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# Automated Cerebellar Lobule Segmentation with Application to Cerebellar Structural Analysis in Cerebellar Disease

Zhen Yang[a,*], Chuyang Ye[b], John A. Bogovic[c], Aaron Carass[a,d], Bruno M. Jedynak[e], Sarah H. Ying[f], Jerry L. Prince[a,d,e,f]

[a] *Department of Electrical and Computer Engineering, The Johns Hopkins University, Baltimore, MD 21218 USA*
[b] *Brainnetome Center and National Laboratory of Pattern Recognition Institute of Automation, The Chinese Academy of Sciences, Beijing, 100190 China*
[c] *Janelia Research Campus, Howard Hughes Medical Institute, Ashburn, VA 20147 USA*
[d] *Department of Computer Science, The Johns Hopkins University, Baltimore, MD 21218 USA*
[e] *Department of Applied Math and Statistics, The Johns Hopkins University, Baltimore, MD 21218 USA*
[f] *Department of Radiology, The Johns Hopkins School of Medicine, Baltimore, MD 21287 USA*

**Abstract**

The cerebellum plays an important role in both motor control and cognitive function. Cerebellar function is topographically organized and diseases that affect specific parts of the cerebellum are associated with specific patterns of symptoms. Accordingly, delineation and quantification of cerebellar sub-regions from magnetic resonance images are important in the study of cerebellar atrophy and associated functional losses. This paper describes an automated cerebellar lobule segmentation method based on a graph cut segmentation framework. Results from multi-atlas labeling and tissue classification contribute to the region terms in the graph cut energy function and boundary classification contributes to the boundary term in the energy function. A cerebellar parcellation is achieved by minimizing the energy function using the $\alpha$-expansion technique. The proposed method was evaluated using a leave-one-out cross-validation on 15 subjects including both healthy controls and patients with cerebellar diseases. Based on reported Dice coefficients, the proposed method outperforms two state-of-the-art methods. The proposed method was then applied to 77 subjects to study the region-specific cerebellar structural differences in three spinocerebellar ataxia (SCA) genetic subtypes. Quantitative analysis of the lobule volumes show distinct patterns of volume changes associated with different SCA subtypes consistent with known patterns of atrophy in these genetic subtypes.

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* *Please address correspondence to:*
Zhen Yang,
Dept. of Electrical and Computer Engineering, Johns Hopkins University,
105 Barton Hall, 3400 N. Charles St., Baltimore, MD 21218.
Email: zyang11@jhu.edu
Fax: +14105165566