

ISMRM 2011
Sunrise Session “Image Analysis”

Wednesday Course Lecture:
Registration: Theory and Practice

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Image registration has become one of the most important tools in medical image analysis. Building of population-specific atlases, longitudinal analysis, mapping of images to a common template space, automatic segmentation via the use of segmented templates, or integration of multiple image modalities are just a few of the many widely used applications. While there is still rapid progress on new methodological developments of registration algorithms, successful use of such technology requires understanding of some basics in order to optimally apply them, to avoid eventual pitfalls, and to explore new potential uses that would answer specific new research questions. As in many other scientific areas, there is no notion of a best tool that fits all purposes. Users need to choose the appropriate methodology given a specific task, which requires understanding of fundamental methodological principles and differences.

This course will introduce the current state-of-the-art of image registration technology, discuss important conceptual differences between various algorithms and their parameter settings, and illustrate its use with the example of challenging clinical applications in neuroimaging. In particular, we will introduce important fundamental aspects such as image descriptors (grayscale intensity values, tensors, anatomical landmarks) transformation properties (diffeomorphism, regularization, invertibility, smoothness) and image similarity metrics (mutual information, cross-correlation).

To demonstrate how these tools can have an impact in clinical studies, we will discuss the applications of these algorithms in both cross-sectional and longitudinal studies. We will show how we can successfully measure subtle changes between groups, for instance in neurodegenerative disease such as Alzheimer’s disease or Huntington’s disease. We will illustrate how the combination of multiple types of image descriptors can improve the registration process and enhanced their analysis.

