ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Iris Recognition

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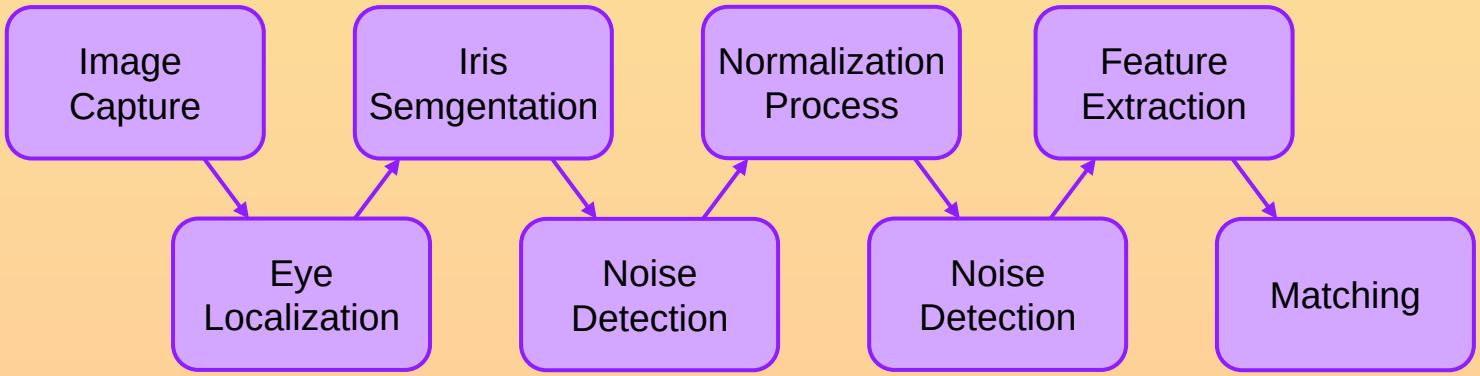
Outline

- Block Diagram
- CASIA Iris image database
- Eye localization
- Iris Segmentation
- Noise detection
- Comparing iris codes
- Possible improvements

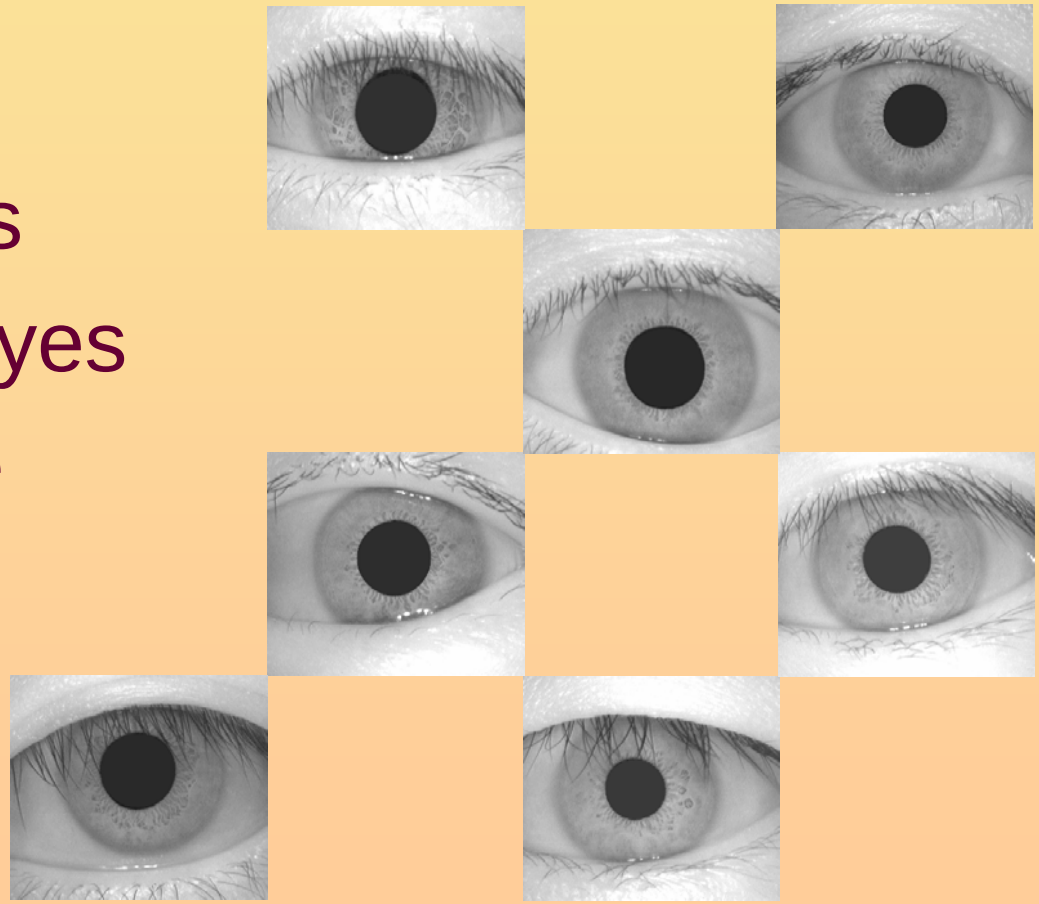
Block Diagram
How Iris recognition works



CASIA Iris Image database

Version 1.0

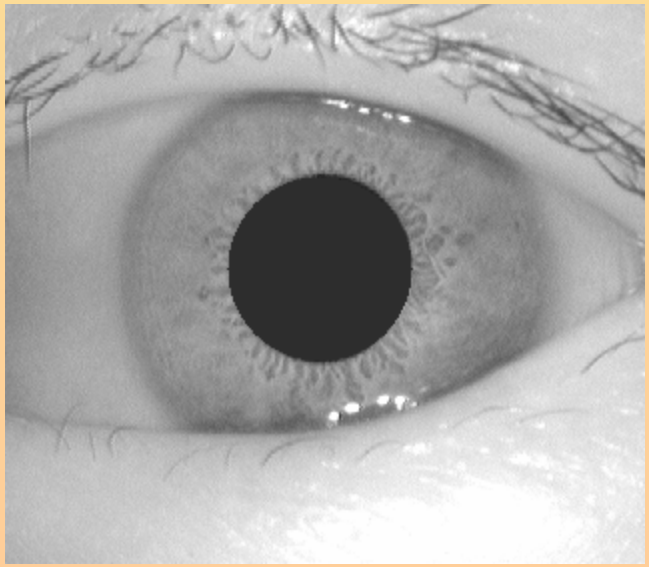
- 756 iris images
- 108 different eyes
- 7 images / eye



CASIA Iris Image database

Version 1.0

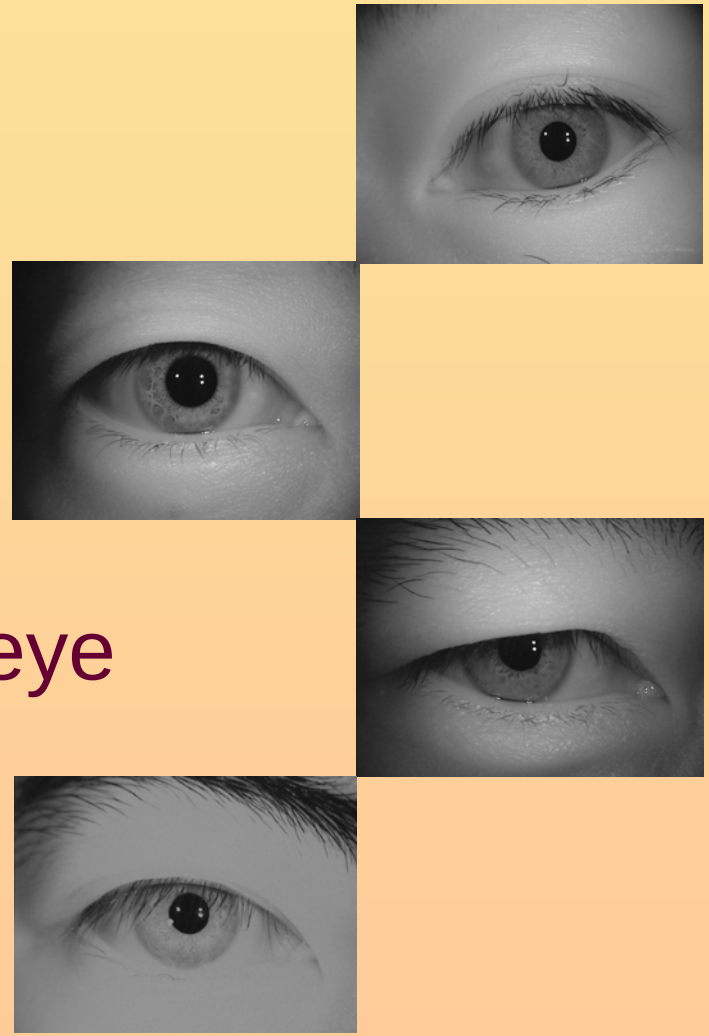
320 x 280 pixels



CASIA Iris Image database

Version 2.0

- 2400 iris images
- 60 different eyes
- 2 devices
- 20 images / device / eye



Eye localization

Version 2.0

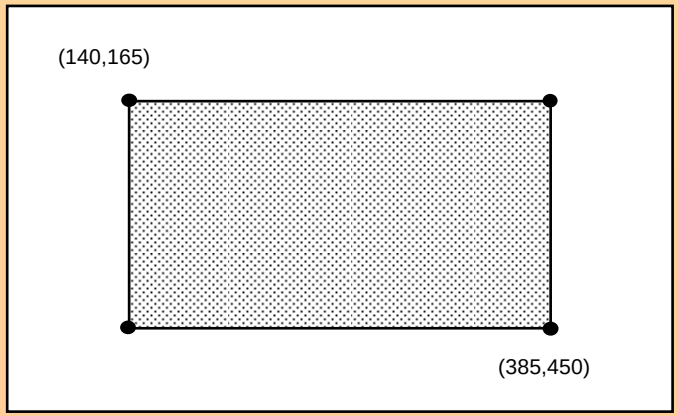
640 x 480

pixels

Eye localization

Algorithm to localize the eye

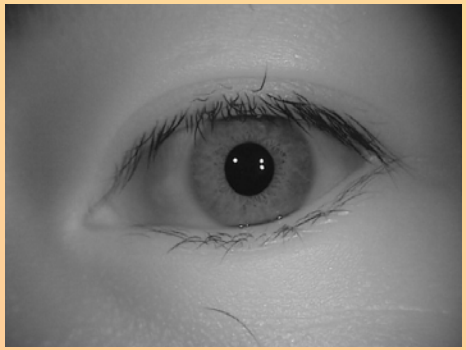
1. Mean intensity of the image
2. Cut off the interest part of the image
   285 x 245 pixels
   (640 x 480)



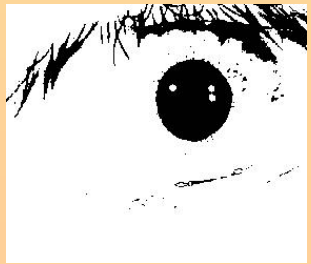
Eye localization

3. Binarization of the interest part

$$threshold = 0.52 \cdot \frac{1}{size_{image}} \sum Intensity_{pixels}$$



640 x 480



285 x 245

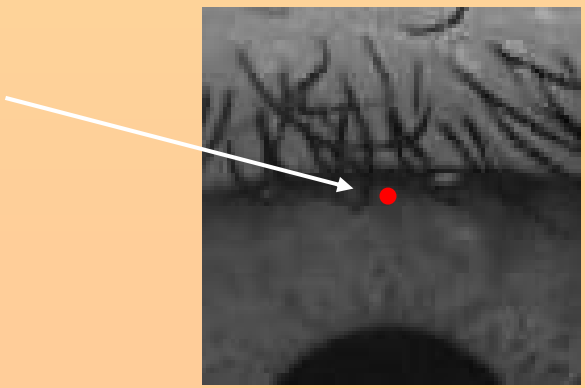
Eye localization

4. Projection in the vertical and horizontal direction

$$X_p 1 = \arg\min_x \left(\sum_y I(x, y) \right)$$

$$Y_p 1 = \arg\min_y \left(\sum_x I(x, y) \right)$$

5. 90 x 90 pixels cut off image, center is Xp1,Yp1



Eye localization

6. Second projection in the vertical and horizontal direction

$$X_p 2 = \arg\min_x \left(\sum_y I(x, y) \right)$$

$$Y_p 2 = \arg\min_y \left(\sum_x I(x, y) \right)$$

7. Calcul of Xp3, Yp3

$$X_p 3 = 0.5 \cdot (X_p 1 + X_p 2)$$

$$Y_p 3 = 0.5 \cdot (Y_p 1 + Y_p 2)$$

Eye localization

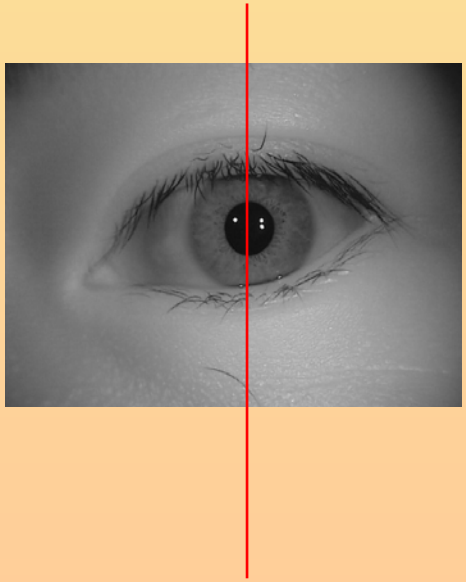
8. Binarization of the original image

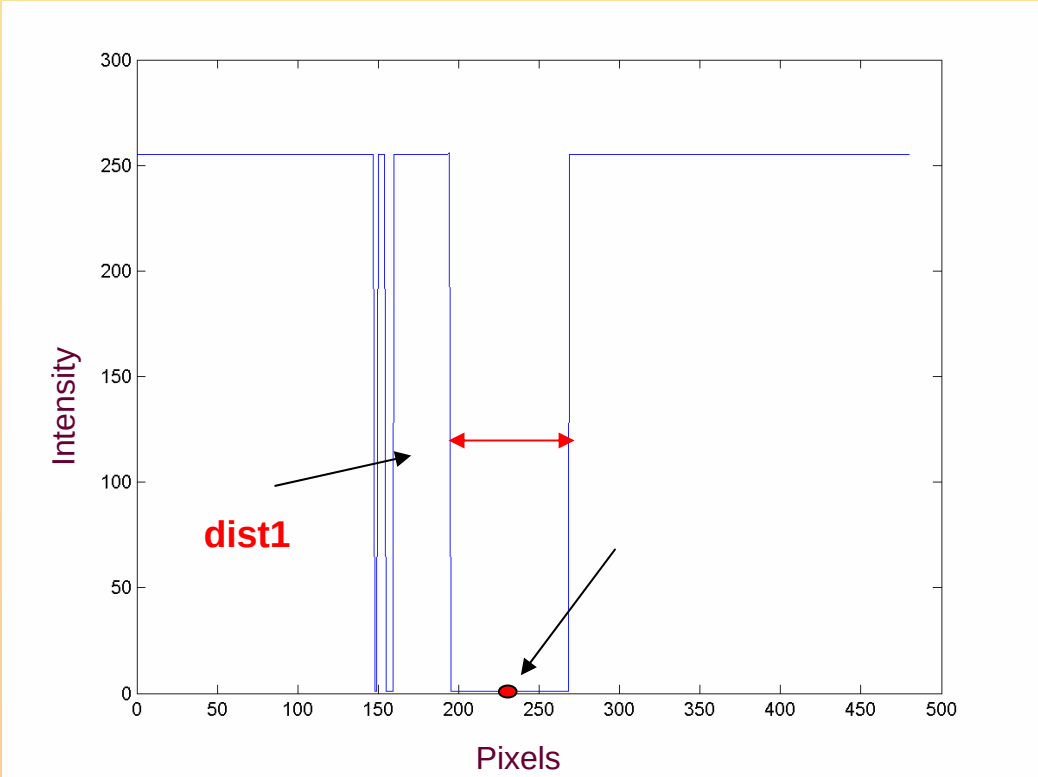
$$threshold = 0.6 \cdot \left(0.52 \cdot \frac{1}{size_{image}} \sum Intensity_{pixels} \right)$$

9. Find the maximum distance between two minimum (black => intensity = 1), vertical direction at Xp3 for a new approximation of Yp3

Eye localization

9. Suite

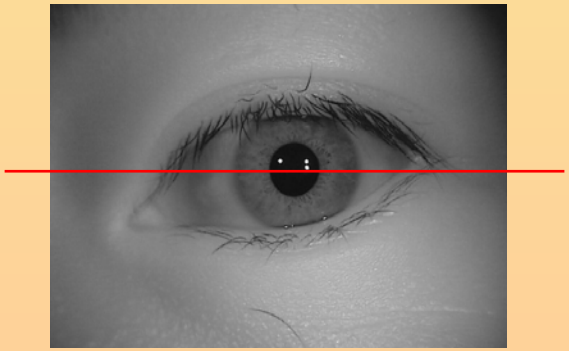


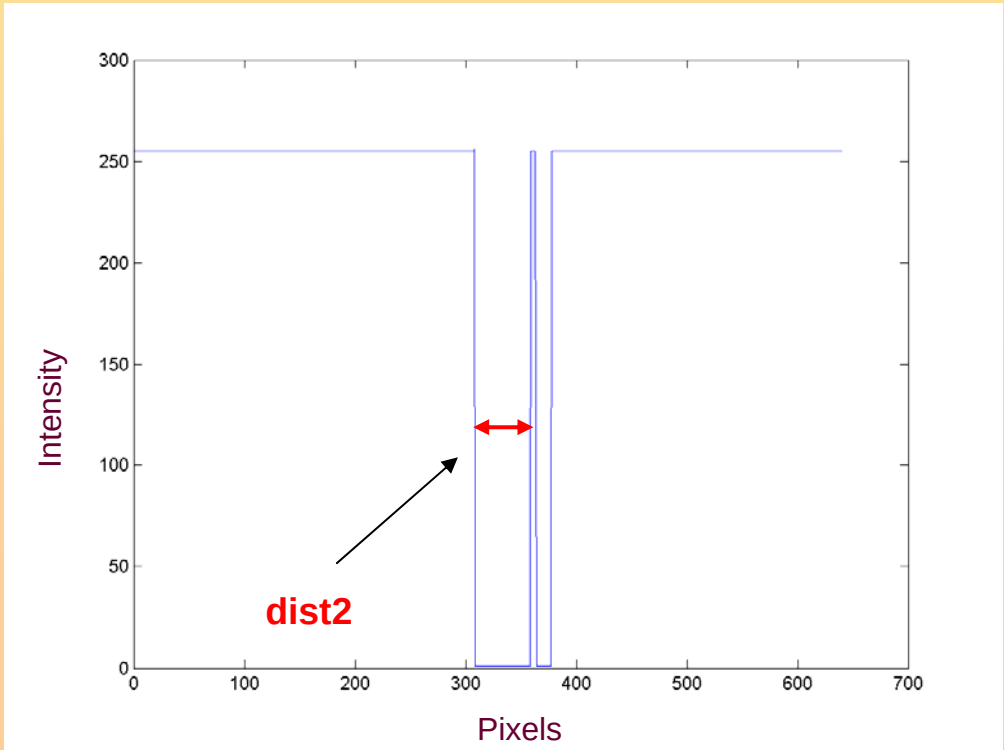


This distance will be use… pupil’s radius

Eye localization

10. Second pupil's radius approximation





Eye localization

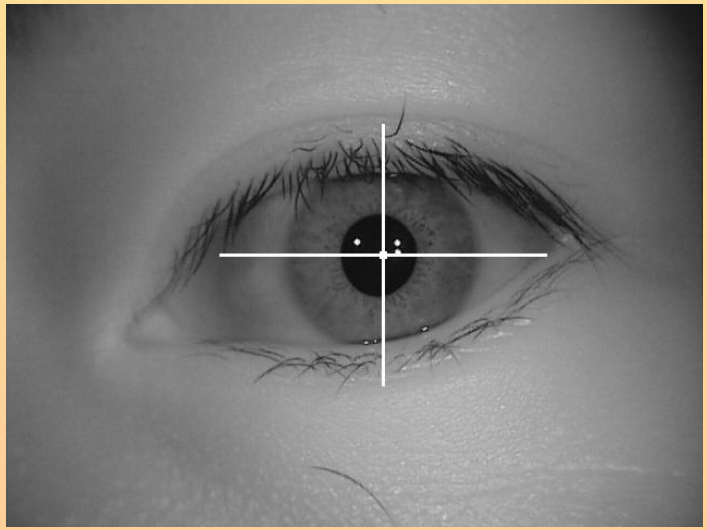
11. Second pupil's radius approximation

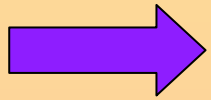
$$Pupil's_{Radius} = \max\left(\frac{dist1}{2}, \frac{dist2}{2}\right)$$

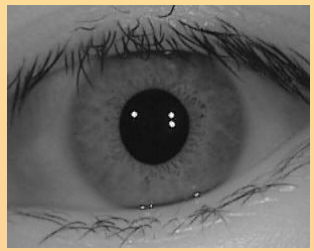
12. End… The algorithm return a 300 by 240 pixels image, center (Xp3,Yp3)

Eye localization

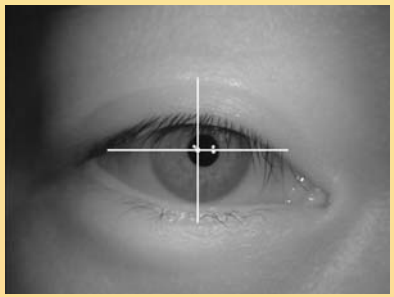
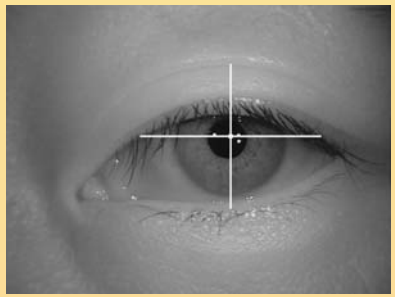
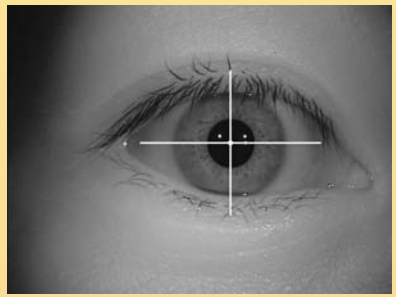
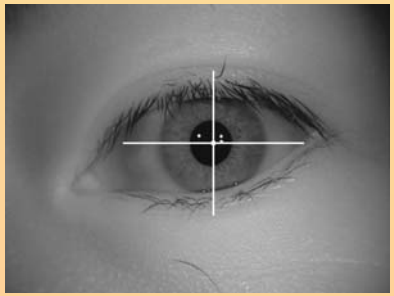
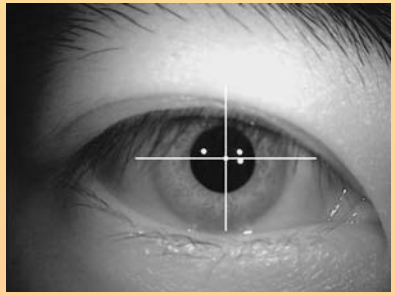
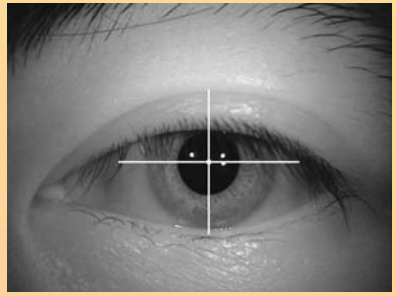
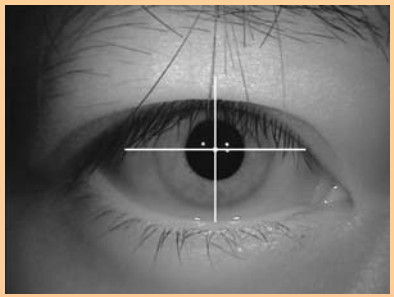
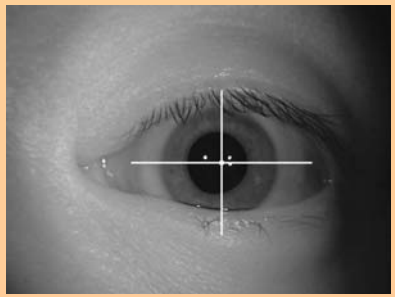
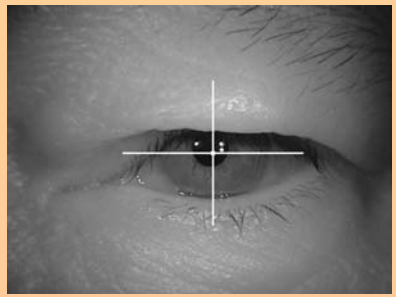
12. Suite





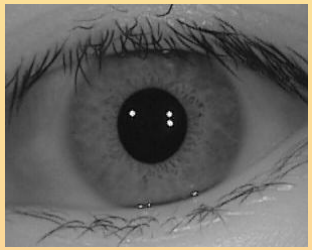


Eye localization

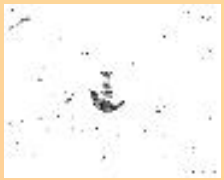










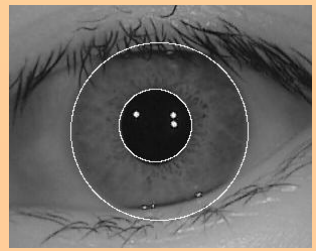
Iris Segmentation

Parameters of the pupil



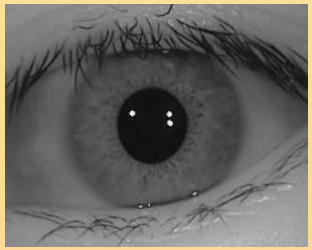
“gradient amplitude”
“gamma modification”
“non-maxima suppression”
“hysteresis thresholding”.





Iris Segmentation

Parameters of the Iris



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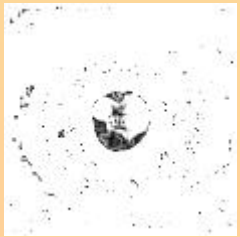
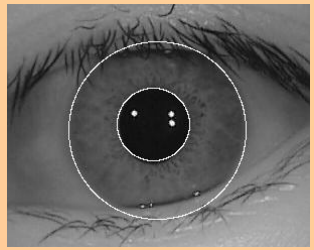
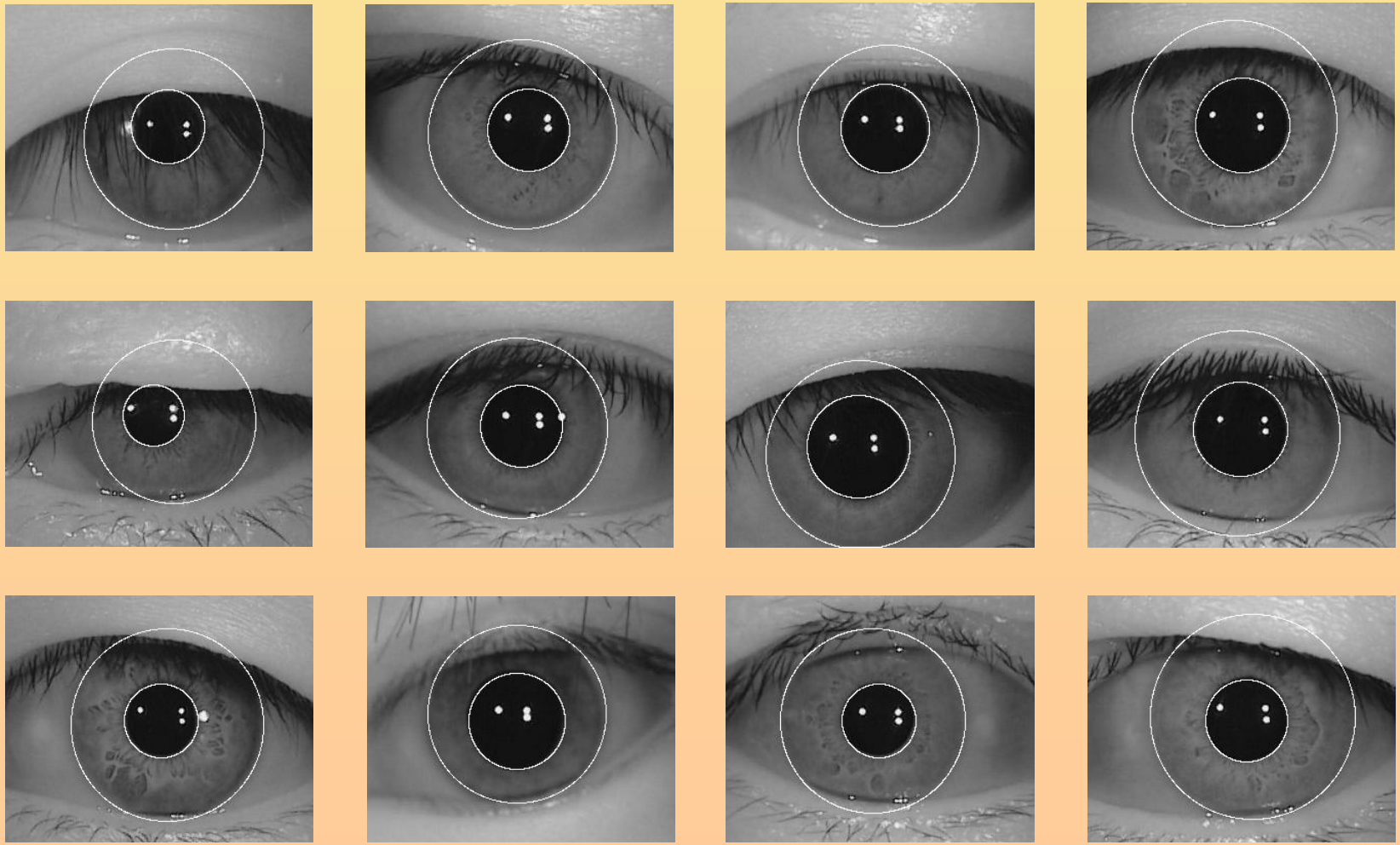
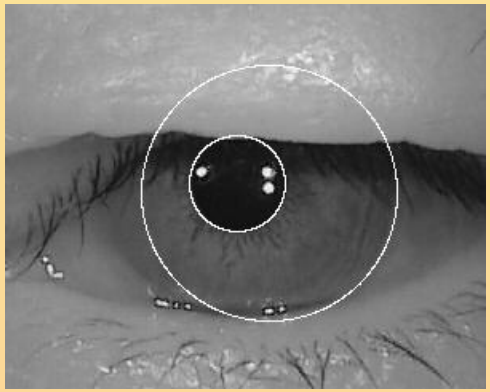


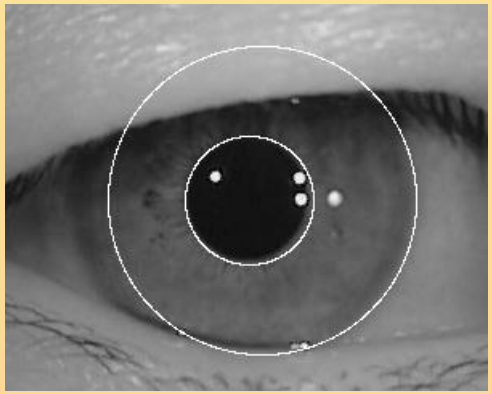


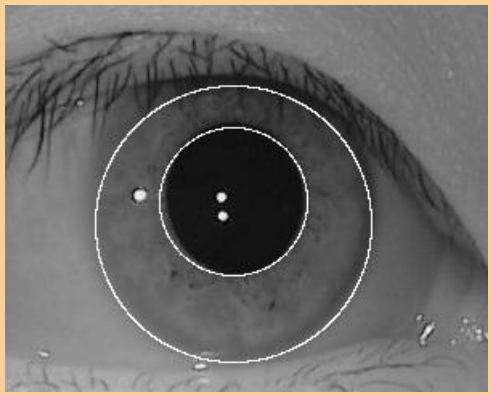
Iris Segmentation

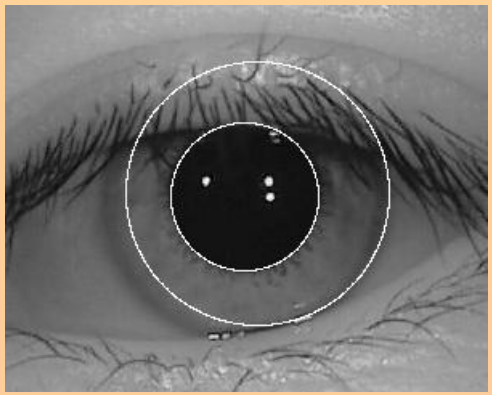


Iris Segmentation





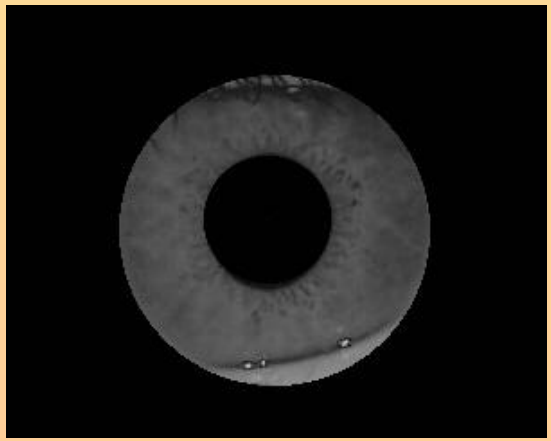


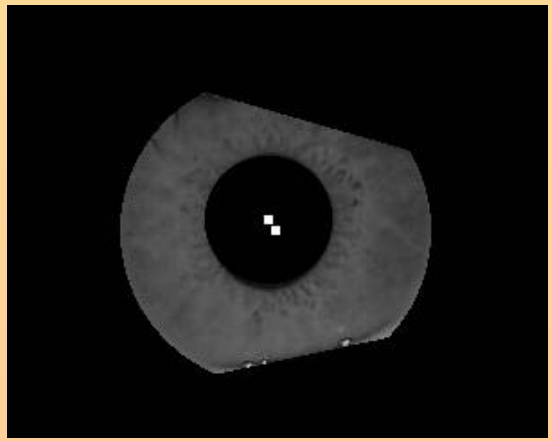


Noise detection

Canny edge detection

Radon transform

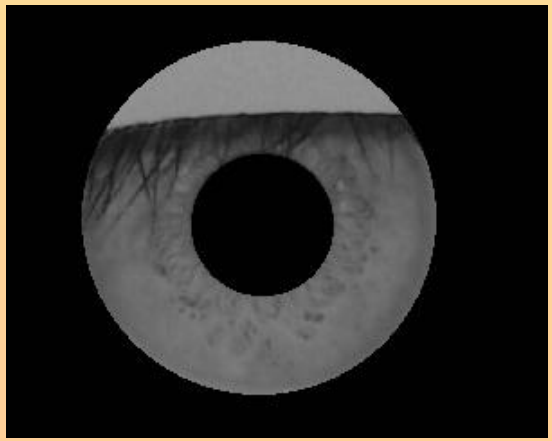


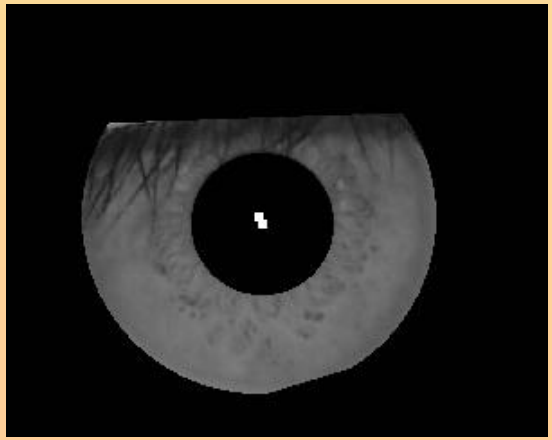


Noise detection

Canny edge detection

Radon transform





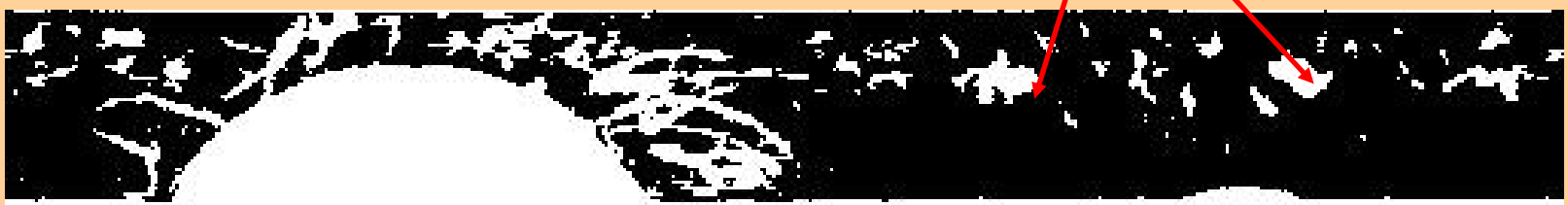
Noise detection

Eyelashes detection

Phase congruency details in [11]

$$N_1(x,y) = PC_2(x,y) + W_1\left(1 - \frac{f(x,y)}{255}\right) - T_1$$

$$N_1(x,y) = \begin{cases} >= 0 \ldots noise \\ < 0 \ldots other \end{cases}$$



White pixels … mask (noise)

Comparing Iris codes

Hamming distance

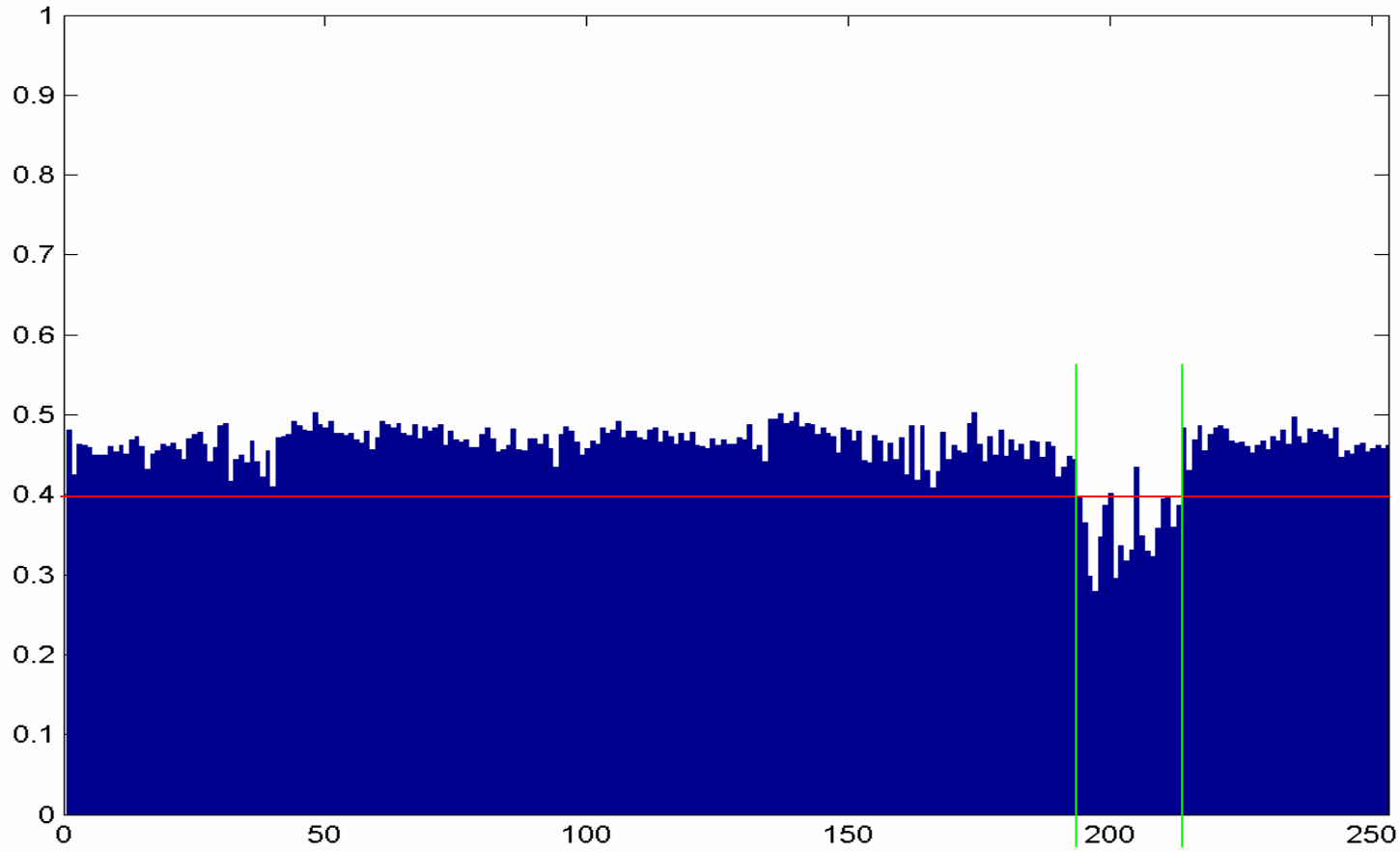
$$Hd = \frac{(A \oplus B) \otimes \square\ mask}{Nbit_{template} - Nbit_{mask}}$$

Hamming distance of two identical vectors is Zero

Test with 253 templates from 39 different eyes

Comparing Iris codes

Comparing Iris codes



Comparing Iris codes

Eye image n°0033_0xy

Iris image	0033_000	0033_001	0033_002	0033_003	0033_004	0033_005	0033_006	0033_007	0033_008	0033_009
0033_000		**0.338**	**0.365**	**0.369**	**0.350**	**0.382**	**0.376**	**0.315**	**0.313**	**0.329**
0033_001			**0.299**	**0.292**	**0.339**	**0.400**	**0.401**	**0.248**	**0.332**	**0.285**
0033_002				**0.279**	**0.348**	**0.387**	**0.402**	**0.295**	**0.336**	**0.318**
0033_003					**0.312**	**0.369**	**0.425**	**0.296**	**0.357**	**0.304**
0033_004						**0.407**	**0.415**	**0.328**	**0.334**	**0.325**
0033_005							**0.415**	**0.406**	**0.388**	**0.414**
0033_006								**0.366**	**0.353**	**0.380**
0033_007									**0.324**	**0.256**
0033_008										**0.299**

Comparing Iris codes

Iris image	0033_010	0033_011	0033_012	0033_013	0033_014	0033_015	0033_016	0033_017	0033_018	0033_019
0033_000	**0.412**	**0.374**	**0.356**	**0.363**	**0.390**	**0.294**	**0.329**	**0.365**	**0.407**	**0.424**
0033_001	**0.340**	**0.371**	**0.362**	**0.331**	**0.319**	**0.343**	**0.388**	**0.375**	**0.339**	**0.360**
0033_002	**0.331**	**0.434**	**0.348**	**0.329**	**0.322**	**0.358**	**0.395**	**0.396**	**0.360**	**0.387**
0033_003	**0.343**	**0.394**	**0.342**	**0.323**	**0.335**	**0.354**	**0.388**	**0.370**	**0.348**	**0.371**
0033_004	**0.341**	**0.390**	**0.300**	**0.327**	**0.351**	**0.369**	**0.390**	**0.408**	**0.371**	**0.400**
0033_005	**0.416**	**0.405**	**0.434**	**0.437**	**0.427**	**0.371**	**0.372**	**0.387**	**0.434**	**0.441**
0033_006	**0.448**	**0.458**	**0.427**	**0.409**	**0.429**	**0.374**	**0.406**	**0.436**	**0.421**	**0.436**
0033_007	**0.333**	**0.396**	**0.326**	**0.292**	**0.323**	**0.341**	**0.373**	**0.370**	**0.347**	**0.375**
0033_008	**0.413**	**0.402**	**0.360**	**0.352**	**0.374**	**0.344**	**0.401**	**0.402**	**0.371**	**0.368**
0033_009	**0.365**	**0.392**	**0.318**	**0.287**	**0.330**	**0.337**	**0.381**	**0.372**	**0.327**	**0.356**
0033_010		**0.397**	**0.355**	**0.324**	**0.323**	**0.408**	**0.358**	**0.355**	**0.407**	**0.440**
0033_011			**0.377**	**0.383**	**0.402**	**0.379**	**0.370**	**0.388**	**0.392**	**0.401**
0033_012				**0.286**	**0.335**	**0.350**	**0.377**	**0.404**	**0.353**	**0.387**
0033_013					**0.278**	**0.348**	**0.369**	**0.355**	**0.307**	**0.338**
0033_014						**0.378**	**0.395**	**0.380**	**0.347**	**0.379**
0033_015							**0.343**	**0.350**	**0.361**	**0.395**
0033_016								**0.324**	**0.417**	**0.445**
0033_017									**0.427**	**0.453**
0033_018										**0.279**
0033_019										

Possible improvements

- Eye detection, no need to cut off the original image
- Approximation of the iris radius
- Size of the template
- Brightness of the normalized image, effects on results ?
- Noise detection, eyelashes

References

[1] J.Daugmann. « How iris recognition works » *IEEE Transactions on Circuits and Systems for Video Technology vol. 14, n° 1,* January 2004

[2] L. Ma, T. Tan, Y. Wang, D. Zhang. « Efficient Iris Recognition by Characterizing Key Local Variations », *IEEE Transaction on Image Processing, vol.13, n°6,* June 2004

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[4] Libor Masek, « Recognition of Human Iris Patterns for Biometric Identification », *School of Computer and Software Engineering, The University of Western Autralia*, 2003

[5] P.J. Czerwinsk, R. Chellali, V. Fremont, « Ellipse Detection Using Hough Transform », *Warsaw University of Technology and Ecole des Mines de Nantes*.

[6] S. Inverso, « Ellipse Detection Using Randomized Hough Transform »,2002

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Matlab Code

To create an iris template
make_template('0001_014.bmp', 1, 1)

The output is **0001_014.bmp-info.mat**
This contains two matrixes mask_G and template_G

To show the iris code and the mask
load 0001_014.bmp-info.mat

Matlab Code (suite)

To compare two iris codes
compare_code_one_to_one('0033_005.bmp info.mat','0001_014.bmp-info.mat');

To compare one iris code to all
compare_code_one_to_all('0016_019.bmp info.mat')

Questions?

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