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AUTOMATIC DETECTION of EYE RETINAL DISEASE Using DEEP LEARNING and IMAGE PROCESSING: REVIEW

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Abstract - Diabetic Retinopathy is a critical health problem. It is a chronic disease of eye that can lead to vision loss irreversibly. Earlier detection can improve cure percentage and also reduces chance of vision loss and blindness. A computerized technique(system) can help detect diabetic retinopathy disease speedily and the patient has followed treatment to avoid blindness to the eye. So, we need to build a tool that will predict diabetic retinopathy with minimum Time and more precision. In this review paper, the literature survey is conducted focusing on the using computer aided detection of the disease using deep learning algorithms. The architecture of the network is both fast and simple. Early Detection can reduce the risk of blindness by 95%. We can automatically classify and differentiate any retinal image as a diseased image or healthy image. This review paper is primarily focus on to direct the doctors and researchers about the advantages and disadvantages of the methods and do identify the specific points or areas in the field to enhance the future research.

Key Words: Image Processing, Deep Learning, Computer-aided diagnosis, Diabetic Retinopathy, Retinal Image, CNN

1.INTRODUCTION

This Vision is a important human sense and eye is most important part of human body. And because of retinopathy the cost of treating the youngers(adults) diabetes and its tentative cost is thousands of crores (850 billion USD) in 2017. Diabetic retinopathy is the most serious and most common complications of diabetes (causes due to high blood sugar) "mellitus" and is a main and leading cause of blindness or low vision in younger age. People with diabetes have the eye disease diabetic retinopathy. retinal disease affects millions of people. Diabetic Retinopathy increased by 64% between 1990 and 2010, respectively. According to the federation report 2017 on diabetes, there were 425 million diabetics in the world and this count will be 629 million by the year 2045. The high blood sugar or blood glucose levels cause and affects damage to blood vessels in the eye retina. These blood vessels can leak or they can close or stop blood from passing through it. Sometimes ab normal and unwanted blood vessels grow on the retina. All of these factors of chances can be stealing eye vision.

The high blood sugar or blood glucose levels cause damage to blood vessels in the retina. These blood vessels can leak or swell or they can close or stop the blood from passing through. Sometimes abnormal blood vessels grow on the retina. All of these changes can steal eye vision.

Diabetes leading cause of low vision or blindness in working age youngers adults. retinal disease affects millions of people. Diabetic Retinopathy increased by 64% between 1990 and 2010, respectively. According to the international diabetes federation report 2017, there were 425 million diabetics in the world and this count will be 629 million by the year 2045.

The proposed framework is deep learning and a machine that detect the feature automatically at different levels using the trained dataset of eye retinal images. Such a general and good model can be useful as a level one screening tool especially in poor areas and rural areas.

2. Literature Work

A. Technical Survey:

[1] Qummar created a design of CAD system for detection of diabetic retinopathy. He uses digital retina images. These images are classified into two different categories, diabetic retinopathy eyes and non-diabetic retinopathy eyes which are healthy eyes. For classification, the AdaBoost algorithm is used. The examination of system is done by test dataset for interpretation and evaluation of the proposed system. After successfully testing the result of this experiments indicates that the capacity and capability of the model increased and chance of errors get reduced with each training phase epoch .The AdaBoost algorithm includes various classification which acts like a multi agent system and this capacity reduces the total time consuming.

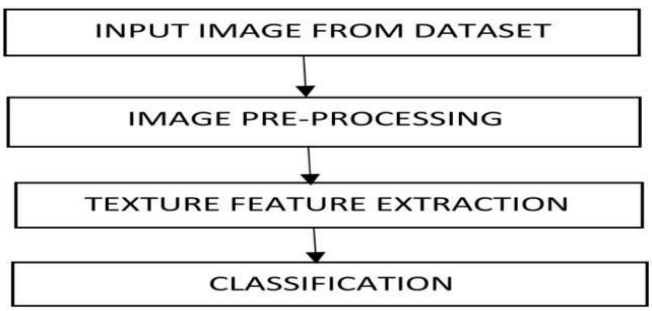

Fig -1: Process

[2] I Sertkaya in 2019, a work was published by Mehmet Emre about eye retinal disease detection using a convolutional neural network. They have done experiments used the existing database images using AlexNet, LetNet, VGG-16 architecture. Here Deep Learning structure is used. There are various layers

in the deep learning structure. The structured layers aim to find the high-level representation as they head toward the same (each) layer. And the layers are Convolution Layer, Rectified Linear Units, Pooling Layer, Full Connected Layer, Dropout Layer. This study use the LeNet, AlexNet to diagnose eye retinal diseases,Vgg16, and Alexie using this dataset. In that direction every model was running in 200 iterations and with good and successful result. And the experiments result in the VGG-16 architecture classification is 93.01 % and that yielded a good. However, the use of the AlexNet dropout layer is observed and has to cause loss reduction.

[3] Mishra(2020) created deep learning based ,model to classify diabetic retinopathy into 5 stages. A model uses multiple CNN architectures, DenseNet121 architecture and VGG16 architecture, and compares them to find whose performance is better. The dataset used for this contains 3662 images that acted as input. A trained model further extracted the features of fundus image of the eye retina and after that activation the function gives the output successfully. The architectures are DenseNet121 and VGG16 and the accuracies are 0.9611 and 0.7326 respectively.

[4] Sumandeep Kaur and Daljit Singh proposed a model for early diagnosis as well as classification of diabetic retinopathy by means of fuzzy logic and k-means clustering is used. Features like exudates and hemorrhage used for detection. At first, a Sobel edge detector is employed for detecting the edges of the eyeball. After that k-means color compression is employed. This model used the DIARETDB0 database for identifying normal and abnormal retinal images. The accuracy of the model is 96% and the sensitivity of the model 94.7%.

[5] In 2020, a work published by Nurul Atikah Binti Mohd Sharif et al. about image enhancement techniques used in diabetic retinopathy. They have done experiments by applying different image enhancement techniques on 90(65-NPDR and 25-PDR) retinal fundus images collected from the Clinic Hospital of Ophthalmology at University Sains, Malaysia. Histogram equalization, low light image, image negative, gray level slicing, brightness enhancement, contrast stretching have been performed by MATLAB and successfully compared by qualitative and quantitative measurement. qualitative measurement includes Mean Squared Error, Peak Signal to Noise, Entropy. Contrast stretching has been preferred over other techniques for image enhancement by Ophthalmologists as human experts. Quantitative measurement showed contradictory results, meaning a very high value of PSNR and lowest MSE value for the Brightness enhancement method and lowest entropy value for the gray level method.

[6] Md.Ahsan habib Raj at all considered CNN-VGGNet model Using this model ,we can recognize diabetic retinopathy untimely . The proposed model gives about 95.41 accuracy than the other three models AlexNet, Google Net, ResNet are given 73.04%,82.18%,78.68%accuracy respectively. Eye Packs dataset from the Kaggle website has been used for this project. They used an adaptive median filter . Median filter is used for to cut out the noise from the given image and a median filter to smooth the image. detection of blood vessels from an image is done by normalization and 2D Gaussian matching model. Microaneurysm has been detected by selecting the green channel of an image and applying dilation, erosion, and Gaussian filter. Gaussian filter is used for increase the unlighted region of an image.

[7] “On Deep Learning Based Algorithms for Detection of Diabetic Retinopathy” This paper analyzed prominent deep learning-based techniques used for screening the DR symptoms. mechanized screening techniques are inexpensive. This technique can be worked like quick augmentation. This system can be used on the head of pretrained model. This model can provide substantial boost to result. Accuracy is 74%.

[8] Yuchen Wu and Ze Hu* have used transfer learning approach for detection . The proposed ensemble model uses the kaggle dataset . It gave them 72% of accuracy . They found that inceptionv3 network having 300 epochs and 0.0001 learning rate can give the best performance.

[9] “A Deep Learning Ensemble Approach for Diabetic Retinopathy Detection”. This paper uses ensemble approach for detection of diabetic retinopathy . It detected all 5 stages of DR. It uses the fundus images to train the model. It uses pretrained CNN models - ResNet50 , InceptionV3 , Xception , Dense121 , Dense169 model. It overall gives about 72% of accuracy.

[10] Feng Li1, Zheng Liu1, Hua Chen1, Minshan Jiang1, Xuedian Zhang1, and Zhizheng Wu2 have proposed the model which uses pratrined CNN model i.e. InceptionV3 network which gives about 93% of accuracy and 96% of accuracy . Butit needs high processing power. This model gives more accuracy and sensitivity than other models.

3. Algorithms

A. Image Processing Algorithms

- Contrast Stretching: Contrast stretching is an easy image improvement technique that improves the difference in luminance of an image and makes it identifiable. It extends the range of intensity values of the image. It can only apply a linear scaling function to the pixel image values. Minimum value intensity of pixel of input image is set to 0 and maximum intensity value of pixel of images is set to 255 and others are set proportionally.
- Adaptative Median Filter: This filtering technique examines whether the present pixel is noise or not according to definite conditions, if it is noise, then it uses a nearby pixel to replace the pixel. If it is not noise then don’t change it.
- Median Filter: This filtering is a non-linear technique used to separate noise from an image.it is used in preprocessing steps to improve the results of later processing.

- Morphological Operations: Morphology gives a big set of image processing operations that processes images based on shapes.
    - Dilation: It adds pixels to object boundaries, the dilation operators takes input as two pieces of data. Firstly, the first image which is to be dilated. The second is a set or multiple coordinate point called is to be dilated. The second is a set or multiple coordinate point called as structuring element. This element(structured) determines the effects of the dilation on the given input image. A pixel is set to 1 if any of the nearby pixels have the value 1. $A \oplus B = \{z \in E \mid (B^s)_z \cap A \neq \emptyset\}$
    - Erosion: Erosion is another morphological operation that takes out pixels from the object boundaries. $A \ominus B = \{z \in E \mid B_z \subseteq A\}$

B. Deep Learning Algorithms:

- *Resnet:* It has approx. 11M parameters. Two pooling layers are used in the network.
- *Vggnet:* The current vgg model vgg16 and It has about 138 M parameters. The size of
- maxpool kernels is 2x2 and conv kernel is 3x3.
- VGGnet takes mode numbers of parameters.
- Resnet and Alexnet have approximately 60M parameters.
- Resnet need more computation power than the Alexnet There is 10% difference in their accuracy.
- Alexnet and Inception take same time for training.
- Vggnet : The current vgg model is vgg16 and It has about 138 M parameters . The size of maxpool kernels is 2x2 and conv kernel is 3x3.
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- Alexnet and Inception take same time for training.
- To evaluate the algorithm we can use following metrics 1] True Positive = When algorithm gives you that the given unaffected image don't have diabetic retinopathy. 2]True Negative = When algorithm gives you that the given affected image has diabetic retinopathy. 3]False Positive = When algorithm gives you that the given affected image don't have diabetic retinopathy. 4]False Negative = When algorithm gives you that the given unaffected image has diabetic retinopathy. By forming the confusion matrix we can easily calculate the performance measure . It is very useful for measuring the sensitivity , accuracy , area under the curve , precision. Values of sensitivity , accuracy , area under the curve can be calculated as:
    - Accuracy = (true pos.) + (true neg.) / (true pos. + true neg. + false pos. + false neg.)
    - Sensitivity = (true neg.) / (true pos. + false neg.) Precision = (true pos.) / (true pos. + false pos.).
    - Area Under Curve = ∫ Sensitivity(T) Precision(T)dT.

- Precision: - Out of all positive images we predicted correctly how many of them are actually positive is called precision.
- Accuracy: - Out of all images how much we predicted correctly is called accuracy.

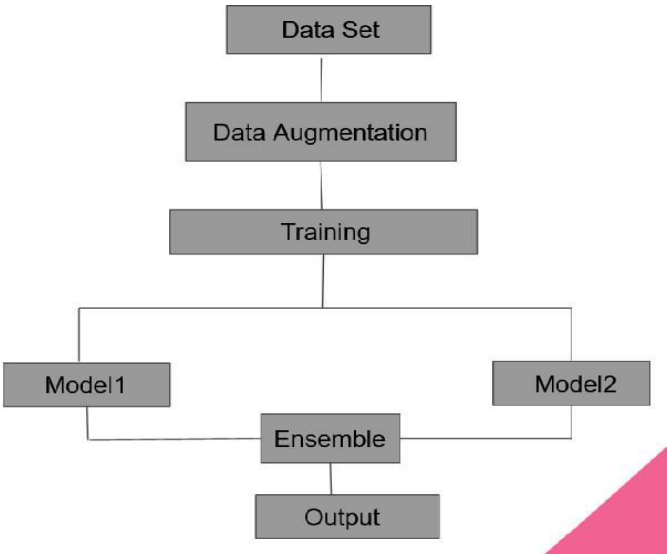

Fig -2: Data Process

Author	Image Enhancement Technique	ImageProcessing / Segmentation Technique	Result
Narul Atikh Binti Mohd Sharif el al.[]	1. Histogram equalization 2. Low Light Image 3. Image Negative 4.Gray Level Slicing 5.Brightness Enhancement 6.Contrast Stretching	NA	Contrast Stretching is preferred over other technique for image enhancement by Ophthalmologist as a human export.
Md.Ahsan habib raj at el.[]	1.Adaptive Median Filter 2.Median Filter	1. Dilation 2.Erosion 3.Gaussian Filter 4.Normalization	Blood Vessels and Microaneurysm are detected.

Dulanji Lokuarachchi at el. []	1.Median Filter 2.Histogram Equalization	1. Top Hat Transformation 2. Adaptive Thresholding	Microaneurysm and hemorrhages detected.
M. Vijaya Maheshwari and Dr.G.Murugeswari []	1. Unsharp Mask Filtering 2. Histogram Equalization 3. Processing in Color space	1.Kernel based image segmentation technique 2.Mathematical Morphology 3.Machine Learning Technique 4.Edge based Detection. 5.Region Growing Method	1.Adaptive Histogram is commonly used for image preprocessing.

TABLE 1

Comparative and Analysis of Existing Algorithm

Neural Network	Epochs	Learning Rate	Accurate
VGG19	300	0.0001	0.51
Resnet50	300	0.0001	0.49
InceptionV3	150	0.0001	0.50
InceptionV3	300	0.01	0.55
InceptionV3	-	-	0.93
VGG19 , Resnet50, InceptionV3	-	-	0.74
DCNN + SVM + TLBO	-	-	0.86
Densenet50 + InceptionV3 + Xception + Dense 121 Dense169	-	-	0.72

TABLE 2

Comparison and Analysis of Existing Technique

3. CONCLUSIONS

In this literature survey on diabetic retinopathy, we compare different deep learning algorithms to detect disease. From this study it is observe that Histogram Equalization, Contrast Stretching, Adaptive median filter method are commonly used for image preprocessing. Red lesion containing microaneurysms and hemorrhages which is early sign of diabetic retinopathy is detected successfully but further study need to be done focusing on different practical approach and analysis of different machine learning algorithm. Here we conducted survey and observe that, That the traditional CNN algorithm will not give the maximum efficiency. If we implement ensemble two or more pre-trained CNN model then that can give maximum efficiency.

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