

The momentum map representation of images

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This paper discusses the mathematical framework for designing methods of large deformation matching (LDM) for image registration in computational anatomy. After reviewing the geometrical framework of LDM image registration methods, a theorem is proved showing that these methods may be designed by using the actions of diffeomorphisms on the image data structure to define their associated momentum representations as (cotangent lift) momentum maps. To illustrate its use, the momentum map theorem is shown to recover the known algorithms for matching landmarks, scalar images and vector fields. After briefly discussing the use of this approach for Diffusion Tensor (DT) images, we explain how to use momentum maps in the design of registration algorithms for more general data structures. For example, we extend our methods to determine the corresponding momentum map for registration using semidirect product groups, for the purpose of matching images at two different length scales. Finally, we discuss the use of momentum maps in the design of image registration algorithms when the image data is defined on manifolds instead of vector spaces.

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