GLAUCOMA IMAGE DETECTION USING NEURAL NETWORKS

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ABSTRACT

Most people suffer from eye diseases in rural and semi-urban areas such as diabetic retinopathy, glaucoma, age-based macular loss, etc. Glaucoma is an optic nerve injury neurological condition, and is the second leading cause of vision loss. It is regarded as silent sight robber. This causes a persistent deterioration of the optic nerve head (ONH) caused by an increase in intraocular pressure in the eye. The optic nerve brings information regarding the image to the brain. A blind spot is produced due to damage to large numbers of nerve fibres which leads to vision loss. The review paper discusses the application of the various techniques of image processing for automated glaucoma detection.

Keywords: Glaucoma Identification, Image Analysis, Image Segmentation, Machine Learning Algorithms, Computerized Therapy, Retina, Automation, Intraocular Pressure.

INTRODUCTION

Glaucoma is an optic nerve disease which involves the loss of retinal ganglion cells in an optic neuropathy characteristic pattern. Our eye has just as much pressure as our blood, which is called intraocular pressure. When that intraocular pressure (IOP) increases to a certain level, the optical nerve is damaged. This can lead to reduced peripheral vision, and ultimately blindness. Manual eye image analysis is fairly time consuming and the accuracy of measurement of parameters varies among experts. Hence the need for an automated methodology emerges.

Glaucoma is a group of diseases that affect the optic nerve in the eye and cause visual impairment and vision loss. The word glaucoma emanates from the ancient Greek word, meaning' obscured or blue-green hue apparently depicting a person with a swollen cornea or rapidly developing a cataract, both of which can be caused by persistent (long-term) eye pressure increases. Glaucoma is an eye condition which causes damage to the optic nerve and gets worse over time. Glaucoma has a tendency to be acquired, and may not appear in life until later. The increased pressure, called eye pressure intraocular, can damage the optic nerve, which transmits images to the brain. If this damage continues for a long time, glaucoma can cause permanent loss of sight.

Causes of Glaucoma

Precise cause of glaucoma involves mechanical compression or reduced optic nerve blood flow. The optic nervous system is a bundle of over one million nerve fibres. The retina is linked to the brain. The retina is the tissue at the back of the inner eye that is sensitive to light. For good vision a healthy optic nerve is needed. Glaucoma usually occurs when pressure elevates above average in the eye, and this can occur when fluid movement, or aqueous humor, is not properly circulating. If the mesh like channel in which fluid flows is blocked, then an intraocular pressure on the optic nerve is created and the optic nerve is impaired.

Types of glaucoma

Two major types of glaucoma occur

a) **Wide angle glaucoma:** The most common type of glaucoma, also referred to as wide angle glaucoma. The eye structures appear normal but the fluid in the eye does not flow through the eye drain properly, called the trabecular meshwork. In this, the trabecular meshwork is not clearly irregular. A space named the anterior chamber is in the front of the eye. A clear fluid continually flows into and out of the chamber, nourishing tissues nearby. The fluid leaves the open angle in the chamber where the cornea and the iris cross. When the fluid reaches the angle, it flows like a drain through a spongy meshwork, leaving the eye. In open-angle glaucoma the fluid passes through the meshwork drain too slowly even though the drainage angle is "open." The pressure inside the eye rises to a level that can damage the optic nerve, as the fluid builds up. If elevated pressure damages the optic nerve, open-angle glaucoma and loss of vision will result.
b) **Closure angle glaucoma:** happens when the iris booms tightly or covers the cornea and iris drainage angle. As a result, if the channels inside the eye do not function properly, tluid can not circulate through the eye and pressure increases. In this, the iris (colored part of the eye) is pushed against the trabecular mesh network (drainage channels) within the angle of the front of the eye, thereby blocking the channels and causing pressure to increase. Glaucoma occurs largely in adults over the age of 40 but it can also occur in young adults, kids, and even infants. There is an increased risk of glaucoma over age 40 with family history of glaucoma, poor vision, diabetes and eye trauma.

Glaucoma symptoms

The primary sign of glaucoma is often the loss of peripheral or side-view, which can go unnoticed until late in the disease. That's why glaucoma is often called the "sneak vision thief" The intraocular pressure may occasionally rise to severe levels. In such cases, there may be sudden eye pain, headache, blurred vision, or the appearance of halos around lights.

Seeing halos of lights throughout.

- Lack of vision.
- Grease in the eye.
- Eye with a hazy appearance (especially in infants).
- Heartburn or vomiting.
- The eye pressure.
- Vision narrowing (view of a tunnel).

LITERATURE REVIEW

Zhuo Zhang [2010], Work done, "ORIGA-light: An Electronic Retinal Fundus Photo Database for Analysis and Research on Glaucoma. The author presents an online resource, ORIGA-light, aimed at exchanging clinical retinal images with the general public. Author had continuously updated the program with more ground-truth clinical images. The proposed method focuses on segmentation of the optic discs and cups.

Vahabi Z [2010], "New approach to automatic detection of Optic Disk from non-dilated retinal images" Author describes a new filtering approach to detect Optic Disc, such as Sobel edge detection, Texture Analysis, Intensity and Template matching. The proposed algorithm is based on 150 Messidor data set images in wavelet domain.

Zafer Yavuz [2011], performed a work, "Segmentation of Retinal Blood Vessels Using Gabor Filter And Tophat Transform"[10]. In this, Author gave a method for segmentation of the retinal blood vessels by first applying Gabor filter to improve the blood vessels and then applying top-hat transform. The output is later converted to binary image with p-tile threshold.

Nilan jan Dey [2012], Work done, Optical Cup Disc Ratio Measurement for Diagnosis of Glaucoma Using Harris Corner. In this paper Harris Corner is used to assess CDR. Harris comer detector tests a small amount of local signal shifts, with patches moved in various directions. It is based upon a signal's local auto-correlation function.

R. Geetha Ramani [2012], Job, Automatic Diabetic Retinopathy and Glaucoma Prediction by Retinal Image Analysis and Data Mining Techniques. This paper introduced a novel approach to the automated detection of diseases. Retinal image processing and data mining methods are used to categorize the retinal images correctly as either affected Normal, Diabetic Retinopathy and Glaucoma.

ManjulaSri Rayudu [2012], Suggested, Review of Image Processing Techniques for Automatic Eye Disease Detection. The review paper provides information on the application of imaging processing techniques for automated eye disease detection. Main image processing techniques for detecting eye diseases include image capture, fusion, segmentation, extraction of features, enhancement, pattern matching, classification of images, analysis and statistical measurements.

Annu, N., and Judith Justin et al., in [2013] suggested a novel approach for the identification of glaucoma using textural energy features based on DWT along with the Probabilistic neural network classifier. Five filters defined in. create wavelet features Z-score normalization for the equalization of illumination irregularities is performed in the beginning. This program increases the accuracy of 95 per cent.

Simonthomas, S., et al., in[2014] Automated proroposed glaucoma diagnostic device utilizing texture features based on GLCM and Haralick. After preprocessing of the file, thirteen texture features from Haralick are extracted. KNN classification technique is subsequently applied to identify fundus picture as being glaucomatous or stable. The program states that glaucoma detection is 98 per cent effective.

Xiangyu Chen et al.,[2015] Proposed CNN with 6 layers. Using response-normalization and with pooling layers is also taken care of over fitting problem. The system also utilized strategies for dropout and data increase to improve performance. Data sets ORIGA and SCES were used. (AUC) 0.831 from ORIGA data set and 0.887 from SCES data set for the receiver operating characteristic curve in glaucoma detection.

Julian Zilly et al., in [2017], Automatic segmentation of the OC and OD using a novel CNN-based method. The proposed method employed Entropy sampling to select sampling points that are claimed to be better than uniform sampling. The selected sampling points are further exploited to build a convolutionary filter learning system. The extracted OC and OD can be used for calculation of CDRs which can be used for diagnosis of glaucoma.

S. Maheshwari et al., in [2017] Proposed a new testing test for glaucoma. EWT is initially used for image breakdown into different bands of frequencies. After that the image gets features of correntropy. Then feature ranking is done on the selection algorithm for the value of the t value feature. Least squares help the classification of vector machines classifies the image between the glaucomatous or non-glaucomatous image. This strategy improves a relatively good 98.33 per cent accuracy for 3 fold validation.

U Rajendra Acharya [2017] Suggested a system for diagnosing glaucoma using apps based on the texton and local configuration sequence. Firstly, adaptive histogram equalization is performed, followed by image convolution operation with different filter banks, resulting in texton generation. Furthermore, it produces LCP. Local pattern configuration (LCP) refers to distinguishing pattern found in image. SFFS and statistical t-test together with K-NN classifier perform feature selection and feature ranking, respectively. The machine improves the performance by 95.8 per cent.

U Raghavendra, et al., in 2017, Suggested 18 layers:-convolution layer(CL), batch normalization layer (BN), Relu(R), MaxPool(MP),CL-2,BN-2,R-2,MP-2,CL-3,BN-3,R-3,MP-3,CL-4,BN-4,R-4,MP-4, fully connected layer, and softmax layer, CNN glaucoma diagnostics architecture using CFIs. All the fundus images are resized to 64X64 sized images during preprocessing phase. Authors experimented with different learning rates of 0.1, 0.01, 0.001 and 0.0001 to find different parameters such as precision, sensitivity, specificity and PPV. Optimum learning rate is considered to be 0.001. 98.13 per cent accuracy is reached. The dataset used is of 1426 fundus images as accuracy of CNN is highly dependent on the variability and scope of the training dataset used.

Alan Carlos de Moura Lima, et al., in [2018], A comparison study is being carried out between different CNNs. A variety of CNNs are used for the analysis, containing Visual Geometry Group architecture versions 16 and 19, Residual Neural Network architecture version 50 and Inception CNNs. Formerly qualified picture net challenge weights are used with everything. Each CNN architecture per image has extracted a large number of features which form five datasets for each image. Each of the above has been checked with different influential classificators. With the r2 version of the RIM-ONE and Logistic Regression classifier, CNN ResNet50 obtained the best 90 per cent accuracy score.

Juan J. Gómez-Valverde et al., in [2019] Done a glaucoma detection system using the transfer learning method. Using morphological operations, position of the optic disk is

performed in the preprocessing step, and the localized image is further scaled to 256x256 pixels. VGG-19 platform is used for learning how to pass. The performance comparison is made between a simple approach based on CNN and a learning based approach based on transfer. The transfer learning scheme with VGG19 clearly outperforms the other approach which achieves an AUC of 0.94.Total of 2313 images (RIM-ONE 49, DRISHTI-GS 50, and 1 Private Data set).

CONCLUSION AND FUTURE WORK

Several works associated with the computerized detection of glaucoma were included in this survey article. Glaucoma is one of the crucial elements that contributes to most visual impairment around. Implementation of some modest computerized procedures is necessary for the exact discovery of various phases of glaucoma. For underdeveloped nations where there is an extreme scarcity of ophthalmologists these programs will be of strange support. In the future, it is expected to grow ever more reliable with the intention of passing on the benefits to the least fortunate of needy people. Once glaucoma is diagnosed correctly, they will easily take appropriate identification or skilled medical procedures to preserve a pragmatic buffer from all visual impairment.

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