Lan-yan XUE, Jia-wen LIN, Xin-rong CAO, Shao-hua ZHENG, Lun YU, 2019. A saliency and Gaussian net model for retinal vessel segmentation. *Frontiers of Information Technology & Electronic Engineering*, 20(8):1075-1086. https://doi.org/10.1631/FITEE.1700404

A saliency and Gaussian net model for retinal vessel segmentation

Key words: Retinal vessel segmentation; Saliency model; Gaussian net (GNET); Feature learning

Corresponding author: Lan-yan XUE
E-mail: xuelanyan@126.com

ORCID: http://orcid.org/0000-0003-2886-2983

Motivation

- Information about the personal risk of potential cerebrovascular diseases can be obtained through the quantization parameter of the retinal vessel, which is widely used in clinical practice and may improve the prevention of strokes in hypertensive patients. Retinal vessel segmentation facilitates the quantification of characteristics.
- The advantage of this method is that it can overcome the randomness of boundary selection and the subjective error of quantization, and provide a convenient way for doctors to select vessels of interest. This can help in the early diagnosis of diseases and the monitoring of prognosis and treatment.

Main idea

- A low-level and bottom-up visual saliency model is adopted to detect the fundus image. By computing the distance between the mean pixel value and the Gaussian blurred version of the fundus image, the distance image is used in the saliency image. This method can highlight the saliency region of the retinal vessel and obtain clear edges with a complete resolution.
- Given that the GNET model used to learn the characteristics of the fundus image may lose some details, an improved model is proposed, and the classification results are obtained through a training classifier.

Method

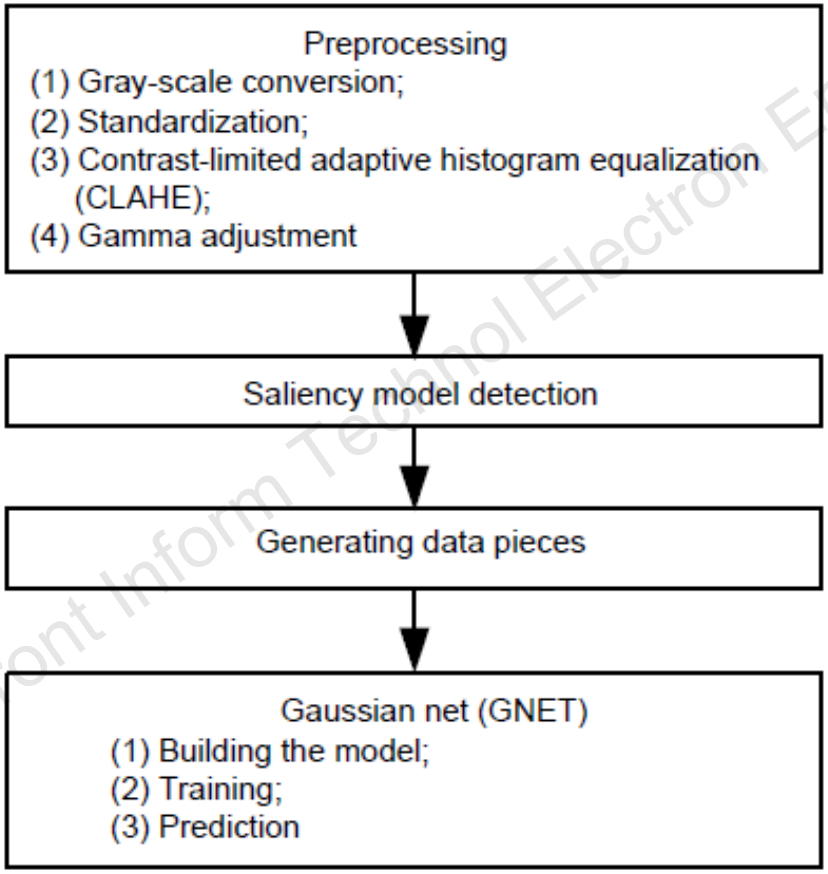

Fig. 1 Flowchart of the proposed algorithm

Major results

Table 1 Performance comparison between our method and the methods used by other researchers

Method	Spec	Sen	ACC
Wang et al. (2015)'s	–	0.7527	0.9457
Maji et al. (2015)'s	–	–	0.9327
Fu et al. (2016)'s	–	0.7603	0.9523
Ronneberger et al. (2015)'s	0.9835	0.7671	0.9559
Ours	0.9861	0.7967	0.9629

Spec: specificity; Sen: sensitivity; ACC: accuracy

The quantitative performances of both enhancement and segmentation steps show that our method effectively detects the blood vessels with an accuracy of above 95%.

Major results

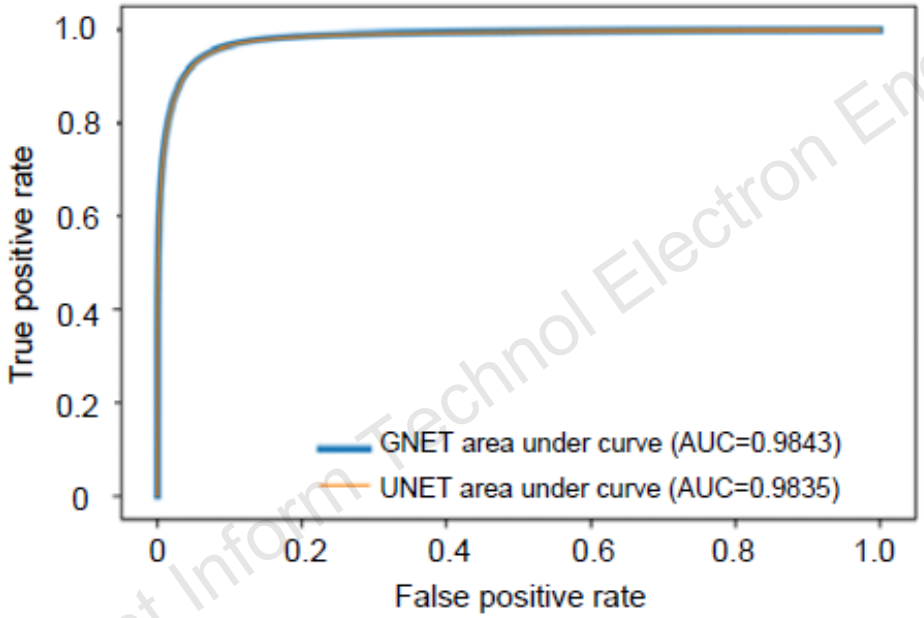

Fig. 13 ROC curves of the GNET and UNET models

The true positive rate is on the *y* axis, whereas the false positive rate is on the *x* axis. The AUC of the UNET model is close to 0.9835 and that of the model combining saliency and GNET is close to 0.9843.

Conclusions

To obtain clear edges with a complete resolution of retinal vessels, a saliency image has been used as the input image of the deep learning network. A novel GNET model has been proposed to train the features and classify the pixels using classifiers. Upsampling has been operated before max-pooling and the opposite operation was implemented in the right layer to reduce the loss of several features caused by the size after convolution and to obtain details. The proposed algorithm has been evaluated using images from the DRIVE database.

Compared with other deep learning algorithms, the proposed algorithm had higher accuracy, sensitivity, and specificity. The retinal vessels can be accurately segmented, and vessel change characteristics can be extracted to provide a basis for the screening of cerebrovascular diseases.