IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

REVIEW ON AN AUTOMATIC DETECTION OF GLAUCOMA USING DEEP LEARNING TECHNIQUES

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Abstract: Glaucoma is a visual disorder characterized by damage to the optic nerve which results in a narrowing of the field of view and can lead to blindness. The main cause of glaucoma is eyeball fluid or commonly called aquos humor which functions to provide nutrition to the inner eye organs, the cycle of producing and secreting this fluid is unbalanced, therefore resulting in increased pressure in the eyeball, which causes the eye nerves to become damaged. Glaucoma is the second leading cause of blindness in the world after cataracts. However, glaucoma is different from cataract because glaucoma causes permanent blindness. In 2020 glaucoma affected 79.6 million people. Therefore, early detection of glaucoma can reduce the severity of the patient. At this time, the main and popular way to diagnose glaucoma is by measuring cup-to-disc ratio (CDR) on digital fundus images. In the cup to disc ratio (CDR) measurements are made to see the Optical Disk (OD) and Optical Cup (OC). However, the detection of digital fundus images for the measurement method cup-to-disc ratio (CDR) until now has been done manually, it takes a lot of time and each expert has differences in the parameters to make measurement accuracy. Because of this, the need to perform automatic digital fundus image examination is urgently needed. One of the deep learning methods that has the best expertise in terms of classifying objects in images, namely methods CNN using Deep Learning. However, In this study, the various reviews of glaucoma classification was carried out using the Deep Learning model Convolutional Neural Network and reveals that CNN is a effective and appropriate model to classify glaucoma.

Index Terms **- Glaucoma Detection, Deep Learning, Artificial Neural Networks, Convolutional Neural Networks.**

I. INTRODUCTION

Glaucoma is a disease that attacks the sense of sight and becomes wrong one of the main causes of blindness in the world besides cataracts. In contrast to cataracts, blindness due to glaucoma is permanent or cannot return to normal [1]. Estimated at by 2020, more than 76 million people worldwide suffer from blindness due to glaucoma and will experience a significant increase to 111.8 million people in 2040 [2]. Many of the patients with glaucoma are not aware of the disease experienced because the development of glaucoma is slow.

Therefore, early detection of someone who indicated glaucoma needs to be done to minimize the damage that occurs to the nerves optical. Currently, the process of observing retinal structures can be done through various techniques, ranging from direct observation by an ophthalmologist to using medical equipment. such as Optical Coherence Tomography (OCT), Confocal Scanning Laser Ophthalmoscopy (CSLO) and Heidelberg Retinal Tomography (HRT) [3]. However, those methods have drawbacks, for example the first method has the level of subjectivity is quite high in the observation process while the availability of modern medical equipment mentioned is relatively limited and high cost.

Whereas, fundus image is one type of image that is widely used for detection eye abnormalities, such as diabetic retinopathy, glaucoma, cataracts, hypertension, myopia, etc [4]. This image is a two-dimensional (2D) representation of the network three-dimensional (3D) retina taken using a special low-power microscope. Image fundus is non-invasive and has a fairly low cost so it is effective to use to detect eye disease. Detection of eye disease is usually done based on manual analysis by doctors (experts) on fundus images so that the results of the analysis are very good depending on the experience of the doctor. Differences in analysis results between one doctor with other doctors is very likely to occur (inter-observer error). Therefore, it has Several computer vision (computer-aided diagnosis / CAD) methods have been developed for assist doctors in analyzing eye diseases.

In general, CAD systems use conventional methods that are automated segmenting objects in the fundus image that are suspected as a sign of abnormality in retina, extract the features of the object, and use them to determine Is it true that the object shows an abnormality in the retinal area. this method has a high level of difficulty in the automatic object segmentation stage, where objects with one another have different shapes, colors, and sizes. Therefore, many studies that propose segmentation methods, both automatic segmentation and semi-automatic, to separate abnormal objects from other structures on fundus images.

However, due to differences in signs of abnormality from one another, such as between glaucoma and retinal disease, so this conventional detection method is usually only specific can be used for one type of disease only. To detect the type of disease, deep learning algorithms is needed to segment the marker abnormal object the disease and extract its features. Currently, the process of

detecting glaucoma using fundus images has been carried out by utilizing technology computer vision using machine learning and deep learning

II. LITERATURE REVIEW

2.1 Eyes

Eyes are the five senses of sight which are very important for humans in carrying out their daily activities. In the eye there is a cornea that has a function in deflecting light entering the eye. There is eyeball fluid on the back of the cornea or what is commonly called aquos-humor. Process of production and absorption aquos-humor must be balanced to maintain intraocular pressure so that there is no excess pressure that results in damage to the eye structures [14].

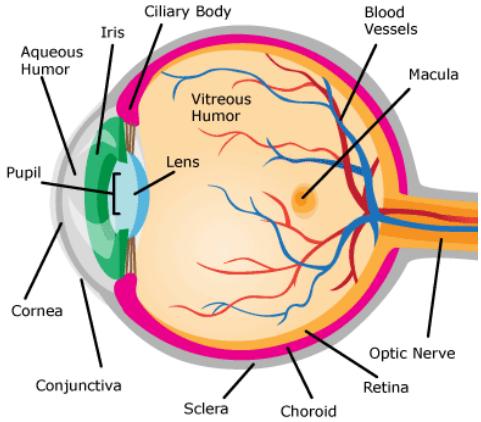

Figure 1. Parts of the Eye

2.2 Glaucoma

Glaucoma is an eye disease in which the optic nerve is damaged and then interferes with the field of view. Glaucoma is caused by an increase in intraocular, this increase occurs due to the process of production and absorption aquos humor unbalanced resulting in pressure on the optic nerve [51].

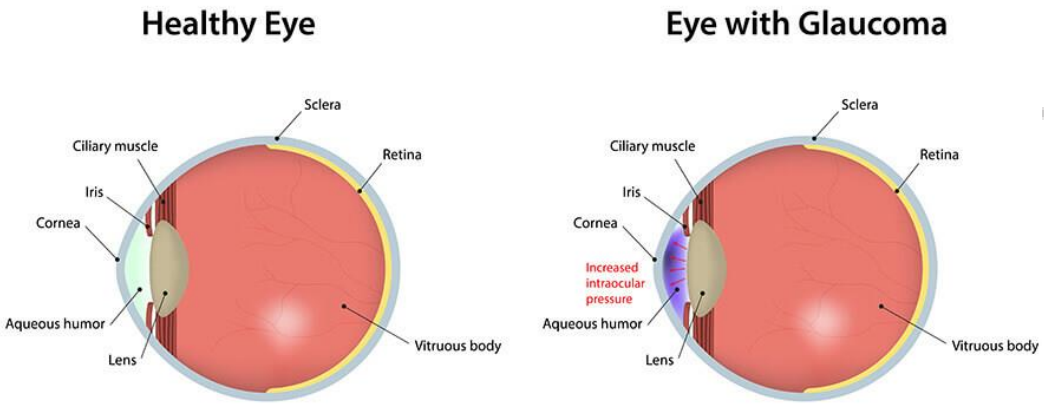

Figure 2: Differences between normal eyes and glaucomatous eyes

2.3. Cup to Disc Ratio (CDR)

Cup to Disc Ratio (CDR) is popularly used by medical personnel in diagnosing glaucoma. CDR measurement is done by looking at the ratio of the disc and cup diameters. By using the results of dividing the Optical Cup (OC) and Disk Optical (OD) values. In normal eyes, CDR values range from 0.3 to 0.5 [21].

2.4 Convolutional Neural Networks (CNN)

Convolutional Neural Networks (CNN) is part of the method machine learning development results from Multi Layer Perception (MLP). On Convolutional Neural Networks(CNN) each neuron is shown in a two-dimensional form consisting of three main layers, viz convolutional layer, pooling layer, and fully connected layer. Convolutional Neural Networks (CNN) receives more than one dimensional data originating from image data that is entered into the input layer, then the received data will be propagated to the hidden layers which will be processed and produce output [16-20].

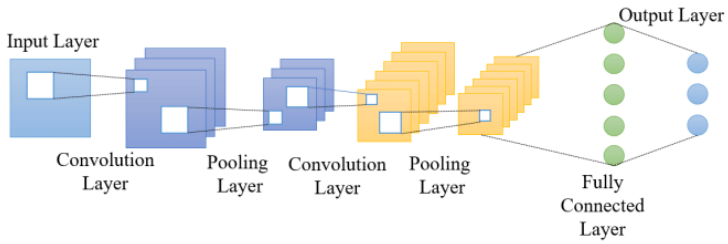

Figure 3: CNN architecture visualization :

On process Convolutional Neural Networks (CNN) there is the most important process, namely the process Convolutional layers to perform the convolution operation on the previous output layer. The purpose of convolution on image data is to extract features from the image inputs. There are three parameters in the convolution operation in image processing, namely filters, stride, and padding. The next process in CNN is activation Rectified Linear Units(ReLu) which is an operation to introduce nonlinearity and levels of model representation. ReLU will change the negative value in the receptive field to 0. Then, there is a pooling layer process which is a process of reducing the size of the matrix which functions to shorten computation time. The next process is fully connected layer function to change all multidimensional nodes !! into one dimension so that the data can be classified linearly. The end of the CNN process, namely the activation function softmax which aims to get the classification results of more than two classes based on the highest probability value [16-20].

2.5 Related References

There have been many proposed methodologies related to the detection and classification of glaucoma.

1. In 2014 [5] proposed the Principle Component Analysis method (PCA) to extract features from the retinal fundus images that have gone through stages preprocessing. The Bayesian classification method based on the Gaussian model is implemented in system testing process and the accuracy obtained is 78%.
2. In 2016 [6] proposed the Adaptive Thresholding method for the segmentation process against optic cup, optic disk, and retinal vessels from fundus images. Cup-to-Disk Ratio feature (CDR) and Imperior, Superior, Nasal, and Temporal (ISNT) from the images were then used as indicators for glaucoma classification using the Support Vector Machine (SVM). result, the resulting accuracy of 96%.
3. In 2016 [7] used the PCA method to extract features from the retinal fundus images through a series of preprocessing operations as well as SVM for the classifier. Level the accuracy that the system can provide is 86%.
4. In 2018 [8] conducting research related to glaucoma detection using deep learning-based models. By using the Convolutional Neural Network method, two research schemes were carried out. The best scheme of the research is to use Google's algorithm TensorFlow and produces an accuracy rate of 87.9%.
5. In 2019 [9] performed glaucoma detection in 1707 images fundus uses 5 different CNN architectures (VGG16, VGG19, InceptionV3, ResNet50, and Xception). The best results were obtained by the Xception architecture with an average score AUC is 96%, specificity is 85.8%, and sensitivity is 93.5%.
6. In 2019 [10] proposed who built three deep convolutional neural subnetworks (AG-CNN), one for the location of pathological areas, another for the location of attention, and a third of attention prediction, which operated together for the detection of glaucoma, obtaining an AUC of 0.98, accuracy of 96.2%, sensitivity of 95.4% and specificity of 96.7%.
7. In 2019 [11] proposed a Regions with Convolutional Neural Network (RCNN) based method for segmentation and classification of glaucoma. From this study it can be concluded that deep learning methods can detect and localize objects in a robust, accurate, and automatically when trained on large annotated datasets.
8. In 2020 [12] using the InceptionResNetV2 architecture to detect diabetic disease retinopathy on fundus images with an accuracy of 72.33% for the MESSIDOR-1 dataset and 82.18% for the Kaggle dataset.
9. In 2020 [13] the YOLO-v3 architecture for detected glaucoma in 2000 fundus images with an accuracy of 93.7%, sensitivity of 89.1%, and a specificity of 95.8%.
10. In the year 2021 one of them was [21], who used a pre-trained CNN for segmentation of the ocular nerve and compared the performance of three CNNs (SCNN-DAE, SSCNN, TCNN) for classify the images of the patients, obtaining a precision of 93.8 %, 91.7 % and 90.5 %, respectively.
11. Similarly in the year 2018 [22] proposed a deep neural network to segment the region of interest and compared three deep learning algorithms called VGG16, Inception and ResNet, obtaining AUC (Area Under Curve) values of 0.89, 0.9 and 0.91 respectively.
12. In the year 2020 [23], who used the ARGALI (Automatic Reasoning Graph Algorithm for Learning and Inference) approach to detect the region of interest by varying the intensity of the pixels and then used two CNNs, one to extract the cup characteristics and another to detect glaucoma, obtaining an AUC of 0.882.
13. In the year 2020 [24] who made a comparison with three different CNNs (ResNet, DenseNet and YOLOv5) to know the impact that segmentation Previous with each architecture has on a glaucoma detection model, which he called ALADDIN (Adaptive Learning with Adjustable Deepening and Inter-Neuron Noise). The results indicated that the images segmented with YOLOv5 obtained an AUC of 0.81, this being the best of the three cases. This finding is relevant, since it suggests that the YOLOv5 network could be a valuable tool to improve the performance of models glaucoma screening.
14. However in the year 2018, some authors preferred to process the images directly without prior segmentation, such as [25], who extracted features directly from the image using CNN ResNet. This study considered images of patients with myopia and glaucoma, which allowed the algorithm to discern between these conditions, obtaining an AUC of 0.96.
15. Similarly in the year 2020 [25] proposed a methodology to detect and predict the onset of glaucoma, using CNN MobileNetV2 and the transfer learning technique. The approach was 95% accurate in detecting glaucoma after its onset, 88% accurate in predicting disease 1 to 3 years before, and 77% accurate. % in the prediction of suffering from glaucoma between 4 to 7 years prior to its manifestation

16. However in the year 2017 [26], who, although he used CNN AlexNet to extract relevant features from the images, used this information as input for an SVM (Support Vector Machine) model that was in charge of classifying the images. The model achieved a precision of 88.20%, a sensitivity of 85%, and a specificity of 90.8%.

III. CONCLUSION

It is important to point out that, various studies found in the literature have used the CNN as a compulsory characteristic model, to determine glaucoma progression. Consequently, it remains necessary to better define how these convolutional neural networks will be used in clinical routine. The most advanced application is the use in glaucoma screening programs to identify patients who are at high risk of blindness. Subsequently, based on literature authors under this scheme emphasis that CNN should be the defecto standard to detect glaucoma and its progression stages.

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