Segmenting and Detecting the Area of A True Retina and Diagnosing Its Retinal Disease Using SLO

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Abstract

Artificial Neural Network (ANN) classifier can be want to detection of retinal diseases. Scanning laserophthalmoscopes (SLOs) will be used for early detection of retinal diseases. It is a technique of examination of the attention. The advantage of using SLO is its wide field of read, which will image an oversized a part of the tissue layer for higher identification of the retinal diseases. On the other facet, during the imaging method, artefacts such as eyelashes and eyelids also are imaged together with the retinal area. This brings a big challenge on the way to exclude these artefacts. In proposed novel approach to mechanically extract out true retinal space from An SLO image based mostly on image process and machine learning approaches. The Simple Linear Iterative Clustering (SLIC) is that the rule utilized in super pixel calculation. To decrease the unpredictability of image getting ready errands and provide an advantageous primitive picture style. To reduce the complexness of image process tasks and supply a convenient primitive image pattern, also to classified pixels into completely different regions based mostly on the regional size and compactness, known as super pixels. The framework then calculates image based options reflective textural data and classifies between retinal space and artefacts. The experimental evaluation results have shown sensible performance with a high accuracy.

KEYWORDS: Feature selection, retinal artefacts extraction, retinal image analysis, scanning laser ophthalmoscope (SLO) Super pixel Classification.

I. INTRODUCTION

Digital funds photography is a common method in ophthalmology and provides important diagnostic data of retinal pathologies, such as diabetic retinopathy (DR), glaucoma, age-related macular degeneration, and vascular abnormalities. The research community has place forth a nice effort towards the automation of a computer screening system able to promptly discover DR in fundus pictures. An algorithmic program ready to automatically assess the quality of the fundus image is a vital pre- processing step for reliable diseases detection for a computer based screening system.

The two dimensional retinal scans produces from imaging equipment [e.g., fundus camera, scanning laser ophthalmoscope (SLO)] could contain structures alternative than the retinal area; Collectively considered artefacts. Exclusion of artefacts is important as a pre- processing step before automatic detection of features of retinal diseases. In a retinal scan, extraneous unwanted objects such as the eyelashes, eyelids, and dust on optical surfaces may be appear bright and focused. Therefore, automatic segmentation of these diseases from a pictured retina isn't a trivial task. Early detection and treatment of retinal eye lesion is vital to avoid preventable vision loss [1]. Retinal disease identification techniques are primarily based on manual annotation. Optometrists and Ophthalmologists typically trust on image operations like modification of contrast and distinction to interpret these images and diagnose results supported their own experience and domain knowledge. These diagnostic techniques are time consuming. Automatic analysis of retinal pictures has the potential to reduce the time, which clinicians want to check out the images, which will expect additional patients to be screened and more consistent diagnoses is given during a time efficient manner.

SLIC may be an easy linear iterative clustering algorithm in which it is used for super pixel segmentation. The function is that it takes the middle purpose of the image thereto of the adjacent purpose and from that the typical value is taken and produces the simplest result from it.Compared to that of the (GS04, NC05, TP09,Q309) SLIC provides the equal segmentation in order that there is no wastage of pixel quality. The step by step method is enclosed within the method therefore there's clarity of pixel quality. In combination with the SLIC rule ANN (Artificial Neural Network) is used. It is primarily a dataset or machine that performs input and output operation.

In this study, I have created a completely unique framework for the extraction of retinal space in SLO pictures. The three main steps for constructing my implemented system include:

1. Determination of features that may be won't to distinguish between the retinal space and therefore the artefacts;
2. Selection of features which are most relevant to the classification of the retinal area;
3. Construction of the machine learning approach which might classify out the Retinal space from SLO pictures.

For differentiating between the true retinal area and the artefacts, we've determined totally different image based features that reflect textural information at multiple resolutions. Then, selected the features among the big feature set, which are relevant to the classification. The feature selection method improves the classifier Performance in terms of processing time.

II. LITERATURE SURVEY

The strategies for detection and segmentation of eyelids and eyelashes applied on pictures of the front of the eye that contains the pupil, eyelids, and eyelashes. On such a picture, the eyelashes are typically within the kind of lines or bunch of lines grouped along. Therefore, the primary step of detection them was the applying of edge detection techniques like Sobel, Prewitt, Canny, Hough transform, and wavelet transform]. The eyelashes on the iris were then removed by applying nonlinear filtering on the suspected eyelash areas. Since eyelashes will be in either divisible kind or within the kind of multiple eyelashes classified together, Gaussian fliter and variance filter were applied so as to differentiate among each kinds of eyelashes]. The experiment showed that divisible types of eyelashes were most likely detecting by applying Gaussian filter, whereas Variance filters are a lot of preferred for multiple eyelash segmentation]. Initially, the eyelash candidates were localized using active shape modeling, and then, eight-directional filter bank was applying on the possible eyelash candidates. The size variation of the convolution kernels additionally differentiated between divisible eyelashes and multiple eyelashes. They were thresholded using Otsu's technique, which is an automatic threshold selection technique supported explicit assumptions regarding intensity distribution. All of those ways are applied on CASIA information, which is internet information of Iris pictures. In an image obtained from SLO, the eyelashes show as either dark or bright region compared to true retinal area depending upon however laser beam is concentrated because it passes the eyelashes.

These features have been calculated for various regions in fundus pictures, mostly for quality of analysis. The characterization of Retinal pictures were performed in terms of image features like intensity, skewness, textural analysis, histogram analysis, sharpness, etc.,. In determined four totally different classifiers using four kinds of options. They were analyzed for the retinal area as well as color, focus, contrast, and illumination. The outputs of those classifiers were concatenated for quality classification. For classification, the classifiers like partial least square (PLS) and support vector machines (SVMs) were used. PLS selects the foremost relevant features needed for classification [2]. For determinative image quality, the features of region of interest of anatomical structures like optic nerve head (ONH) and fovea have additionally been analyzed. The features included structural similarity index, area, and visual descriptor etc. some of the higher than mentioned techniques recommend the use of grid analysis, which may be a time effective technique to generate features of particular region instead of every pixel.

III. METHODOLOGY

To perform superpixel classification from scanning laser ophthalmoscope images by using simple linear iterative clustering methods. Also calculate the features of each image by using gray level co-occurrence method. After this process by using artificial neural network to classify the true retinal area and finding input image is normal (Healthy) or abnormal (Diabetic).

This block diagram is consisting of different modules

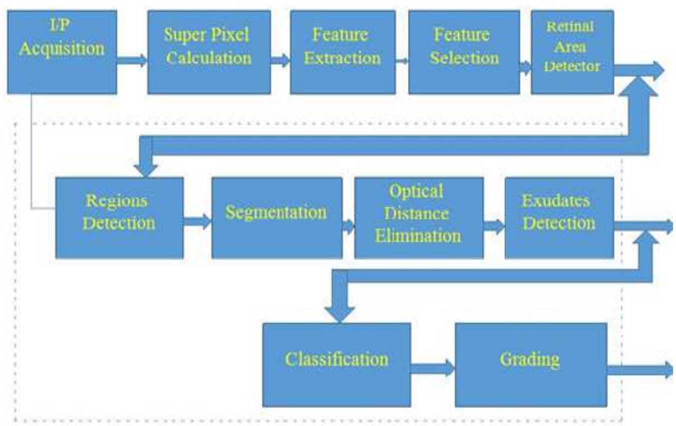

Fig.1 Proposed Method Block Diagram

They are feature extraction contains image pre-processing, superpixel generation, feature generation, feature selection, machine learning approach i.e. ANN classifier, create model, superpixel Classification, image post processing and automatic annotation. Features are then extracted from every image. Also this block diagram shows the three stages such as training stage, testing and evaluation stage, deployment stage. The training stage is involved with building of classification model supported training images and also the annotations reflective the boundary around retinal space. In the testing and evaluation stages, the automatic annotations are performed on the test set of pictures and also the learning machine approach performance is evaluated against the manual annotations for the determination of maximum accuracy. Finally, the deployment step produces the automatic extraction of retinal space.

I/P Acquisition: It is a process of acquiring image into MATLAB program for applying a transformation.

Image Pre-processing: Images are then pre-processed in order to bring the intensity values of every image into a selected range.Images were normalized by applying a Gamma (γ) adjustment to bring the mean image intensity to a target value. γ was calculated using

$$\gamma = \frac{\log_{10}(\mu_{\text{target}}) - \log_{10}(255)}{\log_{10}(\mu_{\text{orig}}) - \log_{10}(255)} \quad (1)$$

Where μorig is the mean intensity of the original image and μtarget is the mean intensity of the target image. For imagevisualization, μ_{target} is set to 80. Finally, the Gamma adjustment of the image is given as

$$I_{\text{norm}} = \left(\frac{I}{255}\right)^{\gamma}. \quad (2)$$

Super pixel classification: The training images after pre-processing are described by tiny regions known as super pixels. The generation of the feature vector for each super-pixel makes the method computationally efficient as compared to feature vector generation for every pixel.

Feature Extraction: Feature extraction is the process of defining a set of features, or image characteristics, which will most efficiently or meaningfully represent the information that is important for analysis and classification. In remote sensing the spectral bands and the spectral and spatial resolution of satellite.

Feature Generation: Generate image based features that are used to distinguish between the retinal area and alsothe artefacts. The image based features replicate textural information and they were calculated for every super pixel of the image present within the training set. In testing stage, only those features can be generated that are selected by feature selection method. Gray level co- occurrence method is used for finding the texture feature. GLCM finding different feature like Autocorrelation, Cluster Shade, Cluster Prominence, Contrast, Correlation, Difference Entropy, Dissimilarity, Energy, Entropy, Homogeneity, Information Measures, Sum average, Sum Entropy, Sum of Squares: Variance, Sum of Variance, Maximum Probability. In this features Area Under the Curve is above 0.9 of feature value is selected.[4]

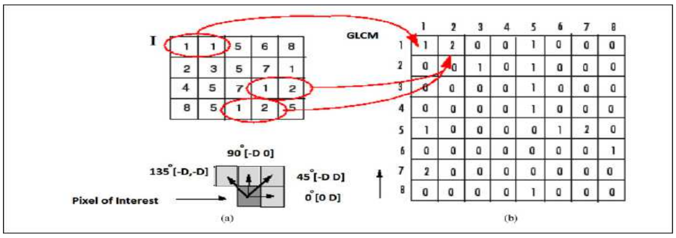

Figure.2 (a) GLCM directions and offset. (b) GLCM process using image **I**

Feature Selection: Feature selection, also known as variable selection, attribute selection or variable subset selection, is the process of selecting a subset of relevant features (variables, predictors) for use in model construction.

Retinal Area Detecting: Image based features representing textural and structural information are calculated and are used to classify the super pixels as retinal area and artefacts.

Regions Detection: Image is divided into four functional regions R1, R2, R3, and R4 to remove the mask in every region and detecting each region to calculate the exudates.

Exudates: A mass of cells and fluid that has seeped out of blood vessels or an organ especially in inflammation.

Segmentation: Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an imageinto something that is more meaningful and easier to analyze.

Optical Disk Elimination: The blood vessels detection and elimination is also important as the optic disc detection for further process because the optic disc and the blood vessels are the normal features of the images To detect the blood vessels, first the input image is converted into grayscale image due to strengthen the appearance of the blood vessels. Then the median filtering and the CLAHE techniques are used for reducing noise and image enhancement purposes. Then, the closing and the filling operators are used to close the same intensity values and fill the holes in the vessels.

Exudates Detection: This performance will be done by artificial neural network model. The exudates are also detected effectively from the retina fundus image using segmentation algorithms. Finally the segmented defect region will be post processed by morphological processing technique for smoothing operation.

Classification: In conjugation with manual annotations, the selected features are then accustomed construct the binary classifier. The result of such a classifier is the super-pixel representing either the true retinal area or the artefacts. This processis done by using ANN classifier. Itgives more accurate accuracy as compare to other classifier such as SVM and kNN.

Classifier	Filter Approach			Filter/SFS Approach			SFS Approach		
	D_I	D_R	D_A	D_I	D_R	D_A	D_I	D_R	D_A
ANN	89.36%	89.49%	89.22%	88.88%	89.00%	88.75%	90.48%	90.28%	90.68%
SVM	88.48%	88.48%	88.47%	88.41%	88.36%	88.46%	90.93%	90.89%	90.96%
kNN	88.35%	88.53%	88.17%	88.09%	88.24%	87.94%	90.34%	90.17%	90.52%

Degree of overlap has been calculated by taking superpixels as samples.

Table.1: Classifier Approaches and its Dimensions

Feature Set	Textural Features	Gradient Features	Regional Features
SFS Approach	90%	10%	0%
Filter Approach	72.73%	24.24%	3.03%
Filter and SFS Approach	100%	0%	0%

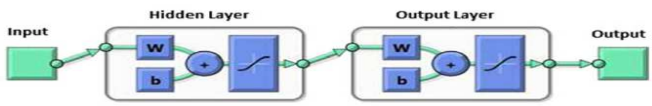

Table2 Feature Set and Its Percentages

Grading: This is the last step. In this step, we are getting the final ouput and understand that original image is clinically significant or non-clinically significant or abnormal image.[5]

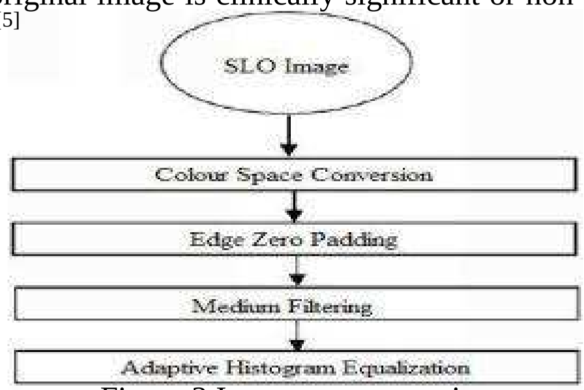

Figure.3 Image pre-processing steps

Color space conversion: HSV (Hue saturation value) is a transformation of an RGB color space, and its components and colorimetry are relative to the RGB color space from which it was derived. HSL (hue, saturation, lightness/luminance), also known as HLS or HSI (hue, saturation, intensity) is quite similar to HSV, with "lightness" replacing "brightness".[6]

Edge Zero Padding: This means that without padding the image properly, results from one side of the image will wrap around to the other side of the image. You can think of 2D filtering as a sliding window that is centered over each pixel in the image and the center output pixel is a weighted sum of the pixels in the window.

Median Filtering: In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise.

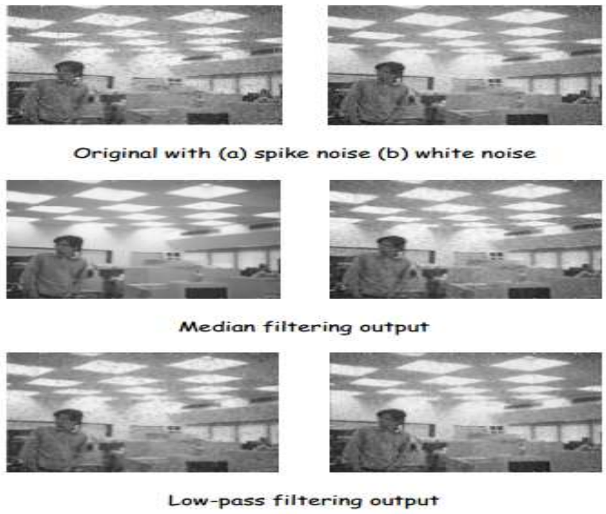

Figure.4: Noise, Low-pass & Median filtering outputs

Adaptive Histogram Equalization (AHE): Adaptive histogram equalization (AHE) is an imageprocessing technique used to improve contrast in images. It differs from ordinary histogram equalizationin the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast and enhancing the definitions of edges in each region of an image.However, AHE has a tendency to overamplify noise in relatively homogeneous regions of an image. A variant of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) prevents this by limiting the amplification.[7]

Image Post processing: Image post processing is performed by morphological filtering thus as to confirm the retinal space boundary using super-pixels classified by the classification model.

Marphological Image Processing: Morphologyis a theory and technique for the analysis and processing of geometrical structures, based onset theory, lattice theory, topology, and random functions. It is most commonly applied to digital images.Morphological image processing, which consists of a set of operators that transform images according to the above characterizations.The basic morphological operations are erosion, dilation.

Erosion: It is used to expanding the images of the regions and removing the noise in that image

Dilation: It is used to thinning the image in image processing system.

By using this, we can form the mask in the regions for removing noise, blood vessels and detecting optical disk and removing it from the regions of the original image.

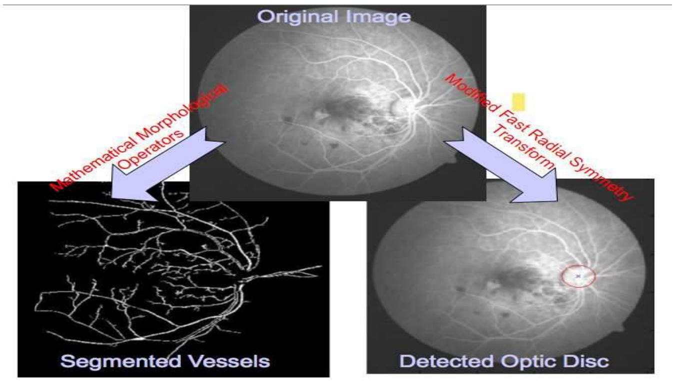

Figure.5: Marphological Image Processing

IV.EXPERIMENTAL EVALUATION

In this process we are using PNG (Portable Network Graphic) file images, BMP (Bitmap Images) & JPEG (Joint Photographic Experts Group) images to get the output by using segmentation method and representing the histogram equalization for equalizing all the intensity values in Adaptive Histogram Equalization.First we need to take a PNG image as an input we should resize the image area values.And then we process segmentation for evaluating the exudates in that image. In this segmentation, we are using kirsch interpolation technique in order to get the ouput of highest intensity values. Kirsch interpolation is edge based segmentation. In this process, all edges will become white color (highest Intnsity values) and non edges will become will become black color. In this kirsch segmentation, Only green plane will be considered because green plane have moderate intensity values so thatwe've to consider 2nd plane then applying kirsch segmentation.Then we will get 'g' grey level values and then we will get black & wight images i.e., BW images.We are applying this process is to, it returns double sptial floating point images and not unsigned integer values.By using this double sptial floating point images, we will get white color images with high intensity values.Then you've to process the image. For this, we are diving our image into four region R1, R2, R3, R4. And then calculating the Exudates in R1 Area, R2 Area, R3 Area, R4 Area.By applying morphological image processing in this four regions, using erosion expand the R1 area and removing blood vessels and then form mask in that region by using classifier ANN (Artificial Nueral Network) with considering the constant K=1 in order to remove the optical disk.And finally we get the final ouput .From this representation, we'll come to know that the image is clinically significant or non-clinically significant or abnormal image.[8]

V.RESULTS

Superpixel classification results and final output after postprocessing of different examples of healthy and diseased retinal images. ANN classifier is able to achieve the average accuracy nearer to that of other two classifiers, while saving significant computational time when processing maximum number of images for automatic annotations.

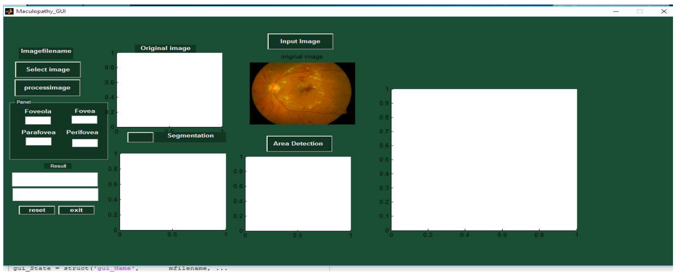

Figure 6.Taking the input image

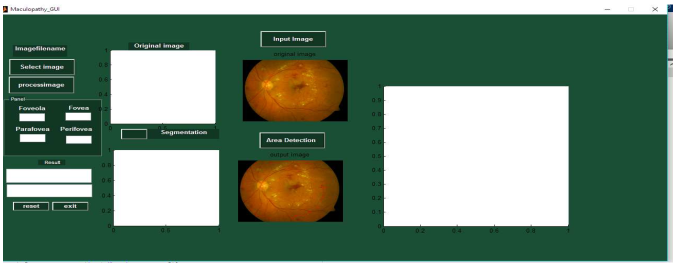

Figure.7 Detection of Area

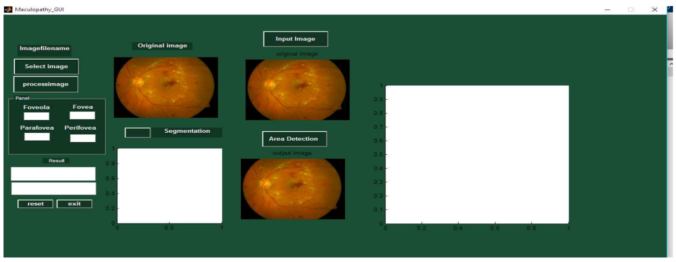

Figure.8 Taking the original image

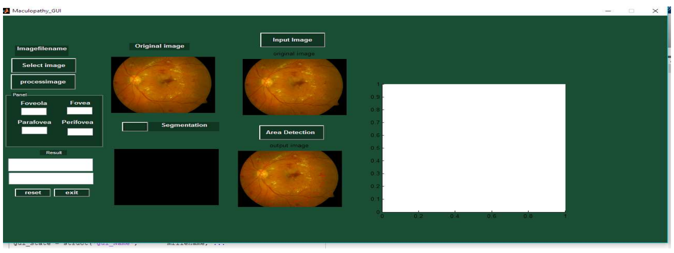

Figure.9 Segmentation

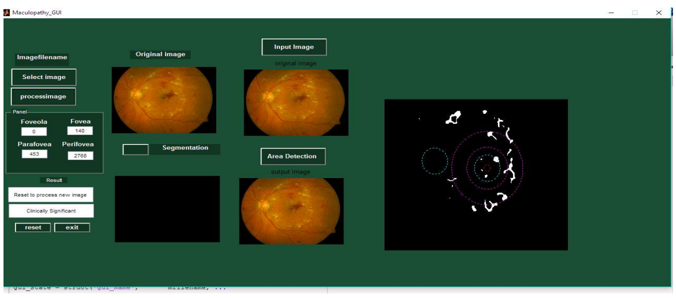

Figure.10 Processing and final ouput & considering the image is clinically significant or non-clinically significant or abnormal image

VI.CONCLUSION

In this proposed system, we have proposed a novel framework for automatic detection of true retinal area in SLO images. We have used super pixels to represent different irregular regions in a compact way and reduce the computing cost. Feature selection enables the most significant Features to be selected and, thus, reduces computing cost too. A classifier has been built based on selected features to extract out the retina area. It has been compared to other two classifiers and was compatible while saving the computational time. The experimental evaluation result shows that our proposed framework can achieve an accuracy of 92% in segmentation of the true retinal area from an SLO image. Feature selection is necessary so as to reduce computational time during training and classification. Among different approaches used for feature selection, the performance of our feature selection approach surpassed the filter approach and "Filter and SFS" approaches in terms of classification power.

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