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DETECTION OF LESIONS FOR DIABETIC RETINOPATHY SCREENING

R.SANTHANAMARI M.SELVA KAMATCHI C.UMARANI

Mrs.A.Murugalakshmi (AP/ECE)

Renganayagi Varatharaj College Of Engineering

ABSTRACT

Retinal images are influenced by all the factors that affect the body vasculature in general. The human eye is a unique region of the human body where the vascular condition can be directly observed. In addition to fovea and optic disc, the blood vessels contributes one of the main features of a retinal fundus image and several of its properties are noticeably affected by worldwide major diseases such as diabetes, hypertension, and arteriosclerosis. Blood vessel segmentation of retinal images plays an important role in the diagnosis of eye diseases. Automatic and accurate blood vessel segmentation system could provide several useful features for diagnosis of various retinal diseases, and reduce the doctors' workload. However, the retinal images have low contrast, and large variability is presented in the image acquisition process, which deteriorates automatic blood vessel segmentation results. For improving the segmentation results, we construct a multi-dimensional feature vector with the green channel intensity and the enhanced intensity feature by the morphological operation. Blood vessel segmentation of retinal images plays an important role in the diagnosis of eye diseases. In this project, the system propose an automatic unsupervised blood vessel segmentation method for retinal images. Firstly, a multidimensional feature vector is constructed with the green channel intensity and the vessel enhanced intensity feature by the morphological operation. However, the retinal images have low contrast, and large variability is presented in the image acquisition process, which deteriorates automatic blood vessel segmentation results.

INTRODUCTION

Segmentation is the process of partitioning an image into set of components. Segmentation of blood vessel and optic disc is necessary for early detection of affected area in the retina. The eye is very unique part in human body where the vascular conditions are directly observed in vivo. The different approaches have been developed for blood vessel and optic disc detection; few of the approaches are discussed in this paper. The blood vessel identification is performed on the basis of blood vessel characteristics such as blood vessel's orientation, cross-sectional area, surface shapes, and abnormal regions volumes. The quantitative

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analysis of retinal images is of increasing importance in the diagnosis of the blood vessel abnormalities. An automated method for identification of optic disc has two methodologies location methodology and boundary segmentation methodology. A computer aided fundus image analysis provides an immediate detection and properties of retinal features prior to specialist inspection. The image segmentation algorithms play an important role in numerous biomedical imaging applications such as diagnosis, localization o pathology, treatment planning, anatomical structure and treatment planning. This paper presents a survey

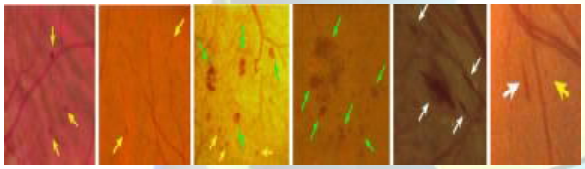

Fig. 1.Portions of different fundus images with red lesions. The yellow, green and white arrows point respectively to MAs/dot HEs, blot HEs and flame HEs.

of blood vessel and optic disc segmentation techniques and algorithms, putting the various approaches and techniques in perspective by means of a classification of the existing research. In the retina blood vessels and optic disc are important parts for an automatic eye detecting diseases, which are shown below.Vessel segmentation approach uses supervised and unsupervised method to segment the blood vessel features. The unsupervised method sub divided into techniques based on the morphological processing, matched filter, multi scale analysis and vessel tracking. The supervised segmentation approach uses ground truth data for the classification of vessels based on given features. Diabetic retinopathy is one of the major causes of blindness. The presence of the diabetic retinopathy is identified by the Vector quantization method. They proposed novel method of detection of the diabetic retinopathy using Gaussian Intensity feature input to a VQ classifier. They achieved 90% diagnostic performance by using vector quantization approach. Few methods uses pure intensity based pattern recognition approaches such as thresholding followed by connected component analysis (CCA). I. Liu et al proposed a method based on vessels tracking technique to obtain the vasculature structure, along with vessel diameters and branching points. Retinal maps were automatically generated by retinal vascular pattern for the treatment of age related macular degeneration. The characteristics points of the retinal vasculature are extracted for multimodal image registration. Retinal images are influenced by all the factors that affect the body vasculature in general. The human eye is a unique region of the human body where the vascular condition can be directly observed. In addition to fovea and optic disc, the blood vessels contributes one of the main features of a retinal fundus image and several of its properties are noticeably affected by worldwide major

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diseases such as diabetes, hypertension, and arteriosclerosis. Further, certain eye diseases such as choroidal neovascularization and retinal artery occlusion also make changes in the retinal vasculature. As per previous statement, the segmentation of blood vessels in retinal images can be a valuable aid for the detection of diabetic retinopathy and glaucoma diagnosis. An automated segmentation and inspection of retinal blood vessel features such as diameter, color and tortuosity as well as the optic disc morphology allows ophthalmologist and eye care specialists to perform mass vision screening exams for early detection of retinal diseases and treatment evaluation. This could prevent and reduce vision impairments; age related diseases and many cardiovascular diseases as well as reducing the cost of the screening. Over the past few years, several segmentation techniques have been employed for the segmentation of retinal structures such as blood vessels and optic disc and diseases like lesions in fundus retinal images. However the acquisition of fundus retinal images under different conditions of illumination, resolution and field of view (FOV) and the overlapping tissue in the retina cause a significant degradation to the performance of automated blood vessel and optic disc segmentations. Computer based automatic blood vessel segmentation is an efficient way to segments the retinal blood vessels. Retinal blood vessels plays and important role in diagnosing eye related diseases. The main function of Retinal blood vessels is to carry fresh blood from heart to eye and then deoxygenated blood back to heart from eye. Many diseases may effect these blood vessels and leads to eye blindness. But the early stage observation of these blood vessel structures through retinal images can help diagnosing eye sight related problems. Many techniques have been proposed for automatic segmentation of retinal blood vessels. This paper is presenting a review of some previously proposed techniques or methods for segmentation of retinal blood vessels. Automatic Retinal blood vessel segmentation plays an important role in diagnosing eye related diseases at early stages in medical field. It is a fast and efficient way of segmenting blood vessels. Blood vessels are the one of the main part of the human eye retina. These blood vessels carry fresh oxygenated blood from heart to feed nutrition's to tissues and cells present in retina and then carry the deoxygenated blood from eye to heart. There are mainly two types of blood vessels arteries those carry fresh blood and vein those carry oxygenated blood. These arteries and vein have many features like diameter, color, tortuosity, opacity etc. there are many diseases like diabetes, hypertension, arteriosclerosis, cardiovascular diseases, Glaucoma and stroke. These disease can affect the blood vessels in some way and can lead to eye sight weakness or

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eye blindness. All these features are observable in some way. The observation of all these feature can lead to relevant information regarding blood vessels. Like width measurement can provide the information regarding any change happen in width of the blood vessel. This information can be further used to detect the diseases, and to prevent the vision loss by providing the required treatment. The detection of diameter of retinal blood vessel also plays an important role in detecting blood vessel structure. Human eye retina also contains an important part that is OD (Optic disc). Detecting OD can help in detecting blood vessel structure easily. Because the blood vessels are originate from OD, also it is a convergence point of blood vessels. According to study Diabetic retinopathy (DR) and glaucoma are the main cause of vision loss or eye blindness in adults. The main cause of DR is long term diabetes. Segmentation of blood vessels with high accuracy is very difficult task because of contrast difference between tree like blood vessel structure and its background, variation in width of vessels, noise, and presence of other features like OD and macula. The image may also contain other pathologies like red lesions and exudates. Manual observation of retinal blood vessel take long period of time and can be affected by inter and intra observation bias. Thus it may take time to diagnose the disease and provide relevant treatment at early stages. As the vascular network is very complex and difficult to segment manually with high accuracy. Thus computer based automatic segmentation can provide fast and easy segmentation of retinal blood vessel without any bias.Several studies were carried out on the segmentation of blood vessels in general, however only a small number of them were associated to retinal blood vessels. In order to review the methods proposed to segment vessels in retinal images, seven classes of methods have been considered: matched filters, vessel tracking, morphological processing, region growing, multiscale, supervised and adaptive thresholding approaches. Retinal blood vessel segmentation has been widely used in various scenarios. For example, change of the retinal blood vessel appearance is an important indicator for various ophthalmologic and cardiovascular diseases, such as diabetes, hypertension, and arteriosclerosis, therefore, automatic segmentation and analysis of the retinal vasculature play an extremely vital role in the implementation of screening programs for diabetic retinopathy, the evaluation of retinopathy of prematurity, foveal avascular region detection, arteriolar narrowing detection, the diagnosis of cardiovascular diseases and hypertension, and computer-assisted laser surgery. [9] proposed a system, this system has concentrated on finding a fast and interactive segmentation method for liver and tumor

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segmentation. In the pre-processing stage, Mean shift filter is applied to CT image process and statistical thresholding method is applied for reducing processing area with improving detections rate. Moreover, the generation of retinal maps and detection of branch points have been utilized for temporal or multimodal image registration, retinal image mosaic synthesis, optic disc identification, fovea localization and biometric identification. Both manual delineation and automatic algorithms have been used in retinal vessel segmentation. However, they have not gained wide acceptance due to several challenges. Manual delineation is skill demanding, tedious, time-consuming, and infeasible if given a large volume of fundus image databases. Accuracy of the automatic segmentation algorithms is limited due to low blood vessel contrast, irregular shaped bright and dark lesions (in the form of hemorrhages, exudates, drusen and the optic disc boundary), intricate vessel topology (including vessel crossing and branching, as well as variation of vessel diameter and vessel grey levels) and nonuniform illumination of images as well as image deformation of scaling, skewing and other distortions. In this paper, we present the hybrid method based upon convolutional neural network (CNN) and ensemble random forests (RFs) for automatic retinal blood vessel segmentation. We first employed a set of preprocessing steps to correct the nonuniform illumination of retinal images and to improve vessel contrast. We then used CNN to extract a set of hierarchical features which are not only invariant to image translation, scaling, skewing and other distortions, but also contain image based multi-scale information of the geometric structure of retina. We finally trained ensemble RFs to obtain a vessel classifier. The whole pipeline of the proposed method is trainable and automatic. Moreover, our method can effectively deal with the challenges of retinal vessel segmentation, as shown by our evaluations conducted using two publicly available databases (the DRIVE and STARE) and comparisons with state-of-the-art.

EXISTING SYSTEM

In the unsupervised methods category, algorithms that apply matched filtering, vessel tracking, morphological transformations, and model-based algorithms are predominant. In the matched filtering-based method, a 2-D linear structuring element is used to extract a Gaussian intensity profile of the retinal blood vessels, using Gaussians and their derivatives, for vessel enhancement. The structuring element is rotated 8–12 times to fit the vessels in different configurations to extract the boundary of the vessels. These methods require that beginning and ending search points are manually selected using cursor or by using simple thresholding techniques. Vessel tracking methods provide very accurate measurements of vessel widths but

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tracking methods often tend to terminate at branch points. Classifier-based method employs two-step approach. They start with a segmentation step often by employing one of the mentioned matched filter-based methods and then the regions are classified according to many features. In the next step neural networks classifier is constructed using selected features by the sequential for-ward selection method with the training data to detect vessel pixels. Mathematical Morphology is employed for segmentation of blood vessels as reported. These methods exploits features of the vasculature shape that are known prior, such as it being piecewise linear and connected. They work well on normal retinal images with uniform contrast but suffer when there is a noise due to pathologies within the retina of eye. Many papers have reported work on segmentation of vessels, but still there is scope for improvement as these methods detect vessels along with artifacts. Also detection process becomes much more complicated in presence of lesions and other pathological changes affect the retinal images. The proposed retinal vessel detection method is comprised of two steps that is the retinal vessel enhancement followed by entropic thresholding. A set of Gabor filters tuned to particular frequency and orientation are used to enhance the blood vessels suppressing the background. Entropy based thresholding based on gray level co-occurrence matrix is employed for the segmentation of the vessels. The following sections elucidate materials and methods for vessel segmentation method, results and discussion. In the colour retinal images, blood vessels appear darker than the background similar to the colour of lesions like microaneurysms and hemorrhages. So it becomes essential to exempt the vessel area during the detection of lesions to avoid false positives. Only one step is involved in the preprocessing of retinal images for segmentation of vessels. It can be seen in the Figure that the blood vessels appear most contrasted in the green channel compared to red and blue channels in RGB image. Only the green channel image is used for further processing suppressing the other two colour components. The Gabor filters are widely applied to image processing and computer vision application problems such as face recognition and texture segmentation, strokes in character recognition and roads in satellite image analysis. Since, the vessels in the retinal image are connected and piecewise linear, for their segmentation gabor filters are better suited as they are capable of detecting oriented features and can be fine-tuned to specific frequencies. Because of their frequency sensitive-ness it is possible to filter out the background noise of retinal images. Different techniques of segmentation of retinal images have been investigated so far. They are filter based methods, vessel tracking methods,

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classifier based methods and morphological methods. The techniques utilize the prior knowledge such as, contrast that exists between the blood vessels and surrounding background, origin of vasculature from the same point that is the optic disc and connectivity of the vessels. Filter based methods employ a two dimensional linear structural element that has a Gaussian cross-profile section to identify the blood vessels, which typically has a Gaussian profile. The gaussian kernel is rotated into different orientations to fit into vessels of different configuration to obtain a vessel enhanced image. The image is then thresholded to extract the vessel part from the background. This works well on images of healthy retina, but in diseased states such as diabetic retinopathy it results in detection of many false positives. These methods suffer from problems associated with detecting smaller and tortuous vessels that are prone to changes in background intensity. Individual segments are identified using a search procedure which keeps track of the center of the vessel and makes some decisions about the future path of the vessel based on certain vessel properties. The underlying idea of this approach is that the response of directional differential operators, using kernels adapted to the local vessel direction, has opposite signs on the two hillsides of an ideal vessel cross pro file; we will, therefore, explore this fact by considering the occurrence of specific combinations of filter response signs. To carry out the initial selection of the most likely centerline segments, the magnitude of the filter response is kept on the positions that verify one of the established sign conditions; this newly generated image is then segmented using region growing in order to retain just those points where restrictive intensity and connectivity conditions meet. Our method can be classified as a pixel processing-based approach. The initial step of vessel centerline detection combines local information, used for early pixel selection, with structural features, as the vessel length.

PROPOSED SYSTEM

This process is mainly used to analyze the blood vessel of the retinal fundus image. This is mainly used to diagnosis the hypertension, arteriosclerosis, cardio vascular disease etc. This process consist of major three things, at first the image is undergone for the process of preprocessing, then the binary conversion is carried out by the effective morphological operation. Then the second step carried out the remaining pixels in the binary images are classified by the use of GMM. i.e., Gaussian mixture model. Then the third step involves the major post-processing process, to classify the blood vessel by the segmented region using the effective feature extraction algorithm. This paper presents a new supervised method for segmentation of blood vessels in

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retinal photographs. This method uses an ensemble system of bagged and boosted decision trees and utilizes a feature vector based on the orientation analysis of gradient vector field, morphological transformation, line strength measures, and Gabor filter responses. The feature vector encodes information to handle the healthy as well as the pathological retinal image. The method is evaluated on the publicly available DRIVE and STARE databases, frequently used for this purpose and also on a new public retinal vessel reference dataset CHASE_DB1 which is a subset of retinal images of multiethnic children from the Child Heart and Health Study in England (CHASE) dataset. The performance of the ensemble system is evaluated in detail and the incurred accuracy, speed, robustness, and simplicity make the algorithm a suitable tool for automated retinal image analysis. This paper presents a new supervised method for segmentation of blood vessels by using an ensemble classifier of boosted and bagged decision trees. The feature vector is based on gradient orientation analysis (GOA), morphological transformation with linear structuring element; line strength measures and the Gabor filter response which encodes information to success-fully handle both normal and pathological retinas with bright and dark lesions simultaneously. The classifier based on the boot strapped and boosted decision trees is a classic ensemble classifier which has been widely used in many application areas of image analysis, but has not been applied within the frame-work of retinal vessel segmentation for automated retinal image analysis. The obtained performance metrics illustrate that this method outperforms most of the state-of-the-art methodologies of retinal vessel segmentation. The method is training set robust as it offers a better performance even when it is trained on the DRIVE database and tested on the STARE database, thus making it suitable for images taken under different conditions without retraining. This attribute is particularly useful when implementing the screening programs over a large multiethnic population where there is a large variability in the background pigmentation level of the acquired retinal images. Moreover, the algorithm is computationally fast in training and classification and needs fewer samples for training. The classification accuracy of the ensemble can be estimated during the training phase without supplying the test data. A new public database CHASE_DB1 is also introduced for the evaluation of the algorithm. This image database includes retinal images of 9-and 10-year-old children of different ethnic origin, along with the ground truths for annotated blood vessels. The database includes images with stark differences in background levels of retinal pigmentation (being more pigmented in South Asians compared to white Europeans). In this paper, we have presented an effective retinal

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vessel segmentation technique based on supervised classification using an ensemble classifier of boosted and bagged decision trees. We have used a 9-D feature vector which consists of the vessel map obtained from the orientation analysis of the gradient vector field, the morphological transformation; line strength measures and the Gabor filter response which encodes information to successfully handle both normal and pathological retinas. The important feature of bagged ensemble is that the reliable estimates of the classification accuracy and feature importance are obtained during the training process without supplying the test data. The ensemble classifier was constructed by using 200 weak learners and is trained on 20 0000 training samples randomly extracted from the training set of the DRIVE and 7 5000 samples from STARE databases. These parameters are chosen by empirically analyzing the out-of-bag classification for a given number of training samples and the decision trees. Our algorithm renders better AUC accuracy, sensitivity, and specificity measures than other state-of-the-art algorithms for both of the DRIVE and STARE databases, being fractionally outperformed in terms of accuracy only. This observation gains more importance by the fact that technique used 41-D feature vector as compared to a 9-D feature vector used by our algorithm and approximately four times more training samples than this work. The Ricci method is proved to be very dependent on the training set, as with cross training, the accuracy dropped from 0.9595 to 0.9266 whereas the drop in accuracy in this study is from 0.9480 to 0.9456; thus, the technique appears to be more robust to the training set used. This training set robustness allows our algorithm to be used on multiple datasets without retraining, which is very useful for large-scale screening programs.

CONCLUSION

In this paper, we proposed a hierarchical retinal blood vessel segmentation method based on feature and ensemble learning. The proposed method has several unique characteristics. First, our features are extracted using not only the last layer output but also the intermediate output therefore contain multiscale information of the geometric structure of the retina. Second, we are the first to introduce random forest into retinal blood vessel segmentation, and employ winner-takes-all as the classifier ensemble method. Third, the whole pipeline of the proposed method is automatic and trainable, which is accomplished by a combination of feature learning and ensemble learning. Fourth, our method was validated using two publically available databases and shown to outperform state-of-the-art. Finally, our method was shown to better handle the challenges in retinal vessel segmentation. This is because it is able to extract

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scale and rotational invariant features and RF is well-known for strong generalization capability.

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