INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis work is an investigation of multiscale analysis of diagnostic features of the color fundus images. Analysis of diagnostic features is done in the multiscale domain by wavelet transform. There are three major contributions. First, the different wavelet subbands are investigated for the presence of retinal features such as exudates and microaneurysms. Secondly, the pathological features are extracted. Blood vessels are extracted by using Kirsch and Gaussian matched filter (MF) based method. Inpainting is performed on the green channel image by considering the blood vessels structure as a mask for detecting the amount of blood vessels affected by pathologies. Independent component analysis (ICA) is used in multiscale for extraction of exudates and detection of changes in the retina, which occurs due to the progression of diabetes. Third, glaucoma is detected by evaluation of differential entropy in wavelet subband. The performance of different methods is analyzed by different quantitative measures such as, specificity, sensibility, accuracy, universal quality index (UQI), Pearson correlation coefficient (PCC), and structural similarity (SSIM) etc.

The clinically important features of retinal image are the optic disc (OD), the macula and the blood vessels. The ophthalmologists examine these features for signs of various eye related diseases. The retinal image should be of sufficient quality to ensure a reliable diagnosis. Various approaches are available in the literature to study the clinical usefulness of the normal retinal features for different applications. Different features developed over the retina, such as microaneurysms, exudates, and haemorrhages, etc. due to diabetic retinopathy (DR). The analysis of the DR features is not done in the literature from the diagnostic point of view. Here, the spatial localization and multiresolution properties of discrete wavelet transform (DWT) is used for image analysis. The DWT is used to decompose the image into different subbands. The contribution of each subband towards the DR feature information is different. In the present work, the analysis is done in two ways.

First, at a particular level of wavelet decomposition, one level subband coefficients are made zero while un-altering the other level subband coefficients. The reconstructed image is analyzed. Secondly, the image is reconstructed by considering one level subband coefficients only and zeroing other level subband coefficients. From the reconstructed image, the significant information about the DR features at a particular level of subband is analyzed.

These subband information is used for extraction of features. Blood vessels and pathological features are extracted for finding the amount of blood vessel damage due to diabetic retinopathy. ICA is used in the wavelet subbands for extraction of exudates and detection of changes in the retina. ICA on multiscale improves the performance of detection of independent components, which is measured by the Amari performance index (API) and Comon test values. Detected diagnostic features are evaluated quantitatively by the Pearson correlation coefficient (PCC), universal quality index (UQI), structural similarity (SSIM), sensitivity, specificity, and accuracy etc.

The diagnostic information in wavelet subband is used for detection of glaucoma. In the literature, glaucoma is detected by the measurement of the ratio of cup area to the disc area and known as cup to disc ratio (CDR). In case of disc anomalies and inflamed disc, the disc region is not distinguished clearly. So, CDR cannot be used as a measure for glaucoma detection. Here, differential entropy and machine learning techniques are proposed for glaucoma detection. Differential entropy (DE) of the cup is calculated in wavelet subband for detection of glaucoma. The appearance of the cup changes due to glaucoma, which is used for glaucoma classification. Two classification methods are proposed, one is principal component analysis (PCA)-linear discriminant analysis (LDA) and the second is hidden Markov model (HMM)-singular value decomposition (SVD). HMM-SVD has better performance than PCA-LDA based method. DE based measure provides better performance in the detection of glaucoma from other methods.