Image Processing Pipeline for Diabetic Retinopathy Screening in Fundus Images Using MATLAB

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***Abstract*—Diabetic Retinopathy (DR) is a major complication of diabetes that can lead to permanent blindness if not detected early. This paper presents an automated image processing pipeline developed entirely in MATLAB to screen for DR in retinal fundus images. The pipeline utilizes grayscale conversion, histogram equalization for enhancement, Gaussian filtering for noise reduction, and Canny edge detection for feature extraction. Experimental results on sample datasets demonstrate that this approach effectively identifies pathological lesions through area-based thresholding, making it suitable for initial medical screening.**

***Index Terms*—Diabetic Retinopathy, Image Processing, MATLAB, Canny Edge Detection, Regionprops.**

I. INTRODUCTION

Diabetic Retinopathy (DR) affects the blood vessels in the light-sensitive tissue called the retina. Early detection is crucial for effective treatment. Computer-Aided Diagnosis (CAD) systems provide a solution by automatically analyzing digital fundus images. This project implements a robust image processing pipeline using MATLAB's Image Processing Toolbox to assist in this screening process. "Computer-Aided Diagnosis (CAD) systems provide a solution [1], [2]."

II. METHODOLOGY

The proposed pipeline involves several key stages as implemented in the MATLAB environment: "The core segmentation utilizes Canny Edge Detection [1]."

A. Preprocessing and Enhancement

The input RGB fundus image is converted to grayscale to reduce computational overhead. To improve the visibility of lesions, Global Histogram Equalization (histeq) is applied to enhance the contrast between pathological features and the retinal background.

B. Noise Suppression

To ensure the edge detection algorithm does not flag retinal nerve fibers as lesions, a Gaussian Filter (imgaussfilt) with σ=2 is applied to smoothen the image.

C. Edge Detection and Boundary Tracing

The core segmentation utilizes the Canny Edge Detection algorithm. Following edge detection, the boundary's function traces the exterior contours of all detected objects.

D. Feature Extraction

The structural properties of traced boundaries are analyzed using regionprops. The area of each detected region is calculated. A logical threshold (T >100 pixels) is applied to identify potential retinopathy regions while filtering out minor noise.

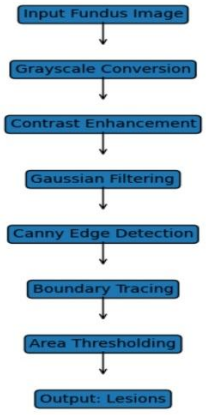

Fig.1 Block Diagram of Image Processing Pipeline for Diabetic Retinopathy Screening in Fundus Images

III. RESULTS AND DISCUSSION

The pipeline was tested on a batch of four images (DFI3 to DFI6). The MATLAB simulation successfully identified pathological features through numerical analysis in the command window.

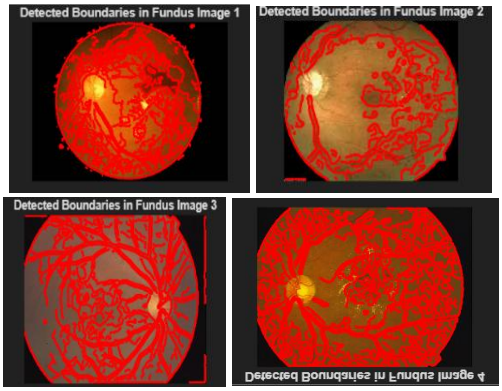

Fig. 2. Detected lesion boundaries in sample fundus images

TABLE I: DETECTION RESULTS FOR SAMPLE IMAGES

Image ID	Total Regions Analyzed	Detected DR Lesions
Image 1	469	15
Image 2	100	11
Image 3	233	24
Image 4	357	26

The visual output (Fig. 2) confirms that the boundaries correctly encapsulate lesions. The numerical output shows that the system can handle large amounts of data efficiently.

IV. CONCLUSION

This paper presented an effective image processing pipeline for Diabetic Retinopathy screening using MATLAB. By leveraging Canny edge detection and area thresholding, the system accurately segments retinal lesions. Future work will focus on classifying the severity of DR based on lesion count.

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