A STUDY OF EXUDATE SEGMENTATION TECHNIQUES FOR FUNDUS IMAGES

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Abstract

The major reason behind new blindness and vision defects in working-age people, diabetic retinopathy is really a serious public health problem in developed countries. Automatic identification of diabetic retinopathy lesions, such as for instance exudates, in fundus images can subscribe to early diagnosis. Currently, many studies in the literature have reported on segmenting exudates, but none of the techniques performs as needed. Moreover, segment exudates with a new unsupervised approach on the basis of the ant colony optimization algorithm indicate better results nonetheless it is suffering from the effectation of the noise. In this paper, a survey on various image segmentation techniques has been done. From the survey, it's been discovered that none of the technique performs effectively in most fields. Consequently the paper ends with the long run scope to overcome these issues.

Keywords

Image Segmentation, Exudate Segmentation, Ant Colony Optimization

TYPE (METHOD/APPROACH)

Ant colony optimization algorithm, Exudate detection

1. INTRODUCTION

Image segmentation is the procedure of partitioning a digital image into multiple segments. The segmentation is to simplify alter the representation of a graphic into something that is more meaningful and better to analyse. Image segmentation is normally used to locate objects and boundaries in images. More precisely, segmentation of image is the procedure of assigning a label to every pixel in a graphic in a way that pixels with the exact same label share certain visual characteristics.

Fig. 1 From left to right: original color image; green plane image; normalized gray level image; normalized image histogram

Fig. 2 From left to right: original color image; binary image with exudate candidates (Icand); ACO algorithm gray-level image; green plane image with the exudate segmentation.
2. IMAGE SEGMENTATION TECHNIQUES

1.1 Multilevel thresh-holding segmentation

Multilevel thresh-holding helps in segmenting a gray-level image into different distinct parts. Multi-level thresh-holding is gaining popularity over bi-level thresh-holding for its capability to divide an image into several meaningful segments. This makes the image suitable for other pattern recognition and machine vision applications. In the multilevel thresh-holding cases there can find the two issues that are occur: first one is that the computation time that is still relatively high depending on the complexity of the image to be processed and the other concerns the determination of the threshold number, corresponding to how many the regions constituting the image [4]. Multilevel thresh-holding detects the multiple objects in an image and it gives much meaningful information in comparison with the bi-level thresh-holding.

1.2 Watershed Segmentation

The watershed technique solved the problem of over-segmentation. Watershed algorithm is widely applied in image segmentation techniques and can quickly get an individual pixel wide, continuous closed object boundary. However, the traditional watershed segmentation algorithm leads to the generation of a sizable number of false edges, seriously interfere with the actual edge of target identification. The adaptive and marker-extraction algorithm are used to improving the situation of watershed problem. The watershed transform has interesting properties which make it ideal for numerous image segmentation applications. Its simple and intuitive, could be parallelized, and always produces an entire division of the image. The main drawback of watershed segmentation is so it generates excessive over segmentation for easiest images because of spurious gradients due to forms of noises and textures.

1.3 GAs Based Segmentation

Genetic Algorithms (GAs) form a class of popular metaheuristic algorithms based on the principles of Darwin theory an evolution and natural genetics. It is an evolutionary technique which follows different steps to find the best chromosomes. GAs were also employed to segment images through both bi-level and multi-level thresh-holding. The GA-based context sensitive technique is just a clustering technique which can be used for the image segmentation. To adopt this technique for solving image segmentation problem, first the input patterns are generated corresponding to each pixel of the image. The generated input patterns included neighbouring pixels information in order to take contextual information of the image.

1.4 Fuzzy rule based segmentation

There are numerous fuzzy operators; properties, mathematics, and inference rules are apply, to provide ways to handle the uncertainty inherent in many different problems due to ambiguity as opposed to randomness. There are numerous disadvantages and the limitations of the fuzzy rule based segmentation. The advantages come in which the fuzzy membership function can be utilized to represent the amount of some properties or linguistic phrase, and fuzzy IF-THAN rules can be utilized to perform approximate inference. The disadvantages are the determination of fuzzy membership is not a insignificant job and the computation linked with fuzzy approaches could possibly to be intensive.

1.5 Edge-Detection segmentation

Edge detection methods locate the pixels in the image that correspond to the edges of the objects seen in the image. These algorithms are ideal for images which are simple and noise-free, and will often produce missing edges, or extra edges on complex and noisy images. Edge detection is definitely the most frequent approach for detecting meaningful discontinuities in intensity values. The points where image brightness changes sharply are usually organized into a couple of curved line segments called edges. Edge detection is just a fundamental tool in image processing, machine vision and computer vision. An edge detection filter may also be used to enhance the looks of blurred or anti-aliased image streams. Edges can be detected using various edge detectors. These generally include Sobel, Prewitt, Roberts, Laplacian of Gaussian (LoG), Zero crossings and Canny. In this paper we've used LoG to detect the edge of the image.

1.6 Clustering based segmentation

Clustering is the most used technique for medical image segmentation. The job of partitioning some entities into quantity of homogenous clusters is known as partitioned clusters. Quantity of fuzzy clustering methods was developed centered on fuzzy set theory. The main difference between hard and soft clustering is that, in the former the information elements belong to 1 cluster and in the latter the information elements belong to more than one cluster with different quantities of membership. K - Means clustering is really a simple unsupervised learning algorithm, which defines K centroids, one for each cluster. It assigns each pixel in the image, to the cluster. This algorithm is trusted because of its simplicity, efficiency and self organizing capability. But, it belongs to hard clustering and it is really a linearly separating algorithm. The extension of K means algorithm is known as fuzzy K means or fuzzy C means algorithm. Fuzzy C means is widely preferred, as the information element can belong to more than one cluster and associated with each element is some membership levels.

1.7 Exudate segmentation in fundus images using an ant colony optimization Approach

The proposed approach [16] uses a specific number of ants moving on the image driven by the local image intensity values variation. This variation establishes a pheromone matrix, with the same size image, which represents the edge information at each image pixel location. Due to the large image size and to reduce computation time, the ACO algorithm
described below was independently applied on non-overlapping image windows. ACO is an iterative algorithm. At each iteration, a number of artificial ants are considered. Each builds a solution over the solution space through their movements and by updating pheromone information. The process starts with an initialization stage, and then runs for N iterations to construct the pheromone matrix by iteratively performing construction and update processes.

3. LITERATURE SURVEY

Lee, Noah et al. [1] described a method of hybrid segmentation for GA quantification by identifying hypo-fluorescent GA regions from other interfering retinal vessel structures. Firstly, they utilize background illumination correction exploiting a non-linear adaptive smoothing operator. Then, they utilize the amount set framework to outperform segmentation of hypo-fluorescent areas. Finally, they presented a power function combining morphological scale-space analysis with a geometric model-based method of outperform segmentation refinement of false positive hypo-fluorescent areas because of interfering retinal structures. The clinically apparent aspects of hypo-fluorescence were drawn by a professional grader and compared on a pixel by pixel basis to segmentation results. The mean sensitivity and specificity were 0.89 and 0.98%.

Kong, Lingwana et al. [2] proposed a novel color image segmentation scheme for retinopathic fundus diagnosis purpose, combing with the hue-preserving color image equalization and segmentation by means of mean shift filtering of feature space clustering algorithms. After image segmentation with the equalized fundus, experiments showed that the remote and new hemorrhagic spots and areas and the main vessels were well-segmenting compared with the original underexposed retina fundus and its segmentation.

Fanq, Guolian et al. [3] proposed a highly effective framework to automatically segment hard exudates (HEs) in fundus images. Additionally, they create a multi-scale background subtraction method to acquire the coarse segmentation result. After subtracting the optical disc (OD) region from the coarse result, the HEs are extracted with a SVM classifier. The key contributions of the paper are: (1) propose an efficient and robust framework for automatic HEs segmentation; present a boosted soft segmentation algorithm to mix multi-channel information; employ a dual ring filter to segment the OD region. They performed experiments on the public DIARETDB1 dataset, includes 89 fundus images. The performance of algorithm is assessed on both lesion-based criterion and image-based criterion. Experimental results reveal that the proposed algorithm is quite effective and robust. Yin, Fengshou et al. [4] proposed a technique that combines edge detection, the Circular Hough Transform and a statistical deformable model to detect the optic disc from retinal fundus images. The algorithm was evaluated against a data group of 325 digital color fundus images, including both normal images and images with various pathologies. The end result implies that the typical error in area overlap is 11.3% and the typical absolute area error is 10.8%, which outperforms existing methods. The effect indicates a higher correlation with ground truth segmentation and thus demonstrates a great possibility of this technique to be integrated with other retinal CAD systems.

Santos-Villalobos et al. [5] proposed a statistical image processing method of segment drusen with the best goal of characterizing the AMD progression in a data group of longitudinal images. The technique characterizes retinal structures with a statistical type of the colors in the retina image. When you compare the segmentation outcomes of the technique between longitudinal images with known AMD progression and those without, the technique detects progression in longitudinal data set with a place underneath the receiver operating characteristics curve of 0.99. Giachetti, Andrea et al. [6] presented a novel method for the automatic location and segmentation of the optical disk in fundus images. It's on the basis of the decoupling of vessel and background information obtained with morphological segmentation and inpainting. The first experiments (30 DRIVE images, ground truth from two doctors) suggested that the technique can offer accurate results both in term of optic disc location and contour segmentation accuracy. Yin, Fengshou et al. [7] presented a statistical model-based method for the segmentation of the optic disc and optic cup from digital color fundus images. The technique combines knowledge-based Circular Hough Transform and a novel optimal channel selection for segmentation of the OD. Moreover, they extended the technique to optic cup segmentation, which is really a tougher task. The device was tested on a dataset of 325 images. The typical Dice coefficient for the disc and cup segmentation is 0.92 and 0.81 respectively, which improves significantly over existing methods. The proposed method includes a mean absolute CDR error of 0.10, which outperforms existing methods. The results are promising and thus demonstrate an excellent possibility of this process to be utilized in a large screening CAD system. Rozlan, Ahmad Zikri et al. [8] proposed development of a Graphical User Interface (GUI) system that creates enhancement of blood vessels segmentation in digital fundus images. The system might help ophthalmologist in improving morphological procedures by observing significant features in the processed images for early diagnosis. The end result is just a better processed image that may be the foundation for further image enhancement to ensure that eventually a diagnostic tool for diabetic retinopathy could be produced. Muthu Rama Krishnan et al. [9] proposed a novel and probably the first method, using Attanassov intuitionistic fuzzy histon (AIFSH) based segmentation to segment optic disc in retinal fundus images. The proposed method yielded precision-0.93, recall-0.91, F-score-0.92 and mean segmentation accuracy of 93.4%. They had also compared the performance of proposed method with Otsu and Gradient vector flow (GVF) snake methods. Overall, the result shows the superiority of proposed fuzzy segmentation technique over other two segmentation methods. Akram, M. Usman et al. [10] presented a novel method for accurate detection of drusen in colored retinal images. The system uses filter bank to extract all possible drusen regions form retinal image and eliminates false pixels which appear because of resemblance of drusen with optic disc. The validly of the proposed method is also shown by comparing it with already published method. Osdtrcil, Jan et al. [11] improved the concept of matched filtering, and propose a novel and accurate method for segmenting retinal vessels. The performance evaluation shows that the proposed blood vessel segmentation approach is at least comparable with recent state-of-the-art methods. It outperforms most of them with an accuracy of 95% evaluated on the new database. Kafieh, Rahele et al. [12] proposed a multimodal approach for vessel segmentation of macular optical.
coherence tomography (OCT) slices along with the fundus image. The results are also demonstrative of a direct relation between the overall accuracy and percentage of SLO coverage by OCT slices.

Roychowdhury, S. et al. [13] presented a novel three-stage blood vessel segmentation algorithm using fundus photographs. In the first stage, the greyscale of a fundus image is pre-processed to extract a binary image after high-pass filtering, and another binary image from the morphologically reconstructed enhanced image for the vessel regions. In the third post-processing stage, the major portions of the blood vessels are combined with the classified vessel pixels. The proposed algorithm achieves a vessel segmentation accuracy of 95.2%, 95.15% and 95.3% in an average of 3.1 seconds, 6.7 seconds and 11.7 seconds on three public datasets DRIVE, STARE, and CHASE DB1, respectively. Roychowdhury, S. et al. [14] presented a novel unsupervised iterative blood vessel segmentation algorithm using fundus images. First, a vessel enhanced image is generated by tophat reconstruction of the negative green plane image. An initial estimate of the segmented vasculature is extracted by global thresholding the vessel enhanced image. This iterative algorithm is robust to the rate of new vessel pixel addition since it achieves 93.2%-95.35% vessel segmentation accuracy with 0.957-0.9638 area under ROC curve (AUC) on abnormal retinal images from the STARE data set. Additionally, the proposed algorithm has more than 90% segmentation accuracy for segmenting peripapillary blood vessels in the images from the DRIVE and CHASE DB1 data sets. Saleh, Marwan D. et al. [15] presented a method for automated optic disc segmentation from color fundus images. The proposed method comprises three major stages, namely optic disc localization, preprocessing, and segmentation. From the experimental results, it is found that the proposed localization method achieves success rates of 100%. The proposed segmentation method is compared with several known segmentation methods using the same database. Based on the results, it is found that the proposed method achieves values of 87.16%, 91.27%, 99.81%, 90.56%, 98.68%, and 89.71% in terms of overlap, sensitivity, specificity, PPV, accuracy, and kappa coefficient respectively, which are higher compared to the results achieved by other known methods. Pereira, Carla et al. [16] aimed to segment exudates with a new unsupervised approach based on the ant colony optimization algorithm. The algorithm’s performance was evaluated with a dataset available online, and the experimental results showed that this algorithm performs better than the traditional Kirsch filter in detecting exudates.

S. Esakkirajan et al. (2011) [17] described a new algorithm Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) which gives better performance in comparison with existing noise removal algorithms in terms of PSNR and IEF. Even at high noise density levels the MDBUTMF gives better results in comparison with other existing algorithms. Both visual and quantitative results are demonstrated. The algorithm is effective for salt and pepper noise removal in images at high noise densities. If the processing pixel takes the maximum or minimum gray level then it is noisy pixel which is processed by MDBUTMF. Priyanka Kamboj et al. (2013) [18] described that Enhancement of a noisy image is achieved with a dataset available online, and the experimental results showed that this algorithm performs better than the traditional Kirsch filter in detecting exudates.

4. COMPARISON TABLE

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<tr>
<th>REF.</th>
<th>AUTHORS</th>
<th>YEAR</th>
<th>TECHNIQUES</th>
<th>FEATURES</th>
<th>LIMITATIONS</th>
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<tbody>
<tr>
<td>[1]</td>
<td>Lee, Noah, Andrew Laine, and R. Theodore Smith</td>
<td>2007</td>
<td>hybrid segmentation approach</td>
<td>mean sensitivity and specificity of the ROC analysis were 0.89 and 0.98.</td>
<td>The effect of the noise has been neglected in the fundus images segmentation.</td>
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<td>[2]</td>
<td>Kong, Lingwana, Qiong Li, and Shanhu Huang</td>
<td>2008</td>
<td>Color Image Segmentation Scheme</td>
<td>information for diagnosis were improve effectively and accurately</td>
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<td>Yin, Fengshou, Jiang Liu, Sim Heng Ong, Ying Sun, Damon W.K. Wong, Ngan Meng Tan, Carol Cheung, Mani Baskaran, Tin Aung</td>
<td>2011</td>
<td>Model-based optic nerve head segmentation</td>
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Table 1: Comparison table of various techniques
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<td>[9]</td>
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<td>2012</td>
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<td>[10]</td>
<td>Akram, M. Usman, Sundus Mujtaba, and Anam Tariq</td>
<td>2013</td>
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<td>Automated drusen segmentation accurate detection.</td>
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<td>[12]</td>
<td>Kafieh, Rahele, Hossein Rabbani, Fedra Hajizadeh, and Mohammadreza Ommani</td>
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5. CONCLUSION AND FUTURE SCOPE

In this paper, a survey on various segmentation techniques has been done. From the survey it has been found that the effect of the noise has been neglected in the fundus images segmentation. Moreover the use of the decision based median filtering to reduce the effect of the noise has also been neglected in the majority of the existing techniques. Therefore to overcome these issues, a new decision based median filtering based technique can be proposed to reduce the effect of the noise.

REFERENCES


