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Deep Convolutional Neural Network for Detection of Microaneurysms in Retinal Fundus Images at Early Stage

Authors : Goutam Kumar Ghorai, Sandip Sadhukhan, Arpita Sarkar, Debprasad Sinha, G. Sarkar, Ashis K. Dhara

Abstract : Diabetes mellitus is one of the most common chronic diseases in all countries and continues to increase in numbers significantly. Diabetic retinopathy (DR) is damage to the retina that occurs with long-term diabetes. DR is a major cause of blindness in the Indian population. Therefore, its early diagnosis is of utmost importance towards preventing progression towards imminent irreversible loss of vision, particularly in the huge population across rural India. The barriers to eye examination of all diabetic patients are socioeconomic factors, lack of referrals, poor access to the healthcare system, lack of knowledge, insufficient number of ophthalmologists, and lack of networking between physicians, diabetologists and ophthalmologists. A few diabetic patients often visit a healthcare facility for their general checkup, but their eye condition remains largely undetected until the patient is symptomatic. This work aims to focus on the design and development of a fully automated intelligent decision system for screening retinal fundus images towards detection of the pathophysiology caused by microaneurysm in the early stage of the diseases. Automated detection of microaneurysm is a challenging problem due to the variation in color and the variation introduced by the field of view, inhomogeneous illumination, and pathological abnormalities. We have developed aconvolutional neural network for efficient detection of microaneurysm. A loss function is also developed to handle severe class imbalance due to very small size of microaneurysms compared to background. The network is able to locate the salient region containing microaneurysms in case of noisy images captured by non-mydriatic cameras. The ground truth of microaneurysms is created by expert ophthalmologists for MESSIDOR database as well as private database, collected from Indian patients. The network is trained from scratch using the fundus images of MESSIDOR database. The proposed method is evaluated on DIARETDB1 and the private database. The method is successful in detection of microaneurysms for dilated and non-dilated types of fundus images acquired from different medical centres. The proposed algorithm could be used for development of AI based affordable and accessible system, to provide service at grass root-level primary healthcare units spread across the country to cater to the need of the rural people unaware of the severe impact of DR.

Keywords : retinal fundus image, deep convolutional neural network, early detection of microaneurysms, screening of diabetic retinopathy
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