Chapter 1
Glaucoma Detection Using Convolutional Neural Networks

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ABSTRACT

The increase in use of ICT tools and decrease in physical activities has increased the risk of disorders such as diabetes, hypertension, myopia, hypermetropia, etc. These disorders make the person more prone to eye disease such as glaucoma. The actual causes of glaucoma are still unknown. But the study of medical literature reveals that the factors such as intraocular pressure, thyroid, diabetics, eye injuries, eye surgeries, ethnic background, and myopia makes the person more prone to glaucoma. The difficulty in early detection make it an invisible thief of sight. Therefore, it is the demand of the day to design a system for its early detection. The aim of this chapter is to develop a convolutional neural network model "GlaucomaDetector" for detection of glaucoma at an early stage. The evaluation of the model on the publicly available dataset reports the accuracy of 99% for prediction of glaucoma from the input images of retina. This may prove a useful tool for doctors for quick prediction of glaucoma at an early stage. Thus, it can minimize the risk of blindness in patients.

INTRODUCTION

In modern era, the change in life style and increase in use of computer and mobile devices has increased the sensitivity of eyes towards defects and diseases. The diseases such as glaucoma can lead to loss of vision. This disease can cause the damage to the optic nerves which carry signals from the eyes to brain and vice-versa (National Eye Institute, n.d.).

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At the initial stage, the Glaucoma may remain unnoticeable for the person. Even, it is difficult for the ophthalmologist to detect the Glaucoma at an early stage. At moderate stage the symptoms such as poor vision, loss of peripheral vision and eye pain appears. At severe stage, this disease can lead to blindness.

The factors such as intraocular pressure, thyroid, diabetics, eye injuries, eye surgeries, ethnic background, and myopia makes the person prone to Glaucoma (McMonnies, 2017). The difficulty in early detection make it invisible thief of sight. The regular eye check-up is important to minimize the risk of severe stage of Glaucoma. The glaucoma is categorized into four categories.

(i) **Open- angle glaucoma**: This is the primary stage of glaucoma. It is difficult to diagnose, therefore the person remains unaware to take the precautions. This may cause severe impacts at later stage.
(ii) **Angle- closure glaucoma**: In this type, the person feels pain in the eyes. It leads to a rapid loss in vision.
(iii) **Normal tension glaucoma**: This is the rarely observed type of glaucoma. The medical experts are still struggling to delve into the depth of this category. It is difficult to diagnose because it is observed under normal nerve pressure in the eyes. But, the blood supply in the eyes becomes low in the patients of this category.
(iv) **Congenital glaucoma**: This is hereditary disorder. It is generally observed in the babies of one year age (Medical News Today, n.d.).

As per reports presented in (Glaucoma Today, n.d.; National Health Portal, n.d.), about 11.2 billion people in India are suffering from glaucoma. Among these cases about 90% cases remain undetected. Thus, there is a potential risk of increase in severity of glaucoma with increase in age (Glaucoma Today, n.d.). The report published by World Health Organization (WHO) (National Health Portal, n.d.), shows that approximately 4.5 million people lose their vision due to glaucoma. Therefore, it is the demand of the time to provide an automatic tool for the early stage detection of this disease. The effectiveness of Artificial Intelligence (AI) in object detection, image classification, feature extraction, trend analysis and learning gives good insights for employing the AI techniques for early diagnosis of Glaucoma.

In this chapter, the authors propose a Convolutional Neural Network (CNN) model for early diagnosis of glaucoma.

ARCHITECTURE AND WORKING

Convolutional Neural Networks (CNNs) are a type of deep learning networks. These are effective used for image classification (Albawi et al., 2017; Chen et al., 2015). These networks replaced the manual feature extraction with the automatic feature extraction. These are efficient in the tailoring of most prominent features from the image datasets. These are effective in finding the differences in features of images, hence precise in making image classification.

In this chapter, the authors designed a shallow CNN **"GlaucoDetector"** for detection of **glaucoma**. The architecture of the model consists of four Convolution and four Max Pooling layers. These layers are defined at alternate positions as shown in Figure 1. The architecture employs the ReLu activation function between the convolution and max pooling layers. The kernel size for the first convolution layer is set as (3x3). The remaining three convolution layers use the kernal size of (2x2). The size of pool for each max pooling layer is set as (2x2).