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Extracting Features from the fundus image using Canny edge detection method for Pre-Detection of Diabetic Retinopathy

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Abstract: *Diabetic Retinopathy (DR) is an ailment of the eye caused by diabetes. People suffering from diabetes can procure the disease. DR is caused when the high blood sugar level damages the blood vessels of the eye. Also due to high blood sugar level abnormal blood vessels can grow in the retina. This can make the patient lose its vision. Unfortunately, the symptoms of DR cannot be detected easily. The disease can grow increasingly if left untreated. Hence it becomes all the more important to detect DR. In this paper we have made use of Image processing Technique like canny edge detection to extract the features necessary to detect DR and find the severity of the disease. The features extracted from the image can be used to detect DR by various other methods like SVM, Logistic Regression, etc.*

Keywords – Diabetic *Retinopathy, Feature Extraction, Canny Edge Detection, Image Processing Technique*

I. INTRODUCTION

Person with diabetes can develop an eye disease called diabetic retinopathy. This is when high blood sugar causes damage to the blood vessels in the retina. These arteries can become inflamed or leaky, blocking the flow of blood. Sometimes new abnormal blood vessels grow in the retina. All of these changes can steal patient's vision. The symptoms of DR appear gradually over time making it difficult to identify if a particular patient is suffering from DR or not. Hence it becomes important to identify if a patient who's having diabetes has DR.

By looking at various papers and journals while researching for Diabetic retinopathy it was seen that the detection of Diabetic Retinopathy in early stages is difficult as the symptoms are very difficult to detect and test. Many journals and papers have been written and published on the detection of Diabetic Retinopathy which have used many different techniques and processes to detect DR. The prediction that the image is having Diabetic Retinopathy is done by implementing various image processing and machine learning techniques on the extracted features from the image [1][2].

In this paper, we have used Canny edge detection method to extract important features from the input fundus image. By using canny edge detection, features like the gaussian image, weak edges, strong edges, magnitude of the input image is obtained which can be used for detection of Diabetic Retinopathy. This extracted feature can be used with other Image processing technique like k-means clustering, etc. and Machine learning Techniques like Conventional neural network, Support Vector Machine (SVM), etc to predict if the input image is having Diabetic Retinopathy and finding its severity.

II. LITERATURE SURVEY

The collection of different machine learning classifying algorithms on features extracted from output of different retinal image processing algorithms like diameter of optic disk, lesion specific (microaneurysms, exudates), image level (pre-screening, AM/FM, quality assessment) were used for prediction of DR in the first paper. Decision making was performed using SVM, alternating decision tree, Naive Bayes, adaBoost and Random Forest [2].

An automated method for image-based classification of diabetic retinopathy consisting of 3 stages was used in Image-Based Classification of Diabetic Retinopathy using Machine Learning. In the first stage image features were enhanced using 2 image processing technique. On second stage dimensionality of the images and finds features using the statistical method of principal component analysis was reduced. In the third stage various machine learning algorithms like the naive Bayes, neural networks, k-nearest neighbors and SVM were used for classification of images [3].

In research article under title "A Brief Review of the Detection of Diabetic Retinopathy in Human Eyes Using Pre-Processing & Segmentation Techniques", it is briefly presented on the detection of DR in the eyes of people using a variety of pre-screening and classification techniques. There are many ways to separate the blood vessels present in the retina and if the retinal nerve fibers are separated, one can see if the eyes are affected by DR or not. The detection depends on the area of the RNFL network. If the total area of the nerve fibre is less, then it is affected with DR & if the area is more, then the eyes are not affected with the DR and hence it is normal [4].

III. CANNY EDGE DETECTION

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to find a large range of edges in images. It was discovered by John F. Canny in 1986. Canny also give a computational theory of edge detection to prove why the technique works. The Canny edge detection algorithm is consisting of 5 steps:

- Noise reduction
- Gradient calculation
- Non-maximum suppression
- Double threshold
- Edge Tracking by Hysteresis.

After applying these steps, the subsequent result is achieved:

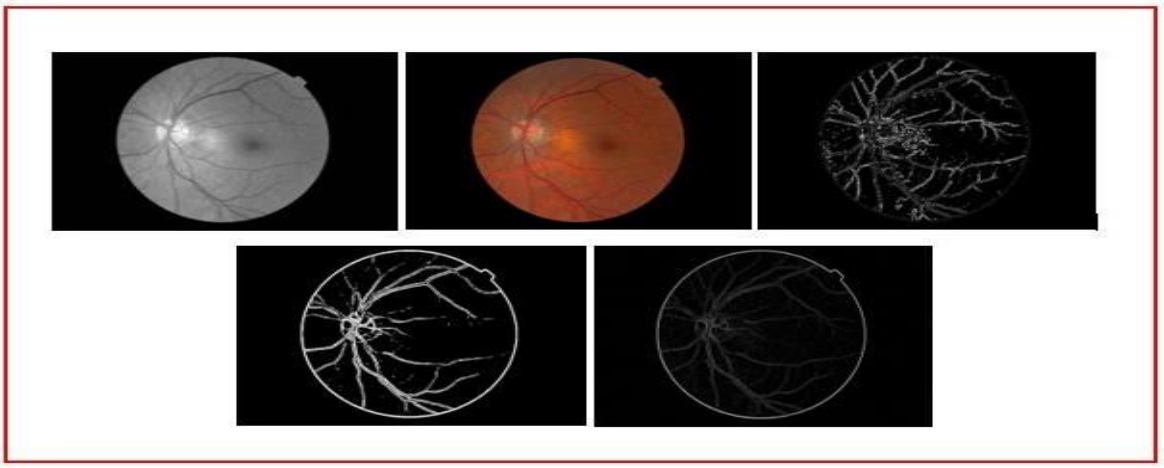

Fig 1. Result obtained after Image Processing

1) Noise Reduction

Since edge detection is susceptible to noise in the image, first step is to remove the eliminate in the image with a 5x5 Gaussian filter.

2) Finding Intensity Gradient of the Image

The smooth image is filtered through a Sobel kernel in both horizontal and vertical direction to obtained first derivative in horizontal direction (Gx) and vertical direction (Gy). From these two images, we can find edge gradient and direction for each pixel as follows:

Edge Gradient(G) : G2x+G2y−−−−−−−√Angle(θ)=tan−1(GyGx)

Gradient direction is always perpendicular to edges. It is rounded to one of four angles representing vertical, horizontal and two diagonal directions.

3) Non-maximum Suppression

After getting gradient magnitude and direction, a full scan of image is done to remove any unwanted pixels which may not constitute the edge. For this, at every pixel, pixel is checked if it is a local maximum in its neighbourhood in the direction of gradient. Check the Fig 2. below:

Fig 2. Edge Detection Non-Maximum Suppression [13]

Point A is on the edge (in vertical direction). Gradient direction is normal to the edge. Point B and C are in gradient directions. So, point A is checked with point B and C to see if it forms a local maximum. If so, it is considered for next stage, otherwise, it is suppressed (put to zero). In short, the result you get is a binary image with "thin edges".

4) Hysteresis Thresholding

This level decides which are all edges are really edges and which are not. For this, we need two threshold values, minimum Value and maximum Value. Any edges with intensity gradient more than maximum Value are sure to be edges and those below minimum Value are sure to be non-edges, so discarded. Those who stand between these two thresholds are categorized edges or non-edges based on their connectivity. If they are connected to "sure-edge" pixels, they are considered to be part of edges. Otherwise, they are also discarded. See the Fig 3 below:

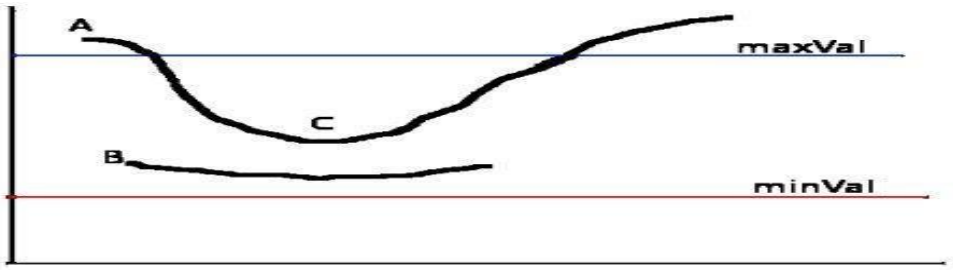

Fig 3. Hysteresis Thresholding [14]

IV. METHODOLOGY

Design Methodology is important for proper planning and execution of the method. In Design Methodology, a flowchart of the method is given which gives a short, simple explanation of the paper.

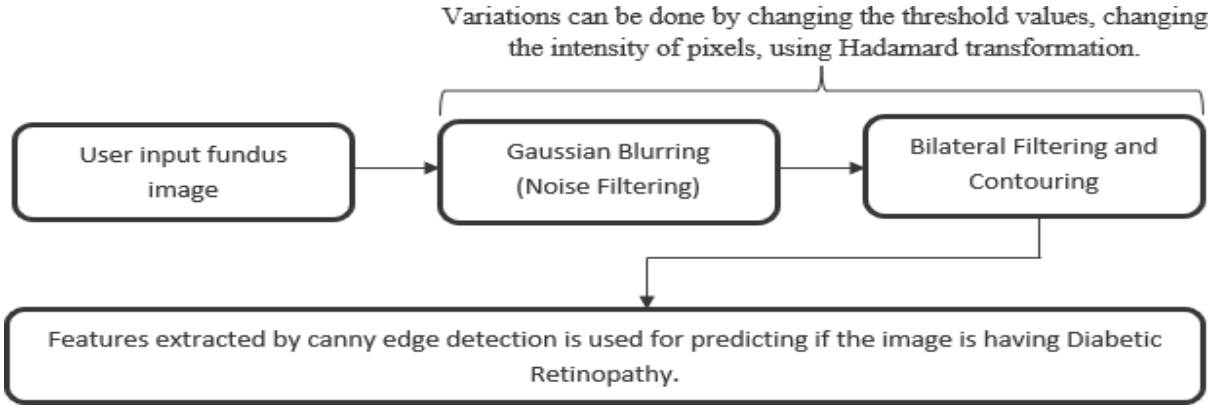

Fig 4. Flowchart of Canny Edge Detection used to extract features.

An input fundus image is sent into the system to extract features. Features are extracted after applying image processing techniques on it such as gaussian blurring (Noise filtering), Bilateral filtering, contouring. Image processing techniques like canny edge detector and histogram equalization have been applied to the input images for detecting their edges, taking their threshold values, increasing the intensity of pixels. This extracted feature can be used for Detection of Diabetic Retinopathy using various other Image processing and Machine learning techniques.

Two datasets from two database company are used for the paper. Using two datasets helps to ensure that the system gets trained for different images from two different databases. Python, was the preferred choice for the paper. Various application like Anaconda, PyCharm, IntelliJ can be used for Python programming.

1) DIARETdb

The database consists of 130 colour fundus images of which most contain at least mild non-proliferative signs (Microaneurysms) of the diabetic retinopathy, and some are considered as normal which do not contain any signs of the diabetic retinopathy according to all experts who participated in the evaluation.

2) Messidor

The 1200 eye fundus colour numerical images of the posterior pole of the Messidor database were acquired by 3 ophthalmologic departments using a colour video 3CCD with a 45-degree field of view. Images were captured using 8 bits per colour plane. The database also provides a excel sheet containing the results of the image.

V. RESULTS

The image processing techniques are implemented on the input fundus image which are used from two datasets namely diaretDB, and messidor. Images from datasets are taken as input for image processing technique. The RGB image is converted into grey scale image before applying canny edge detection algorithm on it. The greyscale image is shown in Fig 5. A canny edge detection algorithm gives output image containing edges. The results of images after canny edge detection are shown in Fig 6. and Fig 7. These images are useful in detecting the swelling veins and red dots inside eye.

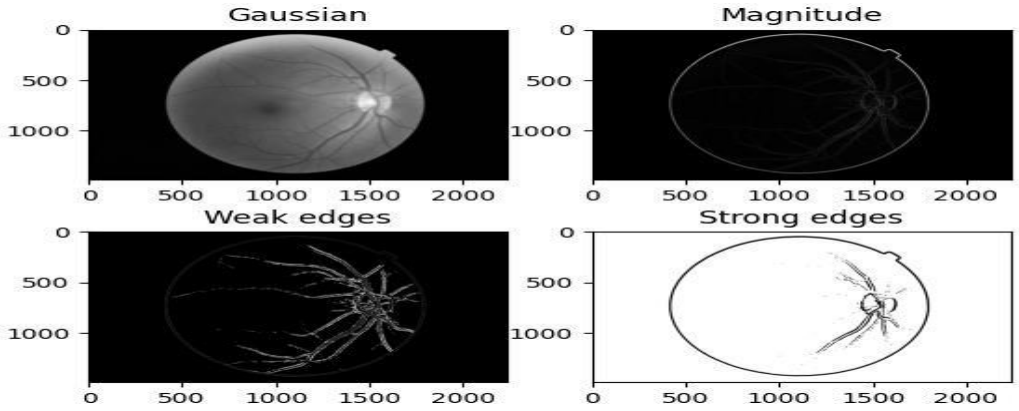

Fig 5 Grey scale of an eye image

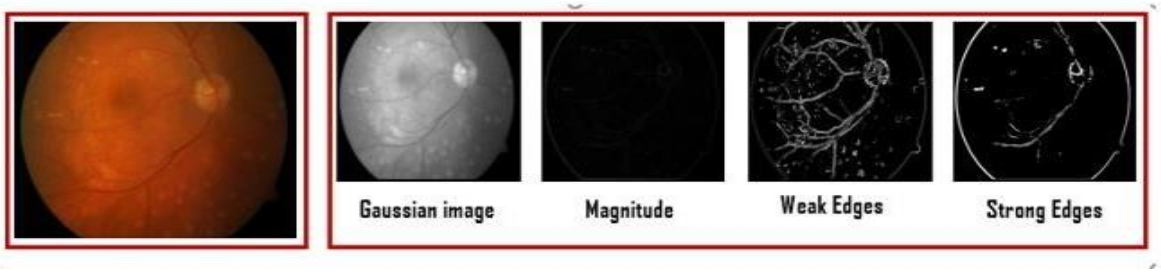

Fig 6. Canny Edge Detection on Dataset 1 image.

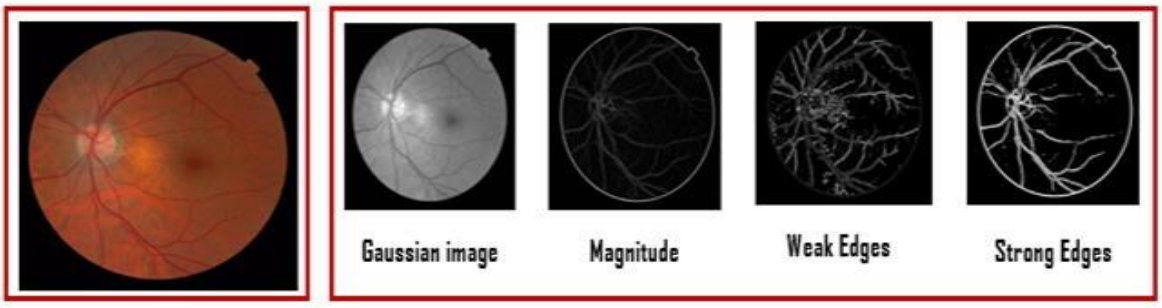

Fig 7. Canny Edge Detection on Dataset 2 image.

VI. CONCLUSION

In this paper, the design and application of a Canny edge detector for detecting small blood vessels from retinal image is discussed. By changing the threshold value and the sigma value, more clear and accurate features can be extracted.

After using Canny edge detection technique, features like weak edges, strong edges, magnitude, gaussian image are extracted from the input image. This features thereby can be used as the base for the detection of Diabetic Retinopathy from fundus images.

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