A SURVEY ON AUTOMATIC DETECTION OF DIABETIC RETINOPATHY

Mohammed Shafeeq Ahmed
Research and Development Centre, Bharathiar University, Coimbatore – 641 046;
Department of Computer Science, Gulbarga University, Kalaburagi, Karnataka, India

Dr. B. Indira
Research and Development Centre, Bharathiar University, Coimbatore – 641 046;
Kasturba Gandhi Degree & P. G. College for Women, Secunderabad, A.P, India

ABSTRACT

Diabetic Retinopathy (DR) is a vascular disease of the retina which affects patients with diabetes mellitus. DR is a prevalent symptom of diabetes which is the leading causes of vision loss and it is the primary cause of visual impairment in the world. There are no of techniques and algorithms that avails to diagnose DR in retinal fundus images. This paper reviews, relegates and compares the algorithms and techniques anteriorly proposed in order to develop better and more efficacious techniques and algorithms for detection of DR.

Key words: Diabetic Retinopathy, Retina, Segmentation, Classifier, Microaneurysms, Haemorrhages, Exudates, Fundus Image, Digital Image Processing.

Cite this Article: Mohammed Shafeeq Ahmed and Dr. B. Indira. A Survey on Automatic Detection of Diabetic Retinopathy. International Journal of Computer Engineering and Technology, 6(11), 2015, pp. 36-45.
http://www.iaeme.com/IJCET/issues.asp?JType=IJCET&VType=6&IType=11

1. INTRODUCTION

DR is an ocular perceiver disease that is associated with long term diabetes and the persons who are having diabetes more than five years. It is a main cause of visual impairment. Increment in blood sugar levels associated with diabetes is major cause of DR, a progressive degenerative disease of the retina that has an asymptomatic stage that can commence long afore the onset of apperceived diabetes. It can additionally affect sundry components of the body. When the diminutive blood vessels have an astronomically immense level of glucose eventually optical incapacitation.
A Survey on Automatic Detection of Diabetic Retinopathy

Recent statistics from Vision 2020: The Right to Visual perception reported that DR is responsible for 4.8% of the 37 million cases of visual impairment due to ocular perceiver diseases throughout the world. Moreover, world health organization (WHO) anticipated that the total number of diabetic patients will at least reach to 366 million by 2030 [1]. According to some estimation, more than 75% of patients with diabetes within 15 to 20 years of diagnosis diabetes are threatened by DR [2]. Generally, the probability of optical incapacitation in a person with diabetes is 25% more than a mundane one, but early detection of DR and timely treatment, visual loss and optically incapacitating can be obviated [3].

Retinal fundus image consists of a network of blood vessels and an optic disc. The initial stage of DR is Nonproliferative (aforetime termed “background”) Diabetic Retinopathy (NPDR) which can be relegated to mild. In this stage, the blood vessels in the retinal become thin and leak fluids, leading to microaneurysm and hemorrhage in case of blood leakage, and exudates in case of fat or protein leakage. Microaneurysm and hemorrhage are red in color while exudates are yellow. Moreover, blood vessels can swell and become fluffy white patches called cotton wool spots. The later stage of DR is Proliferative Diabetic Retinopathy (PDR) which can be relegated to advance. In this stage, due to circulation quandary, the blood vessels in the retina receive inadequate oxygen causing the blood vessels to grow in order to maintain adequate oxygen level. These incipiently grown vessels are impuissant and prone to leakage which decreases the vision. Ophthalmologists diagnose DR by either mere ocular perceiver observation or utilizing computerized systems with intricate detection algorithms.

Fig 1: Nonproliferative Diabetic Retinopathy

Fig 2: Proliferative Diabetic Retinopathy

There are varieties of approaches for automatic detection of Microaneurysms (MAs), Haemorrhaeages (HAs), and Exudates in fluorescein angiography fundus images.
1.1. Eye Structure
Eye is an organ associated with vision. It is housed in socket of bone called orbit and is bulwarked from the external air by the ocular lids [4]. The cross section of the human ocular perceiver is as shown in Fig-3 while that of retina is as shown in Fig-4 below.

Light enters the ocular perceiver through the pupil and is fixated on the retina. The lens avails in focusing images from different distance. The amount of light entering the ocular perceiver is controlled by the iris, by closing when light is effulgent and opens when light is dim. To the outside of the ocular perceiver is a transparent white sheet called conjunctiva. Ciliary muscles in ciliary body control the focusing of lens automatically. Choroids form the vascular layer of the ocular perceiver supplying alimentation to the ocular perceiver structures. Image composed on the retina is transmitted to brain by optic nerve. Optic disk is more effulgent than any component of the retina image and is customarily circular is shape. It is additionally the ingress and subsist point for nerves entering and leaving the retina to and from the brain. Proximate to the centre of the retina is an oval shape object called macula. The fovea is near the centre of the macula and it contains packed cone cells. Due to high amount of light sensitive cells, the fovea is responsible for the most precise vision [4] [5].

The retina is a multi-layered sensory tissue that lines the back of the ocular perceiver. It contains millions of photoreceptors that capture light rays and convert them into electrical sudden (unplanned) desires. These sudden (unplanned) desires walk along the optic nerve to the brain where they are turned into images. There are two types of photoreceptors in the retina: rods and cones. The retina contains about 6 million cones. The cones are contained in the important part of the eye, the part of the retina responsible for central vision. They are most densely packed within the fovea, the very centre part of the macula. Cones function best in effulgent light and sanction us to appreciate colour [6].

1.2. Abnormalities
Associated with ocular perceiver. It can be divided into two main classes, the first being disease of the ocular perceiver, such as cataract, conjunctivitis, blepharitis and glaucoma. The second group is separated and labeled as life style cognate disease such as high blood pressure, arteriosclerosis and diabetes [7].

When the retina has been affected as a result of diabetes, this type of disease is called Diabetic Retinopathy (DR), if not congruously treated it might eventually lead to loss of vision. Ophthalmologists have come to agree that early detection and
treatment is the best treatment for this disease [8]. DR event have been generally categorise into three main form viz, BDR, PDR, SDR. These Three classes can occur in any of the form described below as cognate to this research work.

1.3. Microaneurysms
These are the first clinical abnormality to be described in the ocular perceiver. They may appear in isolation or in clusters as minuscule, dark red spots or looking homogeneous to diminutive haemorrhages within the light sensitive retina. Their size ranges from 10-100 microns i.e. less than 1/12th the diameter of an average optics disc and are circular in shape [9], at this stage, the disease is not ocular perceiver threatening.

1.4. Haemorrhages
Happens in the deeper layers of the retina and are often called ‘blot’ haemorrhages because of their round shape.

1.5. Hard exudates
These are one of the main characteristics of diabetic retinopathy and can vary in size from minuscule specks to astronomically immense patches with clear edges. As well as blood, fluid that is affluent in fat and protein is contained in the ocular perceiver and this is what leaks out to compose the exudates. These can impair vision by averting light from reaching the retina

1.6. Soft exudates
These are often called ‘cotton wool spots’ and are more often optically detected in advanced retinopathy.

1.7. Neovascularisation
This can be describe as weird and unexpected magnification of blood vessels in areas of the ocular perceiver including the retina and is related to vision loss. This happens in copy to ischemia, or diminished blood flow to ocular tissues. If these abnormal blood vessels grow around the pupil, glaucoma can result from the incrementing pressure within the ocular perceiver. These incipient blood vessels have more impotent walls and may break and bleed, or cause scar tissue to grow that can pull the retina away from the back of the ocular perceiver. When the retina is pulled away it is called a retinal separation and if left untreated, a retinal separation can cause strict vision loss, including visual impairment. Leaking blood can cloud the vitreous (the clear, jelly-like substance that fills the ocular perceiver) and block the light passing through the pupil to the retina, causing blurred and distorted images. In more advanced proliferate retinopathy; diabetic fibrous or scar tissue can compose on the retina [10].

2. REVIEW OF METHODS
Meysam Tavakoli et al [11] presents a novel and distinctive arrangement of PC guidelines for programmed recognition of MAs in fluorescein angiography (FA) fundus pictures, predicated on Radon change (RT) and multi-covering windows. This technique is used in recognition of retinal area imprints and injuries to analyze the DR. Top cap change and averaging channel are connected to extract the foundation for pre-handling. After pre-preparing, the entire picture is isolated into sub pictures.
Optic nerve head (ONH) and vessel tree are then recognized and cover by applying RT in every sub-picture. In the wake of distinguishing and concealing retinal vessels and ONH, MAs are recognized and numbered by utilizing RT and thresholding. The proposed system is assessed on three distinctive retinal pictures databases, the Mashhad Database with 120 FA fundus pictures, Second Neighborhood Database from Tehran with 50 FA retinal pictures and separated of Retinopathy Online Test (ROC) database with 22 pictures. Results accomplished an affectability and level of point of interest of 94% and 75% for Mashhad database and 100% and 70% for the Second nearby Database separately.

Marwan D. Saleh, C. Eswaran [12] gives a mechanized choice emotionally supportive network for non-proliferative diabetic retinopathy sickness predicated on MAs and HAs recognition. The proposed framework removes some closer view items, for example, optic circle, fovea, and veins for exact division of dim spot injuries in the fundus pictures. Dull item division methodology is used to find bizarre areas, for example, MAs and HAs. Predicated on the number and area of MAs and HAs, the framework assesses the thoroughness level of DR. A database of 98 shading pictures is used to assess the execution of the created framework. Trial results demonstrate that the proposed framework accomplishes 84.31% and 87.53% qualities as far as affectability for the identification of MAs and HAs individually. As far as specificity, the framework accomplishes 93.63% and 95.08% qualities for the location of MAs and HAs individually.

Istvan Lazar and Andras Hajdu [13] proposed a strategy for retinal MAs Detection through Local Rotating CrossSection Profile Analysis. This methodology apperceives MA identification through the examination of directional cross-area profiles fixated on the nearby greatest pixels of the pre-prepared picture. Top recognition is connected on every profile, and an arrangement of properties in regards to the size, tallness, and state of the top are ascertained in this way. Quality qualities are used as the cross’ introduction area changes. These qualities constitute the list of capabilities that is used in a guileless Bayes assignment to take out duplicitous hopefuls. The last score of the remaining applicants can be thresholded further for a twofold yield. The proposed system has been tried with the Retinopathy Online Challenge and ended up being aggressive with the subsisting methodologies. The proposed strategy has accomplished higher affectability at low wrong positive rates, i.e., at 1/8 and 1/4 Mendacious Positives/picture.

Balint Antal et Al [14] proposed a procedure called a two-stage choice bolster structure for the programmed screening of computerized fundus pictures. Pre-screening is the initial phase in which pictures are consigned as astringently unhealthy (exceedingly atypical) or to be sent for further handling. The second stride of the proposed system distinguishes districts of enthusiasm with conceivable sores on the pictures that aforesaid passed the pre-screening step. These areas will suit as info to the solid sore finders for definite examination. The computational execution of a screening framework is increased because of pre-screening procedure. Test results demonstrate that there is a decrementation in the computational encumbrance of the programmed screening framework.

Balint Antal et Al [15] build up a methodology called an Ensemble-Predicated System for Microaneuryrm Detection and Diabetic Retinopathy Grading. This methodology has demonstrated its high productivity in an open online test with its first position. Our novel structure depends on an arrangement of <pre-preparing strategy, applicant extractor> sets. A pursuit calculation is used to winnow an ideal
combination. Since the proposed methodology is particular, further improvements should be possible by coordinating all the more preprocessing techniques and hopeful extractors. The DR/non-DR evaluating execution of this finder in the 1200 pictures of the Messidor database have accomplished a 0.90 ± 0.01 AUC esteem, which is focused with other subsisting routines.

Anderson Rocha et al [16] introduced an unremarkable methodology for distinguishing both red and lustrous injuries in DR pictures without requiring cement pre- or post-preparing. The proposed methodology requires pinpointing the area of every injury to endorse the pro to assess the picture for determination. It builds a visual word lexicon speaking to purposes of interest (PoIs) situated inside of districts stamped by pros. Fundus pictures are consigned as everyday or DR related pathology predicated on the vicinity or nonappearance of these PoIs. Territory under the bend (AUC) of 95.3% and 93.3% is accomplished for white and red sore discovery using fivefold cross approval. The visual word reference is hearty for DR screening of cosmically gigantic, different groups with fluctuating cameras and settings and levels of aptitude for picture catch.

Solid location of retinal hemorrhages is fundamental in the advancement of computerized screening frameworks. Li Tang et al [17] proposed a novel splat highlight assignment technique with application to retinal drain recognition in fundus pictures. Retinal shading pictures are divided into non-covering fragments covering the whole picture. Every splat contains pixels with homogeneous shading and spatial area. Elements are removed from every splat in respect to its circumventions, utilizing replications from a mixed bag of channel bank, collaborations with neighboring splats, and shape and surface data. An ideal subset of splat components is winnowed by a channel methodology took after by a wrapper approach. Given splats with their related component vectors and reference standard marks, a classifier can then be prepared to identify target objects. A classifier is assessed on the openly accessible Messidor dataset. A zone under the collector working trademark bend of 0.96 is accomplished at the splat level and 0.87 at the picture level.

Haniza Yazid, Hamzah Arof, Hazlita Mohd Isa [18] presents an early way to deal with identify exudates and optic plate from shading fundus pictures predicated on opposite surface thresholding. The proposed methodology includes numerous strategies, for example, fluffy c-means bunching, edge identification, otsu thresholding and backwards surface thresholding. It doesn't rely on upon physically winnowed parameters. The proposed system has accomplished 98.2% in affectability and 97.4% in specificity for DIARETDB1 database and 90.4% in affectability and 99.2% in specificity for the National University Hospital of Malaysia (NUHM), separately. This strategy beats systems predicated on watershed division and morphological recreation.

Akara Sopharak et al [19] have propose a programmed technique to recognize exudates from low-differentiate computerized pictures of retinopathy patients with non-widened students utilizing a fluffy c-means (FCM) bunching procedure. Preprocessing of difference upgrade was connected keeping in mind the end goal to improve the info's nature picture before four elements, in particular, power, standard deviation on force, tint, and number of edge pixels, were chosen to supply to the FCM strategy. The quantity of required bunches was ideally chosen from a quantitative investigation where it was differed from two to eight groups. The number of group enhancement depended on affectability and specificity which is computed by correlation of the distinguished results from master ophthalmologists. The positive
prescient quality and positive probability proportion were additionally used to assess the general execution of this strategy. From the consequence of the subtracted bunch with the quantity of groups equalling 2, it was found that the proposed strategy identified exudates with 92.18% affectability and 91.52% affectability.

Muhammad Salman Haleem et al [20] have propose a novel way to deal with naturally concentrate out genuine retinal zone from a SLO picture in light of picture preparing what's more, machine realizing methodologies. Checking Laser Ophthalmoscopes (SLOs) can be utilized for ahead of schedule identification of retinal ailments. With the appearance of most recent screening innovation, the upside of utilizing SLO is its wide Field of View (FOV), which can picture an expansive piece of the retina for better determination of the retinal sicknesses. On the other hand, amid the imaging procedure, ancient rarities, for example, eyelashes furthermore, eyelids are additionally imaged alongside the retinal range. This brings a major test on the most proficient method to prohibit these curios. To decrease the many-sided quality of picture handling assignments and give a helpful primitive picture design, we have gathered pixels into distinctive locales in light of the local size and conservativeness, called superpixels. The structure then computes picture based elements reflecting textural and basic data and arranges between retinal region and relics. The exploratory assessment results have indicated great execution with a general precision of 92%.

Keith A. Goatman et al [21] have presented the determination of suitable picture highlights for the automatic location of new vessels on the optic plate. The components are picked in light of their separation capacity (tried utilizing the non-parametric Wilcoxon rank total and Ansari-Bradley scattering tests) and nonappearance of connection with different elements (tried utilizing the Kendall Tau coefficient). Order was performed utilizing a bolster vector machine. The framework was prepared and tried by cross-acceptance utilizing 38 pictures with new vessels and 71 typical pictures without new vessels. Fourteen elements were chosen, giving a region under the collector administrator trademark bend of 0.911 for distinguishing pictures with new vessels on the plate, the framework will characterize the unusual picture as the more strange 91.1% of the time. The technique could have a valuable part as a major aspect of a mechanized retinopathy investigation framework.

Akara Sopharak et al. [22] have presented a novel method for detection of exudates from non-dilated retinal images using mathematical morphology methods. Examines and proposes an arrangement of ideally balanced morphological administrators to be utilized for exudate recognition on diabetic retinopathy patients' non-expanded student and low-difference pictures. These naturally identified exudates are approved by contrasting and master ophthalmologists' hand-drawn ground-truths. The outcomes are fruitful and the affectability and specificity for our exudate location is 80% and 99.5%, separately.

Cemal Kose et al [23] built up a methodology called converse division system to recognize DR. Direct division strategies gives poor results in a cases' percentage. The proposed framework abuses the homogeneity of salubrious zones as opposed to managing fluctuating structure of insalubrious territories for portioning bright sores (hard exudates and cotton fleece spots). This framework first causes the reference or lengthened foundation picture from a retinal picture. Salubrious parts of the retinal picture aside from vessel and OD zones are used in the estimation of this reference picture. Next the retinal picture is separated into two segments as low and high force territories predicates on the foundation's intensities picture. Foundation picture is used
as the dynamic edge esteem for dividing high power and low force degenerations in the picture. Both degenerations are fragmented discretely by using the converse division system and element thresholding. The framework's execution is more than 95% in identification of the optic circle (OD), and 90% in division of the DR. Hence, the strategy gives high division and evaluation accuracy. Now and again, the picture lighting relics may influence division execution adversely, which could also be considered as an issue.

C.JayaKumari, and R.Maruthi [24] have introduced relevant grouping calculation to identify the vicinity of hard exudates in the fundus images. After the pre-processing stage, the proposed calculation has been connected to portion the exudates. Elements removed from the sectioned areas are similar to the standard deviation, mean, force, edge energy and smallness. These separated elements are given as inputs to Echo State Neural Network (ESNN) to segregate between the unremarkable and obsessive image. A dataset comprises of an aggregate of 50 pictures have been utilized to discover the exudates. Out of 50, 35 pictures comprising of both commonplace and unusual are habituated to prepare the ESSN and the remaining 15 pictures are accustomed to test the neural system. The execution of the proposed calculation has 93% affectability and 100% specificity regarding exudates predicated assignment.

3. CONCLUSION
Yet the fundamental indicate of this study was early location of DR. Early assignments of DR can be analyzed by the vicinity of microaneurysms and hemorrhages in fundus pictures. The goal for adequate identification calculations is ineluctably fated. There are a few location calculations that have as of now been created and proposed which perform acceptably. A computerized DR location framework is exceptionally central need because of the growing up number of diabetic patients around the globe. This paper can go about as an asset for the future scientists captivated with mechanized recognition of abnormal denotements of DR and benefit them to get a diagram of this field to grow more proficient calculations to show signs of improvement results.

REFERENCES


[20] Muhammad Salman Haleem, Liangxiu Han, Jano van Hemert, Baihua Li and Alan Fleming (2014), Retinal Area Detector from Scanning Laser
A Survey on Automatic Detection of Diabetic Retinopathy

Ophthalmoscope (SLO) Images for Diagnosing Retinal Diseases, DOI 10.1109/JBHI.2014.2352271, IEEE Journal of Biomedical and Health Informatics.


