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Improvement of the Hard Exudates Detection Method Used For Computer- Aided Diagnosis of Diabetic Retinopathy

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***Abstract*—** Diabetic retinopathy is a severe and widely spread eye disease. Early diagnosis and timely treatment of these clinical signs such as hard exudates could efficiently prevent blindness. The presence of exudates within the macular region is a main hallmark of diabetic macular edema and allows its detection with high sensitivity. In this paper, we combine the k-means clustering algorithm and mathematical morphology to detect hard exudates (HEs) in retinal images of several diabetic patients. This method is tested on a set of 50 ophthalmologic images with variable brightness, color, and forms of HEs. The algorithm obtained a sensitivity of 95.92%, predictive value of 92.28% and accuracy of 99.70% using a lesion-based criterion.

***Index Terms*—** Ophthalmology, Color Fundus Images, Diabetic Retinopathy (DR), Hard exudates, Segmentation, Mathematical morphology, k-means clustering algorithm.

I. INTRODUCTION

The diabetic retinopathy (DR) is a microvascular complication of diabetes [1], which affects blood vessels and causes abnormalities in the retina. It remains an important cause of visual impairment and the first cause of blindness in people under 60 years. The evolution of the disease is slow and there are no salient symptoms in the early stages of diabetic retinopathy, but their number color fundus image. The location of the exudates in the macular region is valuable information for the ophthalmologist [4-5], their number is an indicator of disease severity. They are not only a perceptible sign of diabetic retinopathy but also an indication for the occurrence of retinal edema. Edema and exudates are major origins of visual loss in the non- proliferative forms of DR.

Sanchez et al [6] proposed a method based on mixture models to threshold images in order to separate exudates from background. They obtained a sensitivity of 90.2%. at a cost of failure in detecting faint exudates. Garcia et al. [7] used classifiers and machine learning techniques for exudate detection. Using a lesion-based criterion, they obtained a mean sensitivity of 88.14%. Dupas et al [8] presented a pixel-based hard exudate detection method in ocular-fundus images. They obtained 92.8% sensitivity by analyzing 30 images set containing 15 exudates ones. Sanchez et al [9] used a contextual information for exudate detection. They obtained 91% sensitivity and 70% specificity they used 144 images (69 with exudates and 75 normals) divided into two 72-image groups. Hussain et al [10] used a combination of coarse and fine segmentation to detect HEs. The result is achieved with 89.7% sensitivity, 99.3% specificity and 99.4% accuracy. A limitation of this method is that it occasionally fails to exclude some non-exudate objects particularly those that have similar features to real exudates. In another work of Hussain et al [11], top-down