Use Case for seed EP5:

Fusion of tumour images

Version 1.0
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INRIA

Virtual Physiological Human Project

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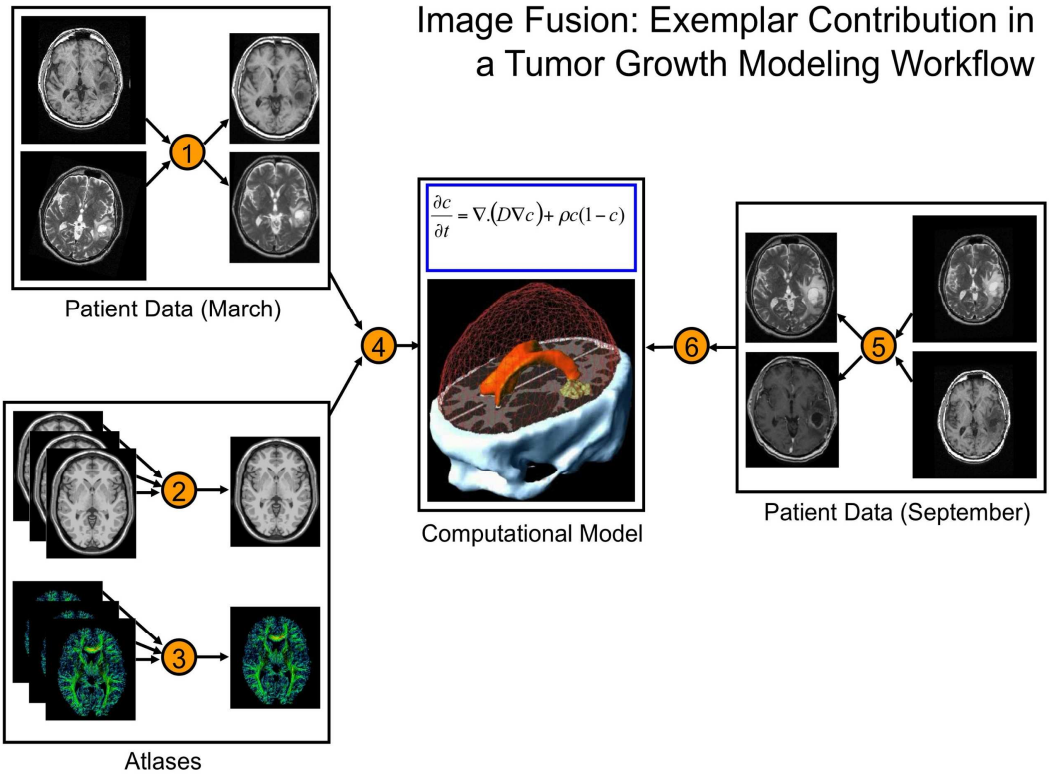
1. Introduction

The Virtual Physiological Human (VPH) ToolKit is a technical and methodological framework to support and enable VPH research - the collaborative investigation of the human body as a single complex system. This is achieved, among other things, through interaction between the Toolkit team and the exemplar projects in order to identify the users' needs.

In this document we will focus on the horizontal data fusion part of the VPH Toolkit. The aim is to show how horizontal data fusion can be used at different steps of a tumour growth modelling workflow, which will constitute an example of use case for seed EP5 (FORTH).

2. Use case: Tumour growth modelling

A tumour growth modelling workflow can be represented with the diagram below. It consists of several successive steps, each one involving horizontal data fusion.



Step 1: Images from the same patient, acquired at diagnostic time need to be fused. Fusion refers here to a rigid transformation of the floating images so that homologous structures get identical positions in both the reference and the transformed image. Typical medical images acquired in the case of brain tumour image are T1, T2, Flair.

This step involves the use of rigid and multi-modal image fusion.

Step 2: Multiples images from healthy subjects are fused to create an anatomical atlas. An atlas here refers to an average image (in terms of geometry and intensity) generated by averaging multiple subjects from a population. When used for segmentation purpose, this atlas comes with a label map that describes the structures of interest in the image. Since multiple subjects have different brain geometries, non-rigid transformations have to be used to match their brains.

This step involves the use of non-rigid and mono-modal image fusion.

Step 3: Multiples diffusion tensor images (DTI) are fused to create an atlas, similarly to step (2). While MR sequences for anatomical images acquire a non-directional scalar tissue characteristic, diffusion tensor imaging measures the directional diffusivity of water into the tissue. Registering those images taking into account the full geometry of the information therefore requires specific algorithms.

This step involves the use of non-rigid and mono-modal multivariate image fusion.

Step 4: To enrich the patient data with atlas-based knowledge, the atlases are fused with the patient images. This information coming from multiple sources is used to create the tumour growth computational model.

This step involves the use of non-rigid and multi-modal image fusion. Non-rigid fusion can be limited to affine transformation in the case of complex deformation of multi-modal images.

Step 5: Similar to step (1): images from the same patient, acquired at a second time step are fused in the same geometry.

This step involves the use of rigid and multi-modal image fusion.

Step 6: Clinical data from step (5) is fused with the model to compare the simulated growth (from the model) with the observed evolution. Images of the patient are acquired at different times, but with a similar MR sequence.

This step involves the use of rigid and mono-modal image fusion.

3. Conclusion

The use case described in this document showed the various ways horizontal data fusion can be used in the case of a tumour growth modelling workflow. This could help identify the technical functionalities a horizontal data fusion tool should provide.