Novel MRI-Based Brain Vessel Segmentation Algorithm for Alzheimer's Disease Research

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It is believed that conditions such as Alzheimer's disease have etiological roots in abnormalities in brain vasculature. Consequently, methods to study the morphology of brain vessels are warranted. Current techniques allow for viewing 3D MRI brain scans to examine a patient's vessels, but automated methods to segment these vessels and obtain quantifiable metrics lack reliability and accuracy. We present a novel image analysis algorithm designed to accurately segment brain vessels from 3D MRI images, enabling more detailed analysis.

Our algorithm begins by preprocessing the image into 'variance wells' (vWells), a type of 'superpixel' derived from the variance in the image's intensity. VWells are small, irregular, and relatively homogeneous clusters of adjacent pixels, which can be connected to segment objects in an image while preserving sharp boundaries. The computed vWells are arranged into a graph structure where vWells serve as nodes, and edges connect adjacent vWells. The algorithm takes two manually placed points along a vessel, then uses the graph structure to connect and complete the corresponding section of a vessel. By combining these powerful automated techniques with human supervision based on detailed visualization, our approach provides a robust and reliable method for brain vessel segmentation. Preliminary results demonstrate the algorithm's potential to advance Alzheimer's research by enabling precise, quantifiable comparisons of vessel measurements across a wide range of 3D MRI brain scans, thereby supporting the study of disease-related vascular changes.