Experimental Laboratory Research

Automatic Misalignment Correction in Neuroimages Using Surface Symmetry Priors

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ABSTRACT

Many brain imaging procedures require the careful alignment of different sets of images obtained in the same individual. The available automatic methods for brain alignment are susceptible to improvement. This paper discusses briefly a new automatic method to reinstall the tilted orientation of head images, using surface symmetry as a prior.

Keywords: Magnetic resonance imaging, brain symmetry, midsagittal plane, pathological asymmetry, misalignment correction.

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Neuroimaging scans often suffer from the lack of perfect alignment of a patient's head, a flaw that poses a challenge in qualitative and quantitative evaluation of brain images. The misalignment of a patient's head in the scanner may lead to distorted clinical assessment of the patient's condition. Manual adjustment of the misalignment of brain images is neither efficient nor clinically recommended. The paper by Liu et al[1] presents a novel algorithm to automatically reinstall the tilted orientation of the head, using surface symmetry as a prior.

Briefly, in our method, the head volume is represented as a reparameterized surface point cloud, where each location is parameterized by its elevation (latitude), azimuth (longitude), and radius (Fig 1). By deploying a shape-based criterion, the symmetry plane is defined as a plane that best matches external surface point clouds. To accelerate computation, the search for the best matching surfaces is implemented in a multiresolution paradigm. After symmetry plane has been identified, a spatial affine transformation is performed to rotate the 3-dimensional brain representation and to realign/recenter it within the coordinate system of the scanner. The breakdown points of our symmetry-plane extraction algorithm are evaluated by testing different brain orientation, lesion size, slice thickness, noise level, and the strength of bias field.

Our algorithm was quantitatively evaluated using both simulated brain MR data and real T1, T2, Flair magnetic resonance images with brain tumors. A small number of images from other modalities like CT, MR diffusion weighted images (DWI) was processed as well. This algorithm was found to be fast (<10 seconds per MR volume), accurate (<0.6 degree of mean angular error), and invariant to the acquisition noise, slice thickness, bias field, and pathological asymmetries.

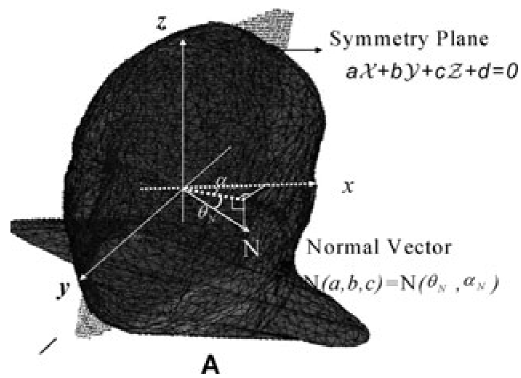

Fig 1. The 3-dimensional head volume is represented as a digitized surface point cloud, and each location on the surface is parameterized by its elevation, azimuth, and radius $\{(\alpha,\theta,r)\}$. The symmetry plane is defined as a plane that best matches external surface point clouds.

This approach relies on the assumption that the external surface of the head ought to be complete and symmetrical, which is generally valid in most stroke, tumor, and other brain pathology patients. Under this assumption, the symmetry of the surface shape provides a good and reliable prior to compute the best estimate of the symmetry plane and subsequently correct the existing spatial misalignment of the brain images.

