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A Computer Aided System for Grading of Maculopathy

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***Abstract*—In medical imaging, digital images are analyzed to develop computer aided diagnostic (CAD) systems using state of the art image processing and pattern recognition techniques. Diabetic maculopathy is one of the retinal abnormalities in which diabetic patient suffers from severe vision loss due to affected macula. In this paper, we propose an automated system for the grading of diabetic maculopathy to assist the ophthalmologists in early detection of the disease. We present a three stage system consisting of macula detection, exudate extraction and grading of maculopathy. First stage uses optic disc and blood vessels to extract macula from retinal image. Exudate extraction stage extracts all possible exudates from retina using filter bank and support vector machines. Finally, the system grades the input image in different stages of maculopathy by using the macular coordinates and exudate feature set. The evaluation of proposed system is performed by using publicly available standard retinal image databases.**

I. Introduction

The research in medical imaging is of great significance in this modern era. The study in this field will greatly benefit the health care systems and society. One of the common diseases all over the world is diabetes in which the lack of insulin causes high blood sugar in humans. The long term diabetes also affects the human retina resulting in a condition known as diabetic retinopathy (DR). This condition damages the retinal blood vessels causing them to leak which ultimately leads to blindness [1].

There are several stages of DR and maculopathy is one of these in which macula is surrounded by the exudates and patient's central vision is affected. Exudates are yellowish deposits of protein present in the retina which are caused by the leakage of blood from blood vessels. Macula is accountable for the clear, sharp and detailed vision [1]. The center of macula is called fovea which is responsible for very fine details in the image. Diabetic maculopathy occurs if exudates appear on or near the macula affecting central vision. The human visual loss can be prevented by early screening and diagnosis of diabetic maculopathy. The two types of macular edema are non clinically significant macular edema (Non-CSME) and clinically significant macular edema (CSME). Non-CSME is a mild form of maculopathy in which there are no symptoms of the disease because the locations of exudates are at a distance from fovea and the central vision is not affected. CSME is the severe form of maculopathy in which the exudates leak out and get deposited very close to or on fovea affecting central vision of the eye [2].

A number of complete systems for maculopathy detection have been proposed by different authors. Shahawy et. al. [4] proposed a method for segmentation of diabetic macular edema in fluorescein angiograms. Their proposed method is based on modeling the macular image in early time frame using 2D Gaussian surfaces which is then subtracted from the late time frame image to enhance the macular edema regions. The resulting difference image is segmented using GMM classification algorithm. The proposed method gives good results on local dataset. In [9], the diabetic macular edema is classified in which marker controlled watershed transformation is used for exudates feature extraction. The exudates from the fundus image are extracted and their location along with marked macular regions is utilized for the classification of macular edema into different stages. The method was tested on MESSIDOR database and the sensitivity is found to be 80.9% and specificity of 90.2%. Deepak et. al [10] proposed a method for automatic assessment of macular edema using supervised learning approach to capture the global characteristics in fundus images. Disease severity is assessed using a rotational asymmetry metric (motion pattern) by examining the symmetry of macular region. The method is tested on publicly available databases like diaretdb0, diaretdb1, MESSIDOR and DMED. The accuracy for the maculopathy detection is found to be 81%. [11] presented a method for classification of exudative maculopathy using FCM clustering and artificial neural networks. The authors have reported sensitivity of 92% and specificity of 82% on some local dataset. In [3], the automated system for grading of diabetic maculopathy is proposed. The macula is localized and hard exudates are detected using clustering and mathematical morphological techniques. Based on the location of exudates, the severity level of diabetic maculopathy is defined in a marked region of macula in abnormal fundus image. The method is tested on local dataset and the sensitivity and specificity were found to be 95.6% and 96.15% respectively.

This article consists of four sections. The proposed system and its complete explanation are given in section 2. The experimental and comparative results of proposed system using different evaluation parameters and databases are elaborated in

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