ABSTRACT

The work in this thesis mainly focuses on the development of an automatic system, for the purpose of detecting anatomical and pathological features in colour retinal images, with its application to diagnosis of diabetic related eye diseases.

Diabetes mellitus, a metabolic disorder, has become one of the rapidly increasing health threats both in India and worldwide. The complication of the diabetes associated to retina of the eye is diabetic retinopathy. A patient with the disease has to undergo periodic screening of eye. For the diagnosis, ophthalmologists use colour retinal images of a patient acquired from digital fundus camera. Limited number of specialist ophthalmologists in most of the countries motivates the need for computer based analysis of retinal images using image processing techniques. This could reduce the workload of ophthalmologists, also aid in diagnosis, to make measurements and to look for a change in lesions or severity of disease. The present study is aimed at developing an automatic system for the extraction of normal and abnormal features in colour retinal images.

Prolonged diabetes causes micro-vascular leakage and micro-vascular blockage within the retinal blood vessels. Therefore segmentation of retinal vasculature is of primary interest in the detection of retinopathy. Filter based approach with a bank of Gabor filters is used to segment the vessels. The frequency and orientation of Gabor filter are tuned to match that of a part of vessel to be extracted in a green channel image. A set of 12 filters with different orientations in the range of 0 to 170 degrees are convolved with the image and only the maximum response at each pixel is retained. Filtering leaves the image with enhanced vessels compared to the background. To classify the
pixels into vessels and non vessels entropic thresholding based on gray
level co-occurrence matrix is applied. The performance of the method is
evaluated on two publicly available retinal databases with hand labeled
ground truths. The result of vessel segmentation could help in
registering two images in order to compare images taken at different
examinations for monitoring the progression of the disease.

The accurate segmentation of optic disc is often an essential
prerequisite step in identification of other retinal anatomical and
pathological features. Optic disc localization and its exact boundary
detection have been addressed in this work. Iterative thresholding
method followed by connected component analysis is employed to locate
the optic disc and to find its approximate center. Geometric model based
implicit active contour is applied to find the exact boundary of the optic
disc. The result of optic disc localization could be used to localize macula
or fovea, the other retinal anatomical feature. Also, the optic disc is
masked during the detection of lesion, that is, hard exudates to avoid
false positives. The result of boundary detection could be used to detect
early signs of Glaucoma, which is another sight threatening disease.

Maculopathy is one of the sight threatening stages of diabetic
retinopathy. Onset of exudates in the macular region is indicator of
macular edema. Manually, severity of maculopathy is decided based on
the distance of exudates from the center of macula. As the manual
method is highly subjective, an automatic maculopathy detection and
severity level grading into mild, moderate and severe is presented.
Hard exudates are detected using a K-Means clustering followed by
morphological reconstruction. Macula is detected based on the distance
from the optic disc. Macular region is drawn based on the international
standards to find the exact locations of exudates. It is hoped that this
system could assist the ophthalmologists to detect the signs of diabetic
maculopathy and its severity level in lesser time. The sample image
data used to validate the system was comparable with the manual graders with regard to severity of the disease. A user interface is also provided for speedy analysis of large number of retinal images during mass screening. It is hoped that the system could assist the ophthalmologists, to detect the signs of diabetic retinopathy in the early stage, for a better treatment plan and to improve the vision related quality of life.