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Vascular segmentation of neuroimages based on a prior shape and local statistics

Key words: Vesselness filter; Neighborhood; Blood-vessel segmentation; Outlier

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Motivation

- Vascular segmentation is an important method in the quantification of morphological changes of blood vessels, enabling an accurate diagnosis during treatment processes.
- However, most of the vessel segmentation techniques ignore the existence of the isolated and redundant points in the segmentation results.
- The proposed method can remove outliers while preserving the connectivity of vessel branches.

Main idea

- An improved vesselness filter is defined, and it quantifies the likelihood of each voxel belonging to a bright tubular-shaped structure.
- A matching and connection process is performed to obtain a blood-vessel mask.
- The region-growing method based on local statistics is implemented on the vessel mask to obtain the whole vascular tree without outliers.

Method

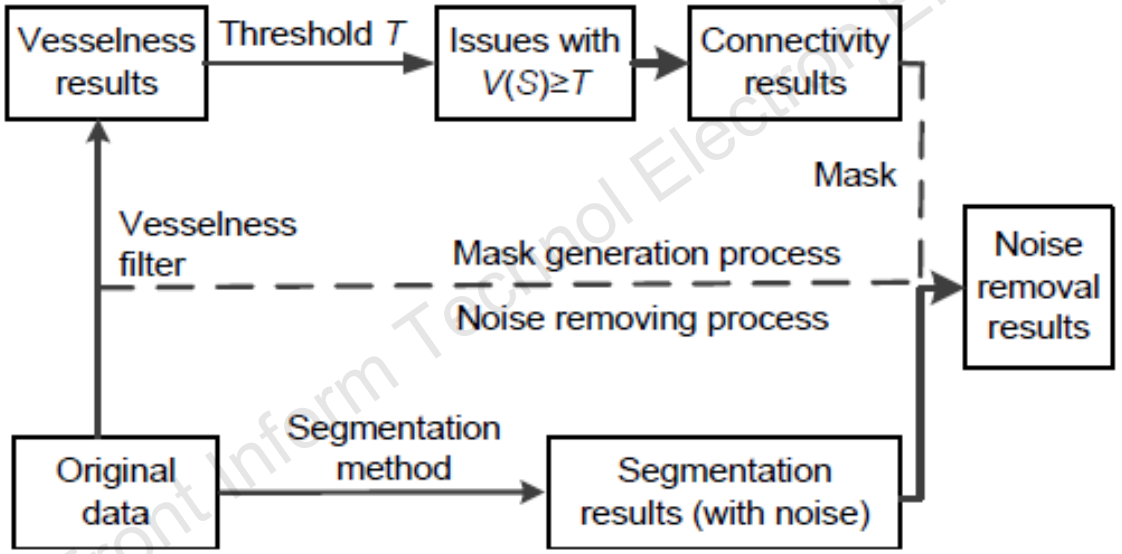

Fig. 7 Flowchart of the proposed method

Major results

Table 1 Different thresholds of Hu and volume ratios of the preserved parts

Threshold of Hu	Volume ratio (%)
100	54.2912
150	32.2688
200	6.1140
250	1.3543
300	0.4750
350	0.2179

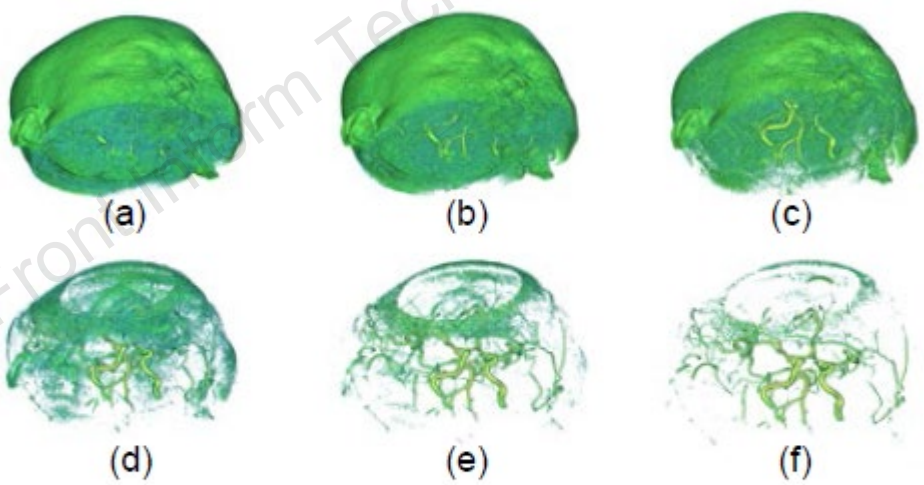

Fig. 8 Blood vessel mask with different thresholds of Hu: (a) Hu=100; (b) Hu=150; (c) Hu=200; (d) Hu=250; (e) Hu=300; (f) Hu=350

Major results (Cont'd)

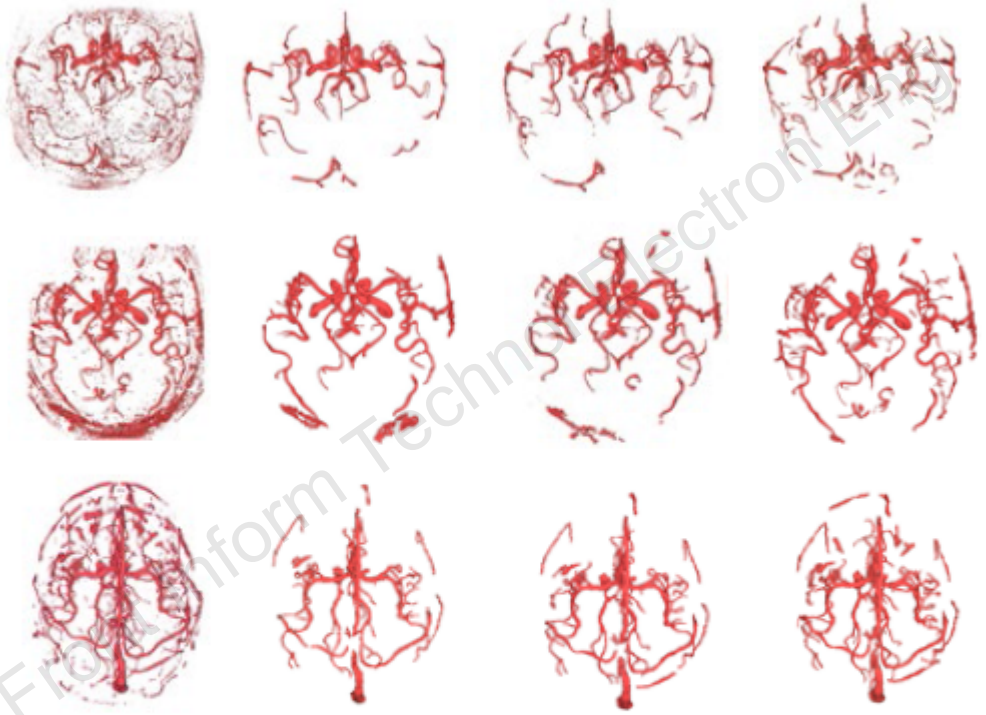

Fig. 11 Comparison of our method with Frangi's and Yang's models on three MRA brain datasets

Column 1 shows the results of the original Frangi vesselness filter; columns 2–4 show the outlier removal results from the cerebral vessels with Frangi's, Yang's, and our models, respectively. The results of the different datasets are presented in different rows

Conclusions

- The improved vesselness filter has a strong response at tubular structures.
- The connected components working as a blood-vessel mask can obtain the thick and thin vessels and remove some outliers.
- The region-growing method based on local statistics has been implemented on the vessel mask to obtain the whole vascular tree without outliers.
- The proposed method can be used for extraction of the coronary artery.