OPTIC DISC LOCALIZATION ON FUNDUS IMAGES

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DIABETIC RETINOPATHY

- Sight is one of the major human senses
- Diabetic retinopathy causes pathological changes in the retina and in the human eye
- Preprocessing digital fundus images of the retina
- Tested image database

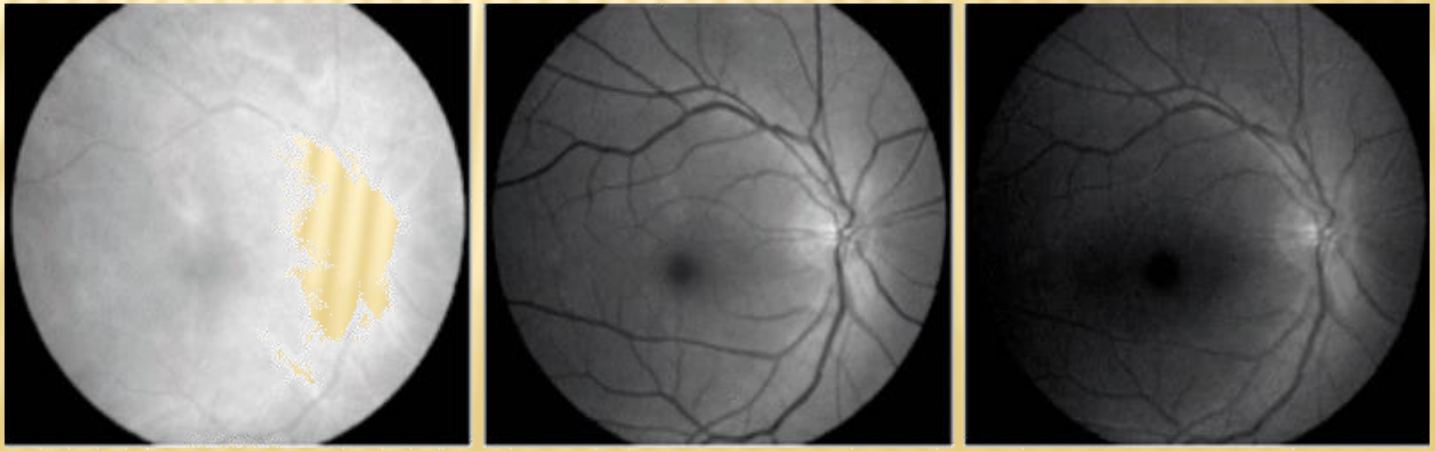
MESSIDOR

OVERVIEW

- Pre-processing is necessary to remove and reduce the effects of noise
- Optic disc localization:
  - Fast radial symmetry transform – FRST
  - Hough transform - Hough space filling method for fixed radius – HOUGH
  - Histogram method based on template (optic disc mask) - HIST
- Results comparison

PRE-PROCESSING OF THE FUNDUS IMAGES

- Basic size of image 2240 x 1488 pixels
- Croping black background and resizing to 687 x 687 pixels
- Distribution on R, G, B, color channel
- Prefiltering with Gaussian and median filter

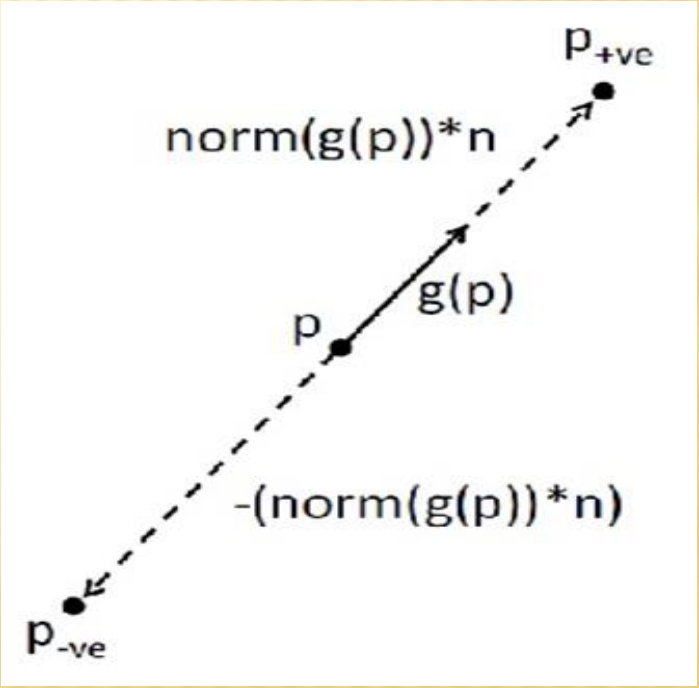


FAST RADIAL SYMMETRY TRANSFORM

- **Gradient - based method**
- **Scanning image projection *On* and *Mn* labeling of white and dark objects (points) of interest**
- **FRST assigns to each**

  one pixel of the image

  an affection value



LOY, G. Zelinski, A. Fast radial symmetry transform for detecting points of interest, IEEE Computer Society ,. 2003 ISSN: 0162-8828, Washington, DC, USA

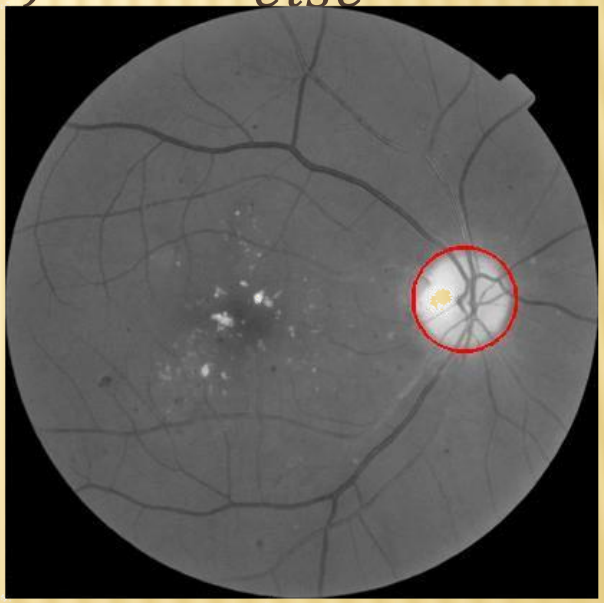
FAST RADIAL SYMMETRY TRANSFORM

- **The search for symmetry:**

$$O_n\left(P_{\mp ve}(P)\right) = \begin{cases} O_n\left(P_{\mp ve}(P)\right) \mp 1 \\ 0 \end{cases} \begin{matrix} if\ \gamma \geq g(P) \geq \beta \\ else \end{matrix}$$

$$M_n\left(P_{\mp ve}(P)\right) = \begin{cases} M_n\left(P_{\mp ve}(P)\right) \mp \|g(P)\| \\ 0 \end{cases} \begin{matrix} if\ \gamma \geq g(P) \geq \beta \\ else \end{matrix}$$

O_n, M_n **projections**, $P_{\mp ve}$ **affected pixel**, g **- gradient of the pixel and** β, γ **- aproximations of the gradient**



$$S_n = F_n * A_n \quad \rightarrow \quad S = \sum_{n \in N} S_n$$

A_n **- 2D Gaussian kernel for smoothing,**

S_n **- contributions to the symmetry** S

F_n **criterium function** $F_n(p) = \left\|\tilde{O}_n(p)\right\|^{(\alpha)} \widetilde{M_n}(p)$

HOUGH TRANSFORM

- **Hough space filling for defined interval of radii r**
- **Maximum value in Hough space corresponds to circle center for correct value of the radius r according to the following equation**

$$x = a + r\cos\varphi \qquad y = b + r\sin\varphi$$

$$a = x - r\cos\varphi \qquad b = y - r\sin\varphi$$

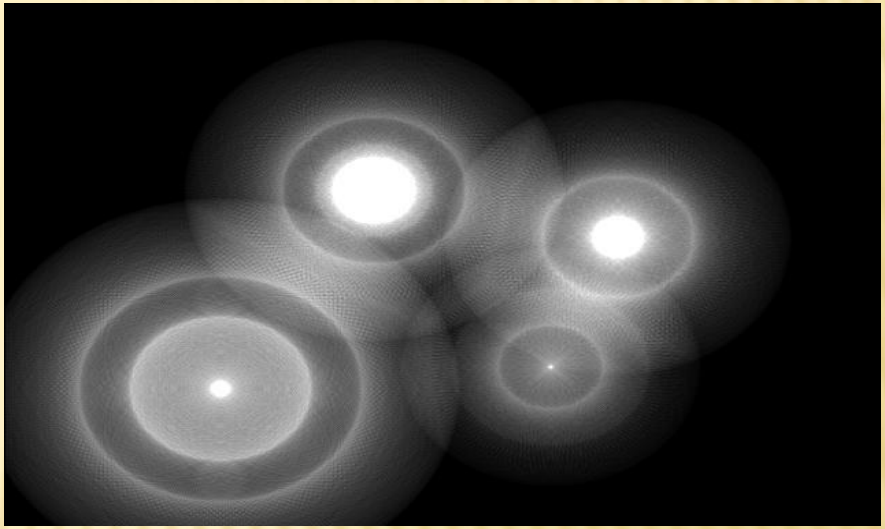
Circle:

$$r^2 = (x-a)^2 + (y-b)^2$$

Tjandrasa, H., Wijayanti, A. Suciati, N. Optic Nerve Head Segmentation Using Hough Transform and Active Contours TELKOMNIKA, Vol.10, No.3, July 2012, e-ISSN: 2087-278X, pp. 531~536

HOUGH SPACE FILLING

- Demonstration of compliance Hough space for radii 30 to 70 pixels
- Localizated optical disc on green channel in color image



HISTOGRAM METHOD

- **Basic Gaussian filter of size 6x6 pixels**
- **Optical disc master template creation from histograms of R, G, B color components**
- **Estimated size of the optical disc**

  80 x 80 pixels
- **Corelation between histograms :**

$$c = 1/(1 + \Sigma_i (a_i - b_i)^2)$$

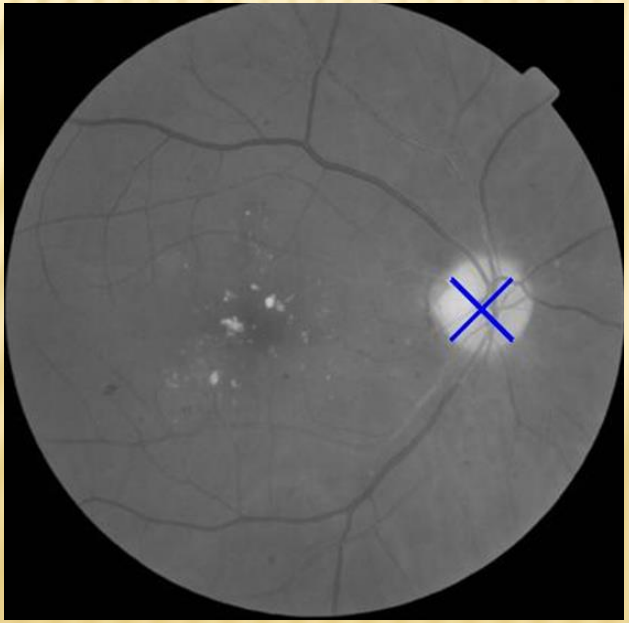
For both histograms (a and b) applies $\Sigma_i (a_i - b_i)^2 \approx 0$, and from that $c \approx 1$, else $c << 1$. From comparison we get:

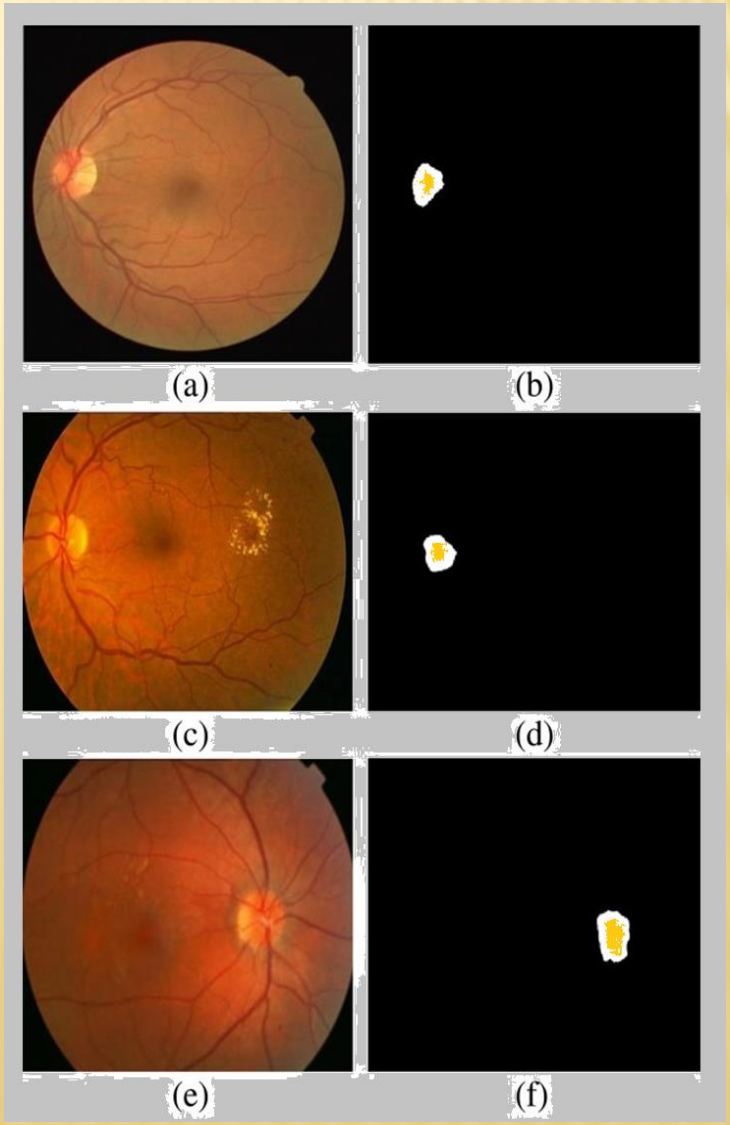
$$c(i,j) = t_r * c_r + t_g * c_g * t_b * c_b$$

Dehghani, A., Moghaddam H. A. Optic Disc Localization in Retinal Images Using Histogram Matching, EURASIP Journal on Image and Video Proc. 2012

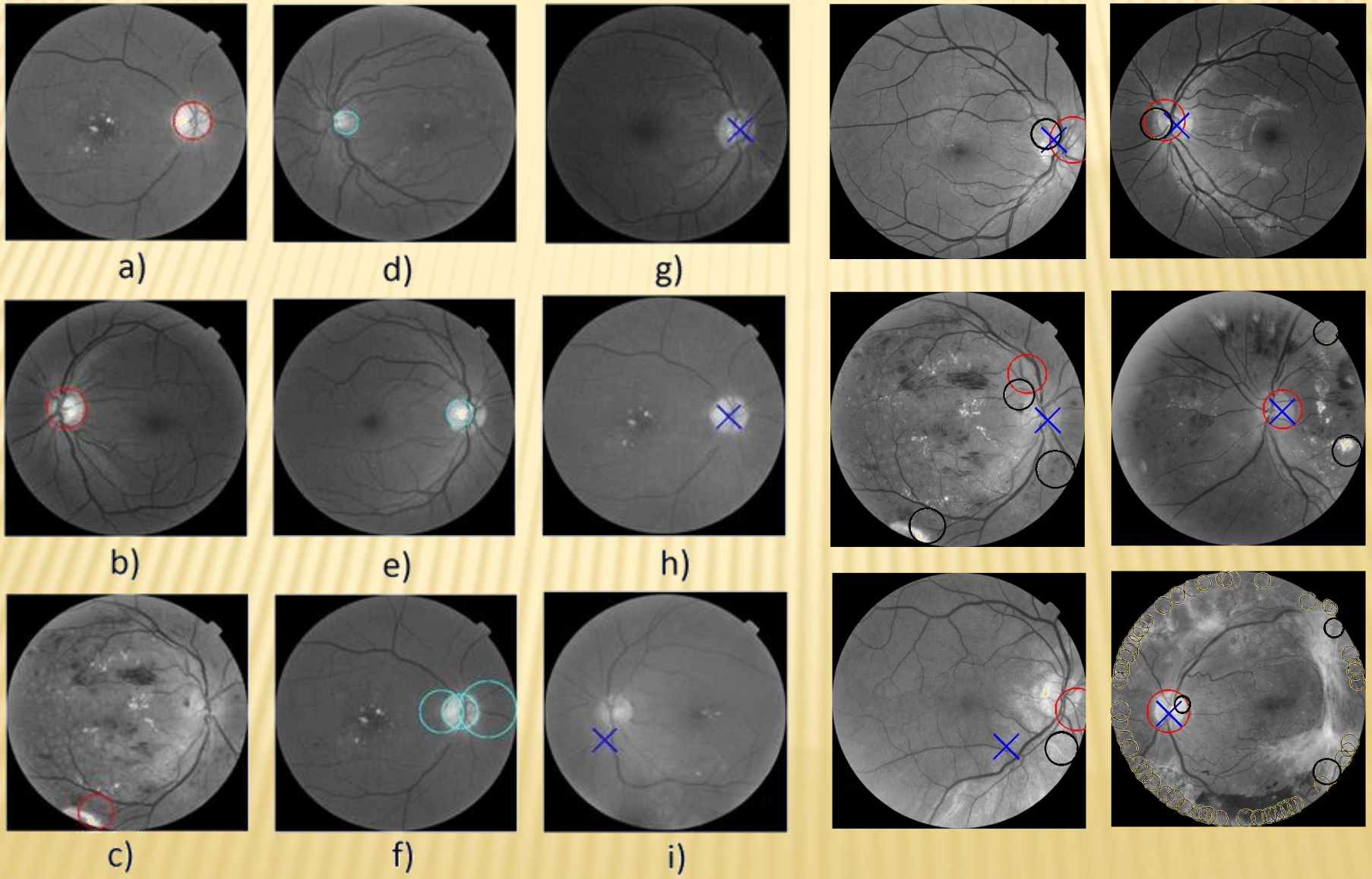
HISTOGRAM TRESHOLDING

- Thresholding of corellation function $c(i,j)$
- The best formula for determining the threshold was $Th = 0{,}5 * \max(C)$





FRST - HOUGH - HIST ---TOGETHER---



THE RESULTS

METHOD	TIME	ACURACY	CORECT LOCALIZ-ATION	PARAMET-ERS
FRST	1,768 – 2,185 [s]	**92, 38 %**	***47/50***	RADII ALFA BETA
HOUGH	**0, 364 – 0, 592 [s]**	71,28 %	*34/50*	RADII SENZITIVITY EDGE
HIST	110,7 – 121,4 [s]	89,38 %	*46/50*	**TEMPLATE ONLY**

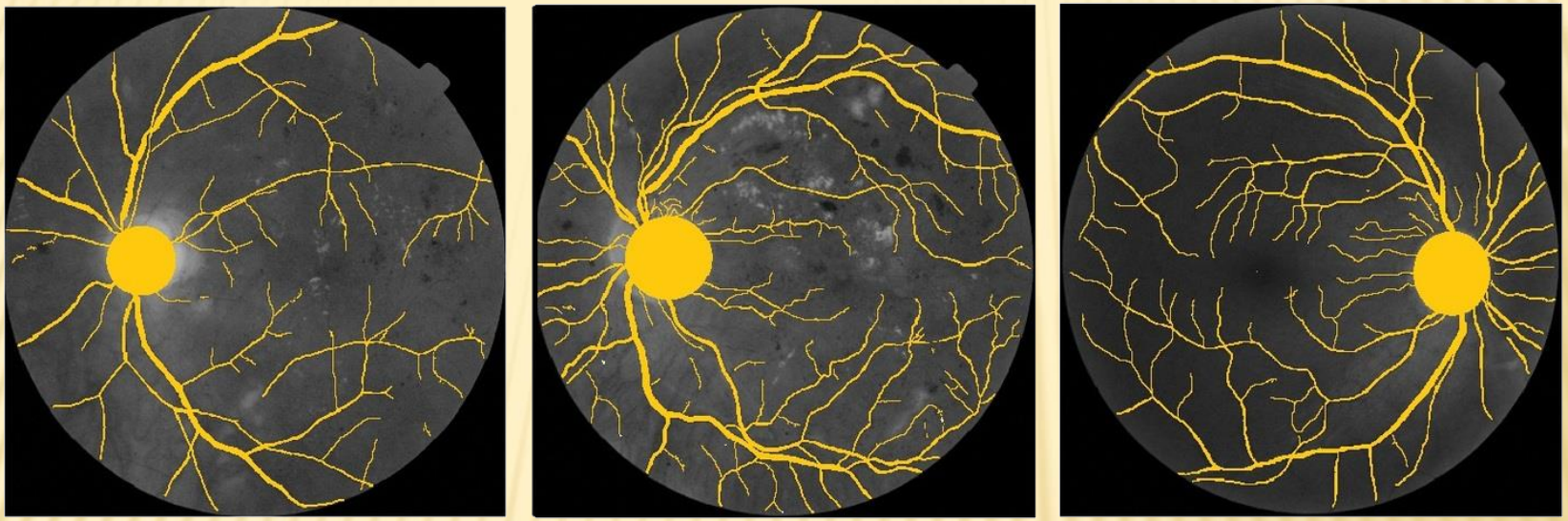
ADVANTAGES AND DISADVANTAGES

- **FRST was the most successful optic disc localization method with highest accuracy**

- **In histogram method it was not possible to modify any parameter, time-consuming**

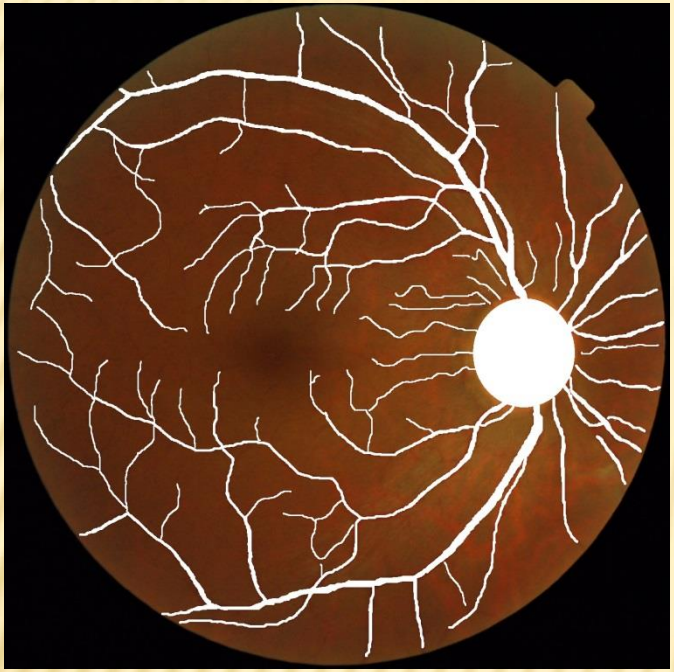
- **Hough method was a great with time, but the false OD detections occured frequently – pathological changes, bright locations, vessels**

OPTIC DISC AND BLOOD VESSELS SUPRESSION



- Fundus images with removed vessels and optic disc, this image is suitable for screening
- Used not only in diabetic retinopathy
- Patological places can be recognized as color different spots from gray background

REMOVED VESSELS AND OPTIC DISC



- Original image with removed vessels and the optic disc
- Suitable for other diseases

- Pathologically altered image with incorect localizations