

Retinal blood vessel segmentation by using matched filtering and fuzzy C-means clustering with integrated level set method for diabetic retinopathy assessment

ABSTRACT

Background: The condition of blood vessel network in the retina is an essential part of diagnosing various problems associated with eyes, such as diabetic retinopathy. **Methods :** In this study, an automatic retinal vessel segmentation utilising fuzzy c-means clustering and level sets is proposed. Retinal images are contrast-enhanced utilising contrast limited adaptive histogram equalisation while the noise is reduced by using mathematical morphology followed by matched filtering steps that use Gabor and Frangi filters to enhance the blood vessel network prior to clustering. A genetic algorithm enhanced spatial fuzzy c-means method is then utilised for extracting an initial blood vessel network, with the segmentation further refined by using an integrated level set approach. **Results:** The proposed method is validated by using publicly accessible digital retinal images for vessel extraction, structured analysis of the retina and Child Heart and Health Study in England (CHASE_DB1) datasets. These datasets are commonly used for benchmarking the accuracy of retinal vessel segmentation methods where it was shown to achieve a mean accuracy of 0.961, 0.951 and 0.939, respectively. **Conclusion:** The proposed segmentation method was able to achieve comparable accuracy to other methods while being very close to the manual segmentation provided by the second observer in all datasets.

Keyword: Retina vessel segmentation; Matched filtering; Fuzzy c-means clustering; Level sets; Frangi filters; Gabor filters