patient motion is a significant consideration in all aspects of cardiac imaging. The heart contracts while beating and respiratory motion can cause large shifts in the location of the heart. This makes it difficult to acquire high quality images and importantly, to automatically analyse them, particularly on a pixel-wise level. For perfusion data, the motion causes deviations in the pixel-wise signal intensity curves which then hinders the applicability of the tracer-kinetic models that are used to quantify perfusion. The effect of respiratory motion on signal intensity curves is visualized in Figure 1.

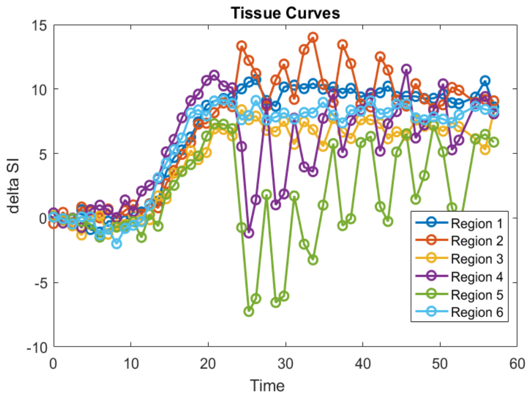

Figure 1

A challenge in the motion correction of perfusion scans with image registration is the changing contrast over time due to the contrast agent injection, see Figure 2. We have previously developed image processing steps using robust principal component analysis (RPCA) to separate the baseline components of the image series from the contrast enhancement to compute deformation fields required for the motion correction using only the baseline images without the local signal enhancement. This is done using traditional image registration but requires many steps and is time-consuming. Recently, it have demonstrated that it is possible to train deep learning models to the parameters of a deformable model that registers two images.

We propose to combine our image processing techniques with a deep learning-based registration. Using deep learning to perform the image registration has the potential to be more robust and to result in more physiologically plausible deformations due to the data driven nature of the procedure. It will also greatly reduce the time taken for the motion correction as it computes the parameters of the transformation that registers the images in “one shot”, as opposed to the iterative optimization used in classical image registration.

Aims:

The project will be conducted in two stages where firstly: strategies for simulating realistic cardiac and respiratory motion deformations on static perfusion images will be investigated, and then it in the second stage: deep learning models are trained to correct these deformations.

Since the data consists of time dynamics videos, it will be studied how best to incorporate the temporal dimension in models and, if time allows, evaluation of the developed methods in the clinical workflow will be performed.

Outcomes: The outcome of this project may result in a scientific conference or journal paper, co-authored by the student.

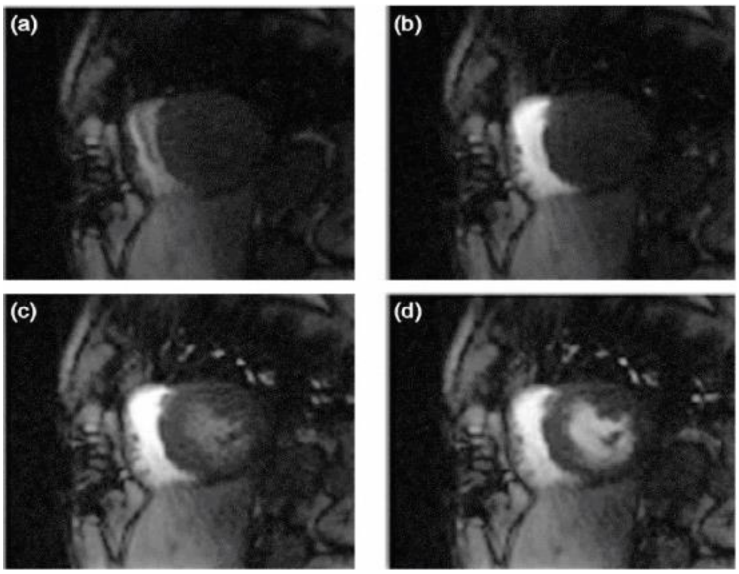

Figure 2

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Further information: This project will be conducted with our clinical collaborators at King's College London and, if interested, the student could arrange to visit their hospital as part of the project.

Expected skills and experience

- Programming in Python, other languages (e.g. course BMB502417)
- Machine learning / deep learning (e.g. courses 8DM40, 8DM00, 8DM20)
- Medical image analysis (e.g. courses 8DC00, 2DMM10)
- Experimental study design (course 8DM20)
- Written and oral communication in English