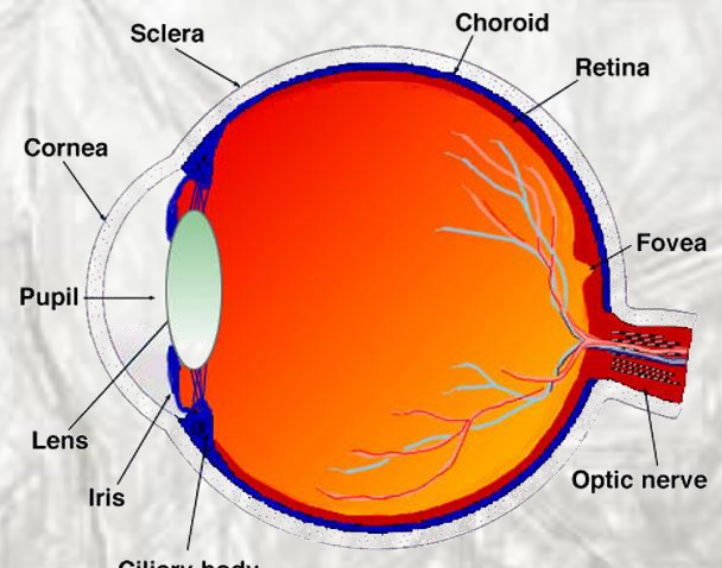
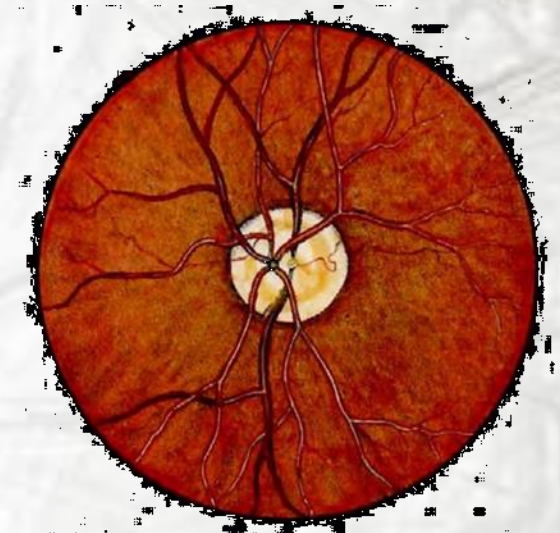


Personal identification based on digital retinal images

Antonio Benc
Ante Gojsalić
Lucija Jurić
Una Pale

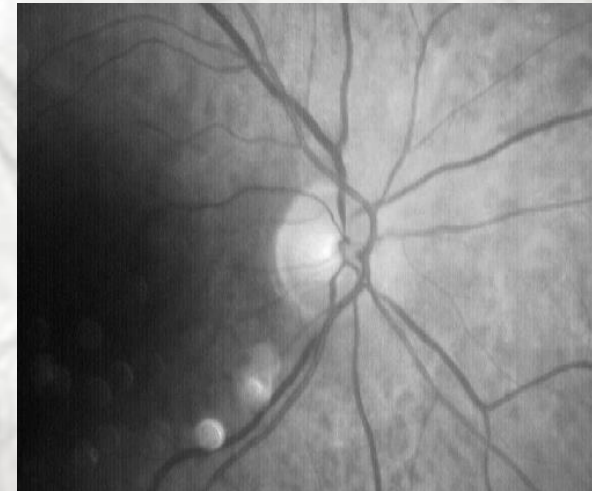
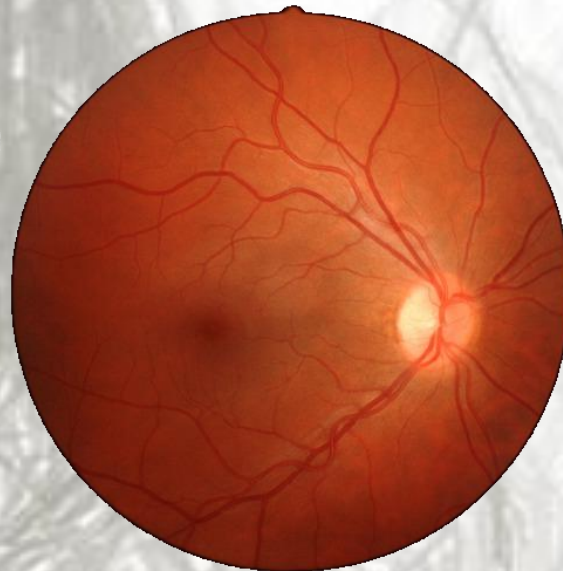
0. Retinal images identification

- RETINA
 - innermost membrane of the eye
 - unchanged from birth until death
 - not entirely genetically determined
- TECHNIQUE
 - biometric technique
 - highly reliable
 - quick results
 - affected by some diseases
 - high equipment cost



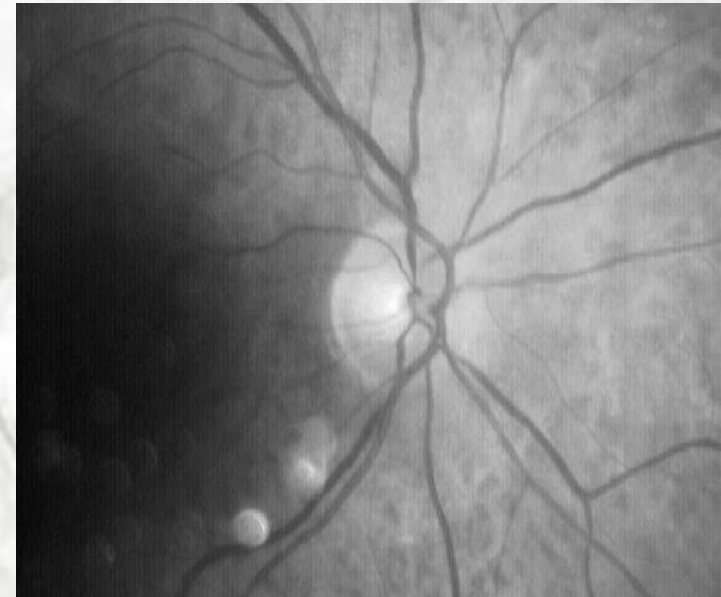
0. Retinal Scan

- beam of low-energy infrared light
- vessels absorb light more than the surrounding tissue
- reflection of light measured
- digital image of vessel positions computed



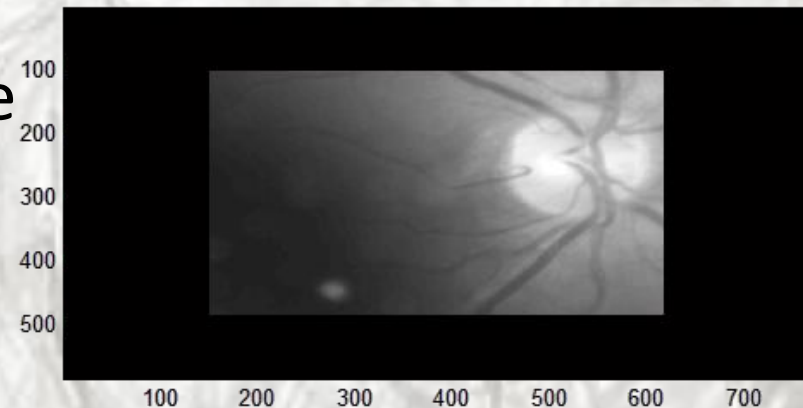
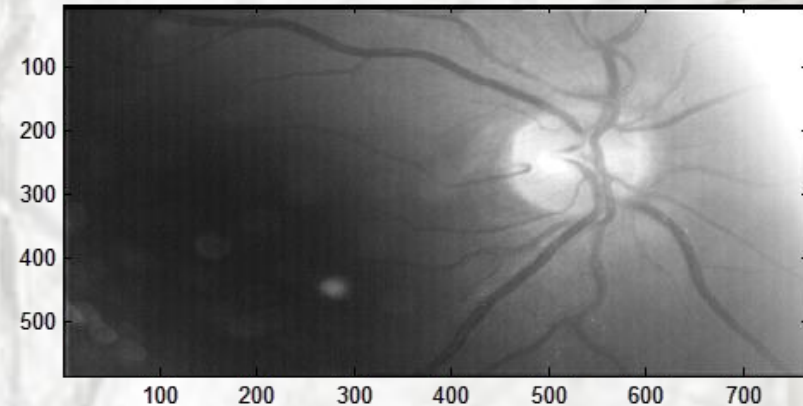
0. Project task

- **Locate optic nerve**
 - beginning of vessels on picture
 - remove it
- **Extract vessels**
 - locate them
- **Follow vessels**
 - locate bifurbications, endings...
- **Measure features**
 - length, width, angle etc.
- **Construct vessel tree of specific person**
- **Comparation of vessel trees**



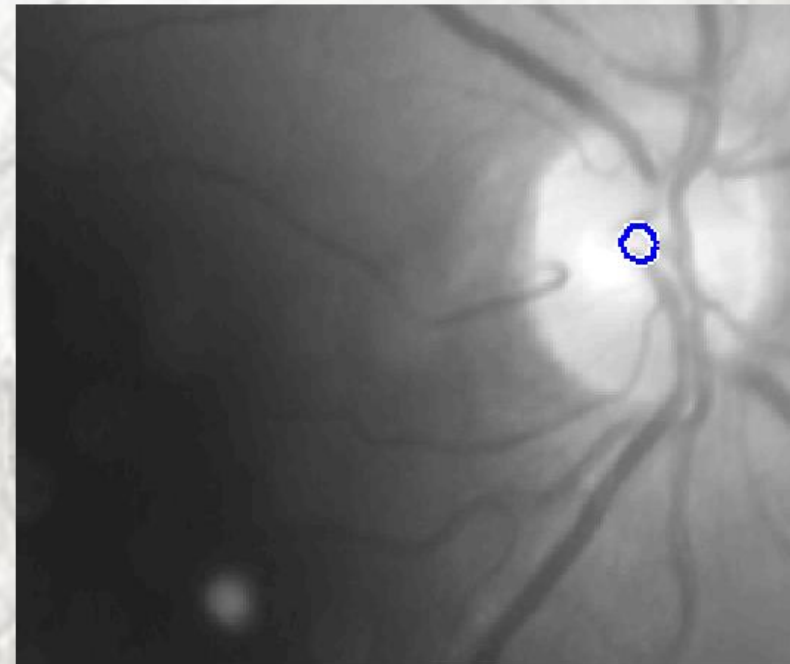
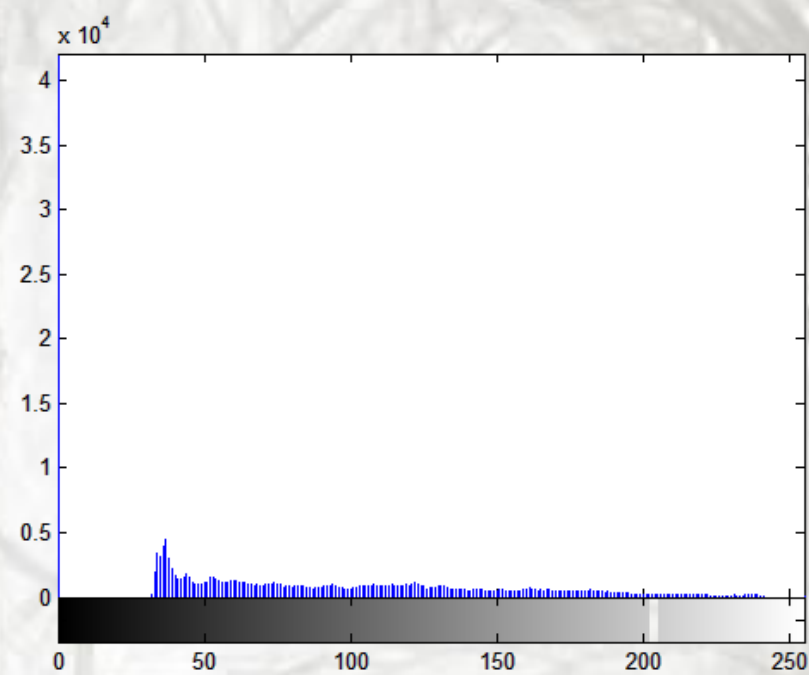
1. Optic disc removal

- bright areas cause problem
 - at edge detection
 - at vessel extraction
- important part of image
 - for alignment of pictures
 - vessel density around it is the largest



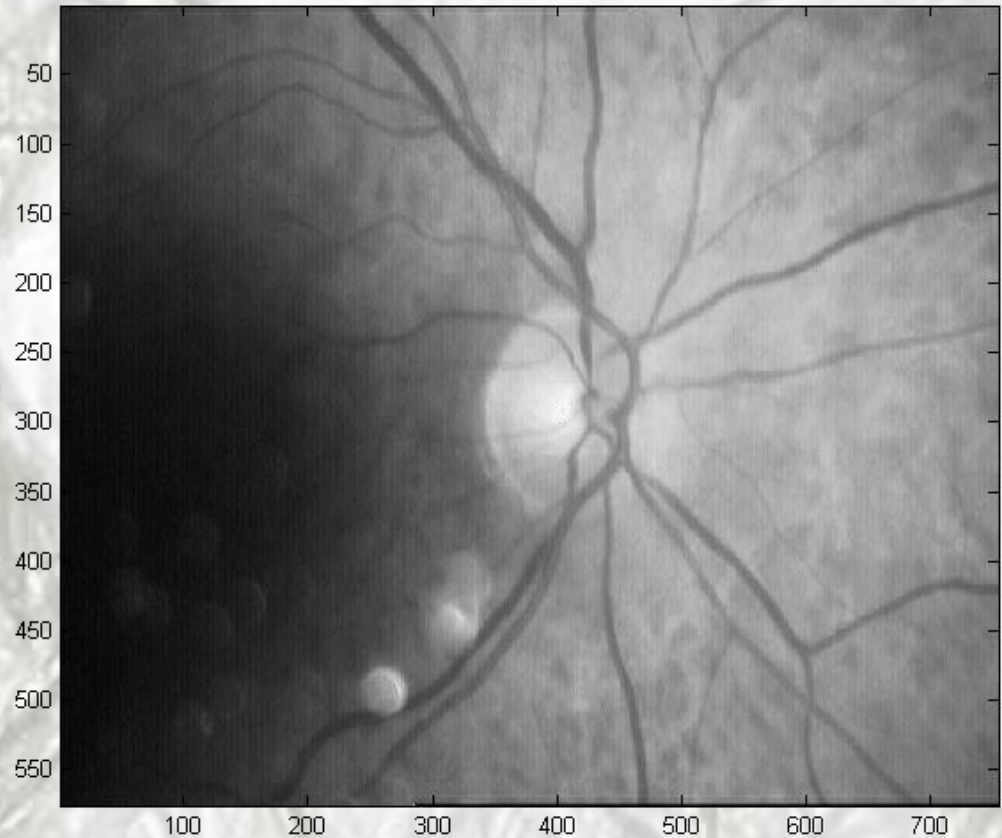
1. Optic disc removal

- steps
 - convolution with averaging filter
 - extraction of central part
 - histogram
 - bright part – 1.5%
 - creating binary mask by thresholding
 - calculation of disc coordinates



2. Blood vessels extraction

- Steps:
 - blurring
 - gradient magnitude using Sobel 5x5 mask
 - thresholding
 - edge thinning
 - edge linking



2. Blood vessels extraction

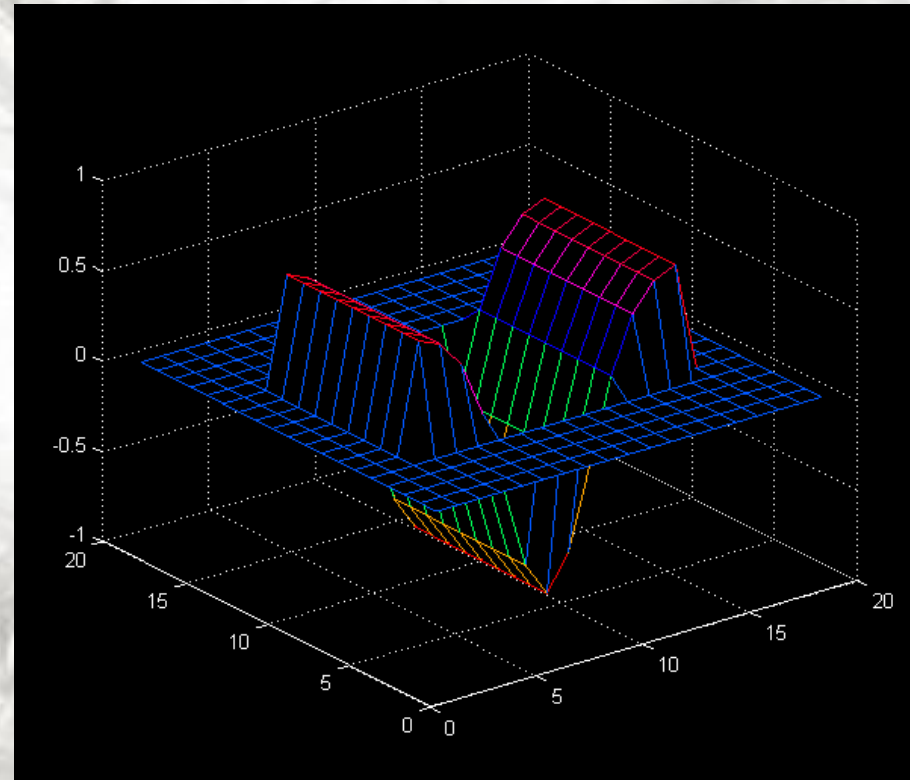
- matched filter
 - shape of object important
 - less discontinuities
- 4 characteristics of blood vessels
 - mild curvature
 - approximated with lines on segments
 - darker than the background
 - no sharp edges
 - intensities can be approximated with Gauss curve
 - gradually narrowing as goind further from optic disc
 - lengthwise symmetrical

2. Blood vessels extraction

$$h(d) = -\exp\left(-\frac{d^2}{2\sigma^2}\right)$$

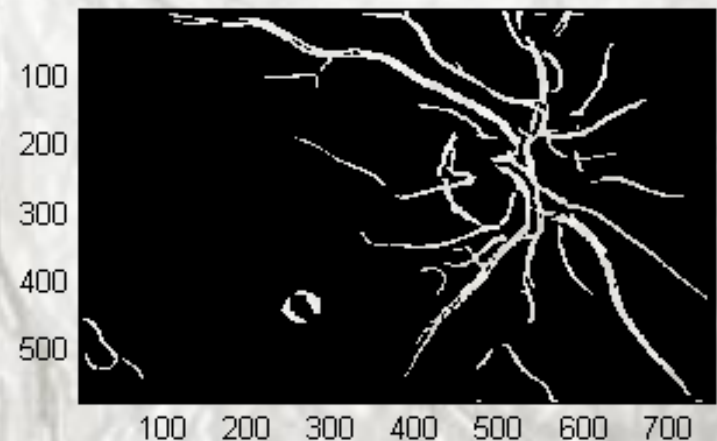
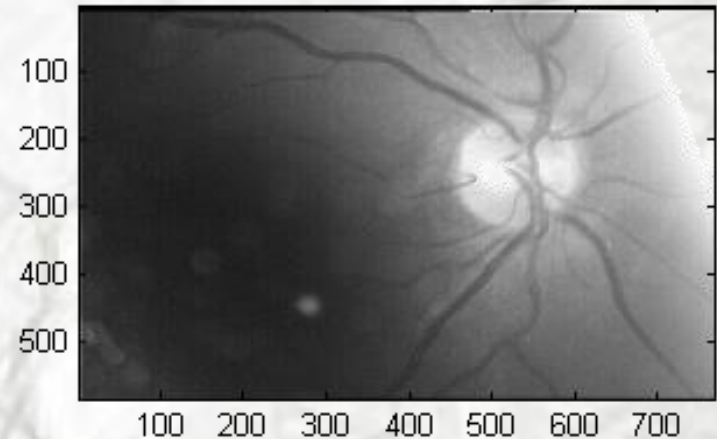
- d vessel width, σ width of Gauss curve
 - width $\pm 3\sigma$, length L
 - vessels are orientated in all directions (0-180°)
 - size of mask $L \times 6\sigma$
- mask coefficients

$$K_i(x, y) = -\exp\left(-\frac{x^2}{2\sigma^2}\right) \quad x \in [-3\sigma, 3\sigma], y \in \left[-\frac{L}{2}, \frac{L}{2}\right]$$



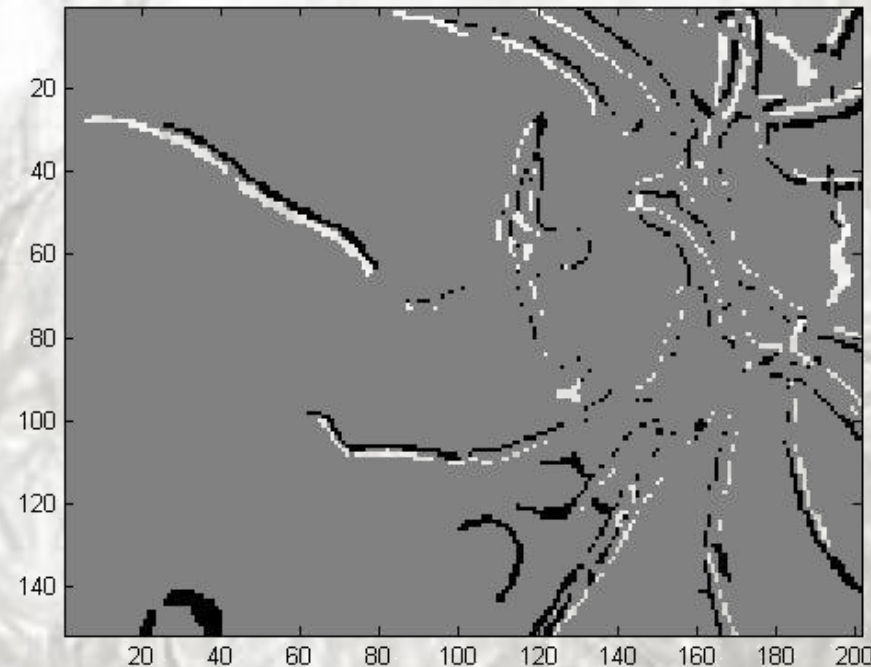
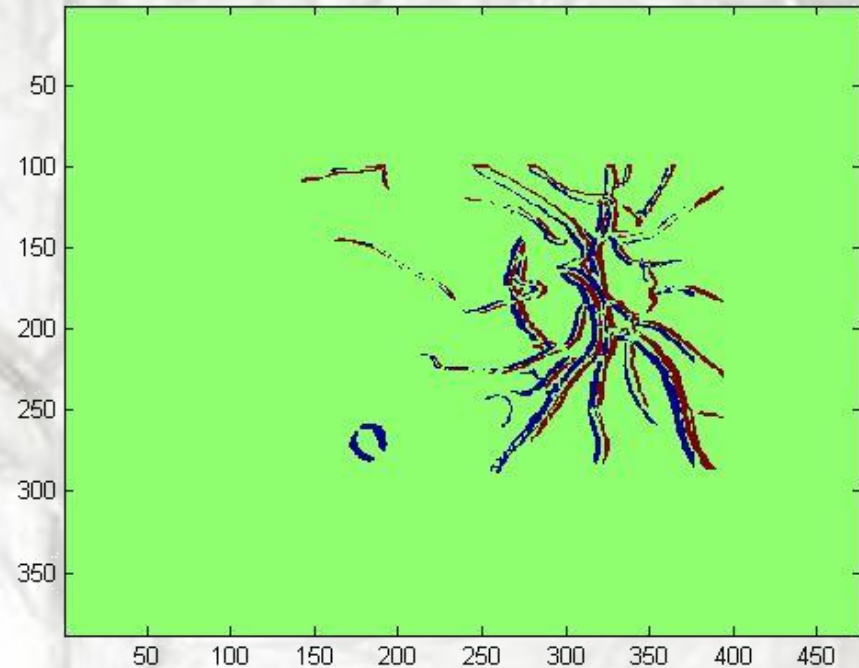
2. Blood vessels extraction

- average value of mask $m = \frac{1}{6\sigma L} \sum_{x,y} K_i(x,y)$
 - set to 0
 - m subtracted from all coefficients
- normalisation
 - coefficients divided with largest coefficient
- extended with 0
- mask rotated and then convoluted with image
 - binary image
 - 4% of brightest pixels are vessels
 - repeated for all angles
 - results integrated using OR operation
- objects smaller than 125 pixels removed



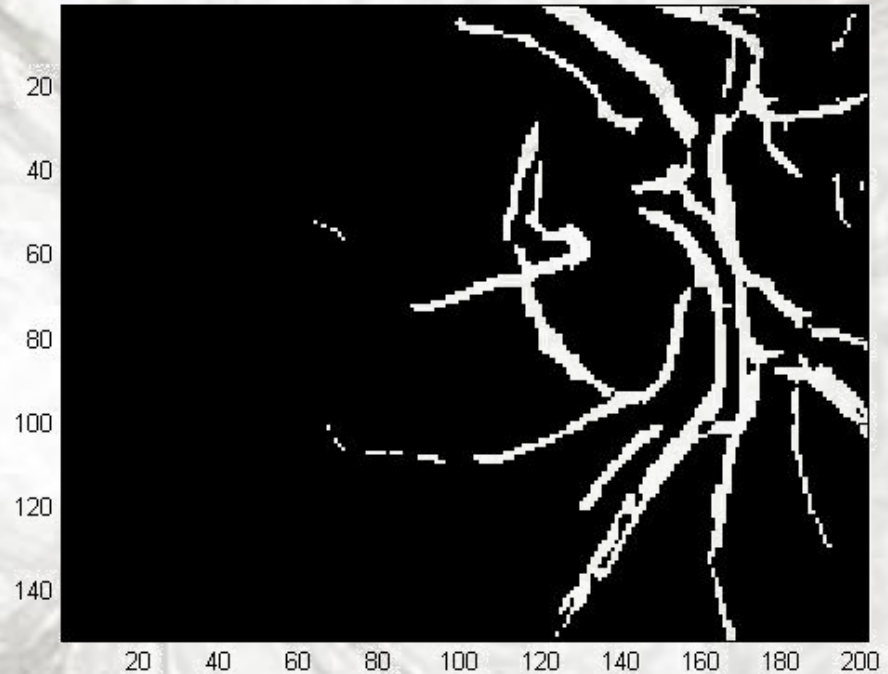
3. Image distinguishing

- retina images of the same eye are usually
 - translated
 - rotated
- referent point
 - center of optic disc
- subsampling
- finding best overlap:
 - translating for +/- 25 pixels
 - rotating for +/- 5 degrees
 - calculating minimum difference



3. Image distinguishing

- rotate and translate second image for optimal parameters
- image subtraction
- final results
 - same parts
 - different parts
 - percentage of overlapped pixels



$$\frac{\text{percentage of overlapped pixels}}{\text{total number of pixels representing vessels in original image}}$$

3. Graphical user interface

- 2 options
 - choosing picture to compare with
 - searching through databasse

The screenshot shows a software window titled "test" with a standard Windows-style title bar. The main content area is titled "Personal identification based on digital retinal images" and "DIPA project 2015". It features a control panel with several buttons: "Choose image", "Choose picture to compare", "Search the database", "Show image", "Filter vessels", "Find optic nerve", "Show different parts", and "Show matching parts". Below the buttons, there are two main image displays. The left display, labeled "Filtrirane žile", shows a binary image of retinal vessels on a black background. The right display, labeled "Djelovi koji su različiti", shows a comparison of two vessel images with differences highlighted in white on a gray background. At the bottom right, a "Matching percentage" is displayed as 32.6261.

test

Personal identification based on digital retinal images

DIPA project 2015

Choose image

Choose picture to compare

Search the database

Show image

Filter vessels

Find optic nerve

Show different parts

Show matching parts

Filtrirane žile

Djelovi koji su različiti

Matching percentage 32.6261



THANK YOU!