ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

Artery/Vein Discrimination Using Graph Based Approach and LDA Classifier

K. Ramudu[1], M. Chakradhara Babu[2]

Assistant Professor, Department of ECE, Annamacharya Institute of Technology and Sciences, Rajampet, Andhra Pradesh, India [1]

PG Scholar, Department of ECE, Annamacharya Institute of Technology and Sciences, Rajampet, Andhra Pradesh, India [2]

ABSTRACT*:* Analyzing the retinal blood vessels can provide very helpful information to doctors for early detection of diseases Such as diabetic retinopathy due to large number of patients. For this generalized arteriolar narrowing, which is inversely related to higher blood pressure levels is usually expressed by the Arteriolar-to-Venular diameter Ratio (AVR). The AVR value can also be an indicator of other diseases, like hypertension, and other cardiovascular conditions. Among other image processing operations, the estimation of AVR requires vessel segmentation, accurate vessel width measurement, and artery/vein (A/V) classification. This paper presents an automatic approach for A/V classification based on the analysis of a graph extracted from the retinal vasculature. The proposed method classifies the entire vascular tree deciding on the type of each intersection point (graph nodes) and assigning one of two labels to each vessel segment (graph links). Final classification of a vessel segment as A/V is performed through the combination of the graph-based labelling results with a set of intensity features. Accuracy values of 88.3%, 87.4%, and 89.8% are obtained for the images of the INSPIREAVR, DRIVE, and VICAVR databases, respectively. These results demonstrate that our method outperforms recent approaches for A/V classification.

KEYWORDS*:* Artery/Vein discrimination, graph links**,** AVR, retinal vasculature.

I. INTRODUCTION

Automatic classification of retinal blood vessels into arteries and veins is drawing increasing attention in recent years and is an open area of research. A group of Diseases such as heart stroke, hypertension, blood pressure have proven to show some signs in retinal blood vessels or make alternations to width of arteries and veins in different ways leading to abnormally thick arteries , thin veins or vice versa. Particularly, many patients are suffering from diabetic retinopathy which is a result of long-term diabetes and may damage retinal vessels and leads to visual loss if not treated early. In eye fundus images using digital image analysis methods has huge potential benefits, allowing the examination of a large number of images in less time, with lower cost and reduced subjectivity than current observer-based techniques. Another advantage is the possibility to perform automated screening for pathological conditions, such as diabetic retinopathy, in order to reduce the workload required of trained manual graders. Several works on vessel classification have been proposed, but automated classification of retinal vessels into arteries and veins has received limited attention, and is still an open task in the retinal image analysis field. In recent years, graphs have emerged as a unified representation for image analysis, and graph-based methods have been used for retinal vessel segmentation, retinal image registration, and retinal vessel classification. In this paper we propose a graph-based method for automatic A/V classification. The graph extracted from the segmented retinal vasculature is analyzed to decide on the type of intersection points (graph nodes), and afterwards one of two labels is assigned to each vessel segment (graph links). Finally, intensity features of the vessel segments are measured for assigning the final artery/vein class.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

II. EXISTING METHODS

A number of automatic researches have been done to classify the vessels.
Huiqi et al. to describe the vessel profile considering the central reflex feature. The parameters of the model were determined by curve fitting using 505 segments of vessels. They could correctly classify arteries and veins 82% and 89% respectively.

Grisan et al. exploit the balanced layout of arteries and veins in optic disk centred retinal images dividing those images to four quadrants, each of which contains almost similar number of arteries and veins with significant local differences in features. Using variance of red and mean of
hue values as features and fuzzy clustering as classifier vessel points are classified on 443 vessel segments with 87.6% accuracy.

In H.F Jelinek et al. method, after optic disk elimination and vessel segmentation, different features are extracted from vessels. Then various classifiers are tested and the best result is achieved using decision table which is reported 70%.
Niemeijer *et al.* proposed an automatic method for classifying retinal vessels into arteries and veins using image features and a classifier. A set of centerline features is extracted and a soft label is assigned to each centerline, indicating the likelihood of its being a vein pixel. Then the average of the soft labels of connected centerline pixels is assigned to each centerline pixel. They tested different classifiers and found that the *k*-nearest neighbor (kNN) classifier provides the performance. The classification method was enhanced as a step in calculating the AVR value. Due to the acquisition process, very often the retinal images are non-uniformly illuminated and exhibit local luminosity and contrast variability, which can affect the performance of intensity-based A/V classification methods. For this reason, we propose a method which uses additional structural information extracted from a graph representation of the vascular network. The results of the proposed method show improvements in overcoming the common variations in contrast inherent to retinal images. In our method, We have tested the most commonly used classifiers, namely linear discriminate analysis (LDA), quadratic discriminate analysis (QDA), and *k*-nearest neighbour (kNN), on the INSPIRE-AVR dataset. For feature selection, we have used sequential forward floating selection, which starts with an empty feature set and adds or removes features when this improves the performance of the classifier linear discriminate analysis (LDA) classifier provides the best overall performance.

III. SYSTEM DESIGN

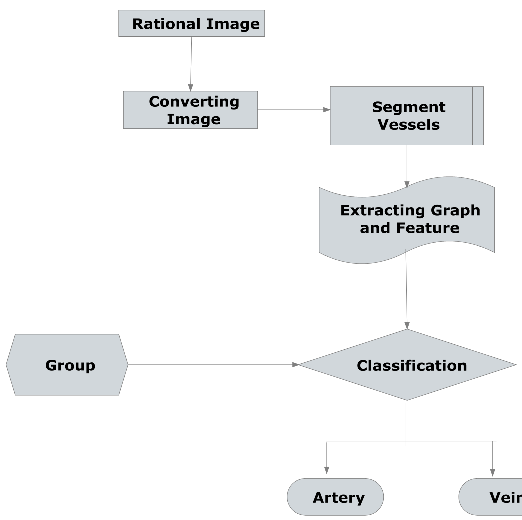

Fig.1.system design of proposed method for A/V discrimination

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

IV.GRAPH-BASED A/V CLASSIFICATION PROPOSED METHOD

A. **Graph Generation:**
Generating the graph, we have used a three step algorithm. First we use the segmented image to obtain the vessel centrelines. Then the second step is the graph is generated from central line image. Finally some additional modifications are applied to the graph .There are four method are used, vessel segmentation, Vessel centreline extraction, graph generation, graph modification.

B. **Vessel Segmentation:**
This method follows a pixel processing-based approach with three phases. The first one is the pre-processing phase, where the intensity is normalized by subtracting an estimation of the information image background. In the second candidates are detected using information provided from a set of four directional differences of offset Gaussian filters. Finally the third step is vessel segmentation using binary maps.

C. **Vessel Centreline Extraction:**
The centreline image is obtained by applying an iterative thinning algorithm. This algorithm removes border pixels until the object shrinks to a minimally connected stroke.

D. **Graph Extraction:**
The graph nodes are extracted from the centreline image by finding the intersection points and the endpoints. To find the links between nodes (vessel segments), all the intersection points and their neighbours are removed from the centreline image. As result we get an image with separate components which are the vessel segments.

E. **Graph Modification:**
The extracted graph may include some misrepresentation of the vascular structure as a result of the segmentation and centreline Extraction processes. The typical errors are the splitting of one node into two nodes; missing a link on one side of a node; false link. Node splitting: when extracting the centreline pixels in a single intersection, we have two graph nodes instead of only one. Missing link: For solving the missing link cases the distance from a degree 1 node (endpoints) to other nodes is calculated .False link: illustrates the last situation, corresponding to an incorrect detection of a link between two nodes.

F. **Graph Analysis:**
The output of the graph analysis phase is a decision on the type of the nodes. The links in each sub graph are labelled with one of two distinct labels (Ci1 and Ci2). In this phase we are not yet Able to determine whether each label corresponds to an artery class or to a vein class. The A/V classes will be assigned to these sub graphs only in the last classification phase.

G. **LDA CLASSIFIER**:
Data sets can be transformed and test vectors can be classified in the transformed space. Class dependent transformation: This type of approach involves maximizing the ratio of between class variance to within class variance. The main objective is to maximize this ratio so that adequate class Separability is obtained. The class-specific type approach involves using two optimizing criteria for transforming the data sets independently.Perform dimensionality reduction "while preserving as much of the class discriminatory information as possible". Seeks to find directions along which the classes are best separated. Takes into consideration the scatter *within_classes* but also the scatter *between classes*. For example of face recognition, more capable of distinguishing image variation due to identity from variation due to other sources such as illumination and expression.

H. **A/V Classification:**
The trained classifier is used for assigning the A/V classes to each one of the sub graph labels. First, each centreline pixel is classified into A or V classes, then for each label (Ci j , j = 1, 2) in sub graph i, he probability of its being an artery is calculated based on the number of associated centerline pixels classified by LDA to be an artery or a vein.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

V. RESULTS

A. Run the main .m in source code file

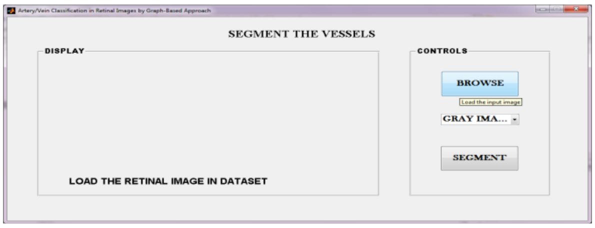

Fig.2. Run the main. m in source code file

B. Convert the gray image by Separate any one of RED, GREEN, and BLUE:

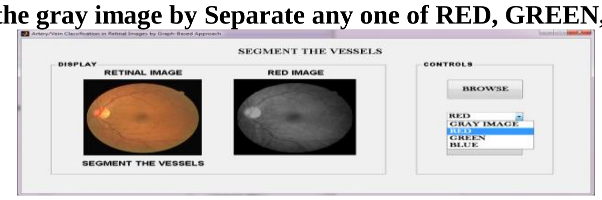

Fig.3. Convert the gray image by Separate any one of RED, GREEN, and BLUE

C. Segment the vessels in gray image using Morphological method:

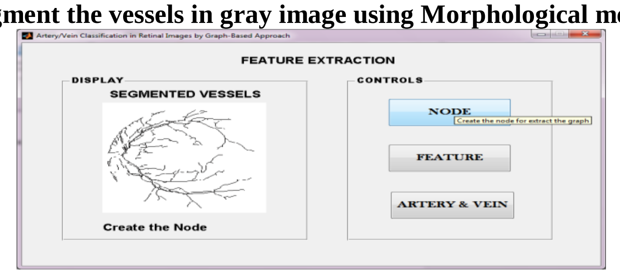

Fig.4. Segment the vessels in gray image using Morphological operations.

D. Find centre line pixels and nodes:

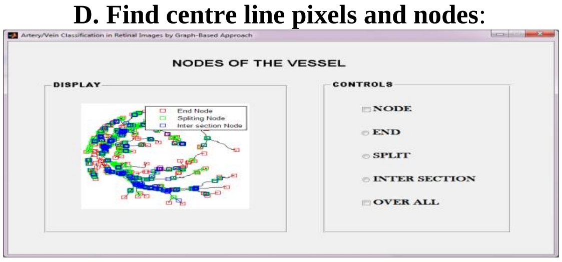

Fig.5. feature extraction

E. Select types it shows our specified pixels:

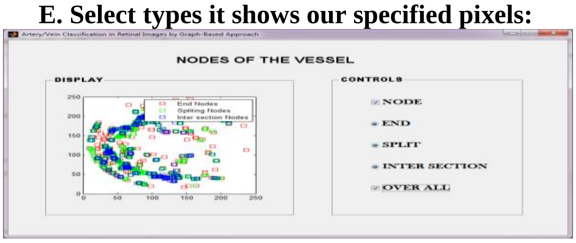

Fig.6. node of the vessel

F. Artery and vein classification:

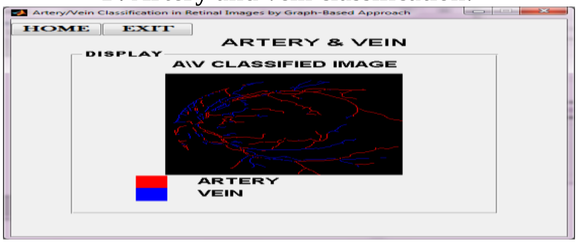

Fig.7. Artery and vein classification

F. Performance

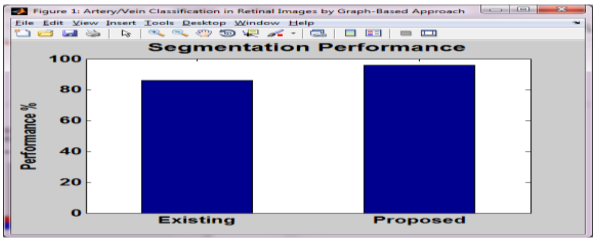

Fig.8. performance of classification

VI. CONCLUSION

Our method allows us to find the retinal vessel boundaries of even small vessels on standard posterior pole images as used in diabetic retinopathy screening programs around the world. Though the performance on the INSPIRE-AVR & DRIVE database was close to the human experts reference standard, it tends to be biased towards showing a smaller measurement, for smaller vessels. The most likely explanation is that the vessel width measurement and segmentation is done fully automated. While most of the previous methods mainly use intensity features for discriminating between arteries and veins, our method uses additional information extracted from a graph which represents the vascular network. Next, based on the node types, the links that belong to a particular vessel are detected. The performance of proposed approach is compared with other recently proposed methods, and it concludes that proposed methods achieves better results.

ACKNOWLEDGMENT

The authors would like to thank the authors of INSPIREAVR, DRIVE and VICAVR databases for making their retinal image databases publicly available.

REFERENCES

[1] N. Patton, T. M. Aslam, T. McGillivray, I. J. Deary, B. Dhillon, R. H. Eikelboom, K. Yogesa, and I. J. Constable, "Retinal image analysis: Concepts, applications and potential," *Progr. Retinal Eye Res.*, vol. 25, p. 99–127, Jan. 2006.
[2] T. T. Nguyen and T. Y. Wong, "Retinal vascular changes and diabetic retinopathy," *Current Diabetes Rep.*, vol. 9, pp. 277–283, Aug. 2009.
[3] K. Guan, C. Hudson, T. Wong, M. Kisilevsky, R. K. Nrusimhadevara, W. C. Lam, M. Mandelcorn, R. G. Devenyi, and J. G. Flanagan, "Retinal hemodynamics in early diabetic macular edema," *Diabetes*, vol. 55, pp. 813–818, Mar. 2006.
[4] A. S. Neubauer, M. Ludtke, C. Haritoglou, S. Priglinger, and A. Kampik, "Retinal vessel analysis reproducibility in
Assessing cardiovascular disease," *Optometry Vis. Sci.*, vol. 85, p. 247–254, Apr. 2008.
[5] C. Sun, J. J. Wang, D. A. Mackey, and T. Y. Wong, "Retinal vascular caliber: Systemic, environmental, and genetic associations," *Survey Ophthalmol.*, vol. 54, no. 1, pp. 74–95, 2009.
[6] L. D. Hubbard, R. J. Brothers, W. N. King, L. X. Clegg, R. Klein, L. S. Cooper, A. Sharrett, M. D. Davis, and J. Cai, "Methods for evaluation of retinal microvascular abnormalities associated with hypertension/ sclerosis in the atherosclerosis risk in communities study," *Ophthalmology*, vol. 106, pp. 2269–2280, Dec. 1999.
[7] M. D. Knudtson, K. E. Lee, L. D. Hubbard, T. Y. Wong, R. Klein, and B. E. K. Klein, "Revised formulas for summarizing retinal vessel diameters," *Current Eye Res.*, vol. 27, pp. 143–149, Oct. 2003.
[8] M. E. Martinez-Perez, A. D. Hughes, A. V. Stanton, S. A. Thom, N. Chapman, A. A. Bharath, and K. H. Parker, "Retinal vascular tree morphology: A semi-automatic quantification," *IEEE Trans. Biomed. Eng.*, vol. 49, no. 8, pp. 912–917, Aug. 2002.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 5, May 2015

[9] K. Rothaus, X. Jiang, and P. Rhiem, "Separation of the retinal vascular graph in arteries and veins based upon structural knowledge," *Image Vis. Comput.*, vol.2

[13] E. Grisan and A. Ruggeri, "A divide et impera strategy for automaticclassification of retinal vessels into arteries and veins," in *Proc. 25th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc.*, Sep. 2003, pp. 890–893.

[14] S. Vazquez, B. Cancela, N. Barreira, M. Penedo, and M. Saez, "On the automatic computation of the arterio-venous ratio in retinal images: Using minimal paths for the artery/vein classification," in *Proc. Int. Conf. Digital Image Comput. Tech. Appl.*, 2010, pp. 599–604.

BIOGRAPHY

K. Ramudu received B. Tech degree in electronics and communications engineering from Jawaharlal Nehru technical university, Hyderabad , ALFA College of engineering and technology, Kurnool, in 2006, and the M. Tech degree in digital electronics and communications systems from Jawaharlal Nehru technical university, Anantapur, Sri vidyanikethan college of engineering, tirupathi in 2010.He currently worked as a assistant professor in Annamacharya Institute of technology and sciences (Autonomous), Rajampet, Kadapa, A.P.

M. Chakradhara Babu received B. Tech degree in electronics and communications engineering from sri venkateswara college of engineering and technology, chittoor ,JNTUA, Anantapur, in 2012.currently, he pursuing the M. Tech degree in digital electronics and communications systems in Annamachary Institute of technology and sciences(Autonomous), Rajampet, Kadapa, A.P.