# Detection of Arteriovenous Nicking in Retinal Fundus Images For Screening Hypertensive Retinopathy

**M.Ilakkiya[1], S.Shenbaga Devi[2]**

[1]PG scholar, Dept. of Biomedical Engineering, Anna university CEG campus, Chennai, Tamilnadu, India
[2]Professor, Dept. of ECE, Anna university CEG campus, Chennai, Tamilnadu, India

---***---

**Abstract -** *Hypertensive retinopathy has adverse effects on the retinal area of hypertensive patients. Arteriovenous nicking is the earliest clinical signs of hypertensive retinopathy. For detecting arteriovenous nicking, the fundus images preprocessed. From the preprocessed images, segmentation of blood vessels performed and then centerline extracted from the segmented blood vessels. Crossover and bifurcation point recognized in the centerline extracted images. Spurious removed by using distance calculation between crossover/bifurcation and termination point. Then the vessel thickness measured at the crossover and bifurcation areas. Veins segmented based on the lowest intensity value. Vessel thickness measured in normal arteriovenous crossing. The average thickness of normal arteriovenous crossing is 11. The proposed algorithm applied in hypertensive retinopathy image and the average thickness of arteriovenous nicking is 16. Based on the vessel thickness, hypertensive retinopathy detected.*

***Key Words***: Hypertensive retinopathy, arteriovenous nicking, Bifurcation, arteries and veins.

## 1. INTRODUCTION

Hypertension is a disease which occurs due to the high blood pressure. Hypertension can cause a lot of disturbance in the retinal area of the eye that is hypertensive retinopathy (HR). Symptoms of HR are arteriolar narrowing, ArterioVenous (AV) nicking while the other major symptoms are retinal microaneurysms, hemorrhages and Cotton wool spots. Based on the level of severity of the retinal findings, HR are classified into four grades. AV nicking is considered as earlier symptom because it presents at the first grade of HR. AV nicking is a disorder, while a stiff artery crossing a vein, which results in the compression of the vein[1][2]. HR signs can be seen by using fundus image of hypertensive patients and the fundus image is captured by fundus camera.

## 2. LITERATURE REVIEW

Jieliang Kang et al.,(2016) [3] proposed the automatic detection of AV nicking in retinal Images. Crossover point detection and AV nicking identification performed in this paper. For detecting crossover points, first they segment the vessels, and then they recognized the feature points. Vessels diameter measured for detecting AV nicking. The proposed algorithms have been tested by using clinical images.

Uyen T.V. Nguyen et al., (2013) [4] proposed an automated method for retinal AV nicking quantification from color fundus images. They have proposed and validated a method for automated AV nicking assessment. In this paper, first they extracted the vascular network and the crossover points in order to localize the AV areas. They are identified four vessel segments such as two associated with the artery and two associated with the vein at each detected crossover point and then they recognized the two venular(veins) segments through the artery vein classification method. The vessel widths are measured along the two venular segments and the measurement provides the AV nicking severity level for each venular segment. The proposed system was applied on 47 high resolution retinal images and it was obtained from two population based studies.

U.T.V. Nguyen, A. Bhuiyan, L.A.F. Park, and K.Ramamohanarao(2013)[6] proposed an effective retinal blood vessel segmentation method using multi-scale line detection. In this paper, they analyse the venular width to classify the severity level of AV nicking.

These authors faced a lot of challenges during the arteries-veins classification and AV crossing detection points.

## 3. PROPOSED METHOD

The proposed algorithm involves 5 steps such as preprocessing, blood vessel segmentation, centerline extraction, crossover recognition and vessel thickness measurement and it is shown in **Fig -1.**

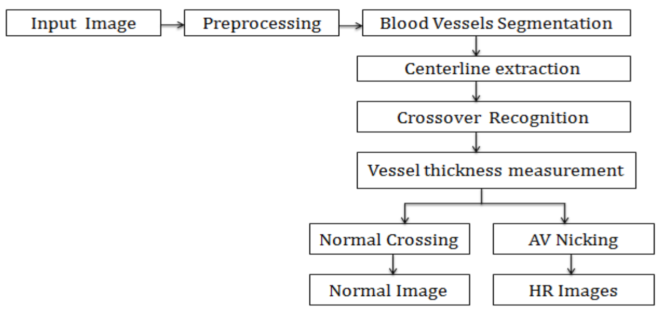


**Fig -1**: Block Diagram

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

### 2.1 Preprocessing

Normal retinal fundus images are preprocessed in order to obtain the contrast enhancement. Preprocessing involves the green channel extraction and histogram equalisation. First the green channel extracted from the input color retinal fundus images because it provides better contrast than red and blue channel [7]. After green channel extraction, histogram equalisation is performed for adjusting the image intensities to enhance the contrast [5]. **Fig -2** shows the fundus image of normal subjects and preprocessed image.

**Fig -2**: Normal fundus retinal image and preprocessed image

### 2.2 Blood Vessels Segmentation

Bottom Hat Transform (BHT) method has been used to segment the blood vessels from the preprocessed images. The concept of BHT method is the subtraction of original image with closing of the original image. Closing of the original image collects the information from the background of an image such as blood components [5].Then the segmented image binarized and it is shown in **Fig -3**.

**Fig -3**: Blood vessels segmented image

### 2.3 Centerline extraction

Skeletonization process has been used to extract the centerline from the blood vessels segmented images, because it removes pixels on the boundaries of objects without destroying its connectivity. Centerline extracted image is shown in **Fig -4**.

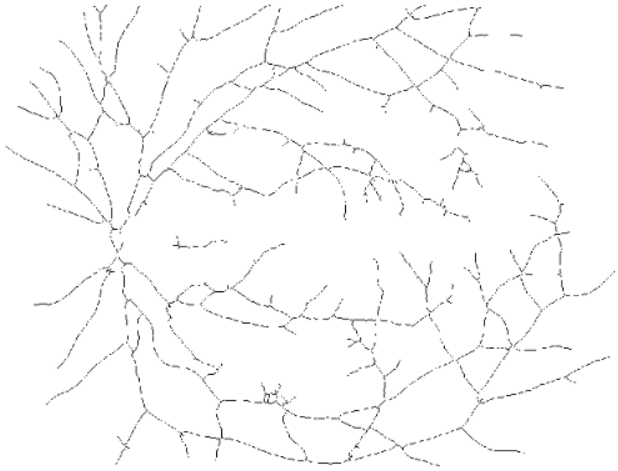

**Fig -4**: Centerline extracted image

### 2.4 Crossover recognition

Crossing number is used for detecting crossover points [4]. A 3*3 mask is created and it moves across all over the centerline areas and then computes the number of one value in each 3*3 window. If the center point is 1 and has only 1 value neighbor, then the center pixel is considered as termination point. If the center point is 1 and has only 3 value neighbor, then the center pixel is considered as bifurcation point. If the center point is 1 and has only 4 value neighbor, then the center pixel is considered as crossover point. Crossover recognized image is shown in **Fig -5.** In this figure, red color circle denotes the termination points and green color circle denotes the bifurcation and crossover points.

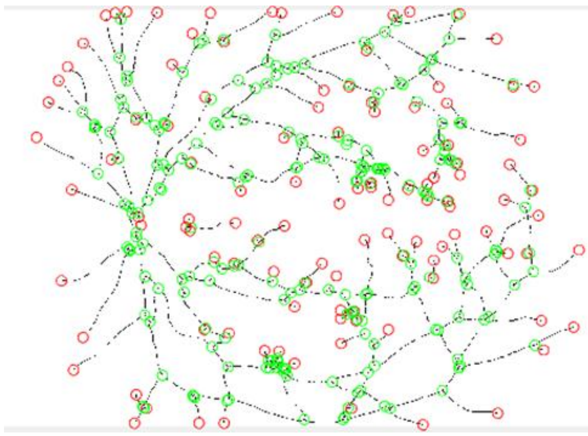

**Fig -5**: Crossover recognized image

### 2.5 Spurious removal

If the distance between one bifurcation point and one termination point is less than D (particular range) and then the crossover point is considered as false crossover and neglected [8]. D range is less than or equal to 26 and it is found by trial and error method. Spurious removed image is shown in **Fig -6.**

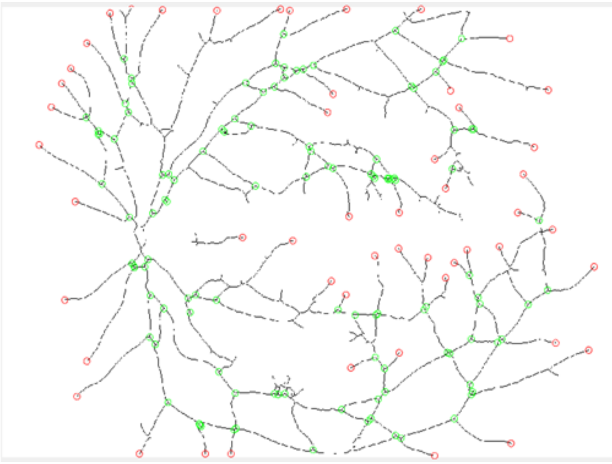

**Fig -6**: Spurious removed image

## 2.6 Arteries vein identification

Crossing Points (CP) in fundus images have 4 types: Bifurcation (Branch points), Veins-Veins (VV) crossings, Arteries-Arteries (AA) crossings, Veins-Arteries (VA) crossings and AV crossings.

Arteries vein identification is an important step to determine the AV crossings. In retinal fundus image, the arteries are lower intensities than veins. Veins appear brighter in red channel. So, red channel are extracted from the input fundus image. Then, BHT is applied to the red channel extracted image. After binarization, Veins are segmented and it is shown in **Fig -7**.


**Fig -7**: (a) Veins extracted image (b) Veins overlays on input image

Total number of CP detected by the crossing number method and it is given in **Table -1.** Detected points in zero intensity range are omitted from the total number of CP. Then, the normal AV crossings in Major Blood Vessels (MBV) are identified from the veins separation.

**Table -1:** CP in Normal image

| Image | Number Of CP Are Detected | No. Of CP Are Correctly Identified | Normal AV Crossings In MBV |
|---|---|---|---|
| 1 | 115 | 79 | 9 |

## 2.7 Vessel thickness measurement

Normal AV crossing coordinates are considered as center points in the segmented blood vessels and then the center points are moved from the centerline to the boundary region until the first zero intensity value detected in binarized image, for calculating the vessel thickness. There are 9 normal AV crossings in MBV and the vessels thickness is given in **Table-2.**

**Table-2:** Vessel Thickness of Normal AV crossings

| Normal AV CP | Coordinates of Normal AV CP | Vessel Thickness in pixels |
|---|---|---|
| 1 | 282,266 | 10 |
| 2 | 493,96 | 14 |
| 3 | 510,90 | 15 |
| 4 | 644,658 | 10 |
| 5 | 653,657 | 10 |
| 6 | 509,680 | 9 |
| 7 | 383,647 | 10 |
| 8 | 811,515 | 14 |
| 9 | 674,125 | 10 |
| **Average thickness of normal AV CP** | | 11 |

## 3. RESULTS AND DISCUSSION

The proposed algorithm is applied in HR images. First the input HR image preprocessed such as green channel extraction and histogram equalisation. Then, the blood vessels are extracted from the preprocessed images Centerline is extracted from the segmented blood vessel and spurious also removed and it is shown in **Fig -8.**

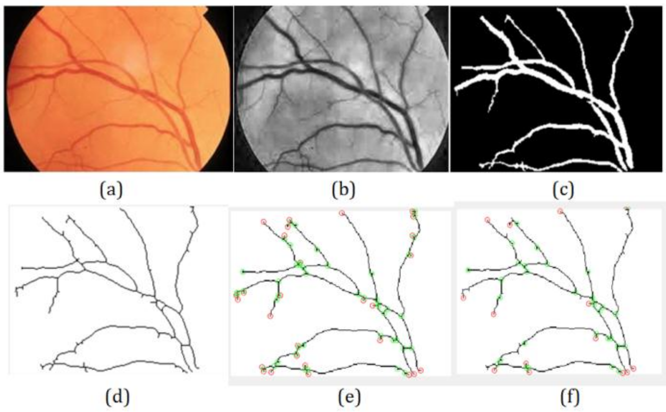


**Fig -8**: (a) HR image (b) Preprocessed image (c) Blood vessels segmented image (d) Centerline extracted image (e) Crossover recognized image (f) Spurious removed image

Total number of CP in HR images is detected by the crossing number method. Detected points in zero intensity range are omitted. AV nicking in major blood vessels are identified and the ranges are given in **Table -3**.

**Table -3:** CP in HR image

| Image | Number Of CP Are Detected | No. Of CP Are Correctly Identified | AV Nicking In MBV |
|---|---|---|---|
| 1 | 30 | 29 | 4 |

There are 4 AV nicking points in MBV. Vessel thickness of these points is calculated and the ranges are given in **Table-4**.

**Table-4:** Vessel Thickness of AV nicking

| AV nicking points | Coordinates of AV nicking points | Vessel Thickness in pixels |
|---|---|---|
| 1 | 80,63 | 17 |
| 2 | 88,66 | 17 |
| 3 | 154,97 | 16 |
| 4 | 178,108 | 15 |
| **Average thickness of AV nicking** | | 16 |

The proposed algorithm is applied in 20 images. It consists of 10 normal and 10 HR images. In normal crossing, the thickness of the vessels at the crossover area is lower than the AV nicking. The results shows average thickness of AV nicking is 16 and normal crossing is 11.

## 4. CONCLUSIONS

The overall objective of this project is to develop an algorithm for the detection of AV nicking in fundus images for screening hypertensive retinopathy. In this project, the input fundus images have preprocessed to obtain better contrast using green channel extraction and histogram technique.

Blood vessels have been extracted from the preprocessed images using BHT method. Next, the Centerline extracted from the segmented blood vessels. Crossover points have been detected in the centerline extracted image by using the crossing number method. The removal of spurious is done by using distance calculation between crossover and termination point. Based on the lowest intensity value, veins have separated. At last, vessel thickness measured in AV crossing points.

The average thickness of Normal AV crossing is 11 and AV nicking is 16. So, the thickness of the vessels in normal AV crossing at the crossover area is lower than the AV nicking. Normal AV crossings and AV nicking in retinal fundus images are detected by the vessel thickness.

## REFERENCES

[1] T. Y. Wong and P. Mitchell, “Hypertensive retinopathy,” New England Journal of Medicine, vol. 351, no. 22, pp. 2310–2317, 2004.

[2] T. Wong and P. Mitchell, “The eye in hypertension,” Lancet, vol. 369, no. 9559,pp. 425–435, 2007.

[3] Zhiyang Ma, Huiqi Li,Liang Xu, Li Zhang , Jieliang Kang, ”Automatic Detection of Arteriovenous Nicking in Retinal Images”,IEEE 11th Conference on Industrial Electronics and Applications ,pp.795-800,2013.

[4] Uyen T. V. Nguyen, Alauddin Bhuiyan, Laurence A.F. Park, Ryo Kawasaki, Tien Y Wong, Jie Jin Wang, Paul Mitchell and Kotagiri Ramamohanarao, An Automated Method for Retinal Arteriovenous Nicking Quantification From Color Fundus Images, IEEE Transactions on Biomedical Engineering, vol. 60, number.11, pp. 3194–3203, 2013.

[5] Gonzalez R. C, Woods R. E, and Eddins S. L., ‘Digital image processing using matlab, Pearson Education India’, 2009.

[6] U.T.V. Nguyen, A. Bhuiyan, L.A.F. Park, and K.Ramamohanarao, “An effective retinal blood vessel segmentation method using multi-scale line detection,” Pattern Recogn, vol. 46, pp. 703-715, 2013.

[7] Jyotiprava Dash,Nilamani Bhoi,”A thresholding based technique to extract blood vessels from fundus images”, Future Computing and Informatics Journal 2, pp. 103-19,2017.

[8] David Maltoni, Dario Maio, Anil K. Jain, Salil Prabhakar “Handbook of fingerprint recognition” Springer Verlag London Limited, pp-371-416, 2009.