Fundus Images Segmentation by Unsupervised Classification

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Abstract

In this paper, we present an original unsupervised segmentation scheme which splits a grey level image into different sets of connected pixels whose grey levels are homogeneous. This approach is based on an analysis of a triangular table denoted "Normalized connectivity degrees pyramid". This method is used in order to detect cytomegalovirus retinitis lesions by fundus image analysis. First, we determine the number of pixels classes and their cores. The core of each class C_j is represented by an interval of grey levels $[min_{C_j}, max_{C_j}]$. For classification purpose, the pixels whose grey level belongs to such an interval are labelled to the corresponding class. The other pixels are assigned by comparison of their conditional probability to belong to the different classes.

1 Introduction

A retinal lesion called CytoMegaloVirus (CMV) retinitis was found for patients suffering from immune deficiency syndrome (AIDS). The patients may lose their visual capability because this ocular infection attacks the optic nerve, the papilla, blood vessels, and the fovea, involving a progressive retinal destruction. The ophthalmologists have to evaluate the evolution of the lesion surface and the color of the retinal in order to determine the response of the CMV retinitis to antiviral therapy.

The evolution of these lesions is evaluated by ophthalmologists through a visual examination of serial fundus photographies where these lesions appear as textured yellow regions against a red background.

As it is difficult to distinguish the contours of these yellow regions, the ophthalmologists can't achieve accurate and reliable measures.

Such limitations call for an automatic system in order to process colorimetric and geometrical information of the retinitis lesions by color fundus images analysis. Such a system will be designed in order to evaluate the evolution of a lesion by the comparison of successive fundus images.

In this paper, we present a new image segmentation scheme designed to extract the homogeneous regions which represent the retinitis lesions from grey level fundus images.

The segmentation is achieved by an unsupervised pixels classification scheme in which an homogeneous region is a set of connected pixels which are assigned to the same class characterized by the grey levels of its pixels.

In order to segment biomedical images, Cheng and al. [1] propose a segmentation method using a competitive hopfield neural network based upon the global grey levels distribution. Vitulano and al. [2] propose a hierarchical tree approach (e.g. quad-tree). The relation between the entropy of an image and the entropy of its sub-domains is explored as an uniformity predicate. Recently, another developed approach consists in applying the concept of fuzzy objects in order to detect multiple sclerosis lesions [3]. An operator interactively selects a few points in the image by pointing different objects in the scene. Then, each of these objects is