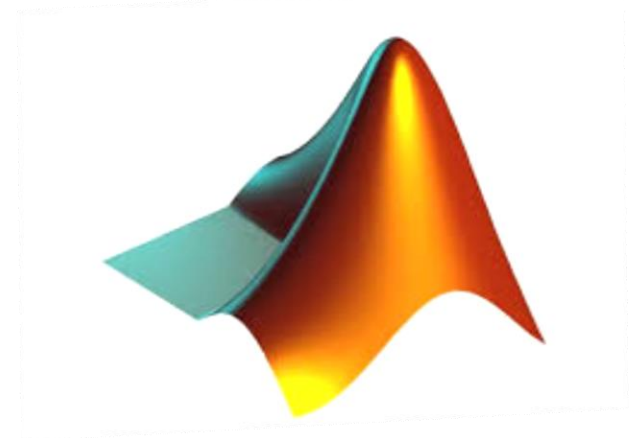# Study And Development Of Digital Image Processing Tool For Application Of Diabetic Retinopathy

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Outline

Aim and Objective

Aim- Aim of this research is to develop **reliable and accurate** image processing and pattern recognition methods to be used as an automatic tool for the mass screening of diabetic retinopathy and to aid ophthalmologist's diagnosis.

Objectives-

❑ Recognize the importance of diabetic retinopathy as a public health problem

❑ To develop algorithms for detection of diabetic eye.

❑ To implement an automated detection tool of Diabetic Retinopathy using digital fundus images.

❑ To extract and detect the features such as Micro aneurysms, Retinal Haemorrhages , Cotton wool spots, Hard exudates and Neovascular textures which will determine two general classifications:

    1) Proliferative diabetic Retinopathy (abnormal (DR) eye).

    2) Non Proliferative diabetic Retinopathy (normal)
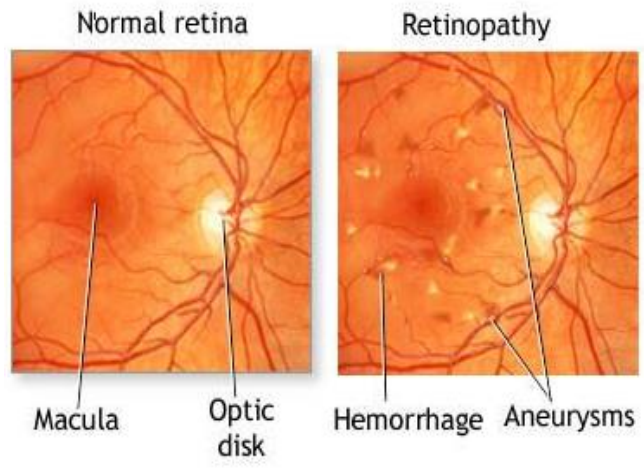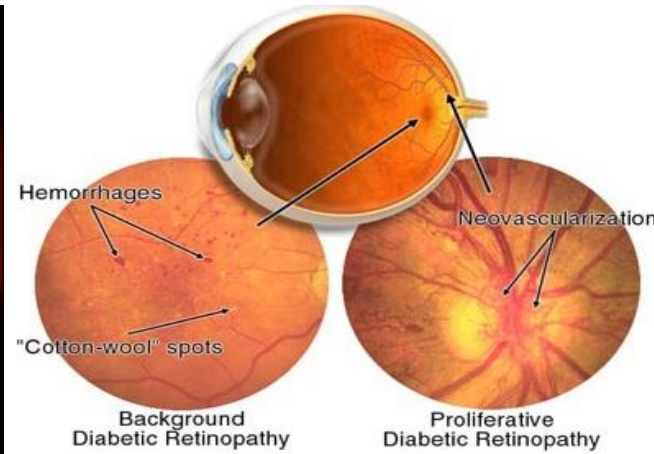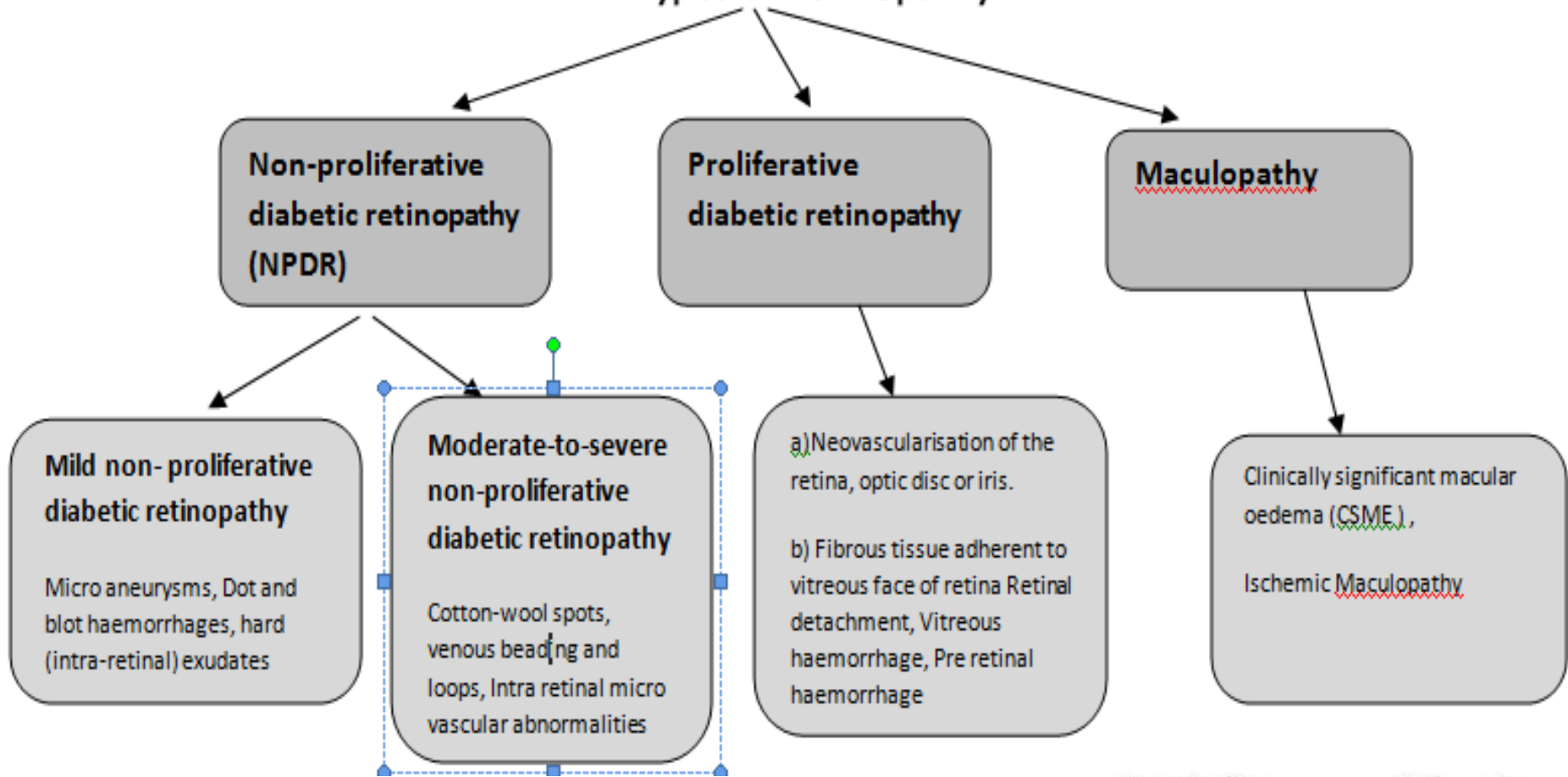
Introduction

Diabetic Retinopathy (DR):

People with diabetes can have an eye disease like diabetic retinopathy, results in swelling and leaking of blood vessels. Sometimes abnormal new blood vessels grow on the retina. All of these changes can steal your vision.

➢ This research detects the presence of abnormalities in the retina using **image processing techniques** by applying morphological processing to the fundus images to extract features such as blood vessels, micro aneurysms, haemorrhages ,exudates and neo vascularization.

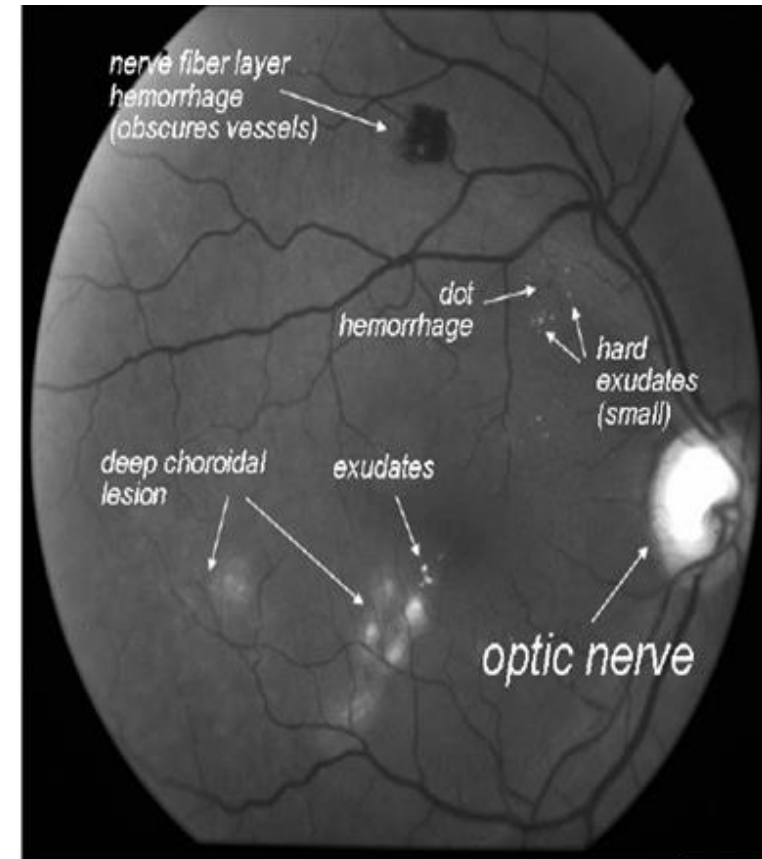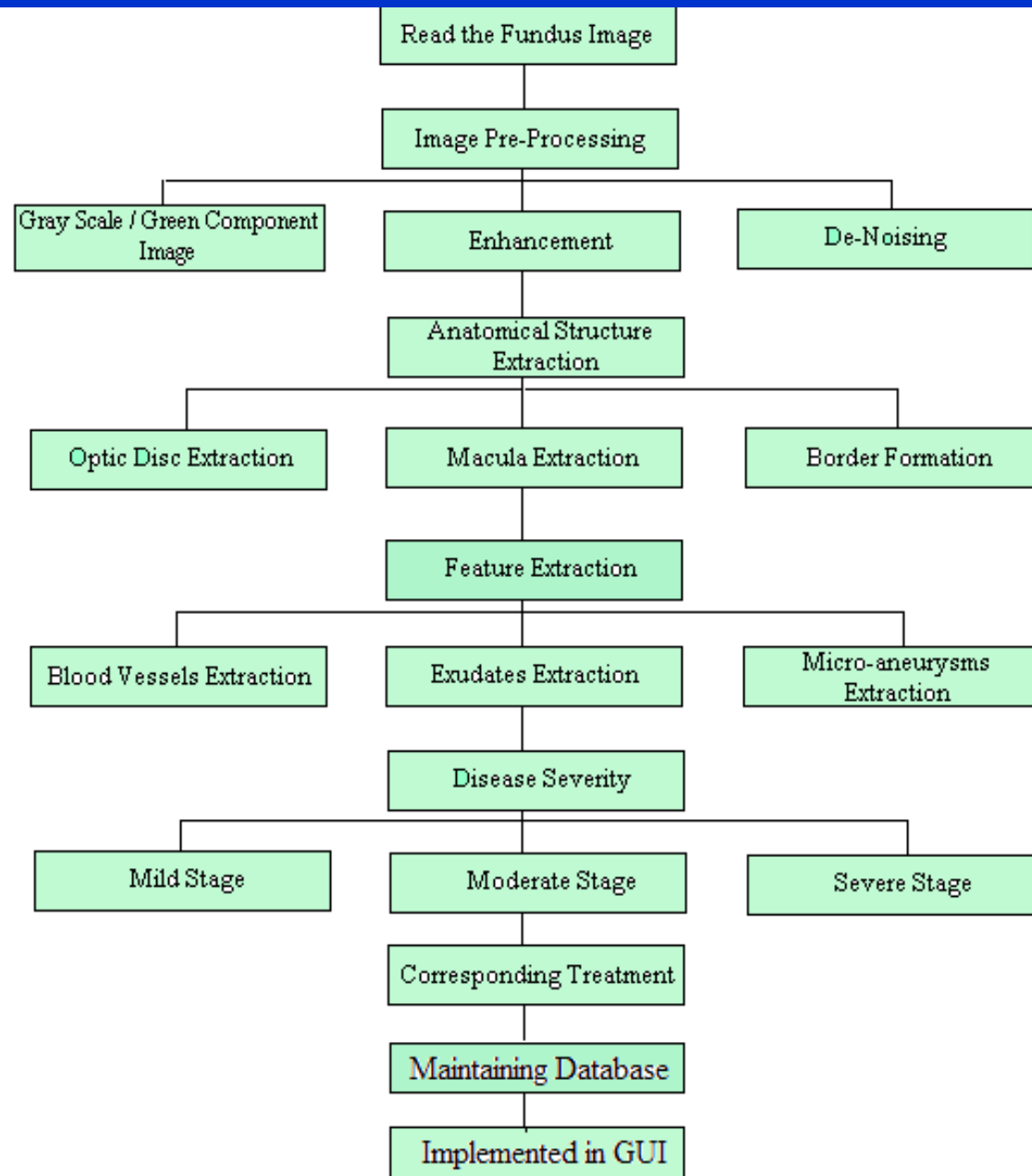➢ Then depending on the Area of these features are used for the detection of severity of Diabetic Retinopathy.

Types of Retinopathy

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                          Types of Retinopathy
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Non-proliferative diabetic retinopathy (NPDR)

Proliferative diabetic retinopathy

Maculopathy

Mild non- proliferative diabetic retinopathy

Micro aneurysms, Dot and blot haemorrhages, hard (intra-retinal) exudates

Moderate-to-severe non-proliferative diabetic retinopathy

Cotton-wool spots, venous beading and loops, Intra retinal micro vascular abnormalities

a)Neovascularisation of the retina, optic disc or iris.

b) Fibrous tissue adherent to vitreous face of retina Retinal detachment, Vitreous haemorrhage, Pre retinal haemorrhage

Clinically significant macular oedema (CSME),

Ischemic Maculopathy

Diabetic retinopathy
Neovascularization
Hemorrhage

Hard Exudate

Hemorrhages

"Cotton-wool" spots

Neovascularization

Background Diabetic Retinopathy

Proliferative Diabetic Retinopathy

Normal retina

Retinopathy

Macula

Optic disk

Hemorrhage

Aneurysms

Tools used :

1. Median filters, Image range filter, Filtering, Gabor filtering
2. Threshold Techniques
3. Laplacian filters
4. Otsu's Method
5. contrast enhance
6. Image segmentation
7. Image enhancement methods like Adaptive Contrast Enhancement, Histogram equalization.
8. Segmentation-color Space Selection,
9. Statistical Measures,
10. Fuzzy Gaussian Filter Tool,
11. Sobel and canny edge detection
12. Contrast Limited Adaptive Histogram Equalization (CLAHE)
13. Walter–klein contrast enhancement

Diabetic Retinopathy Detection

Read the Fundus Image

Image Pre-Processing

Gray Scale / Green Component Image

Enhancement

De-Noising

Anatomical Structure Extraction

Optic Disc Extraction

Macula Extraction

Border Formation

Feature Extraction

Blood Vessels Extraction

Exudates Extraction

Micro-aneurysms Extraction

Disease Severity

Mild Stage

Moderate Stage

Severe Stage

Corresponding Treatment

Maintaining Database

Implemented in GUI

nerve fiber layer hemorrhage (obscures vessels)

dot hemorrhage

hard exudates (small)

deep choroidal lesion

exudates

optic nerve

Red-free fundus image showing the optic nerve, vascular arcades, and a variety of lesions.

Methodology

Extract & detect the features such as blood vessels, micro-aneurysms & exudates , will determine classification : normal or abnormal DR eye.

➢ **Corresponding Steps :**

➢ Read Input Image From Fundus Camera

➢ Image Pre-processing

➢ Anatomical Structure Extraction

➢ Feature Extraction

➢ Disease Severity

➢ Corresponding Treatment

➢ Maintaining Database & GUI
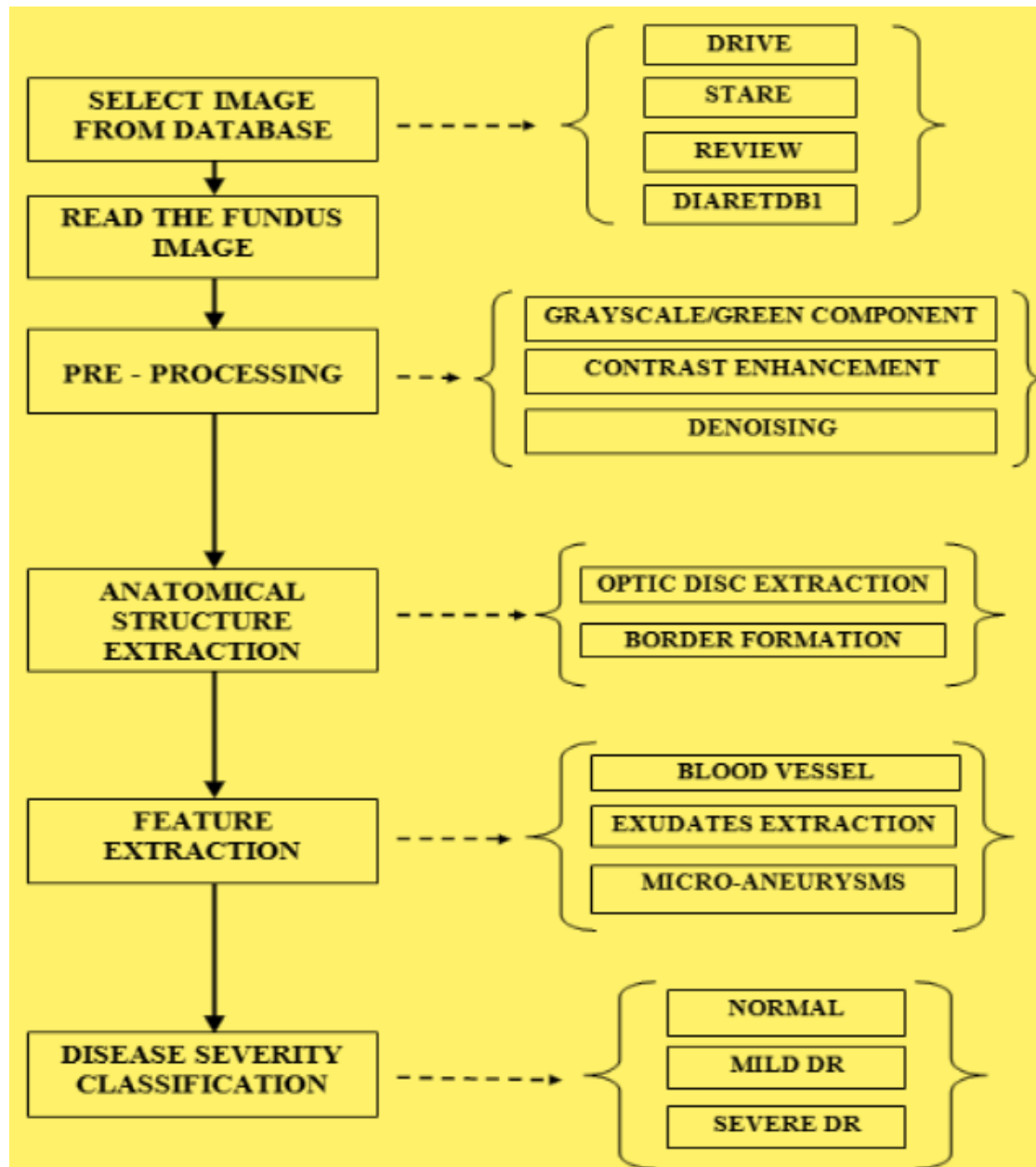
# Methodology:

- ## WALTER–KLEIN CONTRAST ENHANCEMENT

  This preprocessing method aims to enhance the contrast of fundus images by applying a gray level transformation using the following operator:

$$f' = \begin{cases} \dfrac{\frac{1}{2}\left(f'_{max} - f'_{min}\right)}{(\mu - f_{min})^r} \cdot (f - f_{min})^r + f'_{min}, & f \leq \mu \\[4mm] -\dfrac{\frac{1}{2}\left(f'_{max} - f'_{min}\right)}{(\mu - f_{max})^r} \cdot (f - f_{max})^r + f'_{max}, & f \geq \mu \end{cases}$$
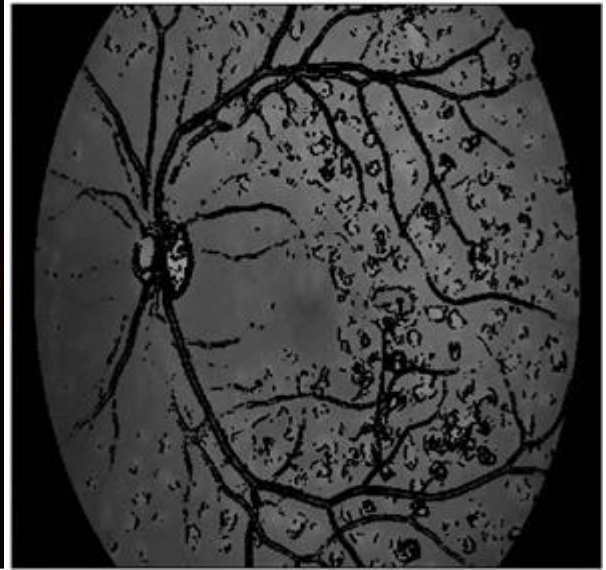
- Where {fmin, . . . , fmax}, {f_ min, . . . , f_ max} are the intensity levels of the original and the enhanced image, respectively, μ is the mean value of the original grayscale image and r ∈ R is a transition parameter.

Possible Outcome

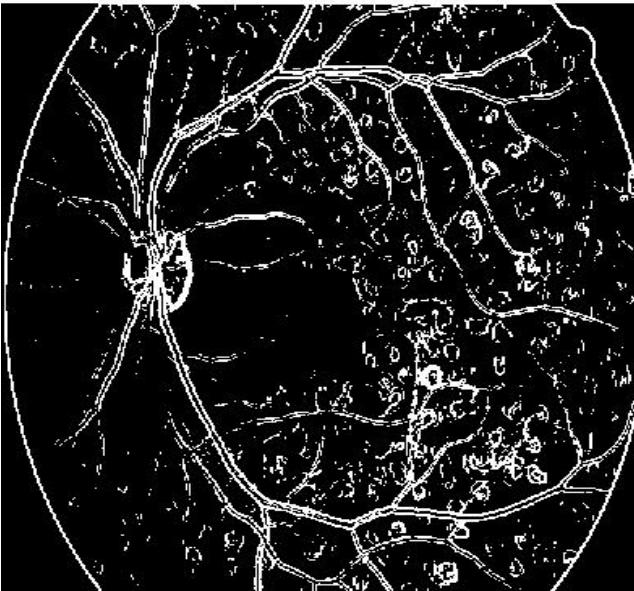Adaptive histogram equalized color image
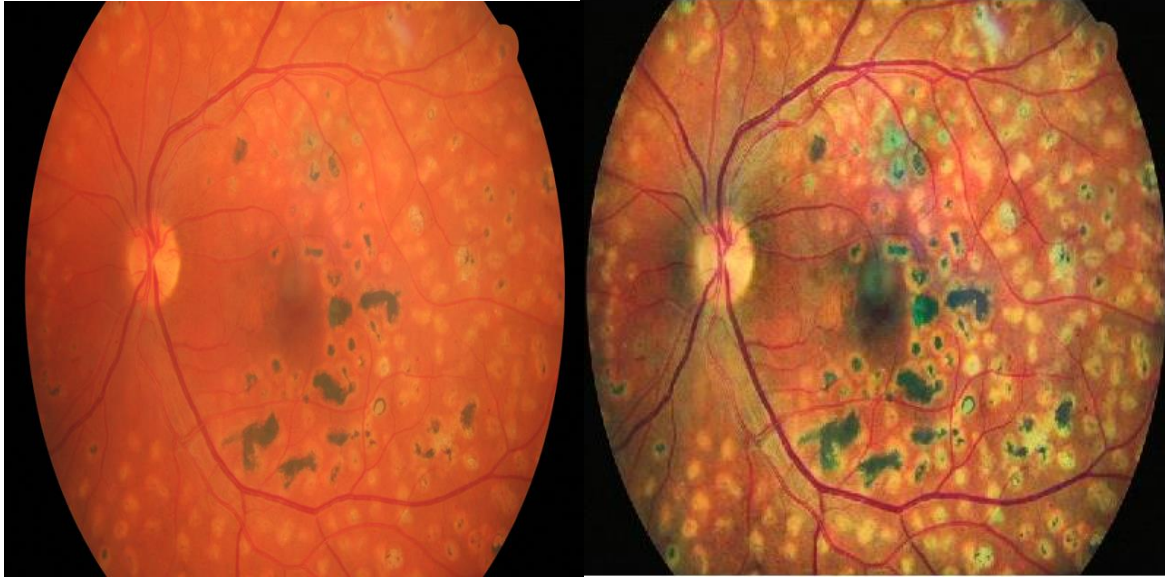
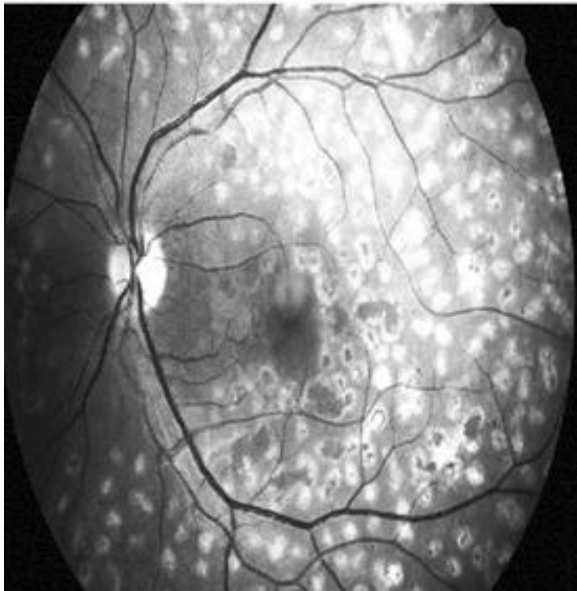vessel removed image-green channel

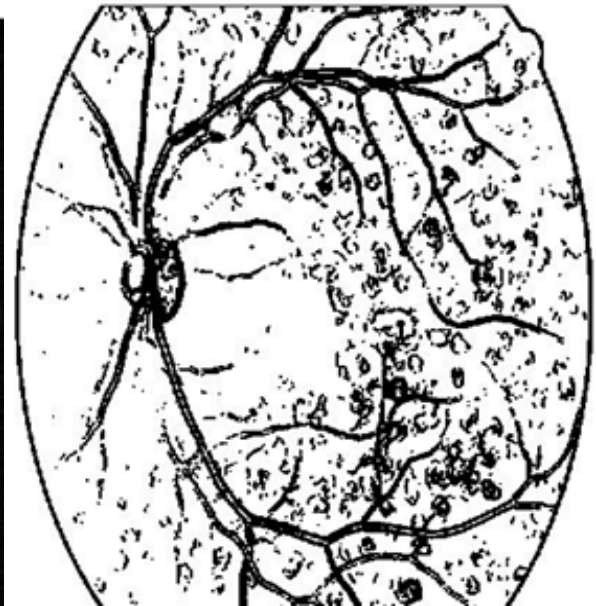**Original image is been process to get clear blood vessels & micro aneurysms**

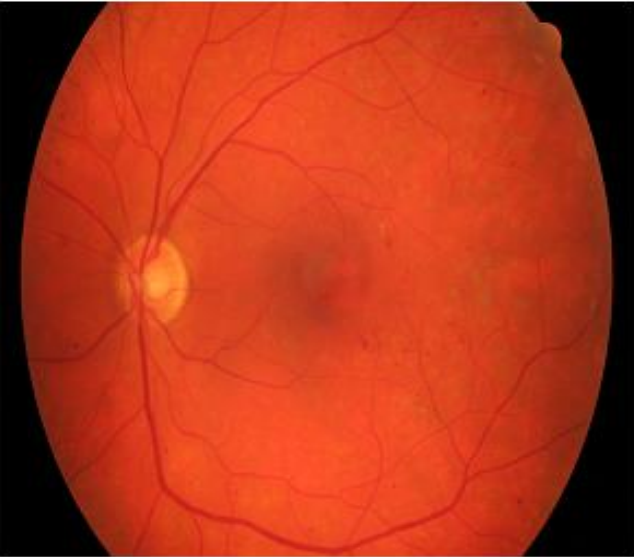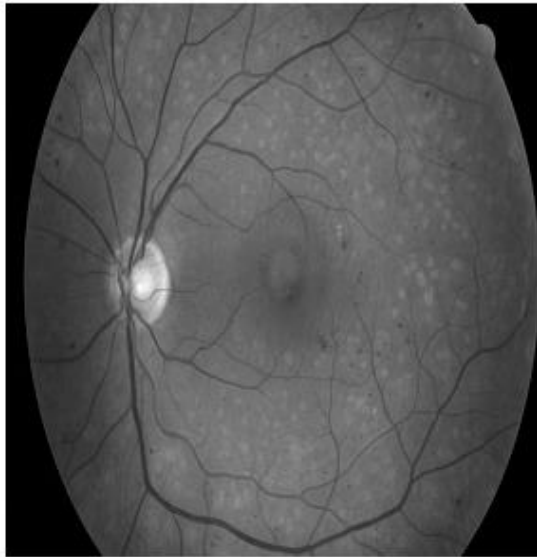Extracted Blood Vessels-GREEN Binary

histogram equalized image

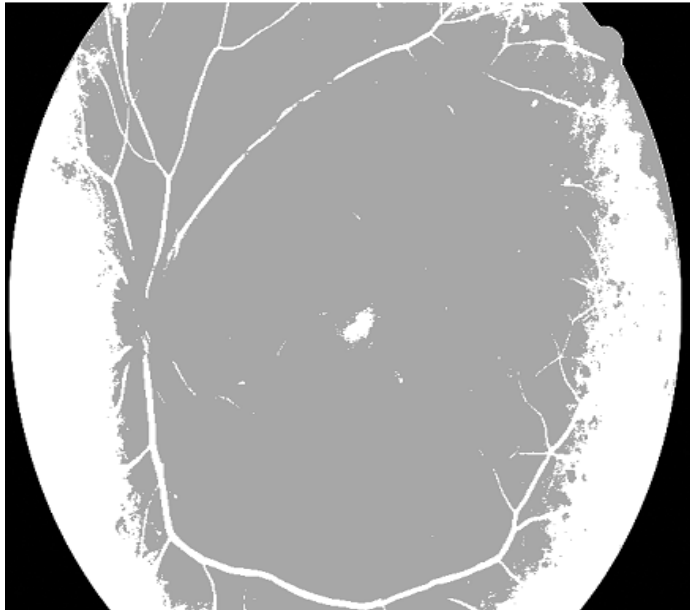Vessel mask-GREEN
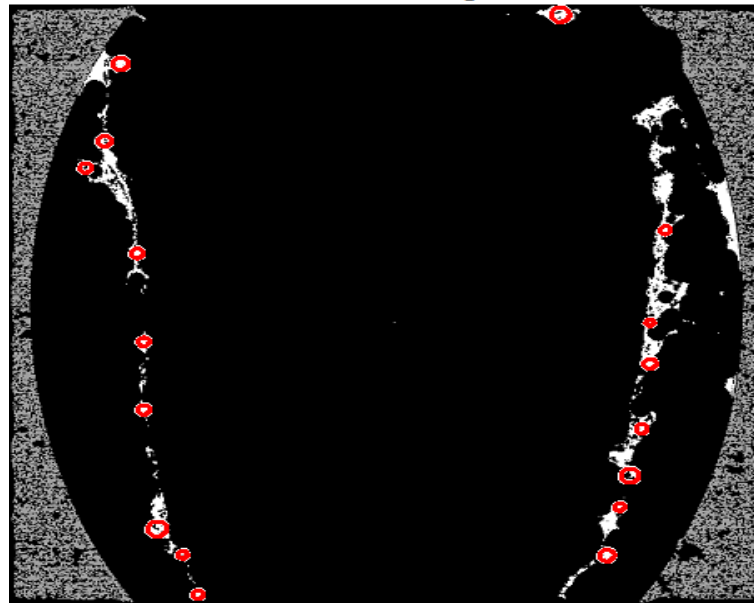
original image

gray image

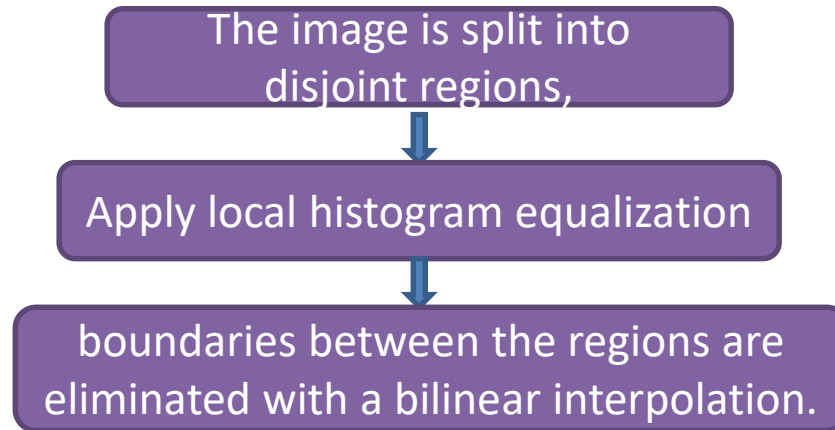**histogram equalized image**

Walter-Klein Contrast Enhancement image

Walter et al image

- **Contrast Limited Adaptive Histogram Equalization (CLAHE) :**

- CLAHE is very effective in making: the usually interesting salient parts more visible.

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│    The image is split into   │
│        disjoint regions,     │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│ Apply local histogram equalization │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│  boundaries between the regions are │
│ eliminated with a bilinear interpolation. │
└─────────────────────────────┘
```

- **Objective of Method :**

➢ To define a point transformation within a local fairly large window with assumption that the intensity value within it is a stoical representation of local distribution of intensity value of the whole image. The local window is assumed to be unaffected by the gradual variation of intensity between the image centers and edges. The point transformation distribution is localized around the mean intensity of the window and it covers the entire intensity range of the image.

- Consider a running sub image W of N X N pixels centered on a pixel P (i,j) , the image is filtered to produced another sub image P of (N X N) pixels according to the equation below

$$p_n = 255 \cdot \left(\frac{[\emptyset_w(p) - \emptyset_w(Min)]}{[\emptyset_w(Max) - \emptyset_w(Min)]} \right)$$

- Where

- maximum and minimum intensity values in the whole image, while and indicate the local window mean and standard deviation which are defined as:

$$\emptyset_w(p) = \left[1 + exp\left(\frac{\mu_w - p}{\sigma_w}\right)\right]^{-1} \qquad \mu_w = \frac{1}{N^2} \sum_{(i,j)\in(k,l)} p(i,j)$$
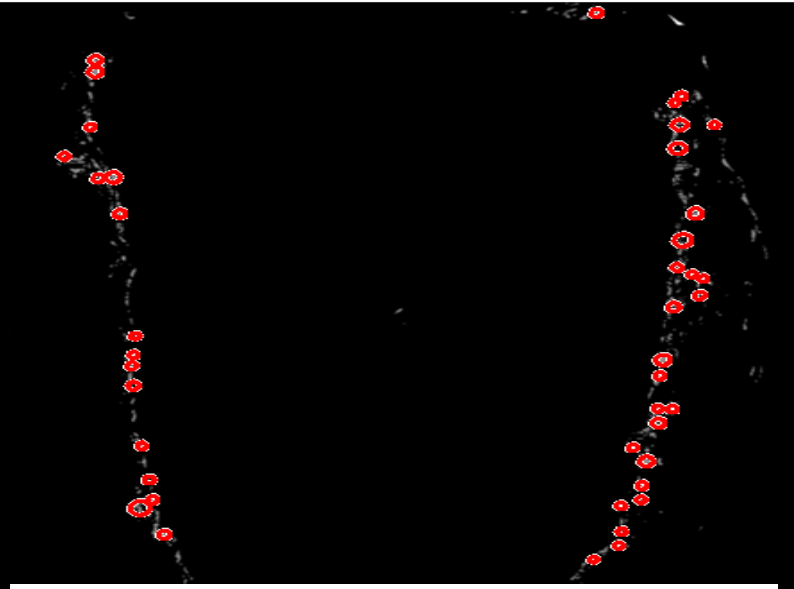
- As a result of this adaptive histogram equalization, the dark area in the input image that was badly illuminated has become brighter in the output image while the side that was highly illuminated remains or reduces so that the whole illumination of the image is same.

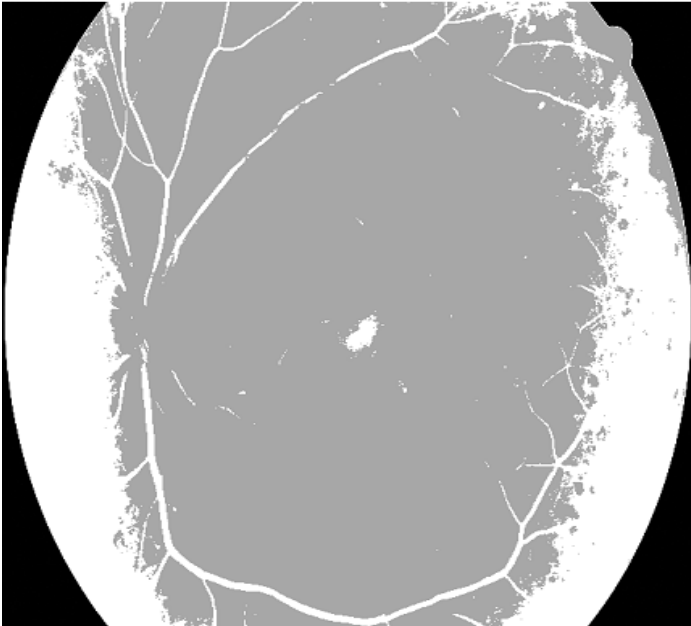$$\sigma_w = \sqrt{\frac{1}{N^2} \sum_{(i,j)\in(k,l)} (p(i,j) - \mu_w)^2}$$
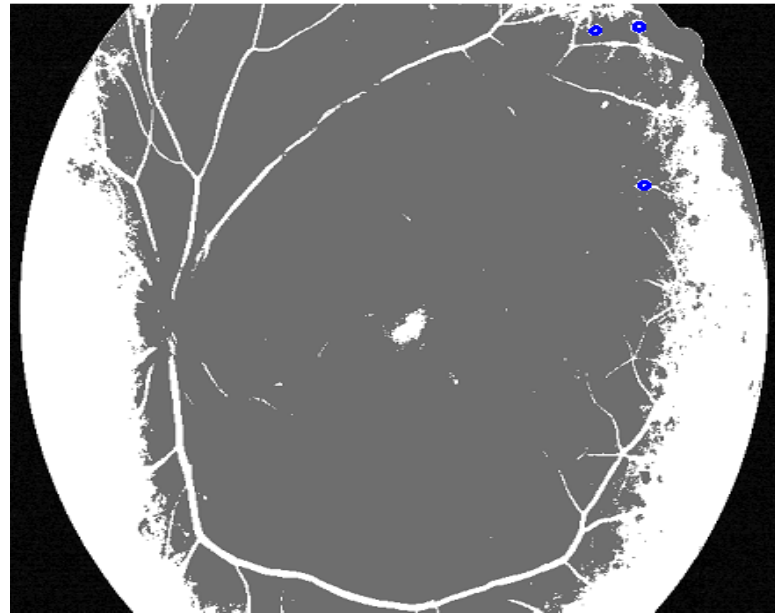
Walter−Klein Contrast Enhancement image
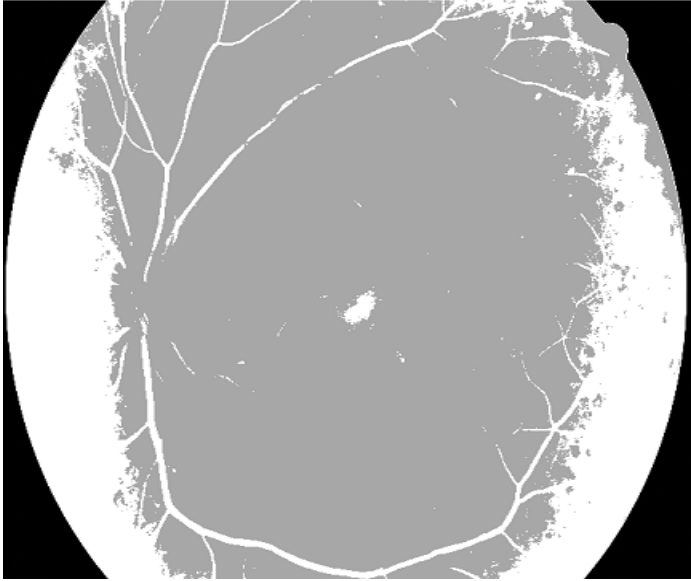
fleming et al image
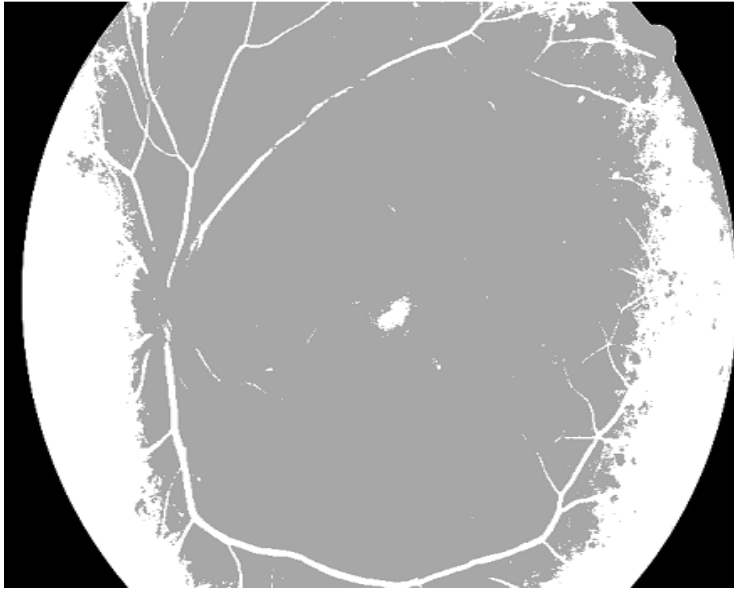
Walter−Klein Contrast Enhancement image

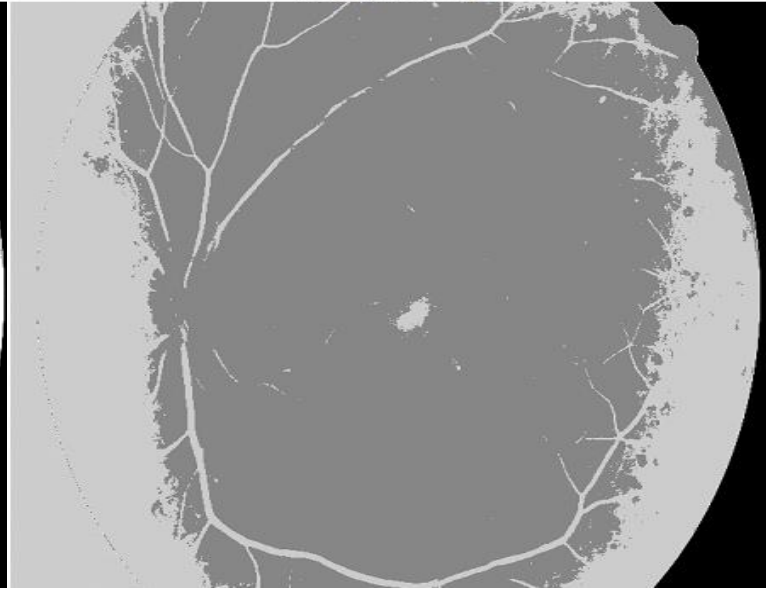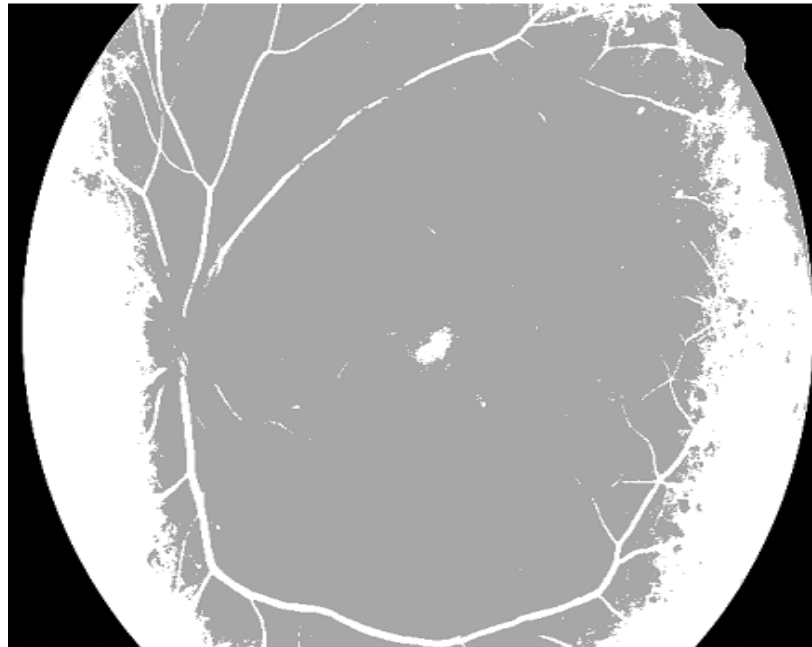**Circular Hough-Transformed image**

Result 5) :

Walter–Klein Contrast Enhancement image

zhang et al image

Walter–Klein Contrast Enhancement image

Result 6):

Diabetic Retinopathy in India

Challenges

- Expensive treatment, Poor metabolic control, Non-awareness

- Affordability : Cost effectiveness Rural population

- Lack of Lab. Facilities &Complex surgical procedures with Unpredictable outcome

- Inadequate facilities for diagnosis, investigation and management of DM – Rural areas

- Vascular complications -No symptoms in stages amenable for treatment

- Available ophthalmologists are less

Social Impact

- Patients can get treatment in early symptoms of Retinopathy.

- Patients will get fast detection results with affordable treatment.

- This project can improve the ability for early detection DR and their progress based on new imaging techniques.

- Ophthalmologists can judge image data. like an automated segmentation and thickness measurement of the nerve fiber layer

Diabetic Retinopathy Detection

MAJOR DISEASE GOING TO BE DETECTED:

 1)MICRO –ANEURYSM,   2)GLAUCOMA

STEPS FOR VESSEL DETECTION

- Input Image
- Preprocessing
- Vessel Extraction Algorithm
- Extracted Vessels

STEPS FOR MICRO –ANEURYSM DETECTION

- Input Images (Training)
- Implementing 5 Algorithms For Preprocessing
- Implementing 5 Algorithms For Candidate Extraction
- Apply The 25 Combinations
- Quantity Analysis (Entropy)
- Best Combination Selection
- Input Image (Testing) Reprocessing)

CANDIDATE EXTRACTION (SEGMENTATION)

MICRO ANEURYSM DETECTION

PERFORMANCE MEASUREMENTS

- ✓ sensitivity,
- ✓ specificity,
- ✓ accuracy,
- ✓ shape features [such as Area' Perimeter Eccentricity Centroid],
- ✓ MajorAxisLength , MinorAxisLength

CLASSFICATION OF THE PATIENT CONDITION

Normal,   Mild,   Moderate,   Severe

STEPS FOR GLAUCOMA DETECTION

1. Input Image .
2. Preprocessing.
3. Optic Disk Segmentation.
4. Optic Cup Segmentation Area .
5. Cup To Disk Ratio.
6. Glaucoma Detection.
7. Classification Of The Patient Condition.
8. Performance Measurements.

Conclusion

❑ DR is extremely asymptomatic disease in the premature stages and it could lead to lasting vision loss if untreated for long time. Before patients reaching to last stage ophthalmologist can detect the disease prissily & can avoid vision loss, using Image Processing Technique.

❑ Outcomes will become available in terms of accurately tracking or monitoring the patient specific evolution of DR.

❑ The severity of DR the area of these features will be calculated. Based on the results of area computation, the system uses the classification as normal, mild, severe to identify the stages of non-proliferative DR and proliferative DR.

Results achieved :

1) The concept of Canny filter detection of signals is used to detect piecewise linear segments of blood vessels in images.

2) Algorithm of Gaussian filter is capable to detect looping structure in the blood vessel which is to manifestation of abnormal symptom.

3) MA candidate extraction

4) Median Filters can be very useful for removing noise from images.

5) Fuzzy Gaussian Filter feature extraction of images. It is very essential to extract infected blood vassals to diagnose early therefore filtering is frequently utilized in image processing

6) Smooth noise & to enhance or detect features within an image. To improve quality of image linear & non-linear method may be used.