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Residual Network-Based Deep Learning Framework for Diabetic Retinopathy Detection

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ABSTRACT

Artificial intelligence and machine learning have been transforming the health care industry in many areas such as disease diagnosis with medical imaging, surgical robots, and maximizing hospital efficiency. The Healthcare service market utilizing Artificial Intelligence is expected to reach 45.2 billion U. S. Dollars by 2026 from its current valuation, off $4.9 billion. Diabetic Retinopathy (DR) is a disease that results from complications of type one and Type two diabetes and affects patients' eyes. Diabetic retinopathy, if remains unaddressed, is one of the most serious complications of diabetes, resulting in permanent blindness. The disease has been affecting the lives of 347 million people worldwide. The paper aims to propose a residual network-based deep learning framework for the detection of diabetic retinopathy. The accuracy of our approach is 83% whereas the precision value for checking the absence of DR is 95%.

KEYWORDS

Artificial Intelligence, Diabetes, Diabetic Retinopathy, Machine Learning, Deep Learning

1. INTRODUCTION

The retina is a particularly sensitive or light-sensitive tissue at the back of our eyes that converts light into pictures. Diabetic Retinopathy is initiated by distorting the blood vessels in the retina of diabetics (DR). Diabetic retinopathy is characterized by double vision and impaired vision. Both eyes are frequently affected. Diabetic retinopathy may scar and destroy the retina if left untreated, resulting in partial or full blindness. Diabetic Retinopathy usually progresses in four phases. Mild, moderate, severe, or Proliferative non-proliferative retinopathy are the phases. Diabetic retinopathy (DR) is the most common cause of visual loss. Diabetes mellitus is connected to ophthalmoscopically undetected neurovascular damage that occurs before the onset of the first clinical signs of DR. Early surgical and nonvisible structural neuroretinal changes have been detected using, reduced contrast

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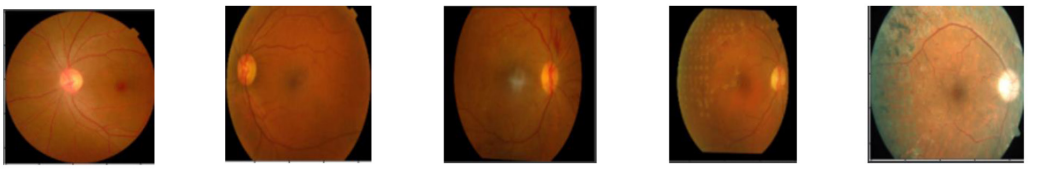
responsiveness primarily at low-frequency components and macular optical coherence tomography, unusual consequences in color vision and microperimetry tests, and a sustained implicit time documented by multifocal electroretinography.

To diagnose the early stages of DR, vascular anomalies such as alterations in retinal artery caliber, morphological indices, and blood circulation have been studied. Early indicators of DR have been discovered as Optical Coherence Tomography Angiography findings, retinal vascular oxygen saturation trends, and higher levels of circulating markers and cytokines. It may lead to complications if not detected early enough. Regrettably, DR is not a curable condition, and therapy merely assists to slow the progression of vision loss. The risk of vision loss may be greatly reduced if DR is detected and treated early. Ophthalmologists must manually detect DR, which is difficult and time-consuming. As a result, automatic identification is necessary, and DR has been identified and categorized using machine and deep learning methods. Unlike computer-aided diagnostic approaches, manual diagnosis of DR retina fundus pictures by ophthalmologists takes time, effort, and money, and is prone to misdiagnosis. Deep learning has recently risen to prominence as one of the most popular approaches for improving performance in a variety of fields, notably medical image processing and classification. Convolutional neural networks are being increasingly commonly employed in medical image processing as a deep learning method, and they are quite successful. The retina images with all the four stages along with healthy retina images are shown in Figure 1. Therefore, we can say that Diabetic Retinopathy is the leading cause of blindness in the developing world as it can develop in people with both Type one and Type two diabetes. Also, the risk of developing diabetic retinopathy increases the longer one has diabetes.

As per WHO, currently, about 422 million people worldwide have diabetes and the majority of diabetic people are living in developing countries. Also, the number of diabetic people is continuously increasing.

Figure 1. Types of non-proliferative retinopathy



Diagnosis of DR is generally done by the eye doctor either by dilating the pupils or by injecting a fluorescent dye to see the images of blood vessels in the retina. But, the diagnosis of DR is very complex and needs to be performed by a trained retina specialist. With the help of a retina specialist, DR can be diagnosed at an early stage and the treatment can be started immediately which can stop the damage to the retina and prevent vision loss. But, due to the inadequate access to trained retina specialists in rural and semi-urban areas, most of the patients affected by DR visit a retina specialist only at a severe stage. Therefore, an intelligent diagnostic system is required that can perform a comprehensive eye test for diagnosing DR along with its current stage. AI-based tools can play an important role in the detection and identification of the severity of eye diseases. In the course of work, the authors perceived that AI can play a major role in the detection of diabetic retinopathy. In this research article, the authors have proposed a residual network-based deep neural network model for the detection of DR. As shown in Figure 2, the proposed model can not only detect DR but also detect the various stage of DR.