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Study on Segmentation and Classification Techniques for Automatic Detection of Microaneurysms

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Abstract-*Diabetic Retinopathy is a huge matter in eye that can steer to decreased vision or blindness. Starting point of Diabetic retinopathy is due to damage to the blood vessels of light-sensitive tissue called retina which is situated at the rear of eye. The manual detection of retinopathy results is not exact. Most common types of Non-proliferate Diabetic Retinopathy include microaneurysms and softexduates. The most basic signs of microaneurysms are small red spots on the retina. In the early hours discovery of this sign helps the ophthalmologists to detect DR, which helps in prevent sightlessness. In this paper, confine the microaneurysms and normal retinal images for processing. In preprocessing phase improve the worth of image. Segmentation phase to segment microaneurysms areas from retinal image. Then extract features. In Classification phase to classify image based on trained database. In this work, include two segmentation (Adaptive k-means and Fuzzy C-means)Techniques for segmentation and two classifier(SVM and PNN) for Classification. At lastly, Compare the performance of two segmentation technique (Adaptive K-means, Fuzzy-c means) with two classification Technique(SVM ,PNN). Based on result to discover best segmentation and classification Technique.*

Keywords: Diabetic retinopathy,light-sensitive, retina, non-proliferate, microaneurysms, softexduates

1.INTRODUCTION

Medical image analysis is one of the most critical studies in the field of medicine. Medical imaging is that the general name given to the cluster of techniques and processes developed for making anatomical or practical pictures of build, that square measure used for each clinical and scientific functions. Moreover, recent improvements in the imaging analysis and medical image processing provided a significant reduction in the requirement for crucial invasive intervention in treatment of various diseases or abnormalities.

Diabetic retinopathy may well be a genetic disorder complication that affects eyes. At first, diabetic retinopathy could cause no symptoms or solely delicate vision issues. Eventually, it can cause blindness. The condition can develop in anyone has type 1 or type 2 diabetes. The longer diabetes and the less controlled the blood sugar is, the more likely are to develop this eye complication. One might not have symptoms in the early stages of diabetic retinopathy. Careful management of the diabetes is the best way to prevent vision loss. Over time, too much sugar in your blood can lead to the blockage of the tiny blood vessels that nourish the retina, cutting off its blood supply. As a result, the attention makes an attempt to grow new blood vessels. However these new blood vessels do not develop properly and might leak simply. **Early diabetic retinopathy-** called non-proliferative diabetic retinopathy (NPDR)new blood vessels aren't growing (proliferating).When NPDR, the walls of the blood vessels in the retina weaken .Small bulges (microaneurysms) protrude from the vessel walls of the smaller vessels, typically unseaworthy fluid and blood into the membrane. Larger retinal vessels will begin to dilate and become irregular in diameter, as well. NPDR will progress from delicate to severe, as a lot of blood vessels become blocked. **Advanced diabetic retinopathy**- Diabetic retinopathy will get to this additional severe kind, called proliferative diabetic retinopathy. Eventually, connective tissue stirred by the expansion of latest blood vessels could cause the membrane to detach from the rear of the attention. If the new blood vessels interfere with the conventional flow of fluid out of the attention, pressure might build up within the eyeball. This can damage the nerve that carries images from your eye to the brain (optic nerve), resulting in glaucoma. Diabetic retinopathy involves the abnormal growth of blood vessels within the tissue layer. Complications can lead to serious vision problems like Vitreous hemorrhage, Retinal detachment, Glaucoma, Blindness.

This study is entirely based on Microaneurysms. Microaneurysms are the earliest clinically visible changes of the diabetic retinopathy. They area unit localized

capillary dilatations that are typically saccular. They seem as little red dots that area unit typically in clusters. Here, segment the clinical image of eye and then extract the features .Then using classification technique to identify the occurrence of the red dots.

Comparative study of this microaneurysms detection is mainly useful in analysis of the specific feature of the retina .Here, we used two segmentation and two classification techniques to evaluate accurate detection of microaneurysms.

2.RELATED WORK

Diabetic retinopathy is affected to diabetic patients. It has no early warning signs of the retina. The manual detection of retinopathy useful for detect effective screening method. In retinal blood vessels are damaged or new unwanted blood vessels are detected, Fluorescein angiography and optical coherence tomography useful to helping of diagnosis and treat diabetes changes in the eye [1].

Non-proliferative diabetic retinopathy, in an initial image processing stage isolates blood vessels, microaneurysms and hard exudates in order to extract features that can be used by a support vector machine to figure out the retinopathy grade of each retinal image. Maximum sensitivity of 95% and a predictive capacity of 94% is obtained in [2].This work is only based on color feature.

The two methods are implemented for the detection of exudates they are morphological method and FCM clustering method. Contrast limited adaptive histogram equalization (CLACHE) is used to extract the green component in the image [4]. Overall sensitivity, specificity and accuracy are calculated and 98%accuracy obtained. The main problem faced in this work is the correct localization of optic disc, in certain images with high illumination.

PDR symptom to have poor vision and even blindness, blood vessels eye get weak, blood and other liquid leaking into the retina. Proliferative (PDR) is ending stage these are also divided into two sections (Haemorrhages, hard exudates) of retinopathy the vision will be lost. PDR symptom to have new blood vessels grow and retina, blood can leak into the middle part of the retina. A person has longer diabetes the higher their risk of developing some visual problem. Diabetic retinopathy is that the results of injury to the tiny blood vessels and neurons of the membrane. When diabetes causes damage to blood vessels on the back of the eye in the retina it is called Diabetic Retinopathy (DR) [8,10].

A person with macular edema is to have blurred vision, making it hard to do things like reading or drive, swelling of the central vision part of the eye [5].Image enhancement is an important role of the image processing, adaptive histogram and contrast stretching are use to enhance the retinal images [6].Threshold segmentation technique and morphological operation are used to identified the normal and abnormal images [9].

Inverse thresholding technique is easily detecting the exudates part of the retinal image, the region identified by the gray scale in active contour method [5,11].Fuzzy c means clustering algorithm detect the abnormal regions accurately, canny edge detection and region growing to segment the fundus (or) retinal images [7].

Circular Hough Transform method is applied in Adaptive K-means clustering algorithm for the purpose of eliminates the optic disc. SVM classification is supervised classification separate the part (or) linear and nonlinear data by kernel function, MultiSvm used to classify the retinopathy. The Neural network is the best algorithm to detect the abnormal blood vessels based on features, the Probabilistic neural network used to membership function. Feed Forward algorithm for detected the accurate result.

3. PROPOSED SYSTEM

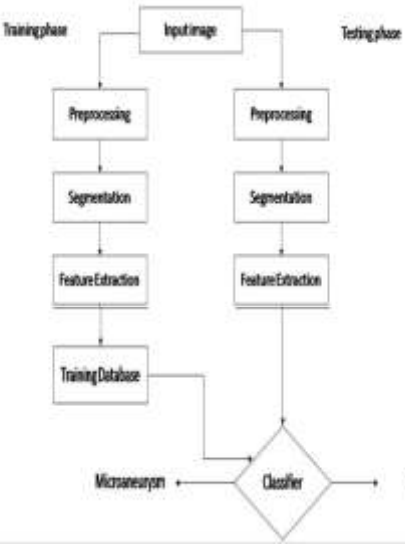

Figure 1:Process flow of Diabetic Retinopathy

3.1 Image pre-processing

The Filter is used to removing unwanted things or noise and removing reflection and masking portion of the image.

3.1.1 Median filter

The median filter is a nonlinear digital filtering technique and also used to remove the noise (unwanted dots other then red). Widely used for this technique in digital image processing. The median filter restores a pixel by the median instead of the average of all pixels in a neighborhood ω,

$$Y[m, n]=\text{median}\{x(i, j),(i, j) \in \omega\} \quad (1)$$

ω stand for a neighborhood defined by the user centered around location[m, n] in the image.

3.1.2 Contrast enhancement

In Contrast enhancement phase to improve the image quality. Adaptive histogram or contrast stretch image function is used to enhance the image. Contrast stretching is limited to a linear mapping of inputs to outputs values. These two methods are best enhancement method. The first step is to fix on the limits over which image intensity values will be extended. These lower limit and upper limit to be called a and b. Next, the histogram of the original image is studied to determine the values limits (lower=c, upper=d) in the unmodified picture. Then for each pixel, the original value r is mapped to output values as using the function:

$$S=(r-c)((b-a)/(d-c))+a \quad (2)$$

3.2 Image segmentation

Image segmentation is useful in many applications as it is divided into separate parts or sections, Adaptive K-means and fuzzy c mean clustering techniques are used and compare these two techniques in this paper.

Data clustering is the method that divides the data elements into clusters such that elements in same cluster are more similar to each other than others.. There are basic two types of clustering .

1) Hard Clustering: Hard clustering is a simple clustering technique that divides the image into set of clusters such that one pixel can only belong to only one cluster. In alternative words it will be a fore said that every component will belong to precisely one cluster.
2)Soft clustering: The soft clump or clustering is a lot of natural style of clustering as a result of in reality actual division isn't doable thanks to the presence of noise. Therefore soft clump techniques square measure most helpful for image segmentation within which division isn't strict.

3.2.1Adaptive k-means clustering

The Adaptive K-means is the simple algorithm of segmenting images into k, Different clusters based on feature, attribute or intensity value. Adaptive K-means is computationally efficient and does not require the specification of many parameters as compared to another method of segmentation. Unlike local thresholding, this can only group into two main classes while K-mean Algorithm can group into k different classes. K-means cluster classification is done by minimizing the sum of the squares of distances between data and the similar to clustering centroid. Circular Hough Transform method is applied in K-means clustering algorithm and to detect the optic disk. It is divided into three clusters Sqeuclidean distance, replicates, and distance. Euclidean metric is that the line distance between 2 points in metric space. Squared Euclidean Distance is not a metric as it does not satisfy the triangle inequality, it is frequently used in optimization problems in which distances only have to be compared.

$$d(x, y) = \left(\sum_{a=1}^{m}(x \quad - y)^2\right)\text{^}2 \quad (3)$$

Sqeuclidean is faster than clustering with regular Euclidean distance.

Algorithm for Adaptive K-means Segmentation

Step 1: Input and number of clusters
Step 2: Calculate groups (clusters) centroids based on initial guess value
Step 3: Distance of each pixel from Class centroids are Calculate
Step 4: The Group pixels into k clusters based on minimal distance from centroids
Step 5: Calculate the new centroids for each cluster
Step 6: Classify into groups based on new centroids, distance
Step 7: if any of centroids appears changes its position and Test it.
Step 8: If there are changes repeat step 3 and 8, else step 9
Step 9: end

3.2.2 Fuzzy c-means clustering

Fuzzy C-means is a form of clustering in which each data point can belong to more than one cluster. Then gives the best result for overlapped dataset and comparatively better than a K-means algorithm. Fuzzy c means that agglomeration rule worksby assignment membership perform every |to every} datum reminiscent of each cluster center on the premise of the gap between the middle and also the datum. The facts is almost the cluster Center a lot of is its membership towards the actual cluster center. This algorithm is based on minimization of the following objective function.

$$J_m = \sum_{i=1}^{n} \sum U_{ij}^{m} \|X_i - C_i\|^2 \quad (4)$$

$$U_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\|X_i - C_j\|}{\|X_i - C_k\|}\right)^{\frac{2}{m-1}}} \quad (5)$$

$$C_j = \frac{\sum_{i=1}^{n=1} U_{ij}^{m} X_i}{\sum_{i=1}^{n} U_{ij}^{m}} \quad (6)$$

Where n is the number of data points,m is any real number greater than 1, U_{ij} is the degree of membership of X_i in the cluster j, $C_j$is the ith of the d-dimensional center of the cluster and $\|*\|$ is any norm Expressing the connection between any measured data the center.

3.3 Feature Extraction

Feature Extraction an important role for identification of an object. The features used are Color, texture, morphology, edges etc.

Texture Feature

The texture contains important information about the surface's basic arrangement. The texture contains vital data concerning the surface's basic arrangement. The gray level co-occurrence matrix is a statistical approach. A co-occurrence matrix also called as co- occurrence distribution is defined as an image which is distributed according to co-occurring values at a given offset and distance over an image sub region of some specific size. GLCM is created from the grayscale image. The GLCM Feature depicts a pixel with gray level values i occurs either horizontally, vertically or diagonally to adjacent pixels with the values j, where i and j are the gray level values in the image. GLCM directions are horizontal (00), vertical (900) and diagonal, bottom left to top right (-450), and top left to bottom right-1350).

Color Feature

Color space represents the color in the form of intensity value. Color is specified, visualize and create by using color space method.HSV colors define easily by human perception, not like CMY or RGB.HSV color space is very effective and it retrieves the most similar images.

Luv color space that divides the luminance and the chrominance values was more suitable. Luv color space is designed in such a way that it completely divides the gray scale intensity from the color parts of an image.

3.4 Classification

Classification is a data mining technique that assigns categories to a collection of data in order to support in more accurate predictions and analysis.

3.4.1 SVM classification

SVM classification is supervised classification to work with the help of a supervisor. A support vector machine constructs a set of hyperplanes in high or infinite dimensional space which can be used for classification and regression. A good separation is acquired by the hyperplane that has the largest distance to the nearest training data point of any class. Whereas the initial drawback is also expressed during a finite dimensional area and it typically happens that the sets to discriminate aren't linearly severable in this area. This classification was proposed that the original finite dimensional space is mapped into a much higher dimensional space.SVM schemes are designed to ensure that dot products may be calculated easily in conditions of the variables in the original space by defining them in terms of a kernel function to choose the problem. Then the objective of the SVM is a separating feature by a kernel function. SVMs can be efficiently perform in a non-linear classification using what is called the kernel function, implicitly mapping their inputs into high-dimensional feature spaces. Multiclass SVM to assign labels to objects by using support vector machine where the labels are drawn from a finite set of several elements. SVM is classifying the disease based on features them to stages Normal and Microaneurysms.

3.4.2 Probabilistic Neural Network

A probabilistic neural network (PNN) has nodes at 3 layers. In PNN that recognizes K = 2 classes, but it can be extended to any number K of classes. The input layer (on the left) contains N nodes: one for every of the N input options of a feature vector. These are fan-out nodes that branch at every feature input node to all or any nodes within the hidden (or middle) layer in order that every hidden node receives the entire input feature vector X. The hidden nodes are collected into clusters: one group for every of the K classes.

There is no iteration nor computation of weights. For a large number of Gaussians in a sum, the error buildup can be significant.

A High Level Algorithm

Step 1 Read in the file of exemplar vectors and class numbers
Step 2 Arrange these into the K sets where each set contains one class of vectors
Step 3 For each k define a Gaussian function centered on each exemplar vector in set k define the summed Gaussian output function
Once the PNN is defined, then feed vectors into it and classify them as follows.
Step 1 Understand input vector and feed it to each Gaussian function in each class
Step 2 For each group of hidden nodes, calculate all Gaussian functional values at the hidden nodes
Step 3 For each cluster of hidden nodes, feed all its Gaussian functional values to the single output node for that group
Step 4 At each class output node, sum all of the inputs and multiply by constant
Step 5 Discover maximum value of all summed functional values at the output nodes

3.5 Testing phase

In the testing phase, each new retinal image is analysed and its principal features are located and compared with the principal features of trained retinal. If some matches were found then the image is classified by the SVM or PNN classifier according to the previously defined rules. Initially, the test query retinal is to be received from the user, then preprocessing, segmentation, feature extraction are done as mentioned in the above Sections. Finally, SVM or PNN classifier approach is applied on the given query image. The trainer will be trained using the Extracted features. Then PNN classifier approach is used to tactically assign exactly one label to each instance.

Figure. 1 shows the detailed explanation on the process carried out in the testing phase during the classification of retinal image. In the retina classification after gathering images we have to apply various image processing techniques in both training and testing phase. Techniques followed in these phases are, preprocessing, image segmentation, Feature extraction and trainer. The pre-processing and feature extraction technique are common for both training and testing phase. When an input image is given to the proposed system the input images are checked by image identifier used in the training phase. This Image identifier detect the type of image and then it search for the presence of related images in the database. If the related image is found it collect all of them then send both input image and images from database for Preprocessing. By these step noise and extra cranial tissue present in the image are removed.

Then the images are taken to segmentation process for segment the image for accurate identification of the principle tissue structure present in the retinal image. Next phase is Feature extraction here features for segmented images are taken for DR detection. Finally in training phase the training samples are collected these are stored in local sub. These stored training samples are utilised in the testing phase for the identification of the availability of DR present in retinal image.

4. EXPERIMENTAL RESULTS

Performance Evaluation is mainly used to compare different techniques under image processing. It is commonly used to measure the quality of reconstruction process. Performance evaluation helps us to find the quality of the image.

4.1 Accuracy

Accuracy alone is not a dependable factor.

$$\text{Accuracy}=\frac{TP+\text{TN}}{\text{TP+FP+TN+FN}}$$

SVM classification method efficiently detects the retinopathy stages then compare with PNN classification. Accuracy for each phase:

1stphase-Adaptive k-means with SVM(80%)

2nd phase-FCM with SVM(80%)

3rd phase –Adaptive k-means with PNN(60%)

4th phase –FCM with PNN(60%)

The work is achieving the maximum accuracy level as 86.667% and the also obtaining the maximum recognition rate for this SVM classifier work. This section elaborates the performance of the proposed system in detail. Performance measure was done by comparing the segmentation results to the reference image. There are four values resulted from the validation procedure, true positive (TP), false positive (FP), true negative (TN) and false negative (FN). True positives is a number of images correctly detected as normal, false positive is a number of images incorrectly flagged, true negatives is a number of images correctly detected as tumor image and false negative (FN) is a number of image incorrectly flagged as DR..

Table 1 Performance Parameters

	Normal	Abnormal
Detected	True positive (TP)	False positive (FP)
Not detected	False Negative (FN)	True Negative (TN)

For evaluation purpose, all the parameters are determined for each image in the data set. Sensitivity, Specificity and Predictivity are used as accuracy measure

Figure 2: Retinal image result (Adaptive k-means&SVM)

Figure 3:Retinal image result(FCM &SVM)

Figure 4: Retinal image Result(Adaptive k-means &PNN)

Figure 5: Retinal image Result(FCM&PNN)

5. CONCLUSION

An competent algorithms are selected for microaneurysms detection. Segmentation and Classification Techniques are performed well. In this work, carry out comparative analysis of microaneurysms detection. Initially, segmentation (Adaptive k-means, fuzzy-c means) to be compared and it is concluded fuzzy c means and Adaptive k-means are performed well. Then Compare the two classifiers, SVM produce best results in microaneurysms

prediction. The best result of this project is a combination of Adaptive k-means and fuzzy c-means clustering with SVM classifier. Accuracy to be increased based on enhancement technique. In Future, will select emerging technique to detect microaneurysms in efficient manner.

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