INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	JYOTI PRAKASH MEDHI
Roll Number	:	10610226
Programme of Study	:	Ph.D.
Thesis Title	:	AUTOMATED DIAGNOSIS OF DIABETIC MACULOPATHY FROM RETINAL IMAGES
Name of Thesis Supervisor(s)	:	PROF. SAMARENDRA DANDAPAT
Thesis Submitted to the Department/ Center	:	ELECTRONICS AND ELECTRICAL ENGINEERING
Date of completion of Thesis Viva-Voce Exam	:	13.02.2021
Key words for description of Thesis Work	:	Diabetic Maculopathy, Fundus Image, OCT Image, Fovea, Macula

SHORT ABSTRACT

Ophthalmology is the study of structure, function, and diseases of the eye. This complex sense organ eye facilitates the vision and perception of the surrounding. But unfortunately, due to aging and several eye associated disorders, the experience of reduced visual acuity has become common among the patients, and if left untreated, it leads to vision impairment and even vision loss. Accordingly, the main focus of the ophthalmologists is to diagnose and manage such types of vision impairments. The recent technological advancements in imaging technologies have upgraded the ophthalmological diagnosis and eventually made it possible to detect minute structural features and anomalies. But high patient to doctor ratio increases the challenges for proper management of the patients. Therefore, to meet up the requirement, the involuntary methods for retinal image analysis are much more convenient and aid the ophthalmologists to screen at a faster rate. Hence, in this thesis, we have taken an engineering perspective and developed automated image analytics methods for the diagnosis of one such vision-threatening retinal disease called Diabetic Maculopathy (DM). Extended diabetes for a longer period starts effecting the vision due to leakage of blood and its components (lesions) over the retina. These depositions become vision threatening if they precipitate over the macula. Such retinal deformity is termed as DM and may lead to vision impairment if not diagnosed in time. The analysis of DM is possible through the evaluation of fundus and optical coherence tomography (OCT) images. This thesis first develops an automated analytics method for the diagnosis of DM using the fundus image. It detects the changes in the retina for the classification of DM. Later, for the investigation of changes in retinal layers with respect to DM progression, the thesis proposes an automated algorithm using the OCT image. The fundus image analysis for DM diagnosis seeks identification of fovea and lesions over the retina. The deposition of these lesions in the fovea neighborhood signifies the presence of DM, and its severity is measured with their position closer to the fovea. Hence, the accurate position of both fovea and lesions is an essential factor. In this thesis, we have identified the exact fovea location with the help of avascular property of fovea, and the novelty of the approach is that it is independent of the optic disc (OD) and fovea geometrical relation. The method is further improvised to detect the fovea in severe DM cases by generating and matching the ellipse template. Under this condition, most of the existing algorithms fail to locate fovea. The detection of OD is necessary to mark the fovea neighborhood, and it is detected by the property of OD, possessing maximum blood vessels. The lesions are identified with the help of their color information, and the method is upgraded by the addition of shade correction and false-positive elimination. The DM is classified into mild, moderate, and severe stages based on the position of these lesions in the calculated fovea neighborhood. Along with classification, the thesis also evaluates the deposition intensity and classifies it into the average and acute stage. The fundus images are subjected to monitoring the changes occurring over the retina. But due to DM, the retinal layers also get effected with blood leakage and deposition of blood due to the growth of fragile new blood vessels. Hence, the requirement of OCT image analysis comes into the picture. During DM, the retinal layers are subjected to blood and exudate deposition, which alters the retinal thickness. Therefore, the automated diagnosis system requires estimation of retinal thickness with localization of inter-retinal cysts. The OCT images are highly susceptible to speckle noise, and the novelty of the thesis work is the elimination of it using Guided image filtering along with preserving the edge information. Thereafter the retinal layer thickness is obtained with the help of automated level set algorithms that detects variational boundaries leaving no component undetected. The boundary separation for the detection of cysts is the positive aspect of the algorithm, which detects the cyst area efficiently. Proposed algorithms are evaluated thoroughly for accuracy and statistical reliability. For the investigations with the fundus image, our methods are experimented on various publicly available databases. Among these, only a few have manually annotated information for comparison. For attaining annotations, we have consulted three ophthalmologists from the Guwahati Eye Institute and evaluated the algorithms. To verify the algorithms on local clinical images, we have also collected fundus images from the hospitals. For OCT images we have analyzed the algorithms on collected color OCT images from local hospitals. Later, for the performance comparison we have conducted tests following state-of-art algorithms on two publicly available database. We want to add in a general clinical context that the proposed algorithms may be treated as a solution to the specific ophthalmologic problem with its engineering perspective.