

Detection of Microaneurysms in Retinal Systems

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Abstract

Retinopathy indicates break to small blood vessels in the eye that can lead to vision problems. This blind rate can be greatly reduced by regular screening. The Screening program is the early detection of the abnormal vessels. Diabetic macular edema is an advanced symptom of diabetic retinopathy and can lead to permanent vision loss. Retinopathy divides into two stages Non-proliferative Diabetic Retinopathy (NPDR) and Proliferative Diabetic Retinopathy (PDR). The manual detection of retinopathy results is not accurate, so the diagnosis process is very mandatory for the medical field. In this paper, initially pre-processing Technique has applied the image using two filters (median filter, wiener filter) and Enhancement phase is carried out by using contrast stretching, so that gray level in the image will get established. Segmentation is the next step after the pre-processing. K-means is used to segment the exudates from the surrounding eye images. Finally, SVM (Binary SVM) classification are used to classify the image.

Keywords: Diabetic Retinopathy, Fundus Image, Image Processing, Median Filter, Wiener Filter, GLCM, Feature Extraction, Texture Features, SVM, Classification, Microaneurysms, Exudates, Haemorrhages.

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Introduction

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. Two stages are Non-Proliferative (NPDR) is an early stage of the diabetic retinopathy these are divided into two sections (Microaneurysms, soft exudates). NPDR 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.^[1] A person has longer diabetes the higher their risk of developing some visual problem. Diabetic retinopathy is the result of damage to the small blood vessels and neurons of the retina. When diabetes causes damage to blood vessels on the back of the eye in the retina it is called Diabetic Retinopathy (DR). 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. Image enhancement is an

important role of the image processing, adaptive histogram and contrast stretching are use to enhance the retinal images. Threshold segmentation technique and morphological operation are used to identify the normal and abnormal images. SVM classification is supervised classification separate the part (or) linear and nonlinear data by kernel function.^[2]

Overview of diabetic retinopathy

Retinopathy is a condition that affects the retina. The retina is a layer of nerve tissue that covers the back of the eye. Many individuals with diabetes develop retinopathy, and this specific type is known as diabetic retinopathy.

If blood sugar levels remain high, diabetic retinopathy can worsen. Although this might seem beneficial these new vessels are delicate and can rupture easily, even during sleep. If they bleed, blood can enter the front part of the eye, in front of the retina, which can alter vision. This bleeding may also lead to the formation of the scar tissue. This scar tissue can pull on the retina, causing it to detach from the back of the eye. This is known as proliferative retinopathy. Sometimes, individuals do not notice symptoms until the condition has advanced too far for effective treatment. This is why regular eye exams are crucial. Retinopathy can also cause swelling in the macula, which is the central part of the retina responsible for detailed vision. This swelling is referred to as macular edema. When the macula swells, it can significantly impair vision and, in some cases, lead to legal blindness.^[2]

Objective of the research work

The objective of this project is to develop a Diabetic Retinopathy detection system, it detect Retinopathy in Diabetic patient and safety on the vision. When Retinopathy is detected on a Diabetic patient, message is issued.^[3]

ANALYSIS OF EXISTING METHOD

In this Paper, first the input image is readed. After reading the input image, Pre-processing step is done. It is divided into 2 types. One step is filtering and another is Enhancement. Filtering is used to remove the unwanted noise and enhancement is used to improve the quality of the image. After the Pre-processing, segmentation is one. Extract the feature by using texture feature. It contains Contrast, Correlation, Energy, Homogeneity. Finally, SVM (Support Vector Machine) classifier is used.^[4]

Pre-processing

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

Median filter

The median filter is a nonlinear digital filtering technique and also used to remove the noise. 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 ,

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

ω stand for neighborhood defined by the user centered around location $[m, n]$ in the image.^[5]

Wiener filter

Wiener filter reduces the mean square error between the estimated random process and the desired process. Wiener filter frequently applied frequency domain. Given a degraded image $x(n, m)$, one gets the discrete Fourier transform (DFT) to obtain $X(u, v)$. The original image spectrum is approximated by taking the product of $X(u, v)$ with the wiener filter $G(u, v)$,

$$S(u, v) = G(u, v) \cdot X(u, v)$$

$$G(u, v) = \frac{H^{-1}(u, v) p_n(u, v)}{|H(u, v)|^2 \frac{p_n(u, v)}{p_g(u, v)}}$$

The term p_n/p_g can be interpreted as the reciprocal of the signal-to-noise-ratio Where the signal is very strong relation to the noise, $p_n/p_g \approx 0$ and the wiener filter becomes $H^{-1}(u, v)$ the inverse filter for the PSF. Where the signal is very feeble, $p_n/p_g \rightarrow \infty$ and $G(u, v) \rightarrow \infty$.^[6]

Feature

A feature is a significant piece of information extracted from an image which provides more detailed understanding of the image.^[3]

Feature Extraction Algorithm

Feature extraction plays an important role for identification of an object. Color, texture, morphology, edges etc. The features which can be used in retinopathy disease detection.^[7]

GLCM: Gray Level Co-occurrence Matrix

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 or it represents the angular spatial relationship and distance over an image sub region of some specific size. GLCM is created from gray scale image. The GLCM depicts how often a pixel

with gray level value i occurs either horizontally, vertically or diagonally to adjacent pixels with the value j , where i and j are the gray level values in the image. GLCM directions of analysis are horizontal (00), vertical (900) and diagonal, bottom left to top right (-450), and top left to bottom right-1350).^[8]

SVM (Support Vector Machine)

Support vector machine builds a hyper plane or set of hyper planes in a high- or infinite dimensional space, used for classification. Generalization error of the classifier^[9]. SVM uses Nonparametric with binary classifier approach and can handle more input data very efficiently. Performance and accuracy depends upon the hyper plane selection and kernel parameter.^[10]

SVM Multi-Class Classification

A SVM is a binary classifier, that is, the class labels can only take two values: Many real-world problems, however, have more than two classes.^[11,12] Four types of classification are used. They are

- ✓ Soft Exudate
- ✓ Hard Exudate
- ✓ Microaneurysms
- ✓ Haemorrhages^[13]

Advantages of SVM

SVMs can model nonlinear phenomena by the choice of an appropriate kernel method. SVMs generally provide precise predictions. SVMs determine the optimal hyperplane by the nearest points (support vectors) only and not by distant points. This thus enhances the robustness of the model in some cases^[13-14]

Disadvantages of SVM

The models are opaque. Although we can explain them with a decision tree, there is a risk of loss or precision. SVMs are very sensitive to the choice of the kernel parameters. The difficulty in choosing the correct kernel parameters may compel you to test many possible values. As a result, the computation time is sometimes length.^[15]

Discussion

The proposed diabetic retinopathy detection system uses image processing and machine learning techniques to identify retinal abnormalities from fundus images. In the preprocessing stage, median and Wiener filters are used to remove noise and improve image quality. GLCM is then used to extract texture features such as contrast, correlation, energy, and homogeneity from the retinal image. The extracted features are given to the SVM classifier to identify abnormalities such as soft exudates, hard exudates, microaneurysms, and haemorrhages.

The method can help in the early screening of diabetic retinopathy and reduce the time required for manual analysis. However, the accuracy of the system depends on image quality, feature selection, and SVM parameter settings. Therefore, a larger dataset and improved image-processing techniques can be used in the future to improve the performance of the system.

Conclusion

An efficient algorithm for the segmentation and classification of the retinopathy stages from the retinal images, which is an important role of the diabetic retinopathy. In this work, presented a comparative analysis of the diabetic retinopathy first we compare the filters (median, wiener) median filter is performed well basis on PSNR values. Feature extraction and GLCM, HSI, Edge, texture features are extracted. Finally, BinarySvm used to classify the four stages of retinopathy (soft exudates, hard exudates, hemorrhages, microaneurysm). The best result of this project is a combination of the median filter and SVM classifier. Accuracy to be increased based on enhancement technique.

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