Optic Disk Detection in Fundus Images

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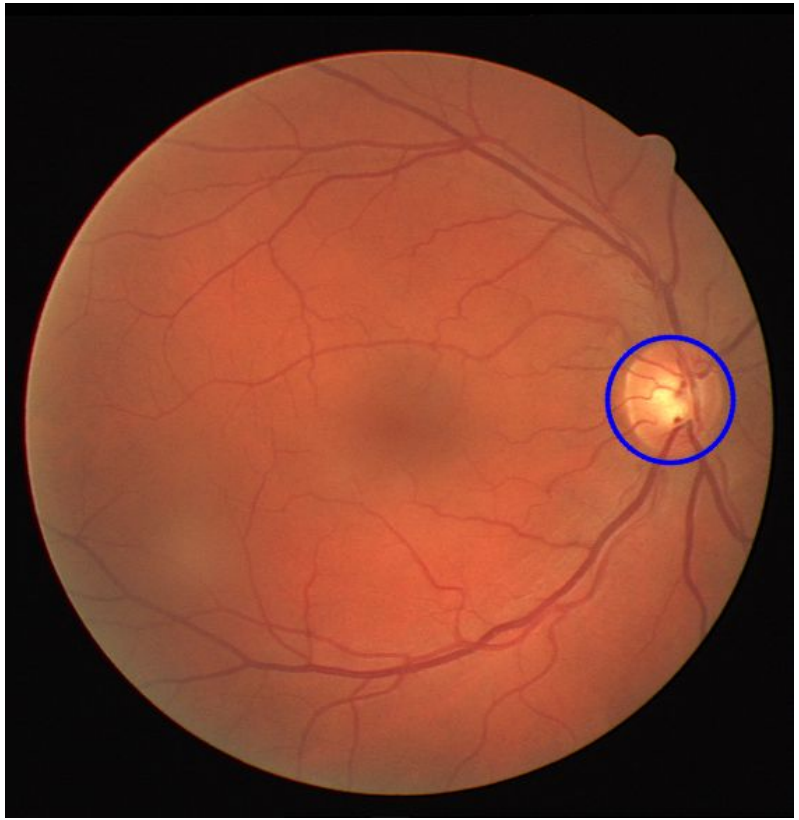
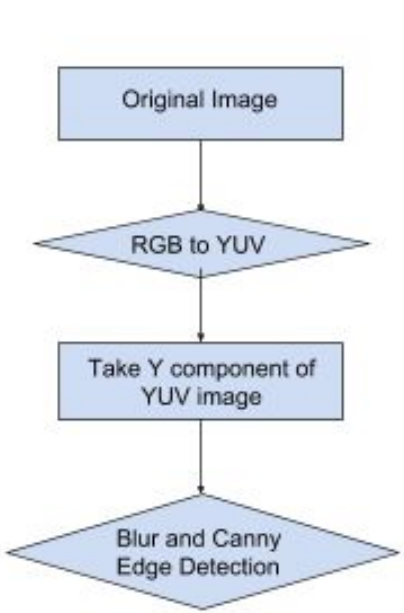
Introduction

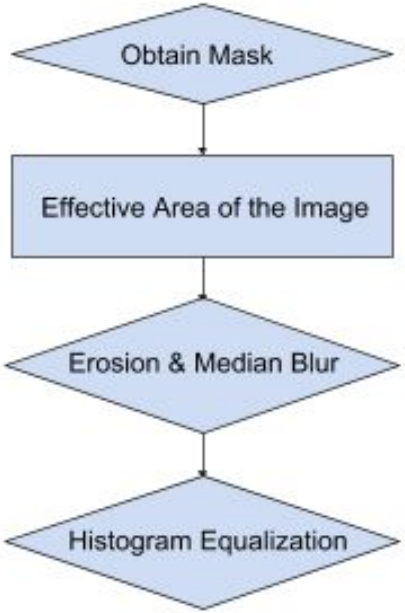
- The optic disk (OD) is one of the main features of a retinal fundus image.
- The OD appears toward the left-hand or right-hand side of a fundus image as an approximately circular area, roughly one-sixth the width of the image in diameter
- It corresponds to small blind spot in each eye



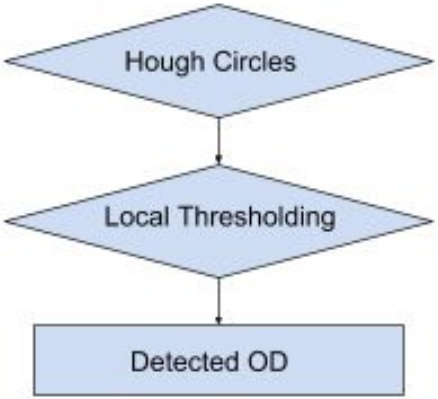
Algorithm



Step 1



Step 2



Step 3

Block Diagram

DRIVE Dataset

- The photographs for the DRIVE dataset were obtained from a diabetic retinopathy screening program in the Netherlands.
- The dataset comprises 40 randomly selected photographs.
- Each image is JPEG compressed and uses 8 bits per color plane at 768 by 584 pixels.
- Download Link: http://www.isi.uu.nl/Research/Databases/DRIVE

YUV Color Space

- The Y component determines the brightness of the color (referred to as luminance or luma)
- One aspect of YUV is that we can throw out the U and V components and get a grayscale image.
- The luminance component Y is computed as Y = 0.299R + 0.587G + 0.114B, where R, G, and B are the red, green, and blue components.

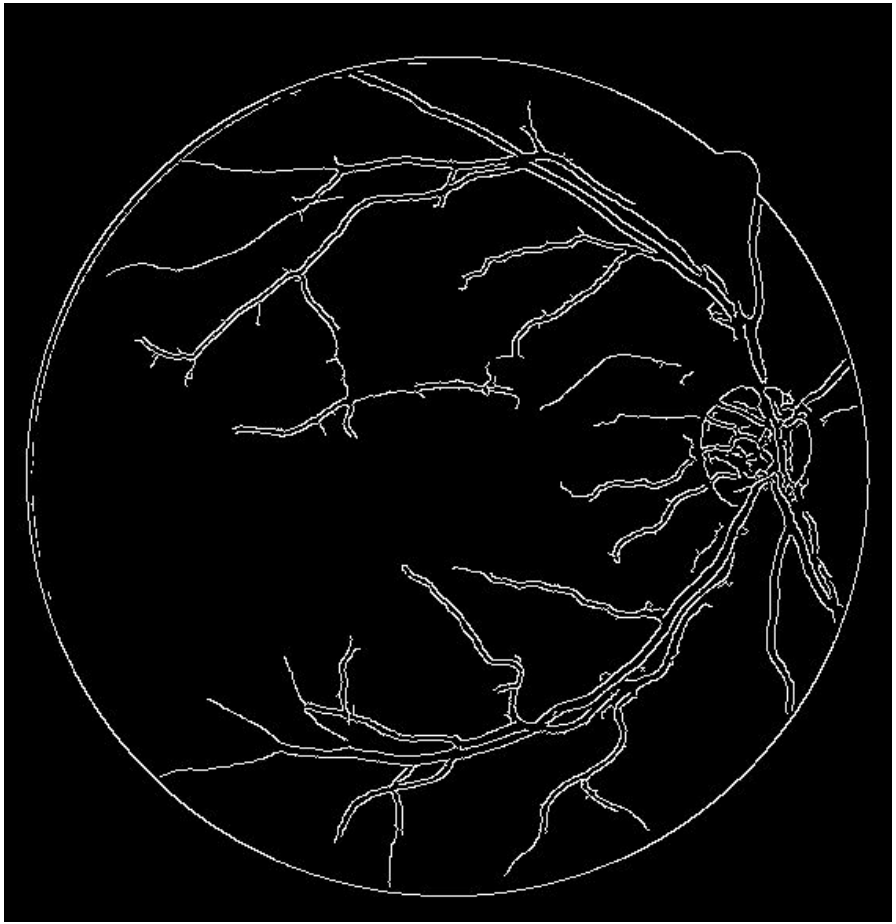
Only Y component has been shown in images further.

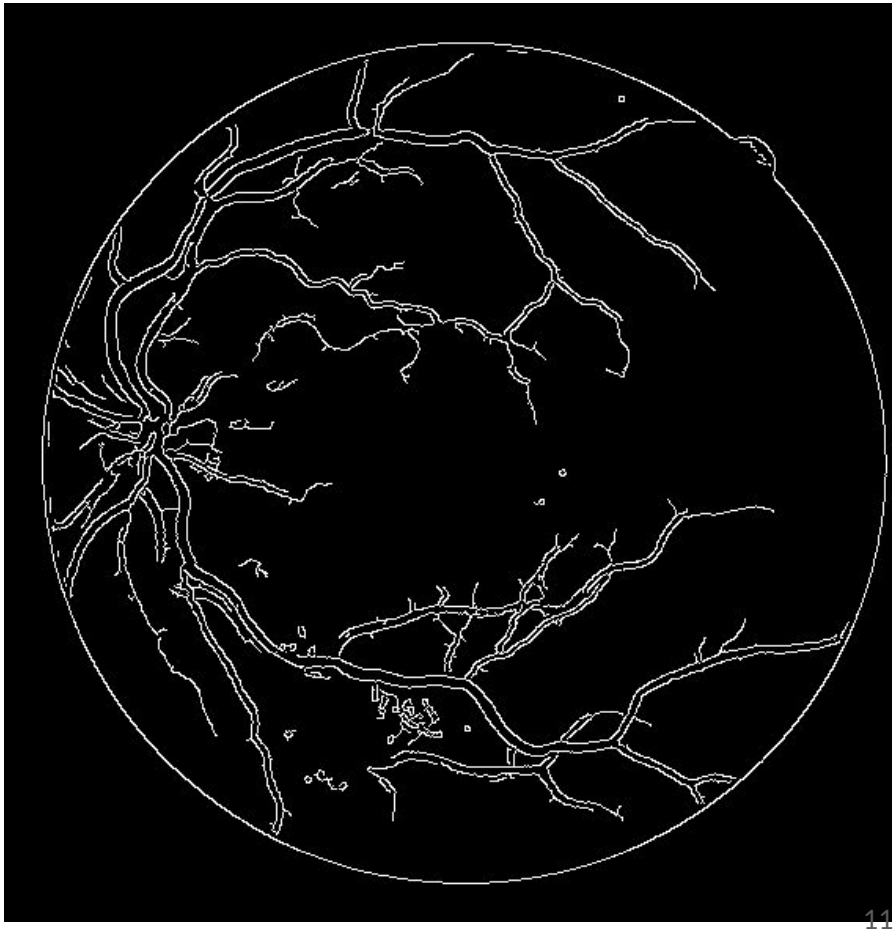
Canny Edge Detection

1. Apply Gaussian filter to smooth the image in order to remove the noise
2. Find the intensity gradients of the image ($G = \sqrt{G_x^2 + G_y^2}$, $\Theta = \text{atan2}(G_y, G_x)$)
3. Apply non-maximum suppression to get rid of spurious response to edge detection
4. Apply double threshold to determine potential edges.
5. Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

Parameters Used:

(Lower Threshold: 16, Upper Threshold: 48, Kernel Size: 3X3)





Thresholding

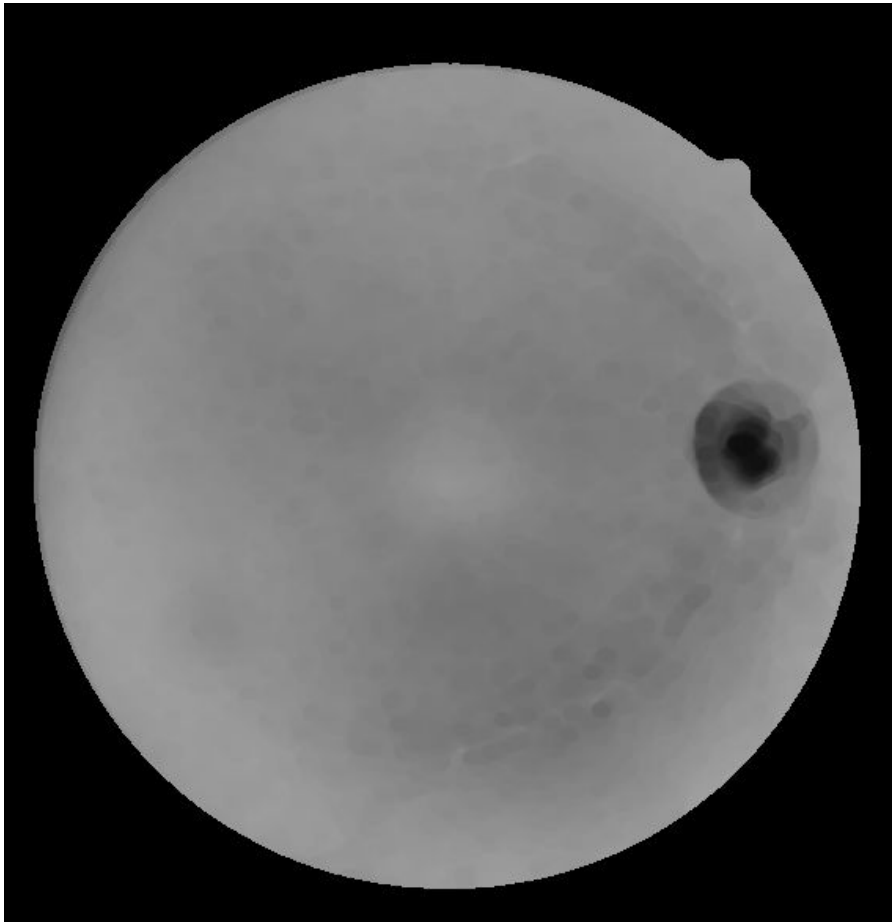
- Reverse thresholding was used.

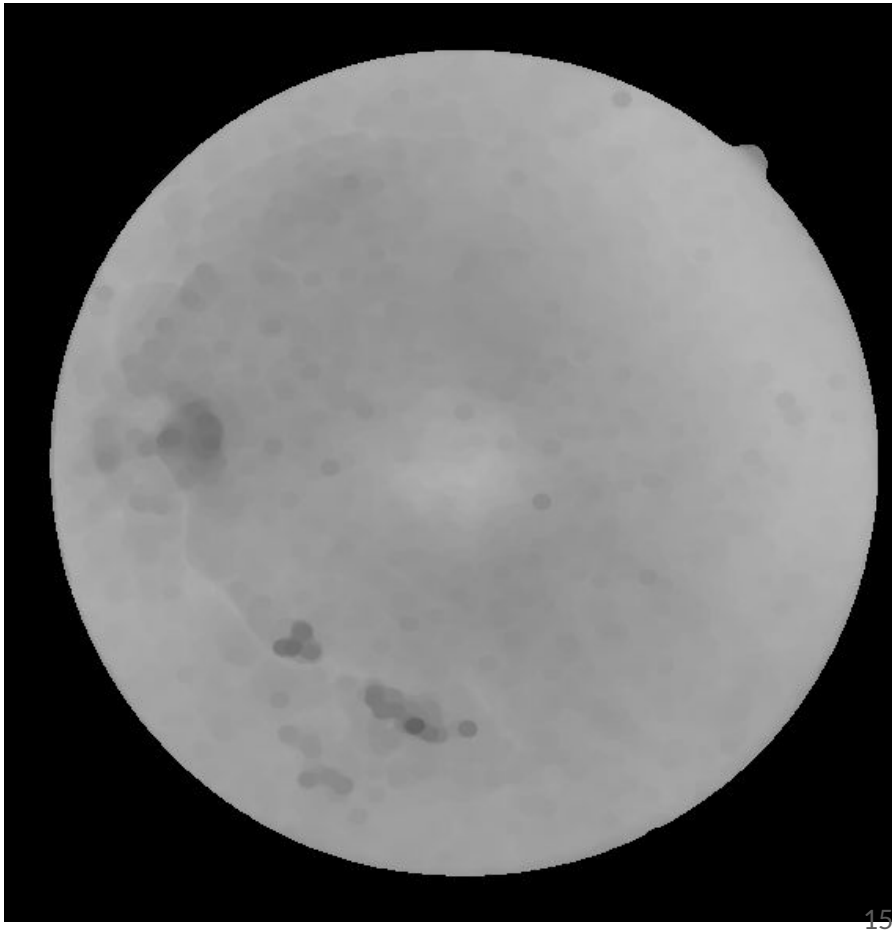
1. A relative threshold of 0.1 was used to obtain a mask.
2. The image was subtracted from this mask to obtain an image to be used for further processing.

- We found that this led to better results than normal thresholding.

Erosion and Median Blur

- A circular element of diameter 11 pixels was used as structuring element.
- Erosion was then performed using the same.
- Median Blurring was applied using 5X5 filter.



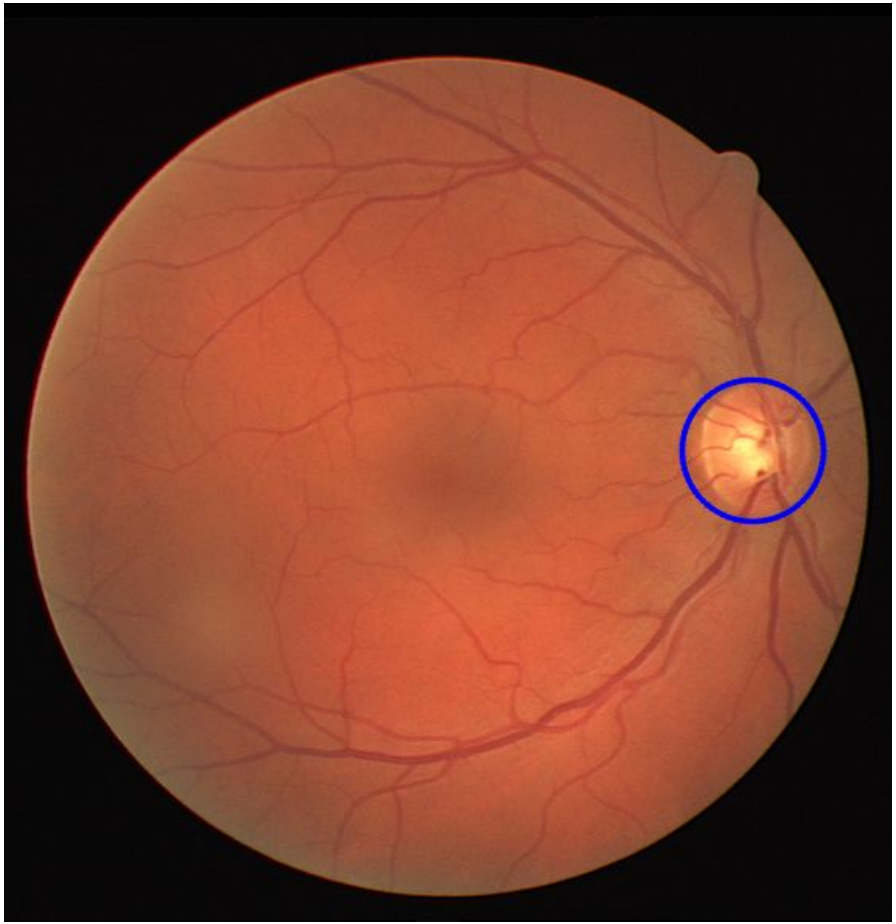


HOUGH CIRCLES

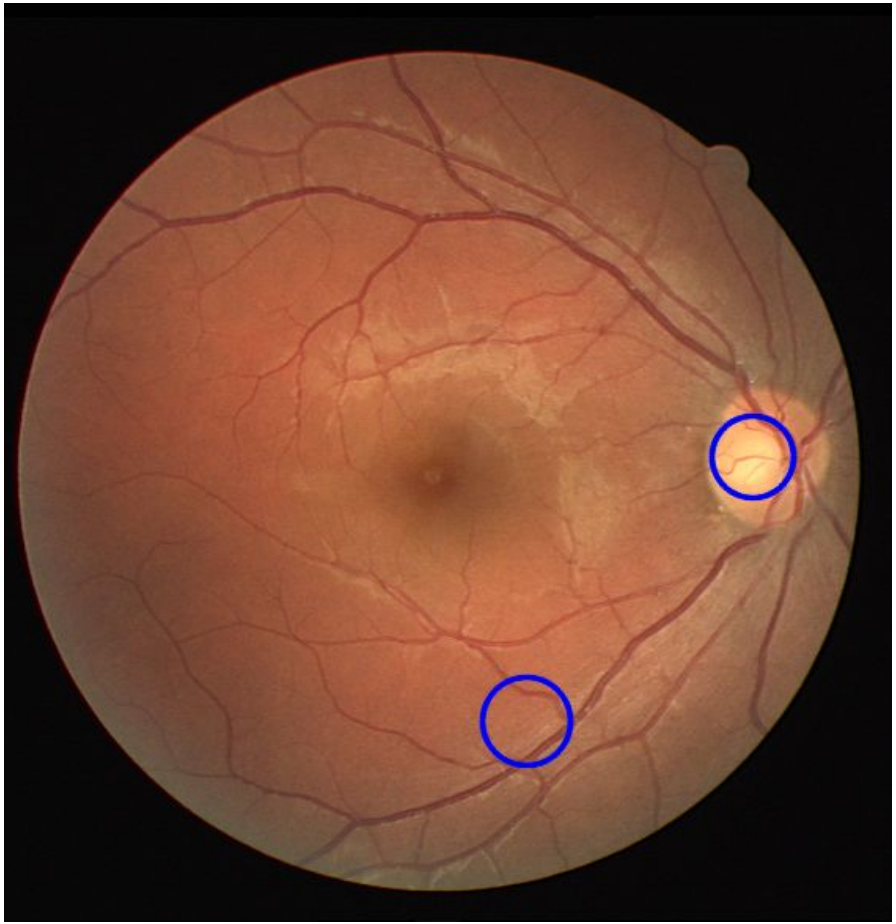
- The purpose of Circle Hough Transform technique is to find circles in imperfect image inputs.
- In a two-dimensional space, a circle can be described $(x-a)^2 + (y-b)^2 = r^2$

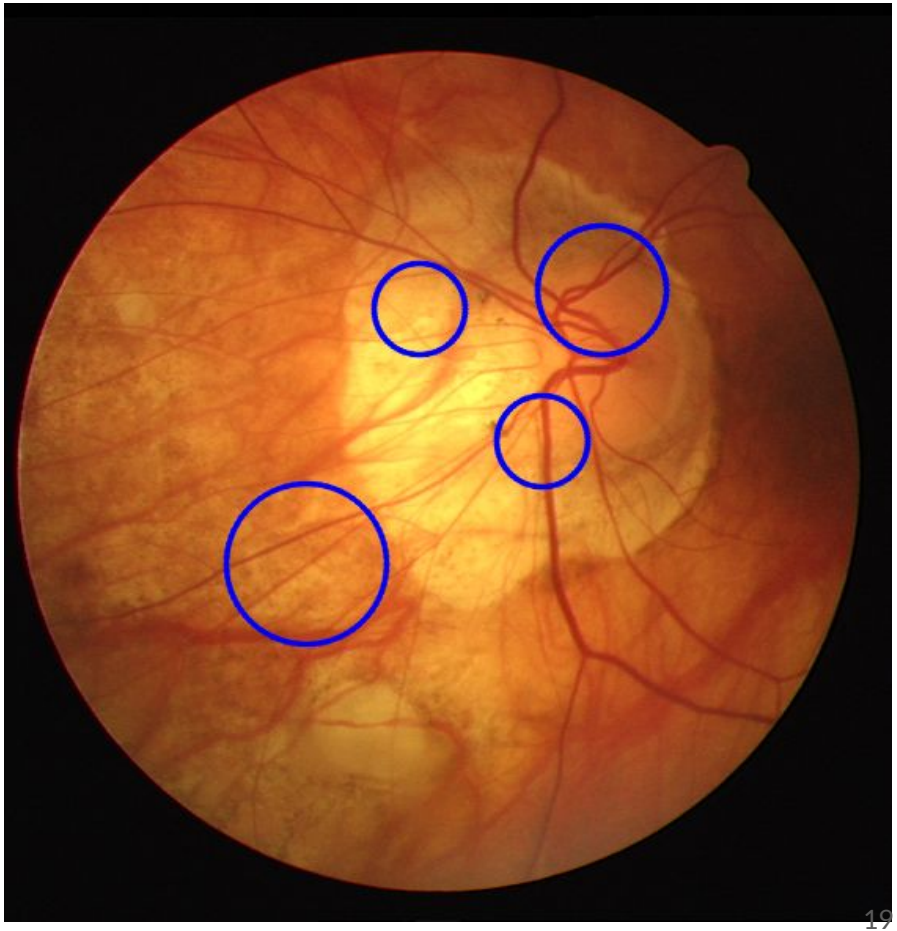
Parameters Used:

1. Minimum distance between detected centers: 60
2. Upper Threshold for Canny Edge Detector: 48
3. Lower Threshold for Canny Edge Detector: 16



Some False Positives





Results

Type of Dataset	No. of Total Images	Correctly Detected	Accuracy
Training	20	17	85 %
Testing	20	16	80 %
Overall	**40**	**33**	**82.5 %**

Conclusions

- Among the 40 images in the DRIVE database, the proposed method correctly detected in 82.50% of the cases.
- The proposed method did not work well in cases where the OD is not circular and/or where bright exudates are present.
- Some False Positives were also obtained

References

1. Xiaolu Zhu and Rangaraj M. Rangayyan, “Detection of the Optic Disc in Images of the Retina Using the Hough Transform,” In *Proceedings of the 30th Annual International IEEE EMBS Conference*, pp.3546-3549, Vancouver, Canada, August 20-24, 2008
2. DRIVE: Digital Retinal Images for Vessel Extraction, http://www.isi.uu.nl/Research/Databases/DRIVE/, accessed on February 15, 2018

THANK YOU!