bUnwarpJ: Consistent and Elastic Registration in ImageJ. Methods and Applications.

Abstract:
Image registration is a wide extended problem in many biomedical fields but also in many other image processing disciplines. Our plugin bUnwarpJ provides with a free tool to elastically register pairs of 2D images. In principle, non-rigid deformations are not invertible. For that reason, our method simultaneously calculates the direct and inverse transformations that minimize the similarity error between the target and source images by imposing a consistency constraint. This approach enables bidirectional registration: from image A to B or from B to A, in a single computation. We take advantage of the B-spline properties to represent both images and deformations in order to make the algorithm efficient and use a powerful optimizer to converge fast to the best image alignment. Our plugin allows guiding the registration process based on the image similarity, the deformations' consistency, vector-spline regularization and/or a set of optional landmarks, which can be automatically detected and integrated from other ImageJ plugins such as SIFT and MOPS features extractors. It is the user's decision how to combine the relevance of each of these terms in the registration process. This paper intends to be a detailed description of the algorithm and its implementation in order to help developers and users to exploit all the plugin potential.

Keywords:
2D Image Registration

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Research interests: image processing, three-dimensional reconstructions, biomedical image registration and segmentation in 2D and 3D.