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Complications of Sight Threatening Diabetic Retinopathy: A Review

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ABSTRACT

A disease mainly known as diabetes is causing several side effects on the human body. The most affected part of the human body is the human eye retina. This disease of the retina that can result in loss of vision. This phenomenon is known as Diabetic Retinopathy (DR.)Basically Daibetis reduces the capability of the human body to store and regulate the blood sugar , as a result of this, the retina of human eye gets effected. In the early stages DR is showing the typical result of damaging the human eye retina and further it leads to the Sight-threatening diabetic retinopathy (SDTR) i.e. complete loss of vision.Computer assisted diagnosis is one of the tool which helps to diagnose the diabetic patient by using the results of medical investigations. i.e assisting images, reports, etc. for initializing the treatment. In the screening of diabetes sight–threatening DR plays a vital role. These are some major techniques available till date for machine-driven analysis of STDR, to detect hemorrhages and microaneurysms. With limitations for analysis of STDR, the survey mainly focuses on both the qualitative as well as a quantitative comparison of the existing study.While considering the future work , it is a try to encapsulate the convenient algorithms for easy understanding and informative to the experimenters working in this field so that to understand the previous algorithms in a better way and try to develop the most effective one .

Key words : Deep Learning, Diabetic Retinopathy(DR), HEM, Machine learning, Microaneurysm, STDR.

1. INTRODUCTION

Diabetes is nothing but a kind of degenerate and organ disease and the cause behind diabetes is that the pancreas is not secreting enough insulin. In other words, when the body is unable to process the sugar in a proper manner [21,22]. Diabetes is a disease mainly caused due to heavy work load and/or irregular routines, improper diet habits and excessive intake of food containing high quantities of sugar [14]. It reduces the ability of the human body of storing and regulating sugar contents as per the needed percentage. It's difficult to overcome the disease like Diabetes which affects the human body functioning causes the damage to several human body parts [12,39]. Over the period of time, it is found that the circulatory system of the human body is get affected due to Diabetes the major part get affected is the retina.one of the severe complication of diabetes is Diabetic Retinopathy.Some of the symptoms are identified of Diabetic retinopathy like cotton wool spots in the retina,facing problem with vision which is called blurred vision,having a tiny dark spot at the center position of the retina and difficulty in seeing at night. As mentioned, in [23], Diabetic retinopathy (DR) is a phenomenon where the fluid leak from blood vessels present in the human eye retina, the retina gets damaged. We can say that a prominent cause of blindness is diabetic retinopathy, which is mostly detected diabetic eye diseases[24]. Because of diabetes Nearly 515 million diabetic patients around the world are at risk of having blindness[25]. Which can be said as diabetic retinopathy disease. Diabetic retinopathy is associated with the diabetes which causes vision loss. It occurs when diabetes or excessive sugar in the body damages the lilliputian blood vessels present inside the human eye retina [26]. Micro-aneurysms, hemorrhages, hard exudates, cotton wool spots or venous loops these are the main damages caused due to the tiny blood vessel which spreads the blood and fluid in the retina[27, 28]. Currently, detecting the disease named DR is a manual process which is the most time-consuming and lengthy process. Examination and evaluation of digital color fundus photographs of the retina a trained ophthalmologist or clinician is necessary to be appointed [29, 38]. Because of this, the delayed treatment and mis-communication may happen, as the time taken by the ophthalmologists to submit their reviews, based on their experience can be a single day or may be more than that.Due to which the results get delayed this may cause the loss of follow ups[30]. In screening for early detection of DR, analyzes the images of the human eye retina through automation is included to prove its importance. [13]. For the early detection of diabetic retinopathy and sight-threatening diabetic retinopathy ,all the patients who are suffering from diabetes, irrespective of its type, needs the regular and repetitive annual retinal screening[1, 2]. Fundus examination or retinal color photography is conventially done through Screening[31]. For this purpose the conventional mydriatic or

non-mydriatic fundus cameras were used for retinopathy by ophthalmologists[32]. The powerful way of screening the retinopathy worldwide is Computer aided retinal imaging [3,4]. The ophthalmologists examined various types of fundus camera images for identification of DR[33, 34].

There is a rapid increase in the number of diabetic patients in India and due to the lack of trained retinal consultants and classifiers of retinal images, but by screening of DR, the burden of the health systems is reduced using an automated approach involving a machine driven approach to examine of the images specified previously [35, 36]. Hence, we would like to take the opportunity to use machine learning for the recognition of specific patterns to predict the presence and respective stage of DR. Detection and classification of DR would be done by using various grades of DR in which thousands of retinal images are fed to the system for learning. This system allows the machine interpreting lots of retinal images through various grades of DR. The aim of the proposed research is to propose an automated machine learning diabetic retinopathy detection system which can accurately detect the diabetic retinopathy (DR) and sight-threatening diabetic retinopathy (STDR) along with its respective stages such as initial, mild, severe, NPDR and PDR patient.

Figure 1. Mild, non-proliferative diabetic retinopathy (NDPR)[45]

In mild NPDR,which has been mainly affecting tiny area of the retina's tiny blood vessels, swelling to that specific area which is called microaneurysms, occur at this initial stage of the disease. These microaneurysms may dropdown fluid into the retina

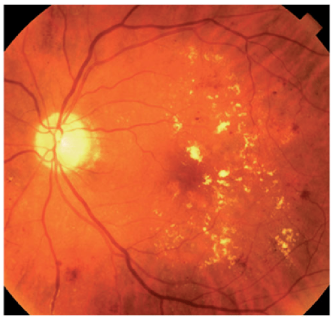

Figure 2. Moderate non-proliferative diabetic retinopathy with retinal hemorrhages, exudates, and DME[45]

If the mild stage of NPDR not treated seriously, then the disease progresses towards moderate NPDR. The tiny blood vessels of the retina may swell which can make an impact on human vision.blood vessel may lose their ability to transfer blood.these conditions may lead to reduced ability of the retina and may lead to DME.

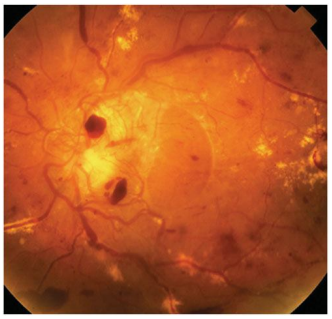

Figure 3. Severe NPDR with, hemorrhages, exudates and retinal detachment[45]

Next stage Severe NPDR(Figure 3) is the most critical stage ample number of blood vessels has been blocked,dispossess blood supply to the area of the retina.The classification of Diabetic Retinopathy is mainly happening in two parts named:-1 .Nonproliferative diabetic retinopathy and 2. Proliferative retinopathy. Most of the diabetic patients after 20 years of diabetes, shows some symptoms of nonproliferative diabetic retinopathy, which is usually not alarming unless until muscular-edema is existing. A greater risk of hemorrhage into the vitreous humor is found in Proliferative diabetic retinop -athy, which is a more serious stage of, in which the clear gel fills the center of the eye, due to which the detachment of the retina can be found which leads to tyrannical vision loss. Nonproliferative or proliferative diabetic retinopathy causes diabetic macular edema. The levels of nonproliferative diabetic retinopathy can only be identified by an eye specialist with the help of your consultation. The blood vessels in the retina are getting damaged in nonproliferative diabetic retinopathy, due to the overblown blood glucose. The leaking of blood or fluid is occurring through these blood vessels . Blurred vision which is called as macular edema mainly occurs when the fluid get collected in the central part of the retina. When central vision is threatened , Macular edema mostly treated with the help of laser surgery.

Proliferative retinopathy is a more dangerous stage of diabetic eye disease than that of nonproliferative diabetic retinopathy. In this stage, the surface of the retina gets surrounded by the abnormal blood vessels which shows swelling or inflammation due to their growth . These delicate blood vessels may breach and causes bleeding in the vitreous humor. Vitreous hemorrhages show the symptoms like vision loss, the passage of light towards the eye retina is blocked or even can lead to blindness. In addition to this , the blood vessels cause scar tissue to get pulled on retina of eye and

causes the retina detachment from the backside of the human eye[40]

The Key Points of this paper are:-

1] The elaborated ongoing study of literature on Diabetic retinopathy using automated screening, by making use of the technique called image processing.

2) To analyze quantitative comparison, qualitative identification in the current ongoing methods, techniques and from over that finding an existing gap.

3) To identify fruitful research domains so that to overcome the gaps in the screening of DR and development is to be done according to the needs

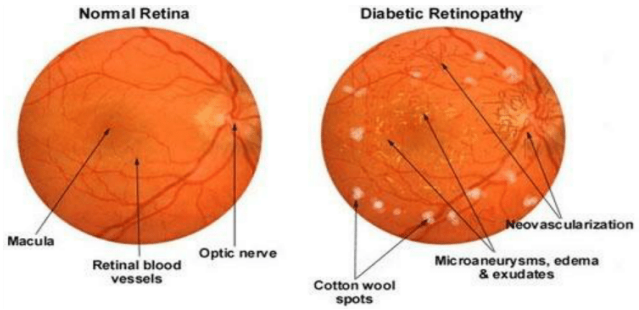

Figure 4. Normal retina Vs Diabetic Retina

2. RELATED WORK

In the section of related work, we are going to present the existing work in the area of identification of diabetic retinopathy using methods such as machine learning. We have covered most of the sate-of-the-art techniques till this year to cover recent developments and research in the area of our proposed research work.

Carson Lam et. al [4], have been used of convolutional neural networks on color fundus images for the identification of diabetic retinopathy staging. For evaluation of the work, they have made use of sensitivity matrix and achieved a validation sensitivity of 95% which is better than the existing techniques.

Pilar Pérez Conde et al [5], the experimental results are presented for an automated method used in diabetic retinopathy for image-based recognition. The proposed work is classified into three parts: image pre-processing, excerption of feature from the images and classifying the various stages. To augment the features of images, initially two image processing techniques have been used. Further, the second stage finds important parameter using the statistical method and shows the proportion of images. At the last stage, the image classification is done by using the existing machine learning algorithms in which the available featured-set is used. In their experimental study, they have performed binary classification: non-proliferative and proliferative. The results show the best result was obtained using k-nearest neighbors having an accuracy of 68.7% which uses f-measure as metric.

Swati Gupta and AM Karandikar [6], focuses on identification of retinal microaneurysms and addressed for identification of DR using classifiers. The identification of bright lesions and retina lesions in digital fundus images is being used while developing an automated DR screening system. After pre-processing of the images, morphological operations are executed to find the features and afterward extraction of features is done using GLCM and Splat. The classification is performed on the existing feature-set. The results have been achieved as the specificity of 87% and a sensitivity of 100% respectively with an accuracy of 86%.

T. Chandra Kumar and R. Kathirvel [7], have proposed deep-learning approach for classification of DR through spatial analysis. The DCNN has been presented as an enhanced way to classify the fundus image using some of the pre-processing techniques. The proposed DCCN architecture has been expanded with the dropout layer techniques with the help of which around 94-96 percent accuracy is achieved.

Sheikh Muhammad Saiful Islam et al [8], a novel deep convolutional neural network (DCCN) has been developed by the authors, which achieved the initial -level sensing. In which all microaneurysms (MAs) are identified, these are detected as the first signs of DR, in this label are correctly assigned to retinal fundus images to which the grades are assigned according to five different categories. The authors used kaggle diabetics retinopathy dataset for testing purpose.In the early-stage detection, the gained results are specificity of 94% and a sensitivity of 98%.

Suvajit Dutta et al [9], fundus images containing diabetic retinopathy (DR) have been taken into consideration. An automated knowledge based model has been considered for identifying the key antecedents of diabetic retinopathy. Authors have been trained with three types of machine learning methods: back propagation NN, Convolutional Neural Network (CNN) and Deep Neural Network (DNN). The Deep Learning models are capable enough for quantifying the features such as, fluid drip, exudate, blood vessels, hemorrhages and micro aneurysms into different classes. To identify the target class, thresholds weighted Fuzzy C-means algorithm has been used. The model acclaims to identify the proper class of severity of diabetic retinopathy images.

Priya and Aruna [10], these authors have presented three models to diagnose DR: PNN (accuracy of about 90%), Support Vector Machine (accuracy of about 98%) and Bayesian Classification(accuracy of about 95%). By extracting the features of the retina, the amount of the disease spread in the retina can be identified . The features such as blood vessels, haemmoraghes of NPDR image and exudates of PDR image are extracted using the image processing techniques from the available images and the obtained input is supplied to the classifier for classification.

M Maliha et. al [11] is to assist in decision making about an existence of diabetic retinopathy by utilizing as group of several ML algorithms on extracting features from the different fundus images. It helps to decide upon which algorithm will be suitable and more accurate for prediction of the disease. To make Decision for prognosticate the presence of diabetic retinopathy is achieved using K-Nearest Neighbor,

Random Forest, Support Vector Machine and Neural Networks. The structure of the research has been built in such a way that with proper dataset and minor alteration, it can work to classify the disease in any number of categories.

Aditya Kunwar et al [14], presents a computerized method for extracting the texture appearance. By applying segmentation techniques, the extracted part is the portion of disc diameter around the eyeball. A tremendous amount of anomalies like micro-aneurysms, hard-exudates and hemorrhages, are the extracted region contents, due to which texture features varied enormously. Variation is due to the combination of extracting the texture appearance from the portion of interest around eyeball and grading using well known classifier SVM. Specifications use for the performance measurement of the automated system, namely Sensitivity which gains 91%, Specificity(75%) and Accuracy (86%)

Ujjwal, A. Chakravarty and J. Sivaswamy [15], In this biologically inspired method is proposed and an unsupervised, for bright lesion annotation. The effectiveness of proposed system has been experimented via the survey mentioned in DiaretDB1 dataset and was resulted in the sensitivity of 60%. a good agreement with the localized abnormal structural change is viewed in the images is achieved using a visual assessment of the obtained results. The system after modification is giving the possibilities to handle dark localized abnormal structural change through expansion, which is mainly a difficult task. Therefore, initially the proposed system the research of an assistive annotation (AAS) idea for retinal images.

Karnowski TP et al [19] have proposed a novel approach for the analysis of DME using a novel set of attributes based on color, wavelet decomposition and automatic lesion segmentation. The Author has used publicly available Dataset.

Quellec G, et al [20] for diabetic retinopathy screening authors proposed multiple instance learning framework, this framework used two dimensional retinal image datasets.

Verma L et al. [22] two general physicians examined the quantity of dataset nearly about four hundred eyes of near about two hundred diabetes patients. Their result was matched with an eye specialist Doctor's diagnosis for those patients only. It has been observed that the diagnosis done by the general physician and the eye specialist agrees the results with the ophthalmologist's values.

Varun G., Lily P., Mark C [25] using deep learning algorithm they proposed automated identification of DR and macular edema in retinal fundus images. The author also used conventional neural network for better result.

Yau JW et al.[31] observe the global current scenario and important key aspects for diabetic retinopathy and sight-threatening diabetic retinopathy diabetic patients. An overall analysis of every participant's data from the study of available data all over the world has been done.

S. Roychowdhury, D. Koozekanani and K. Parhi [35] given machine driven screening system which examines fundus images with the variation in the focused and different aspects, and provides several grades of diabetic retinopathy (DR) using machine learning.

H. H. Vo and A. Verma [38] gives various features obtained unique local binary pattern descriptors on the basis of colour multi-scale, on two proposed hybrid colour spaces and five general color spaces. By using the technique of the enhanced Fisher linear discriminant, EFM, these features are evaluated and extracted.

P. Patil, et al.[40] a methodology is proposed in this paper for auto detecting of ooze out using region growing segmentation algorithm' and 'Gradient Vector Flow Snake algorithm'.

Erika M. Damato,et al.[43],performed screening test on diabetics retina at pacific eye in institute in Fiji.authors pretend their view basis on to the questanaire,duration disease,blood sugar control ability of the various patients.for diabetic retinography screening purpose they had use fundus photograph according to Pacific diabetes retinal screening.after the observation author found that 27% of the patients have STDR and 15% patients bilateral STDR.most of the patients diabetic control was very poor.

Y. Groeneveld et.al.[44] studied on Type-2 diabetic mellitus patients for near about 17 years through the data collected from various sources. Over the studied author found that mild NPDR patients ratio was nearly 1 percentage and average incidence rate of STDR was nearly 8%. The rate of severe sight threatening retinopathy at the successive screening session was low in type -2 Diabetic without retinopathy patients

Shivananda, Dr.Girish.A.Attimarad[46] proposed a system for detection of microaneurysms and exudates in the retina.for detecting it used digital image processing techniques and signal processing.

S. Shafiulla Basha, Dr. K. Venkata Ramanaiah[47] in this paper author mainly focus on the blood vascular analysis,it is very crucial to diagnose diabetic retinopathy.

3. DISCUSSION

Worldwide, nearly 425 million people suffering from diabetes from the current survey [41]. Todays the most medical exigency of the society is nothing but a Diabetes. One of the most popular chronic disease is a diabetes which mainly the effect on the various parts of the human body and DR is mainly attacking and damage the human eyes. Initial stage identified of DR is some how curable, but later identified may cause to face the serious problem such as complete loss of vision, i.e. sight threatening DR. As per observation near about 93 million people suffered from eye related problem due to diabetes. From previous studies it has been observed the scenario for a person,30% people suffering from DR if he/she has diabetes [42]. So it is a global challenge for medical field to identify it on early stage and to avoid serious damage or loss.

4. CONCLUSION

Currently, most of the disease of medical identified automated by using medical image processing methods. From the observation of various papers most of the algorithm,proposed automated identification of Diabetic retinopathy. The recent trend is to use machine learning, deep learning for automated identification of DR.Best result depends on accuracy,time –constraint and test data ratio with trained data.

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