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Disease Classification in Ophthalmology Using Image Processing

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ABSTRACT

Image processing is now an indispensable element occurring in almost every field of life. Image processing is particularly useful in medicine. It provides not only qualitative information (as it has been so far) but also quantitative information. This information applies to both the course of the disease and quantitative assessment of the progress of its treatment. The quantitative information allows for more precise treatment and selection of drugs. This type of image analysis and processing algorithms is also used in ophthalmology.

It enhances retinal images to identify the eye diseases such as diabetic retinopathy, retinal vein occlusion, retinal detachment, glaucoma etc. Various technologies are used in medical imaging. In order to enhance the images obtained by fundus microscope and give a clear output, various techniques are used such as contrast stretching, histogram analysis, edge detection, detection of blood clotting in retinal images, detection of redness of color fundus image and measurement of the damaged portion in the fundus image. In order to process the eye images, a novel system is described.

Keywords: *Feature Extraction, Pre-processing, Disease Classification.*

1. INTRODUCTION

Image processing is playing an important role in ophthalmology to deal with eye diseases.It helps doctors to identify diseases and analyze them with ease. Modern ophthalmology thrives and develops on the advances in digital imaging and computing power. Ophthalmology is no longer a stand-alone branch of medicine conducted exclusively by specialists with the sole purpose of providing medical aid for the visual health of the general population {it is much, much more than that. As it is conceived today, ophthalmology is undisputedly an interdisciplinary field in both research and clinical practice. Fundus imaging plays a key role in the diagnosis and management of ophthalmologic disorders, such as diabetic retinopathy, glaucoma, and age-related macular degeneration; all of them being the most prevalent causes of blindness in the industrialized world. [1]

This study aims to develop disease classification in ophthalmology. Disease recognition is a process performed by humans or computers, which consists of three steps:

1) Detecting the vectors that are obscured (unclear) or simply to highlight certain features of interest in an image. (This is called pre-processing). [4]

2) Extracting the features from the region of interest. (This is called feature extraction).

The feature extraction can be viewed as a dimensionality reduction problem in machine vision and pattern recognition. It refers to transforming the input data into a reduced representation set of features, which encode the relevant information from the input data.

The whole procedure of feature extraction includes two steps:

- A set of one-dimensional intensity signals is constructed to effectively characterize the most important information of the original two-dimensional image.
- The second one includes using a particular class of wavelets, a position sequence of local sharp variation points in such signals is recorded as features. Experimental results on images show that the performance of the proposed method is encouraging and comparable to the best iris recognition algorithm found in the current literature [2] [3].

3) Using this information, classification of diseases like Blood Clotting, Redness Calculation, and Retinitis Pigmentosa. (This is disease classification).

Here, the images are taken by a fundus camera. The conversion of the image to gray scale is the first step. Feature extraction is done by Gradient analysis, Edge detection, Segmentation [5] [6]. Then diseases are classified.

1.1 Pre-Processing

This section is also responsible for color space conversion and image size standardization for the system.

The flowchart of the pre-processing stage is as shown below.

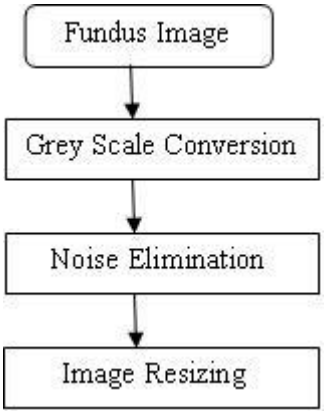

Figure 1: Pre-Processing Stage

1.2 Feature Extraction

The main objective of feature extraction is to extract the feature vectors of an image. Feature extraction is a process which converts the change of texture to a comparable mathematical characterization to distinguish individuals via a pattern match method between any two samples.

In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Only the significant features of the iris must be encoded so that comparisons between templates can be made, this is known as iris feature extraction.Gradient analysis is used in feature extraction.The gradient of the image is one of the fundamental building blocks in image processing. One of the most common uses of gradient analysis is in edge detection. An image gradient is a directional change in the intensity or color in an image. Image gradients may be used to extract information from images. Since the intensity function of a digital image is only known at discrete points, derivatives of this function cannot be defined unless it is assumed that there is an underlying continuous intensity function. With some additional assumptions, the derivatives of the continuous intensity function can be computed as a function on the digital image.Here Global image threshold is found using Otsu's method [6]. Gradient images are created from the original image generally by convolving with a filter, here Sobel filter is used.

1.3 Sobel Filtering

- The Sobel Operator is a discrete differentiation operator. It computes an approximation of the gradient of an image intensity function.
- The Sobel Operator combines Gaussian smoothing and differentiation.[8]

1.4 Segmentation

With same property or characteristics, segmentation plays a major role in image analysis system by facilitating the description into regions of anatomical structures and other regions of interest. The main objective of segmentation is to group the image [7] Method of image segmentation include: simple thresholding, K-means Algorithm, and Fuzzy C-means. In this research, segmentation by K-means with two non-overlapping classes is found to be better than segmentation by simple thresholding. Background and noisy pixels were segmented into one class and the fundus image features which consist of the spots, exudates veins and features of the fundus images were segmented into another class without any pixel belonging into two classes. The non-overlapping of this method made it suitable for this particular research work where it is only of interest to distinguish between the background and the main fundus image features.

1.5 Morphology

Gaussian filtering is used to blur images and to remove noise from an image. Further directional derivatives are applied.
Morphological operations are methods for processing binary images based on shapes. These operations take a binary image as input and return a binary image as output. The value of each pixel in the output image is based on the corresponding input pixel and its neighbors. By choosing the neighborhood shape appropriately, a morphological operation is constructed that is sensitive to specific shapes in the input image.The two principal morphological operations are dilation and erosion. Dilation allows objects to expand, thus potentially filling in small holes and connecting disjoint objects. Erosion shrinks objects by etching away (eroding)

their boundaries. These operations can be customized for an application by the proper selection of the structuring element, which determines exactly how the objects will be dilated or eroded.

2. CONCLUSIONS

Following diseases are diagnosed

Blood Clotting
Occlusions are generally caused due to blood clotting. In retinal vein occlusion, the vein is blocked and cannot drain the blood out of the retina. The blocking of veins causes blood and clear fluid to leak out, thus damaging the sight. Similarly, retinal artery occlusion is a blockage of the main artery supplying the retina of the eye.

Redness Calculation

Eye redness occurs when the vessels in the eye become swollen or irritated. Redness of the eye also called as bloodshot eyes can indicate the presence of several health problems.

Retinitis Pigmentation

Retinitis pigmentosa results from outer retinal degeneration. This causes the outer portion of the inner anatomical retina (outer retina), composed primarily of photoreceptor outer and inner segments and their cell bodies, to become damaged, the inner portion (inner retina), comprising the remaining bipolar, horizontal, and ganglion cells and nerve fiber layer, can be substantially spared. The automatic detection of retinitis pigmentosa is done using image processing.

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