Blood Vessel Segmentation from Retinal Images

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**Preface**

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**Abstract**

Automatic retinal blood vessel segmentation algorithms are important procedures in the computer aided diagnosis in the field of ophthalmology. They help to produce useful information for the diagnosis and monitoring of eye diseases such as diabetic retinopathy, hypertension and glaucoma.

In this work, different state-of-art methods for retinal blood vessel segmentation were implemented and analyzed. Firstly, a supervised method based on gray level and moment invariant features with neural network was explored. The other algo-rithms taken into consideration were an unsupervised method based on gray-level co-occurrence matrix with local entropy and a matched filtering method based on first order derivative of Gaussian. During the work, two publicly available image data-bases DRIVE and STARE were utilized for evaluating the performance of the algo-rithms which includes sensitivity, specificity, accuracy, positive predictive value and negative predictive value. The accuracies of the algorithms based on supervised and unsupervised methods were 0.935 and 0.950 compared to corresponding values from literature, which are 0.948 and 0.975, respectively. The matched filtering based method produced same accuracy as in the literature, i.e., 0.941.

Although the accuracies of all implemented blood vessel segmentation methods were close to the corresponding values given in the literature the sensitivities were lower for all the algorithms which lead to smaller number of correctly classified vessels from retinal images. Based on the results achieved, the algorithms have potential to be accepted for practical use, after modest improvements are done in order to get better segmentation of retinal blood vessels as well as the background.

**Keywords:** Retinal vessel segmentation, retinal image, performance measure, su-pervised method, unsupervised method, matched filtering.

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**List of abbreviations**

Acc Accuracy

CPU Central processing unit

DRIVE Digital Retinal Images for Vessel Extraction (retinal image database)

FDOG First-order derivative of Gaussian

FOV Field of view

FPR False positive rate

GB Gigabyte

GHz Gigahertz

GLCM Gray-level co-occurrence matrix

GMM Gaussian mixture model

GPU Graphical processing unit

JPEG Joint photographic experts group image format

JRE Joint relative entropy

kNN K-nearest neighbors algorithm

MF Matched filter

NN Neural network

Npv Negative predictive value

OR Logical OR operation

PC Personal computer

PCA Principal component analysis

PCNN Pulse coupled neural network

PPM Portable pixel map image format

Ppv Positive predictive value

RACAL Radius based clustering algorithm

RAM Random access memory

RGB Red, green and blue color space

Se Sensitivity

SIMD Single instruction multiple data

Sp Specificity

STARE STructured Analysis of the REtina (retinal image database)

SVM Support vector machine

TPR True positive rate

UI User interface

VLSI Very large-scale integration

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