

Chapter 9

An Approach for Automatic Detection and Grading of Macular Edema

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ABSTRACT

Prolonged Diabetes causes massive destruction to the retina, known as Diabetic Retinopathy (DR) leading to blindness. The blindness due to DR may consequence from several factors such as Blood vessel (BV) leakage, new BV formation on retina. The effects become more threatening when abnormalities involves the macular region. Here automatic analysis of fundus images becomes important. This system checks for any abnormality and help ophthalmologists in decision making and to analyze more number of cases. The main objective of this chapter is to explore image processing tools for automatic detection and grading macular edema in fundus images.

INTRODUCTION

The retina is a light sensitive tissue found at the back of the eye. It perceives light signal passed through the lens and accumulates at the center of retina called macula. The perceived signal is then send to the brain through optic nerve, where it is translated to the picture we see. The legitimate functioning of retina depends on constant supply of oxygen carried through blood vessel (BV)s (Diabetes Care, 2004; Diabetes Care, 2003; NHS Choices, 2014). Inadequate supply of oxygen gradually ceases the functionality of retina leading to vision complexities. There are various aspects causing impairment of the retina such as, hypertension, diabetes, old age, heart diseases etc. Various complexities of the retina is commonly known as ‘Retinopathy’. Retinopathy begins with blockage of BV leading to blood leak over the retina. With gradual progression of the disease blood constituents like lipids and fatty materials also get deposited over retina. With deposition of such materials, the vision becomes blur. We may visualize it as being looking into an object through these depositions as shown Figure 1. As shown in second image of Figure 1 we observe the image as blur, because blood is not clear as water and the black region in the image represents the fatty material depositions over retina.

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Figure 1. Normal vision vs. Vision with Retinopathy



The macula (Cataract and Laser Institute, 2012) of the retina consists of large number of cone cells located at the posterior pole of the eye, between the superior and inferior temporal arteries and is responsible for the central and sharp vision, for example, reading, watching television, writing, recognizing objects, colors etc. During progression of retinopathy, if depositions include macula or neighborhood of macula it is known as maculopathy. During maculopathy the vision severely gets effected and if not taken care at early stage, it may lead to vision loss. Various symptoms of maculopathy (Patient, 2014) includes, gradual loss of central vision causing obstruction or blurred patch as shown in Figure 2, distortion of image size and shape etc. As shown in the figure, the patient is able to see the clock but not the time.

Generally maculopathy occurs with age, (EyeSmart, 2013; ILMO, 2012) commonly known as Age related Macular Degeneration (AMD). Generally AMD starts after the age of 50. During AMD lipid structures leak from epithelial layer of eye and fall in neighborhood and/or over the macula. Maculopathy is also observed in younger age with patients having diabetes, known as Diabetic Macular Edema (DME). At initial stages of diabetes it is not much effective, but gradually with progression of disease the depositions will severely affect the vision and lead to blindness. Therefore one must go for regular eye examinations, at least once a year to avoid such complications. Ophthalmologists widely use fundus images for analysis of retinopathy. To investigate more features Optical Coherence Tomography (OCT) (EyeSmart, 2015) and Fluorescein angiography (MedlinePlus, 2015) are performed. The number of ophthalmologists compared to the retinopathy patients is very less with a ratio of 1:70,000. Thus, analysis of retinopathy with such huge extent is not easy. Many national screening programs have already started but will need time to meet the requirement. Automatic screening programs for analysis of retinopathy provides a helping hand in this regard. The automatic screening algorithms uses fundus images for analysis.

The chapter contains a direction towards automatic detection of maculopathy using fundus images. Few fundus image analysis methods for detection and grading of maculopathy have been presented

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