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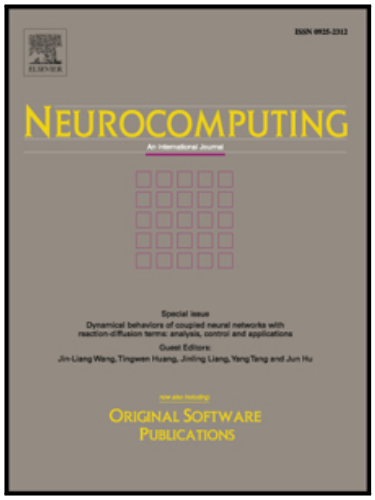

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Diverse lesion detection from retinal images by subspace learning over normal samples

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Abstract

Lesion detection from retinal images is an important topic in the retinal image analysis. Many computer-aided detection techniques have been developed for detecting retinal lesions. However, these techniques are mainly used to detect specific lesion types from retinal images. They cannot be applied to detect diverse types of lesions from retinal images, which is a challenging task because lesion number and types in retinal images are generally unknown in advance, and different lesions may exhibit diverse properties in shapes, sizes, colors, textures and positions. Inspired by the doctors' visual diagnostic mode, this paper proposes a novel computational framework to detect various types of lesions from retinal images. In this framework, many healthy fundus images are collected to act as "doctors' detection experience", and local visual properties of lesions are used to distinguish true positives from false positives. A specific subspace is learned from the collected normal set and acts as a specific structural filter, by which various lesions in a retinal image can be filtered out while other normal regions keep little changes. By computing the difference image between a target image and its filtered image, different types of lesion candidates can be separated from the image. Furthermore, based on local visual context properties of lesions, the true lesions are identified from the lesion candidates. Extensive experiments have shown that the proposed method can more effectively detect diverse lesions from retinal images compared with related methods.

Keywords: Diverse types of lesions; Lesion detection; Normal fundus images; Segmentation; Luminance difference; Subspace learning

1. Introduction

Retinal related lesions (diabetic retinopathy, macular edema, pigmentation, etc.) can damage the patients' vision and may even lead to blindness. Early diagnosis can alleviate the progression of fundus diseases and prevent blindness [1]. For the purpose, fundus disease screening is widely used by inspecting color fundus images of persons. Here, the fundus disease screening is to detect all possible abnormal regions from retinal images. However, this is a complex and time-consuming task. Junior doctors are apt to miss some lesions, or mistakenly identify some normal regions as lesions. Even experienced ones sometimes make similar mistakes when distracted or over-loaded. In order to overcome such drawbacks from human factors, this paper tries to develop a computer-aided technique to detect various types of abnormal regions from retinal images.

In retinal images, large lesions can be easily detected by visual inspection. So, this paper mainly focuses on the detection of small lesions in retinal images. In retinal images, sometimes a large number of small lesions may exist. Additionally, lesion number and types are generally unknown in advance, and different lesions may exhibit diverse properties in shapes, sizes, colors, textures and positions as shown in Fig. 1. Furthermore, the individual differences of blood vessels in retinal images may interfere with the detection of lesions. This makes it a challenging problem to detect different types of small lesions from a retinal image.

In the past few years, extensive computer aided diagnosis (CAD) algorithms [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14] have been proposed to detect lesions from retinal images. In these techniques, lesions of interest are assumed to have certain similar features, which are spec-

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