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Detection of Diabetic Retinopathy Based On Modified Kernel FUZZY C-Means Clustering

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Abstract: Diabetic retinopathy, also known as diabetic eye diseases which causes severe threat on sight. The detection of such abnormalities in the retina is known as diabetic retinopathy. It might reach to blindness in working age people. Many patients make diagnosis only after the vision is lost and vision loss is a late symptom of diabetic eye disease. By comparing retinal blood vessels with retinal vascular structures in retinal images, we can detect diabetes in early stages. In this paper, vessel segmentation is used to extract retinal image vessels. Morphological processing and modified kernel fuzzy c-means clustering have been used to segment the retinal blood vessels. Smoothing operation is performed to overwhelm the background information using mathematical morphology. After mathematical morphology, the enhanced image is segmented using modified kernel fuzzy c-means clustering algorithm. The proposed methodology is more effective than k- means clustering as it achieved accuracy 96.25%.

Keywords: Blood vessel extraction; Diabetic retinopathy; Modified kernel fuzzy c-means clustering; Mathematical morphology; Retinal image.

I. INTRODUCTION

In modern health care community, medical imaging has turn out to be an important tool. Medical imaging is the process of generating visual demonstrations of the interior of a clinical diagnosis and medical intervention as well as visual representation of some organs or tissues. The prime method for estimating diabetic retinopathy involves direct and indirect ophthalmoscopy, using modern ophthalmology is a non-invasive diagnosis. Some basic indicators for evaluating the occurrence and severity of retinal diseases are diabetic retinopathy, hypertension, glaucoma, neo vascularization, macular degeneration, hemorrhages and vein occlusion. Many imaging techniques can be useful depending on manifestation of diabetic retinopathy which also includes optical coherence tomography(OCT).

The diseases like diabetic retinopathy, glaucoma, macular degeneration are found to be more dangerous and it should be identified in early stages so that we can prevent from blindness. Various methods were employed for the detection of landmarks in retinal images such as optic disc, blood vessels, fovea etc., and optic disc can be recognized in the area with highest variation in intensity of adjacent pixels. Blood vessels were identified by multilayer perception neural network for which inputs were derived from component analysis of the image and edge detection. Therefore, segmentation method for retinal blood vessels is important in ophthalmology diagnosis. This type of segmentation will help the ophthalmologist and eye specialists to carry out diagnosis in retinal blood vessels to detect diabetes at early stages. Based on the problem identified, treatment evaluation can be carried out. It also helps to prevent from vision loss, age related diseases, vascular diseases. The paper proposed an accurate segmentation method for retinal blood vessels based on morphological operation and modified kernel fuzzy c means clustering. Morphological processing deals with digital image processing along with structure element to binary images.

Three stage blood vessel segmentation were developed which involves preprocessing center line extraction and artery/vein classification. The sensitive inner part of the eye is damaged. There are two kinds of diabetic retinopathy are non-proliferative (NPDR) and proliferative (PDR) diabetic retinopathy.

Early stages of diabetic retinopathy will affect only fewer blood vessels which leads to blurred vision caused due to fluid leaks called non proliferative (NPDR) diabetic retinopathy. The non-proliferative (NPDR) is more serious than (PDR). The diabetic classification is done using MATLAB. The severity of the diabetic retinopathy is measured by the preprocessing and classification stages.

II. METHODOLOGY

The proposed system consists of two stages

- Mathematical morphology as preprocessing and Classification phase.
- DRIVE (Digital Retinal Images for Vessel Extraction) database are used for this approach.

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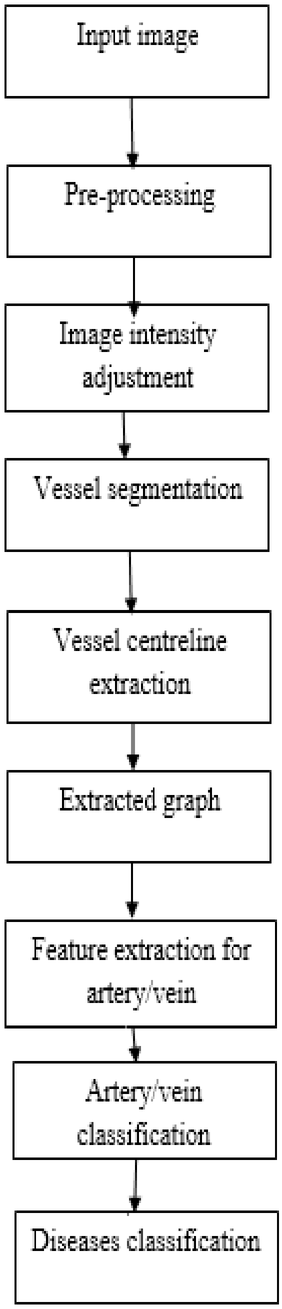

Fig 1 Flow chart of segmentation approach

A. Preprocessing

Preprocessing is the initial step in diabetic retinopathy diagnosis. In this phase image contrast, image enhancement, image denoising have been carried out. Preprocessing increases the reliability of an optical inspection. Preprocessing is sometimes referred to as image restoration. Preprocessing function involves those operations that are normally required prior to the main data analysis and extract of information. Some standard procedures have been used for image extraction. Mathematical morphology process is used for smoothing and removing noise. Opening operation is performed with linear structuring element. After the process there will be no change in vessel structure but some parts of the vessel will be removed. The structuring elements have parallel direction. So that the maximum accuracy can be obtained by using this algorithm. Preprocessing process is done in order to bring the intensity range to a particular range of all image.

B. Filtering

Filtering contains numerous image filters for image optimization. Miscellaneous filters for edge enhancements, noise suppression, character modification etc. Filtering is commonly used to re-establish imagery by reducing noises to enhance the descriptions for better analysis and to extract features such as edger. Filtering is mainly used to suppress the high frequencies are low frequencies in the digital image. The high frequency images are smoothened and low frequencies are enhanced or to detect the edges in the image. The mathematical procedure in spatial field is the convolution process of input data f (i, j) with the filter function g (i, j)

$$h(i, j) = g(i, i) \odot f(i, j)$$

Filtering is the process for modifying or enhancing an image here Gaussian filtering is used to remove the unwanted frequencies in the image. Gaussian filter is a filter in which impulse response in a Gaussian function. In Gaussian filter there will be no overshoot to a step function. The group delay in Gaussian filter is minimum. Gaussian filter is referred to as time domain filter. The input image data will be convolued with a Gaussian function. The Gaussian filters here is used to extract center lines in four directions. Gaussian filter defines the probability distribution for noise or data and it is called as smoothing operator. Two dimensional Gaussian function is used for image processing and works as a point- spread function.

This can be achieved by convolving image with 2D Gaussian distribution function. Discrete approximation is produced. Gaussian filter is a non – uniform low pass filter. In Gaussian filter, the central pixels should have higher weighting then other periphery. The Gaussian filter does not preserve brightness in an image.

Gaussian filter removes salt and pepper noise effectively than other filters. In human visual perception system, it has been found that neurons create similar filter. Gaussian filtering makes the blood vessel boundaries less sharp. Gaussian filtering is more effective in removing Gaussian noise. It also reduces blur at edges. Small 1D filters can be implemented by large filters and it is rotationally symmetric.

C. Intensity Adjustment

Intensity adjustment is a process of mapping an image's intensity values to a particular range. Background enhancement can be functional while obtaining images (a priori) or after acquirement (a posteriori). The modification between these is that a priori correction practices additional images found at the time of image capture while in a posteriori modification, the supplementary images are not obtainable and therefore an ideal brightness model have to be assumed.

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D. Vessel centerline extraction

The vessel centerline extraction of an image is achieved by smearing an iterative thinning algorithm. The border pixels are removed from the segmented image by iterative thinning algorithm. The border pixels are removed till the object contracts to a marginally associated stroke.

E. Morphological Thinning

Morphological thinning operations is used to remove the selected foreground pixels from binary images, which is related to opening and erosion operation. The morphological thinning operation is related to hit- and – miss transform. The morphological thinning operation is determined by structuring element (SE). The thinning operation is measured by translating the origin of the structuring elements to available pixel locations in the image.

If the foreground and background pixels in the structuring element matches exactly, then the image pixel inferior to the origin of the structuring element is set to zero. Thickening the foreground information is correspondent to thinning the background information. Thinning morphology is computed using mathematical morphology .morphological thinning is mainly used for the representation of region shape preserving. Thinning operation are used to create skeletons. Thinning operation is mainly used in preprocessing stage in order to recognize optical characters. The structuring elements is located at all available pixels in the image.

The SE is a tiny pixel compared to the image and its zeros, ones and size forms a matrix to define its shape. The structuring element contains coordinates points as pattern specified to its origin. In structuring element Cartesian coordinates are mainly used to represent the image in a rectangular grid. The structuring element thinning operation is used to decrease the threshold value at edge detection. Sobel operator is used for this process.

F. Graph extraction algorithm

After the thinning operation, the nodes in the graph should be extracted from the center line image. The node points are extracted from the centerline image by defining the intersection points or end points. The intersection points are the images pixels having more than two neighboring pixels. But in end points or terminal points there will be only one neighboring pixels. The intersection points and neighboring points are detached from the centerline image due to identify the links between nodes. Finally the extracted graph contains distortions in vascular structure. So that the distortion should be removed from the graph. Some of the distortion in the extracted graph are one node is splitted in to more than two nodes and there will be a false link.

The vessel calibers are also measured using this algorithm. There are three phases in pixel processing method, they are preprocessing phase, centerline, extraction and validation of the extracted graph. Which contains intensity and length features and the last phase is vessel segmentation in which morphological vessel enhancement and restoration of vessels at four scales. After all these graph extraction process, the graph i.e. arteries or veins should be labelled.

G. Feature extraction for artery/vein classification

There are four phases in feature extraction.

- Feature construction.
- Feature subset generation.
- Evaluation criterion definition.
- Evaluation criterion estimation.

Feature extraction is correlated to dimensionality fall. In this algorithm, if the input image size is too large to process and it is supposed to be terminated then its features can be converted into a processing level by reducing the unwanted information which is called as features vector and this process is known as feature extraction. Finally the extracted data contains only the required information from the input image. so that the processing can be made easier and performance can be higher. Accuracy can also be improved by reducing the large processing data. The invariance properties is considered so that feature extraction process does not change according to specified conditions. Extraction is more complex than detection. The background information is necessary to extract the shape of an image.

III. PARAMETERS

A. Accuracy

Accuracy is well defined in terms of systematic and casual errors or statistical errors. It is a measures of statistical bars. Accuracy is a nearness calculation of the true value. Accuracy is the process of eliminating the casual errors which improves the range of data but there will be no change in precision. The system is effective only if the accuracy and precision is accurate. The accuracy measurements involves the measuring of resolution which is the slight modification in physical quality. Accuracy is the nearness of true value.

$$ACC = (TP + TN) / (P+N)$$

B. Sensitivity and specificity:

Sensitivity and specificity are numerical measurement of the performance of a binary classification test, which is also known in data statistics as classification task. Sensitivity is also called as true positive rate, which measures the part of real positives which are correctly identified. For e.g., the percentage of sick people who are correctly identified, and is complementary to the false negative rate. Specificity is also called as the true negative rate which measures the proportion of negatives which are correctly identified. For e.g., the percentage of healthy people who are correctly identified as not having its state, and is matching to the false positive rate.

Imagine a study for calculating a new test that monitors people for a blood vessel diabetic disease. Each and every

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person who are testing will have either diabetes or does not have the diabetic disease. The test result can be positive (predicting that the person has the diabetic disease) or negative (predicting that the person does not have the diabetic disease). The test results for each substance may or may not match the subject's definite status. In such cases:

- True positive: Sick people correctly analyzed as diabetic patients
- False positive: Healthy people imperfectly identified as diabetic patients
- True negative: Healthy people properly recognized as healthy
- False negative: Diabetic patients incorrectly recognized as healthy

In general, Positive = recognized and negative = rejected. Therefore:

- True positive = properly recognized
- False positive = imperfectly recognized
- True negative = correctly rejected
- False negative = incorrectly rejected

Let us define an experiment from **P** positive illustrations and **N** negative illustrations for some condition.

TPR= TP/P=TP/ (TP+FN)

SPC=TN/N=TN/ (TN+FP)

PPV=TP/ (TP+FP)

NPV=TN/ (TN+FN)

FPR=FP/N=FP/ (FP+TN) =1-SPC

FDR=FP/ (TP+FP) =1-PPV

IV. EXPERIMENTAL RESULTS

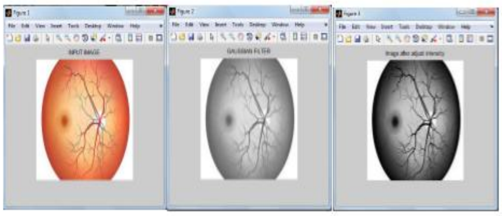
In this vessel segmentation approach, the modified kernel fuzzy c means clustering algorithm was tested with 30 images. Each images are segmented to identify normal or abnormal cases with different ages.

The morphological processing increases the accuracy at low rate misclassification. Diabetic mellitus is a group of metabolic diseases in which there are high blood sugar level over prolonged period which is caused by either pancreas or insulin.

There are two types of cases to identify which type of mellitus formed in the retina, are Type 1 diabetic mellitus, Type 2 diabetic mellitus.

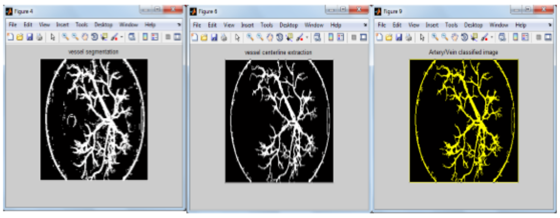
Type 1 diabetic mellitus caused due to pancreas failure to produce enough insulin. It is referred to as insulin dependent diabetic mellitus or juvenile diabetes. Type 1 diabetic mellitus will be managed by insulin injections and it causes tiny blood vessel damages in the eye.

Type 2 diabetic mellitus begins with insulin resistance, a condition in which cells fails to respond to insulin property. It is referred to as non-insulin dependent diabetic mellitus or adult onset diabetic mellitus. Type 2 diabetic mellitus will be treated with medications with or without insulin and it should take special care. .



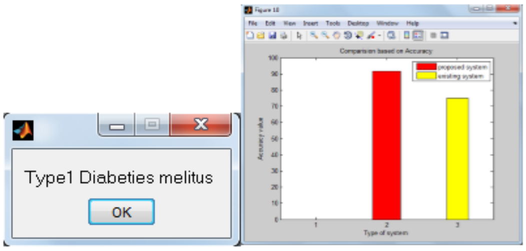
(a) (b) (c)

Fig 2 (a) Input image (b) Gaussian filter (c) After intensity adjustment



(d) (e) (f)

Fig 3 (d) Vessel segmentation (e) Vessel centerline extraction (f) Artery/vein classified image



(g) (h)

Fig 4 (g) identifying the type of mellitus (h) Comparison of accuracy with the existing system

IMAGE	ACCURACY	SENSISTIVITY	SPECIFICITY
1	0.9602	0.8612	0.9564
2	0.9531	0.7601	0.9784
3	0.9621	0.8615	0.9875
4	0.9456	0.7265	0.9873
5	0.9621	0.8723	0.9632
6	0.9893	0.8421	0.9712
7	0.9763	0.7565	0.9815
8	0.9654	0.8621	0.9648
9	0.9865	0.7954	0.8999

Table 1 Accuracy, sensitivity and specificity of different retinal blood vessel segmentation results.

V. CONCLUSIONS AND FUTURE WORKS

In this paper, an automatic method of blood vessel segmentation is obtained. Mathematical morphology is smeared as pre-processing phase with modified kernel fuzzy C-means clustering. Mathematical morphology is used to enhance and flat the digital retinal images and to overwhelm the background information and also to suppress the noise. Gaussian filter is used to remove the noise. Then, the modified kernel fuzzy C-means clustering is applied to segment the blood vessels. And finally the blood vessels are extracted. The results obtained from the proposed system are compared with the existing segmentation algorithms. It achieves quantitative and qualitative results. By identifying the type of mellitus suitable treatment will be provided to the patient to prevent from vision loss. The results shows high accuracy ratio and low misclassification ratio comparing with the other segmentation methods, and in future time complexity should be considered to achieve more efficient performance.

REFERENCES

[1]. R. Udayakumar,V. Khanaa,T. Saravanan and G. Saritha,"Retinal Image Analysis Using Curvelet Transform and MultistructureElements Morphology by Reconstruction", Middle-East Journal of Scientific Research, vol. 12,no.12, PP. 1668-1671, (2013).

[2]. A. Salazar-Gonzalez, Y. Li and X. Liu, "Segmentation of Blood Vessels and Optic Disc in Retinal Images, " in IEEE Journalof Biomedical and Health Informatics, pp. 2168-2194, (2014).

[3]. M. M. Fraz, P. Remagnino and A. Hoppe et al, "Blood vessel segmentation methodologies in retinal imagesa survey, " in ComputerMethods and Programs in Biomedicine,vol. 108 pp. 407433, (2012).

[4]. M. MoazamFraz, G. Owen and Sarah A. Barman, "Delineation of blood vessels in pediatric retinalimages using decision trees-based ensemble classification," in International journal of computer assisted radiology and surgery, pp.1-17, (2013).

[5]. Y. Yin, M. Adel, and S. Bourennane, "Automatic Segmen- tation and Measurement of Vasculature in Retinal Fundus Images UsingProbabilistic Formulation, " in Computational and mathematical methods in medicinel,Hindawi Publishing CorporationComputational and Mathematical Methods in Medicine ,vol.2013, pp. 16, (2013).

[6]. S. Roychowdhury, D. D. Koozekanani , Keshab K and Parhi, "Blood Vessel Segmentation of Fundus Images by Major Vessel Extractionand Sub-Image Classification, " in Biomedical and Health Informatics, IEEE Journal, pp. 2168-2194, (2014).

[7]. Y. Hou, "Automatic Segmentation of Retinal Blood Vessels Based on Improved Multiscale Line Detection, " in Journal of ComputingScience and Engineering,vol.8, pp. 119-128, (2014).

[8]. M.M. Fraz, P. Remagnino, A. Hoppea, B. Uyyanonvarab, A.R. Rudnicka ,C.G. Owen, S.A. Barman, "Blood vessel segmentationmethodologies in retinal images–A survey, " Computer methods and programs in biomedicine, vol. 108, no. 1, pp. 407-433, (2012).

[9]. M. Niemeijer, J.J. Staal, B.v. Ginneken, M. Loog, M.D. Abramoff, DRIVE: digital retinal images for vessel extraction,accessed (2014).

[10]. V.Jumb, M.Sohani and A.Shrivas , "Color Image Segmentation Using K-Means Clustering and Otsus Adaptive Thresh- olding, "International Journal of Innovative Technology and Exploring Engineering (IJITEE), vol. 3, no. 5, (2014).

[11]. J. Cheng, J. Liu, Y. Xu, F. Yin, D.Wong, N.-M. Tan, D. Tao, C.-Y. Cheng,T. Aung, and T. Y. Wong, "Superpixel classification based optic disc andoptic cup segmentation for glaucoma screening," IEEETrans. Med. Imag.,vol. 32, no. 6, pp. 1019–1032, Jun. 2013.