Biomedical Image Analysis based on Computational Registration Methods

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Keywords: Image Matching, Image Alignment, Image Fusion, Spatio-Temporal Registration

Abstract

Image registration, which has become a paramount research topic, is the process of transforming an image so that the associated entities are properly adjusted to the homologous entities in a second image (Figure 1). Such transformations have not only been applied to static bi-dimensional (2D) and tridimensional (3D) images, but also to 2D and 3D image sequences. For example, in Medical Imaging, computational methods of image registration have been assuming an essential role in supporting enhanced image-based diagnosis by addressing: the automatic identification of regions of interest in images (i.e. image segmentation), the fusion of information acquired by different imaging systems (i.e. image fusion), the more effective follow-up of organs and pathologies, and the definition of the best plans in computer-assisted surgery or in radiotherapy treatments, among other roles [1]. Hence, the computational registration of medical images is an extremely useful tool for clinicians and researchers since, after the accurate registration of the data involved, tasks such as shape reconstruction, comparison of a given clinical case with previous cases are facilitated and can be performed with less subjectivity. Moreover, the identification of regions of interest and information fusion can be handled automatically.

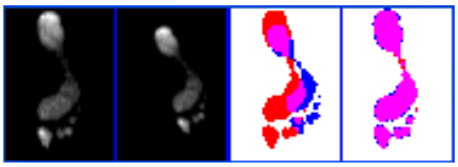


Figure 1 – Registration of two plantar pressure images: original images, and the two plantar pressure regions overlapped (in pseudo-colors) before and after the registration process [1, 12].

Other topics of image analysis are usually associated to image registration, including: image matching, i.e., the searching for correspondences between related images [2-6], similarity measurements, optimization, and image interpolation, especially due to the application of the registration transformations in the image discrete domain [1], Figure 2.

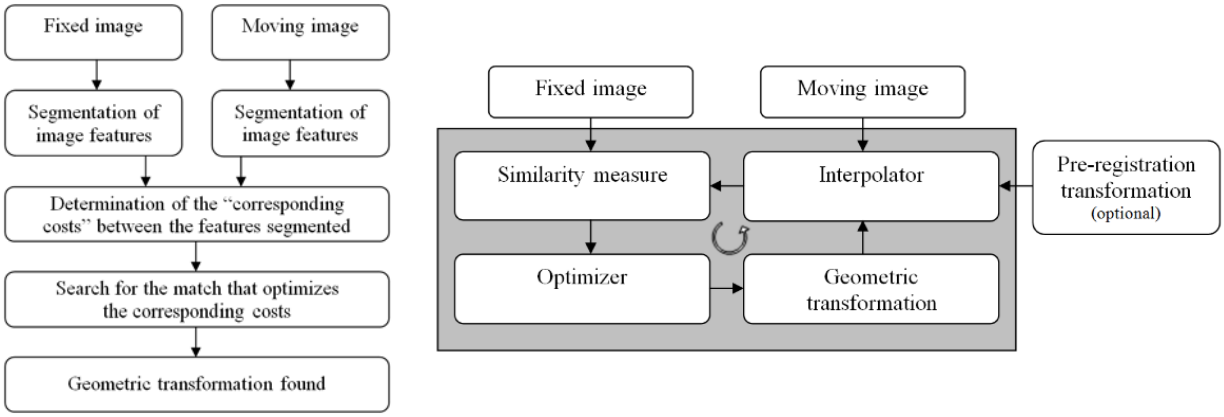
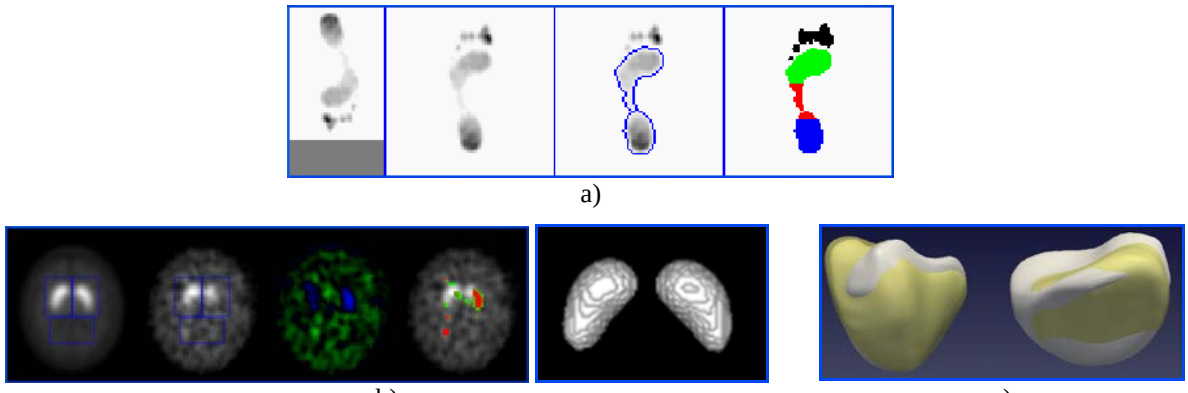


Figure 2 – Topics usually considered in image registration methodologies based on the matching of features (on the left) and based on the optimization of a similarity measure (on the right) [1].

During this presentation, the topic of medical image registration is going to be introduced; computational methodologies for matching and registering static images and image sequences that we have developed are going to be described; and application of cases involving static images, image sequences and images acquired by different medical imaging modalities are going to be presented and discussed [2-15]. The experimental examples that will be presented and discussed include the registration and analysis of plantar pressure in static images and in image sequences [4-13], the computer aided diagnosis of Parkinson´s disease based on I-123-FP-CIT SPECT brain images [14], and the enhanced 3D reconstruction of organs, in this case the bladder, in medical images acquired from different angles [15], Figure 3.



a)

b) c)

Figure 3 – Examples of biomedical image analysis based on computational methods of image registration: a) original plantar pressure image, image after size, position and orientation normalization, segmentation of the main plantar region and identification of the important plantar regions based on a template image for the left foot [9];
b) identification of the ROIs in SPECT brain images and statistical comparisons relatively to population representative templates and 3D reconstruction of the ganglia basal [14],
c) 3D reconstruction of the bladder from magnetic resonance images of the axial and sagittal planes [15].

Acknowledgments

The works that will be presented here have been partially developed in the scope of the project “A novel framework for Supervised Mobile Assessment and Risk Triage of Skin lesions via Non-invasive Screening”, with reference PTDC/BBB-BMD/3088/2012, financially supported by Fundação para a Ciência e a Tecnologia (FCT) in Portugal.

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