RESEARCH FRONT

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A CRITICAL REVIEW OF VASCULAR CHANGES FOR DETECTION OF DIABETIC RETINOPATHY

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ABSTRACT

Diabetic Retinopathy (DR) is a diabetic eye disease, it cause when glucose level increases in body and blood vessels in retina changes. It may cause vision loss at any stage of Non-Proliferative Diabetic Retinopathy (NPDR). The vascular change is early stage of vision loss that occur in NPDR lead to cause retinal ischemia. Thickening of retinal veins causing less blood flow in DR are characteristic of vascular changes. Some papers which use for detection for vessel change, its shape, length, diameter are reviewed here. Various method such as wavelet based method, segmentation of blood vessels, improved iterative adaptive local threshold probing, 2D model have reported for the vessels detection.

Keywords- Diabetic Retinopathy (DR), Non-Proliferative Diabetic Retinopathy (NPDR), retinal ischemia.

INTRODUCTION

Vision for human being is needed to see the beauty of nature and also vision is required to make future of mankind better. One vision is given by eye while other is product of wisdom of human. The glucose in the body exist in the form of energy because of it body organs functions properly. Any changes in glucose level in the body have effect on cardiovascular, cerebrovascular and peripherals vascular. If the glucose level in the body increases disproportionately it leads diabetes and diabetes leads to vision loss. DR is considered to be the result of vascular changes in the retinal circulation. Diabetes affects slowly the circulatory system including the retina. As diabetes progresses, the vision of a patient may start to deteriorate and lead to diabetic retinopathy.

According to Medilexicon's medical dictionary:

Diabetic retinopathy means "Retinal changes occurring in diabetes mellitus, marked by microaneurysms, exudates, and hemorrhages, sometimes by vascularization." Diabetes, which can be characterized as a chronic increase of glucose in the blood, has become one of the most rapidly increasing health threats worldwide.

Diabetic retinopathy is mainly classified as.

1. Non proliferative diabetic retinopathy (NPDR): it is a leading cause of blindness. It develops as result of damage to the blood vessels in the retina, which may leak fluid or blood causing the retina to become swollen [13].
2. Proliferative diabetic retinopathy (PDR) is the advance stage of Non-Proliferative diabetic Retinopathy. in this situation the signals sent by the retina for nourishment trigger the growth of new blood vessel. These new blood vessels are abnormal and fragile. They grow along the retina and along the surface of the clear, vitreous gel that fills the inside of the eye. By

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themselves, these blood vessels do not cause symptoms or vision loss. However, they have thin, fragile walls. If they leak blood, severe vision loss and even blindness can result [14].

3. Clinically significant macular oedema (CSME): may exist by itself or along with NPDR and PDR.

II. Structure eye AND retina

Eye is one of the senses of human being which communicates the beauty of an object to the brain. Eye have three layers, first is called sclera, the outermost layer that provides protection. Middle layer is called uvea and third layer is retina.

Retina is a multi-layered sensory tissue that lines the back of the eye. It contains millions of photoreceptors (rods and cones) that capture light rays and convert them into electrical impulses. These impulses travel along the optic nerve to the brain where they are turned into images. It means that without retina human cannot see anything. Healthy retina is having very important in vision. Structure of human eye is shown in the figure1.

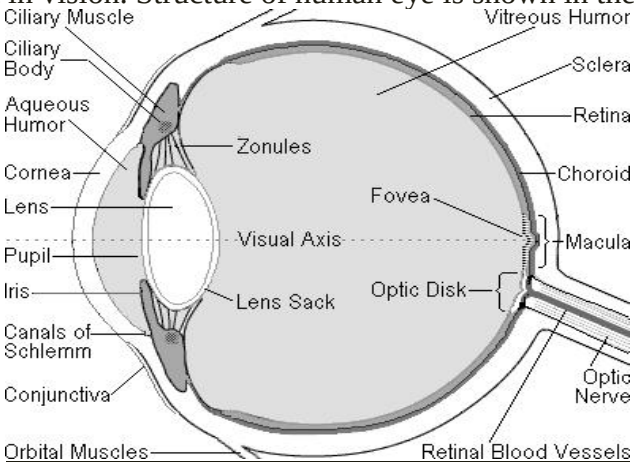

Figure 1 Structure of Human Eye[15]

iii. Retina

Near to the centre of the retina is an oval shape object called macula, responsible for central vision. The fovea is near the centre of the macula, where the cones are almost exclusively found.Rods cells have monochromatic vision and can see in black and white and in dark light. Cone cells have trichromatic vision. and can see in bright light. red, green and blue are are 3 different cone cells. There are an equal amount of coloured Cone cells in the eye. The retina is approximately 0.5mm thick & lines of the back of the eye[19].

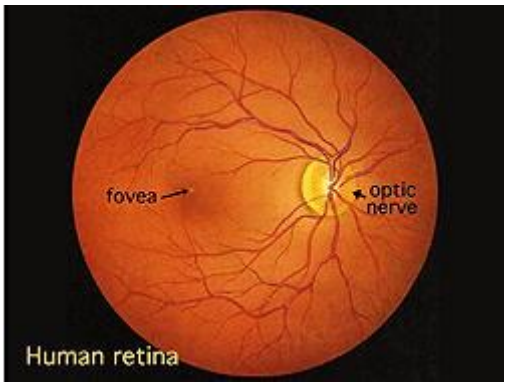

Figure 2 retina as seen through an ophthalmoscope [16]

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Following figure shows normal human eye with a schematic enlargement of the retina.

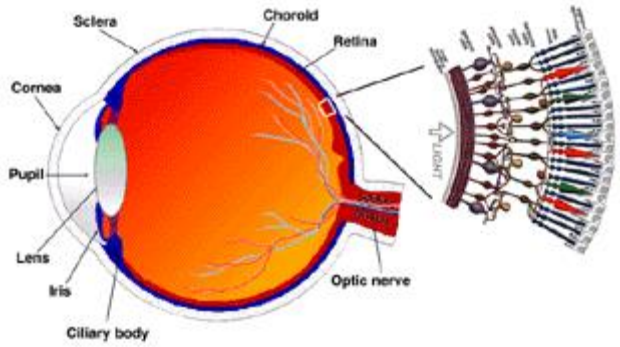

Figure 3 A schematic section through the human eye with a schematic enlargement of the retina [17]

A circular field of approximately 6 mm around the fovea is considered the central retina. The total retina is a circular disc of between 30 and 40 mm in diameter (Polyak, 1941; Van Buren, 1963; Kolb, 1991) The optic nerve contains the ganglion cell axons running to the brain and, additionally, incoming blood vessels that open into the retina to vascularize the retinal layers and neurons. A radial section of a portion of the retina reveals that the ganglion cells (the output neurons of the retina) lie innermost in the retina closest to the lens and front of the eye, and the photosensors (the rods and cones) lie outermost in the retina against the pigment epithelium and choroid. Light must, therefore, travel through the thickness of the retina before striking and activating the rods and cones (Fig. 3)[19].

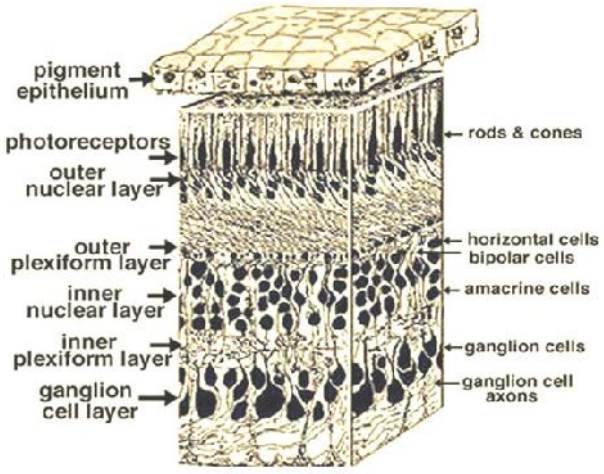

Fig. 4. 3-D block of a portion of human retina.

Figure 4 3-D block of a portion of human retina[18]

All vertebrate retinas are composed of three layers of nerve cell bodies and two layers of synapses. The outer nuclear layer contains cell bodies of the rods and cones, the inner nuclear layer contains cell bodies of the bipolar, horizontal and amacrine cells and the ganglion cell layer contains cell bodies of ganglion cells and displaced amacrine cells. Dividing these nerve cell layers are two neuropils where synaptic contacts occur (Fig. 4)[19].

Several techniques are invented to detect methods related to vessel detection. Some techniques are discussed here, by reviewing papers.

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Abbott L. Willard and Ira M. Herman detected complications of vascular and various mechanisms of diabetic retinopathy. They try to find out best treatment on VEGF. Due to violation of the pericyte-endothelial coupling, chronic hyperglycemia get active. Controlling these things, several medications are in clinical trials. Mural-cell-based therapeutics, pathogenic specific angiogenesis, anti VEGF therapies may offer solution for clinical problems [1].

Yongli Wang , Huihai Lu, Mantao Xu and Jewu Zhang detect retinal blood vessel using iterative threshold probing of a MFR. For segmentation of blood vessel, automated method is proposed. Preprocessing, Gaussian filter and iterative threshold probing are three methods used successfully to detect both large and small blood vessel [2].

Jose Cunha-Vaz, Rui Bernardes reviewed paper on NPDR in type 2 diabetes. They explained all the initial stages of NPDR with its composite data. For alteration purpose they used red dot counting on fundus image, fluoresce in leakage, retinal thickness measurement. They also used multi model for image morphology, blood flow, thickness, leakage, visual function which may be useful in different targeted treatments [3].

L.Pedersen, M.Grunkin, B.Ersboll, K.Madsen have studied changes in quantative measurement of retinal vessel diameter of ocular fundus image. Dijkstra's shortest path algorithm is used for measuring distance between two points. Also FWHM and Gregson methods are used. Here comparison between NAG and ophthalmologist is done. It shows the method performing well [4].

Peter Bankhead, C. Norman Scholfield, J.Graham Mcgeowan, Tim M. Curtis used retinal vessel morphology and measurements using wavelets and edge location refinement. It uses novel algorithm for detection and measurement purposes. Here segmentation achieves a true positive rate of 70.27 %, false positive rate of 2.83 % and accuracy score of 0.9371.The test images are most commonly used from DRIVE and STARE database [5].

Yi-Han Wen, A. Bainbridge Smith and A. B. Morris describe the techniques for assessing image qualities. A sample of 80 test images were selected from the CDHB retinal image database. Automatic detection of blood vessel used two techniques, 1) blood vessel detection 2) K-means cluster. Due to poor quality of image database, unsatisfactory result were shown so that both techniques get failed [6].

Sonal Honale, Vinay kapse describe review of various method for blood vessel segmentation . here top-hat-transform, laplacian filter, Gaussian cross section, adaptive thresholding, snake model, multi scale feature extraction method, recursive dual edge tracking and connectivity recovering technique, KNN method, SVM, bayesin classifier are described for segmentation of blood vessel. Preprocessing , feature extraction and classification methods are used here. DRIVE and STARE database used for different methods [7].

Mohammed. Imran Khan. Heena Shaikh, Anwar Mohammed. Mansuri and Pradhumn Soni explain survey of vessel segmentation method. For analysis of fundus they use DRIVE database. They divide vessel algorithm and technique into six main categories such as parallel multi scale feature extraction and region growing, hybrid filtering, ridge-based vessel segmentation and method based on artificial intelligent. Further these categories are divided into sub categories. All the techniques are satisfactorily performing well [8].

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Albert C.S. Chung describes image segmentation method for detecting blood vessel in angiography. He explains features for detecting blood vessel, frameworks for delineating the vasculatures. Using image segmentation method, research direction is defined [9].
K.A.Vermeer, F.M.Vos, H.G.Lemij, A.M.Vossepoel explain model based method for retinal blood vessel detection. Novel model is based on laplace , thresholding segmentation, classification method. It gives 92% sensitivity, 91% specificity. This method detects split vessel and properties of it.[10].

Mohammed Al-Rawi, Munib-Qutaishat, Mohammed Arrar describe match filter for detection of retinal blood vessel. Database used for the fundus image is DRIVE. Matched filter is one of the templates matching algorithm. For processing, various method are used like thresholding, Gaussian match filter. By using various parameters (ROC,MAA,FOV) filter test gets improved. It compares the image in red band, blue band and green band. It concludes that green band is commonly used for practice [11].

Uyen T.V.Nguyen, Alauddin Bhuiyan, Laurence A.F.Park, Kotagiri Ramamohanarao describe segmentation of blood vessel using multi scale line detection.for the performance of image DRIVE, STARE and REVIEW database is used. By using experiment on blood vessel it shows proposed method is good. Since,

- It gives high segmentation specially at regions around the vessel.
- It is an unsupervised method.
- It is efficient with fast segmentation time.
- It can be easily extended to perform on high resolution retinal images.

For segmentation of retinal blood vessel here various methods are used such as basic line detector, multi scale line detector, generalized line detector. The proposed method is helpful when manual segmentation is not available [12].

CONCLUSION

Different techniques are used in the above discussed papers for detections of vascular changes in Diabetic retinopathy . The research paper with title “An effective retinal blood vessel segmentation method using multi-scale line detection” carried out by Uyen T.V.Nguyen, Alauddin Bhuiyan, Laurence A.F.Park, Kotagiri Ramamohanarao, have detected vessel using multi scale line detection. They have got the best result. for the performance of image DRIVE, STARE and REVIEW database is used .

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