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A smart feature selection technique for object localization in ocular fundus images with the aid of color subspaces

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Abstract

We propose a technique for selecting effective features for object localization in ocular fundus images. The technique has made it possible to conduct smart feature analysis with the aid of color subspaces when solving a problem of selecting the areas of interest. The relevance of the problem is associated with enhancing the effectiveness of laser coagulation surgery. The proposed technique enables not only the informative features to be extracted in particular color spaces but also the most informative color subspace to be identified. The technique allows an effective feature for separating two particular classes to be identified at a definite size of the fragmentation block thanks to the use of various feature selection rules. The technique also makes it possible to find a universal feature using which two particular initial classes can be separated with a minimal clustering error in all color subspaces, also finding a color-specific in-formative feature enabling the majority of classes under study to be separated. The most informative color subspace was defined.

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Keywords: fundus images; image processing; diagnostic features; laser coagulation; texture analysis

1. Introduction

These days, diabetes mellitus has become the most common endocrine disease in the world. Among others,

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diabetes complications include pathological cardiovascular changes of retina (Fig.1), resulting in oxygen deprivation of the retina tissue. This condition of the visual system provokes the development of diabetic retinopathy (DRP).

a b

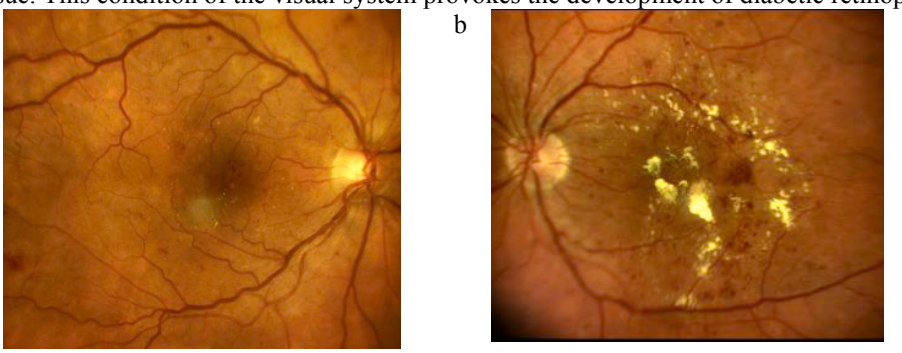

Fig.1. The example of a fundus diagnostic image (a) without pathology; (b) with pathology detected.

Laser coagulation of retina is a gold standard in the treatment of DRP [1, 2]. In the course of laser treatment, the macular edema zone is exposed to a series of dosed microburns or laser coagulates. The coagulates are applied either one at a time or as a series of coagulates arranged in a given regular pattern, or based on a preliminary planning of the coagulate pattern using a real-time retina image [3].

It is preferable to arrange the coagulates in the zone of macular edema in an optimal way, possibly applying them at equal distance and avoiding blood vessels. If the coagulates are arranged manually one by one, their optimal arrangement will be subjective and the planning will take longer (Fig2). For the laser coagulation procedure to be automated, image fragmentation in the region of interest needs to be implemented. Thus, the development of a feature selection technique for fundus image fragmentation enabling coagulates to be automatically arranged in the macular edema zone presents a relevant problem [4]. In order to calculate an informative feature space, the image was preliminarily divided into fragments containing specific regions of interest, with four classes of objects found there: exudates, thin vessels, thick vessels, and intact areas. Note that learning of the recognition system was conducted using the expertise of a medical expert. The area of the macular edema is characterized by the accumulation of exudate zones. When conducting laser treatment, it is forbidden to apply coagulates on thick vessels and recommended to avoid affecting intact areas and thin vessels, thus enhancing the effectiveness of the laser surgery.

a b

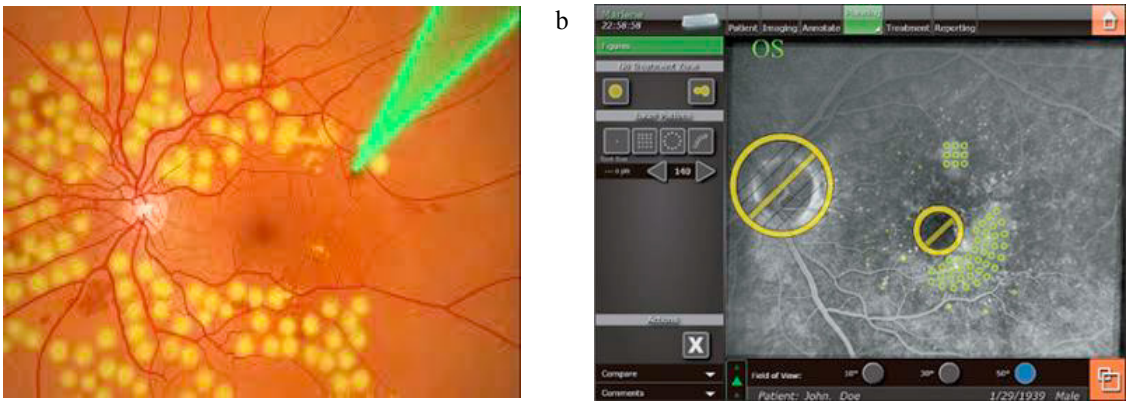

Fig.2. (a) example of laser coagulation of retina; (b) pattern examples of the software NAVILAS.