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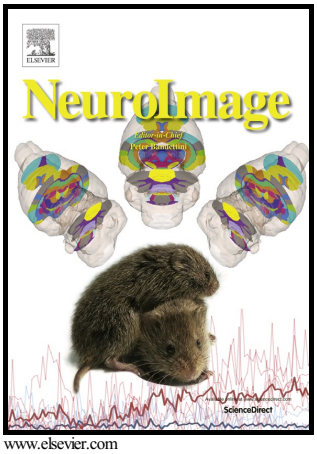

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Robust Automated Constellation-Based Landmark Detection in Human Brain Imaging

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ABSTRACT

A robust fully automated algorithm for identifying an arbitrary number of landmark points in the human brain is described and validated. The proposed method combines statistical shape models with trained brain morphometric measures to estimate midbrain landmark positions reliably and accurately. Gross morphometric constraints provided by automatically identified eye centers and the center of the head mass are shown to provide robust initialization in the presence of large rotations in the initial head orientation. Detection of primary midbrain landmarks are used as the foundation from which extended detection of an arbitrary set of secondary landmarks in different brain regions by applying a linear model estimation and principle component analysis. This estimation model sequentially uses the knowledge of each additional detected landmark as an improved foundation for improved prediction of the next landmark location. The accuracy and robustness of the presented method was evaluated by comparing the automatically generated results to two manual raters on 30 identified landmark points extracted from each of 30 T1-weighted magnetic resonance images. For the landmarks with unambiguous anatomical definitions, the average discrepancy between the algorithm results and each human observer differed by less than 1 mm from the average inter-observer variability when the algorithm was evaluated on imaging data collected from the same site as the model building data. Similar results were obtained when the same model was applied to a set of heterogeneous image volumes from seven different collection sites representing 3 scanner manufacturers. This method is reliable for general application in large-scale multi-site studies that consist of a variety of imaging data with different orientations, spacings, origins, and field strengths.

Keywords: Automated landmark detection, Morphometric measures, Statistical shape models, Principle component analysis.