Diabetic Retinopathy Detection

DIP Final Project

Group Project

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Introduction & Background

Diabetic Retinopathy (DR) is a common consequence of diabetes mellitus that develops retinal diseases that impair vision. It can cause blindness if not identified early. Unfortunately, DR is not reversible, and treatment just prolongs eyesight. Early detection and treatment of DR can lower the risk of vision loss drastically. Unlike computer-aided diagnosis systems, the manual diagnosis of DR retina fundus images by ophthalmologists is time-, effort-, and cost-consuming, and is prone to misdiagnosis. Here, we attempted to develop simple methods for severity grading and lesion Detection from retinal fundus images.

Firstly, we will extract the blood vessels. To extract the blood vessels Following steps were followed:

1. Histogram Equalization
2. Kirch Filter
3. Thresholding
4. Clearing small objects using Median Filter

Then we will Extract the exudates. Exudate may ooze from cuts or from areas of infection or inflammation. It is also called pus. In people who have diabetic retinopathy, exudates form in the retina of the eye. To extract exudates Following steps were followed:

1. Extracting the Green component of RGB image
2. Contrast Limited Adaptive Histogram Equalization (CLAHE)
3. Performing Dilation
4. Inverse Binary Threshold
5. Apply median FIlter

The simple and easily applied methods presented in this study will aid in the diagnosis and severity grading of Diabetic Retinopathy, which may aid in the selection of appropriate Diabetic Retinopathy treatment strategies.

Extraction Of Blood Vessels

1. **Histogram Equalization** is a digital image processing technique that improves image contrast. It achieves this by effectively spreading out the most frequent intensity values, hence expanding the image's intensity range. When the useable data in a picture is represented by close contrast values, this method frequently enhances the global contrast. This permits areas with poor local contrast to gain contrast. An image's color histogram represents the number of pixels in each sort of color component. Histogram equalization cannot be applied to the image's Red, Green, and Blue components separately because it causes drastic changes in the image's color balance. However, if the image is first transformed to another color space, the method can be applied to the luminance or value channel without affecting the image's hue and saturation.

2. The **Kirsch filter**, also known as the Kirsch compass kernel, is a non-linear edge detector that discovers the strongest edges in a few predefined directions. Edges in a digital image are the pixels where their gray level intensity changes abruptly compared to their local neighboring pixels. In the application of image processing, machine vision, and computer vision, edge detection is one of the crucial steps in pre-processing stages for finding the boundaries of objects within an image, for instance detecting local discontinuities in pixels intensity or brightness for boundaries extraction. The directional kernels work in the following directions: north, northwest, west, southwest, south, southeast, east, and northeast. Through basic convolutional procedures, each kernel generates a unique image gradient map. The largest magnitude is then picked among the eight gradient maps, resulting in a complete image gradient map. Overall, Kirsch operators/filters are successful at defining the structure of items in an image.

$$h_{n,m} = \max_{z=1,\ldots,8} \sum_{i=-1}^{1} \sum_{j=-1}^{1} g_{ij}^{(z)} \cdot f_{n+i,m+j}$$

where z enumerates the compass direction kernels **g**:

$$\mathbf{g}^{(1)} = \begin{bmatrix} +5 & +5 & +5 \\ -3 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix}, \mathbf{g}^{(2)} = \begin{bmatrix} +5 & +5 & -3 \\ +5 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix}, \mathbf{g}^{(3)} = \begin{bmatrix} +5 & -3 & -3 \\ +5 & 0 & -3 \\ +5 & -3 & -3 \end{bmatrix}, \mathbf{g}^{(4)} = \begin{bmatrix} -3 & -3 & -3 \\ +5 & 0 & -3 \\ +5 & +5 & -3 \end{bmatrix} \text{ and so on.}$$

The edge direction is defined by the mask that produces the maximum edge magnitude.

3. Image **thresholding** is a basic but efficient method of dividing an image into foreground and background areas. This image analysis technique is a sort of image segmentation in which objects are isolated by converting grayscale photos to binary images. Image thresholding works best in photographs with a lot of contrast. Thresholding can be used to create binary pictures from grayscale photographs. The simple thresholding method involves replacing each pixel in an image with a black pixel if the image intensity src(x,y) is less than some fixed constant T (that is, src(x,y) <T), or a white pixel if the image intensity is greater than that constant.

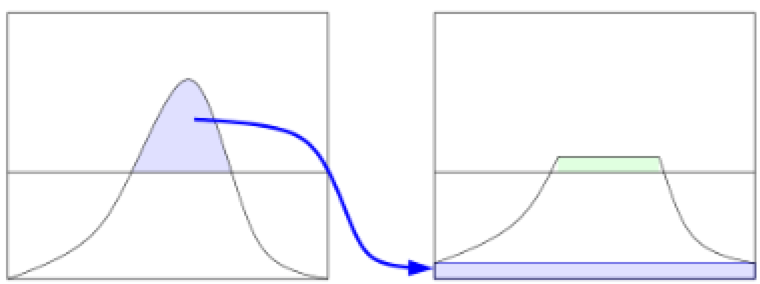
4. The **median filtering** method is a nonlinear method for removing noise from photographs. It is commonly used due to its effectiveness in reducing noise while keeping edges. It's especially good at getting rid of salt and pepper sounds. The median filter operates by pixel-by-pixel traversal of the image, replacing each value with the median value of neighboring pixels. The pattern of neighbors is known as the "window," and it moves across the entire image pixel by pixel. The median is calculated by first sorting all of the pixel values in the window into numerical order, and then replacing the pixel under consideration with the pixel with the middle (median) value.

Extraction Of Exudates

1. First, read the color image to extract the exudates. The **green component** of the input image is taken from it. The morphological Bottom hat operation is conducted on the image's green component, followed by the Morphological Top hat operation

on the image's green component. Subtract the generated image from the morphological bottom hat and top hat operations. Optic disc elimination and hard exudate detection will take place.

2. Because the histogram in such locations is heavily concentrated, ordinary Adaptive Histogram Equalization(AHE) tends to overamplify the contrast in near-constant portions of the image. As a result, AHE may cause noise in near-constant locations to be magnified. **Contrast Limited AHE (CLAHE)** is a type of adaptive histogram equalization that limits contrast amplification to reduce noise amplification. The slope of the transformation function determines the contrast amplification in the neighborhood of a specific pixel value in CLAHE. This is proportional to the slope of the neighborhood cumulative distribution function (CDF) and thus to the histogram value at that pixel value. Before computing the CDF, CLAHE restricts the amplification by clipping the histogram at a preset value. The clip limit, or value at which the histogram is clipped, is determined by the normalization of the histogram and thus by the size of the neighborhood region. The resulting amplification is typically limited to 3 to 4. It is preferable to redistribute the portion of the histogram that exceeds the clip limit rather than discard it.



3. Morphology is defined as a comprehensive range of image processing operations that manipulate images based on their shapes. It is also recognized as a technique for extracting picture components that can be used to depict and describe the form of a region.
   The fundamental morphological operations are as follows:
   - Erosion
   - Dilation

Dilation is used to enlarge an element A by using structuring element B to expand the image pixels. Dilation adds pixels to the edges of objects. The maximum value of all the pixels in the neighborhood is the value of the output pixel. If any of the nearby pixels have the value 1, the pixel is set to 1.

4. **Inverse Binary Threshold** is an image processing approach that generates a binary image by imposing a threshold value on the original image's pixel intensity. While it is most typically used in grayscale photos, it can also be used in color photographs. If the pixel is less than the threshold, it is given one value, and if it is more than the threshold, it is given another value. If the pixel's value is less than the threshold, it will be assigned the maximum value, that is white, in inverse binary thresholding. If it exceeds the threshold, it will be allocated 0 (black).