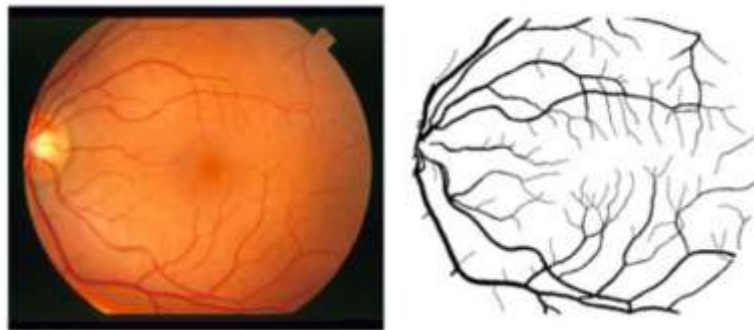


**Assignment # 2**  
**(CLO3 -> PLO3)**  
**Digital Image Processing**  
**Blood vessel segmentation from Fundus Images**  
**Submission Deadline: 13<sup>th</sup> May 2019**

Diabetic retinopathy screening involves assessment of the retina with attention to a series of indicative features, i.e., blood vessels, optic disk and macula etc. The detection of changes in blood vessel structure and flow due to either vessel narrowing, complete occlusions or neovascularization is of great importance. Blood vessel segmentation is the basic foundation while developing retinal screening systems since vessels serve as one of the main retinal landmark features. There are a number of methods presented by researchers for accurate blood vessel segmentation. Figure below shows colored fundus image and binary vessel image against it.



In this assignment you have to **design** different algorithms for vessel segmentation as mentioned below and **analyze** their accuracy. A dataset containing original fundus images along with manually segmented vessels is provided. Apply following algorithms to segment blood vessel from those images

1. Morphological operation
2. Connected component labelling
3. Adaptive thresholding
4. Canny edge detector
5. Gabor wavelets based segmentation
6. Region growing based segmentation
7. Any other technique which you find better than above ones

You have to test each algorithm on all images and then find performance parameters given below. Different performance parameters are used to evaluate the robustness of segmentation algorithms.

$$\text{sensitivity} = \frac{TP}{TP + FN}$$
$$\text{specificity} = \frac{FP}{TN + FP}$$

Here, True positive rate (TPR) is the fraction of number of true positive (pixels that actually belong to vessels) and total number of vessel pixels in the retinal image and false positive rate (FPR) is calculated by dividing false positives (pixels that don't belong to vessels) by total number of non-vessel pixels in the retinal image. Find out sensitivity and specificity values for all algorithms. Based on these

parameter, assign different colors to pixels as show in figure below. Here white and black pixels are TP and TN respectively where as Red and Green are FP and FN respectively.



Another parameter which is used for evaluation of segmentation algorithms is dice coefficient. The expression is

$$\text{Dice Coefficient} = \frac{2 * TP}{FN + (2 * TP) + FP}$$

Make a table showing all techniques and their respective performance parameter values. Also write a discussion paragraph in which you should critically analyze all results and comment on the success of a particular algorithm as compared to others.