Chapter 8
Earlier Glaucoma Detection Using Optimised Blood Vessel Segmentation With CNN

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ABSTRACT

Glaucoma, being one of the major causes of irreversible blindness, is largely asymptomatic in its early stages, and therefore, early detection is the hour of need. Traditional diagnostic techniques are time-consuming and are prone to variability. In response to this problem, we introduce a deep learning-based approach that efficiently segments the glaucoma-sensitive optic disc (OD) and optic cup (OC) using an ensemble of convolutional neural networks (CNNs). To ensure increased accuracy of predictions, the system uses majority voting and state-of-the-art Attention U-Net models with pre-trained ResNet34, Inceptionv3, and DenseNet121 backbones. Following training of the ensemble over a heterogeneous dataset of REFUGE, Drishti-GS, and RIM-ONE images, the ensemble outperforms in glaucoma classification and fundus image segmentation. The novelty lies in the complementary use of ensemble learning and backbone-specific Attention U-Nets, which improve segmentation accuracy and reduce model overfitting. Traditional preprocessing methods, Gaussian noise removal, and a CNN-based classification pipeline further enhance the accuracy of predictions. The system finally offers an efficient and automated way to enable early glaucoma screening and diagnosis.

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I. INTRODUCTION

One of the most common reasons for permanent blindness in the world is glaucoma, a chronic eye disease. Its most prevalent cause is elevated intraocular pressure that progressively destroys the optic nerve. The World Health Organization estimates that millions of people around the world have glaucoma, many of whom remain undiagnosed because no apparent symptoms are observed during its early stages. Its insidious presentation—where patients remain symptom-free until substantial loss of vision has occurred—makes disease prevention against glaucoma very difficult. Prevention of permanent loss of vision and preservation of sight hinge on early and correct glaucoma diagnosis.

Glaucoma screening is typically done by fundus photography, a method that records images of the inner eye surface, such as the retina, optic disc (OD), and optic cup (OC). One of the very important measurements utilized in hospitals for the diagnosis of glaucoma is the optic cup-to-optic disc ratio, or the C/D ratio. The diagnostic unreliability in this context occurs because of the time-consuming nature and interclinician variation in visual examination of these attributes. Thus, this situation highlights the necessity for the development of automated and objective diagnostic equipment to aid ophthalmologists in making faster and more accurate diagnoses.

The recent developments in artificial intelligence have led to very powerful computerized medical imaging equipment. In particular, convolutional neural networks (CNNs) have been found to be very useful in image segmentation and classification. These networks are especially suitable for glaucoma screening fundus photograph analysis because they are able to detect fine retinal image patterns. This paper proposes an automated method suitable for simultaneous segmentation of optic disc and optic cup using an ensemble of convolutional neural network (CNN)-based models. The use of a customized Attention U-Net model coupled with a number of pre-trained backbone models are suggested. Through a combination of predictions from different models through a majority voting technique, the ensemble method increases accuracy and stability. The system was trained and tested on a broad range of data including publicly available benchmark datasets.

The novelty of the approach is in the combination of attention mechanisms with ensemble learning to facilitate better segmentation performance. The framework also employs preprocessing methods for normalizing image data and removing noise, thus ensuring homogeneous input quality. This work is to improve the design of scalable, autonomous, and robust glaucoma screening machines that can be easily implemented in clinics for early detection of glaucoma. This innovation allows for timely intervention through the facilitation of accurate segmentation and classification of glaucoma from fundus images.

Anomalous Event Detection Methodologies for Surveillance Application: An Insight

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