Marie Curie IEF 254261 (FP7-PEOPLE-2009-IEF)

BIO-DISTANCE

Representative results (with slides extracted from presentations given at conferences and talks)

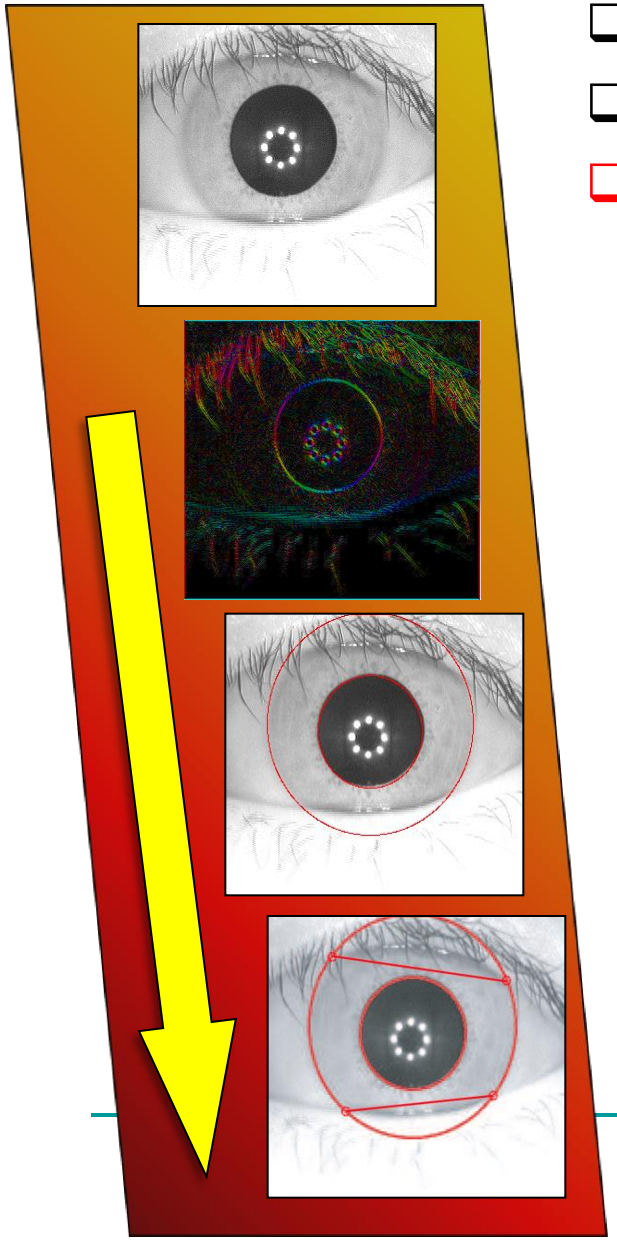
Fernando Alonso-Fernandez (fellow)
feralo@hh.se

Josef Bigun (scientist in charge)
josef.bigun@hh.se

Halmstad University, Sweden

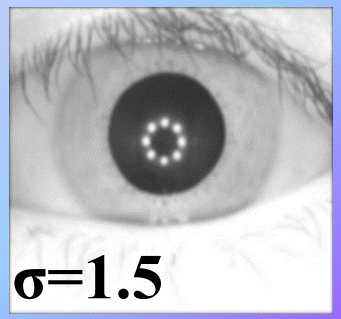
http://islab.hh.se

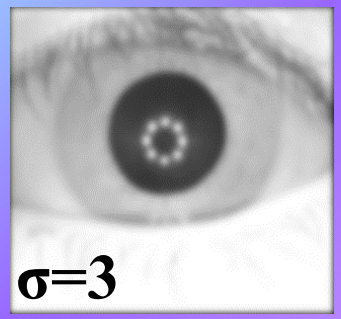
Analysis of eye images



- Eye **detection** and iris **segmentation**
- Image **quality** estimation
- **Identity** by iris and periocular

defocus blur





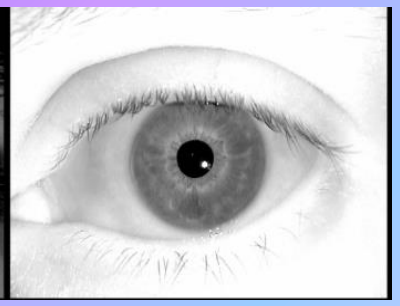
Edge sharpness

Pupil: 40.17
Sclera: 99.77

Gray level variability

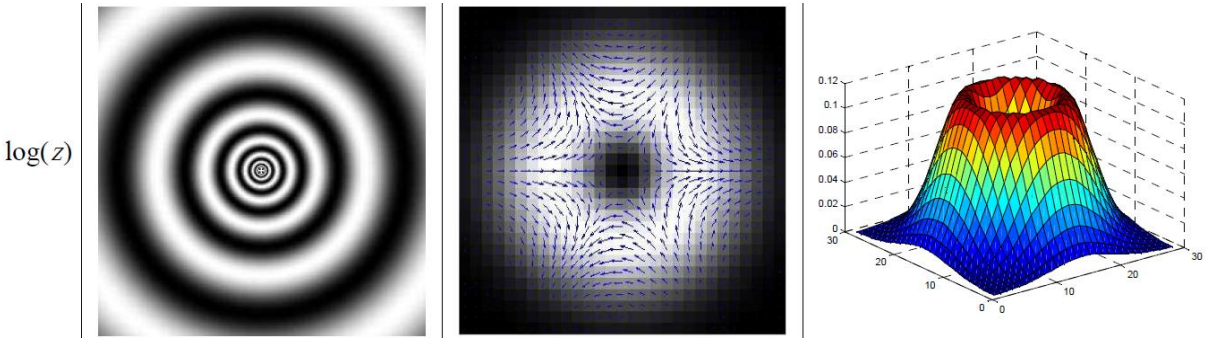
high (0.78)

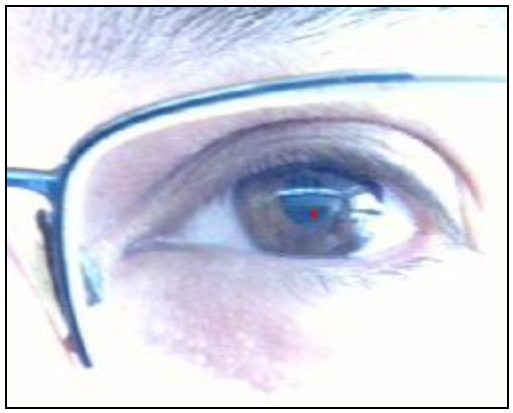
low (0.29)

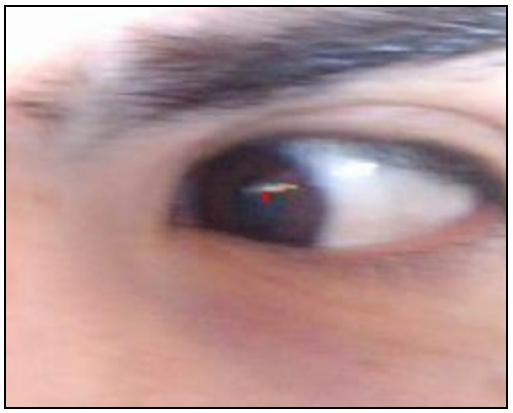


Detection of eye regions

- **Face detection/recognition** with current (existing) algorithms is done holistically, i.e. they are degraded if the whole face is not available
  - Separate detection of facial landmarks (eye, nose, etc.)



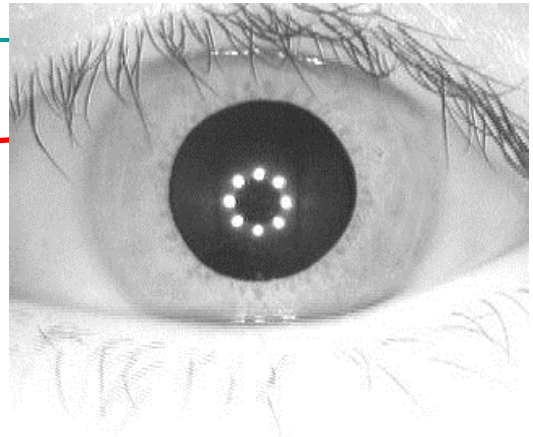




Iris segmentation using Symmetry Filters

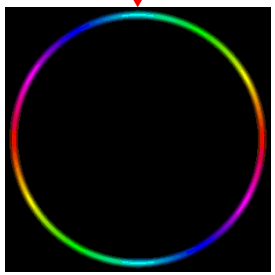
Finding iris boundaries

$$\frac{\partial I}{\partial x}, \frac{\partial I}{\partial y}$$



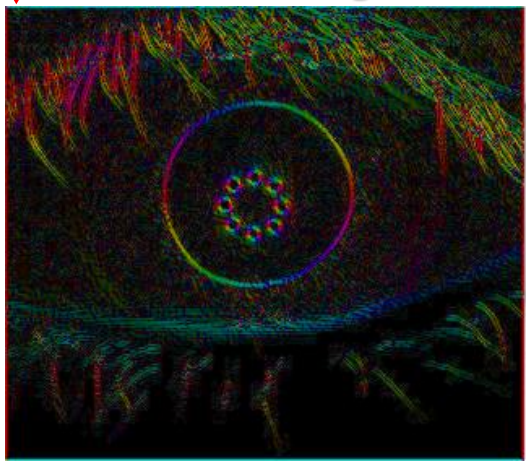
$$I_{20} = cf * \left(\frac{\partial I}{\partial x} + i \frac{\partial I}{\partial y} \right)^2$$

Circular filter of variable radius

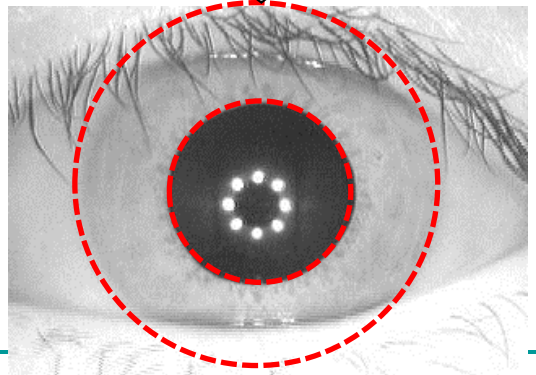


Convolution

Derivative image from gradients



Peak in the response when radius of the filter matches with the sough circle



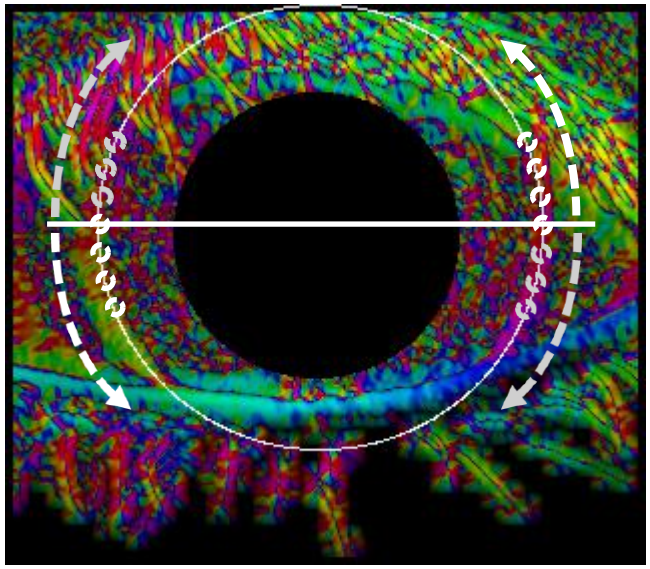
- Color in the images represents local orientation

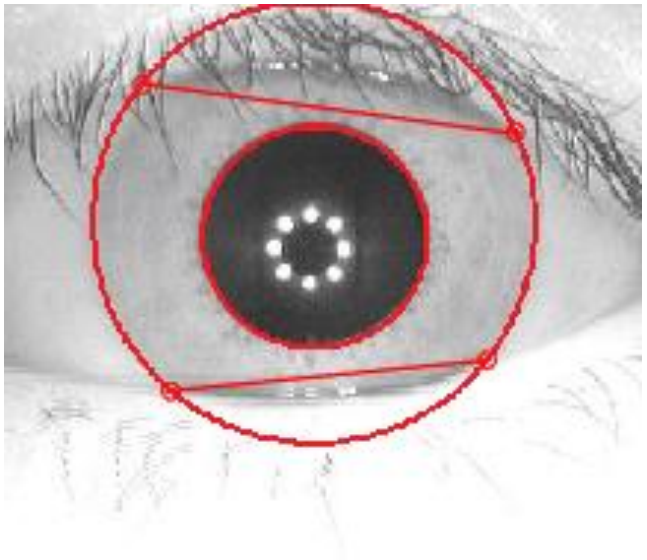
- **Improved performance** in comparison traditional segmentation approaches (circular Hough transform, integro-differential operator)

Iris segmentation using Symmetry Filters

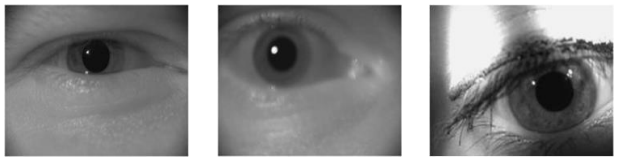
Eyelids occlusion detection: finding cross-points

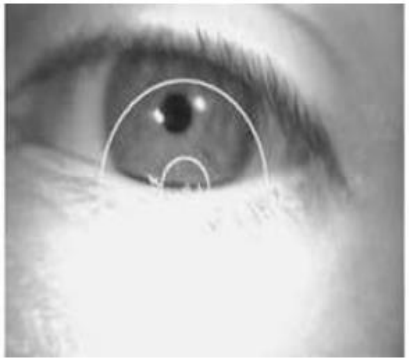
- Once the outer boundary is detected, we locally check if the orientation across the boundary matches with the expected orientation
- Starting from the horizontal axis, we look for the points where the agreement is broken

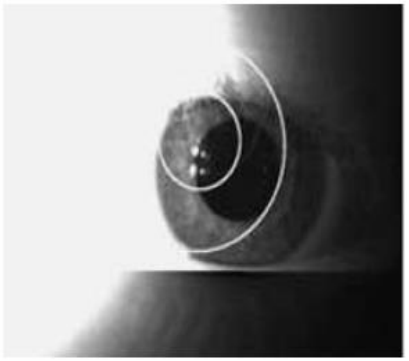




Iris recognition and quality degradation







Segmentation

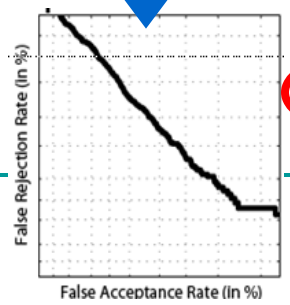
Our case of study

Feature Extraction

Matching

Database

Score



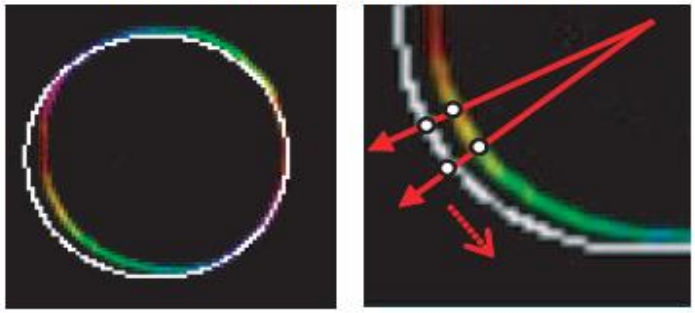
Recognition accuracy

Most works focused on quality impact here

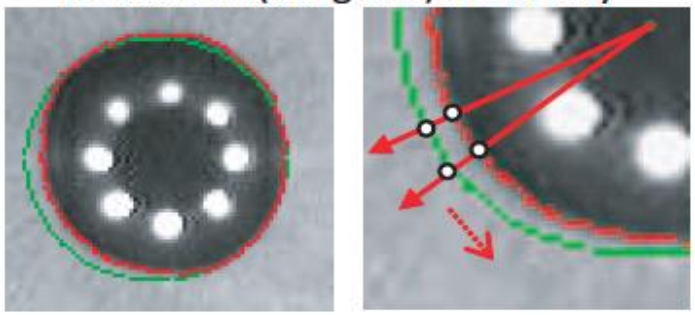
Some quality measures developed

Circularity (pupil: 5.14)

Image gradient (pupil area)

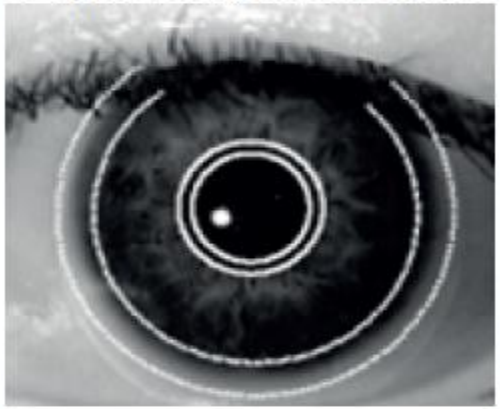


Green: circular boundary
Red: fitted (irregular) boundary



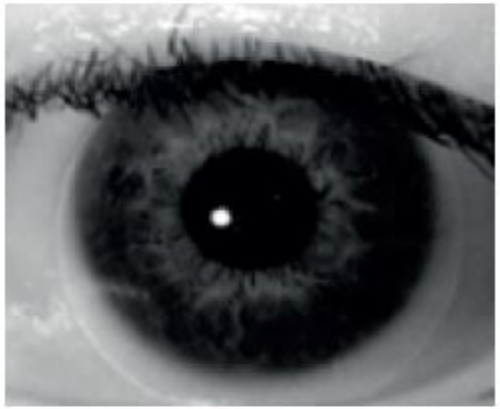
Iris Edge Sharpness (IES)

Pupil: 40.17, Sclera: 99.77



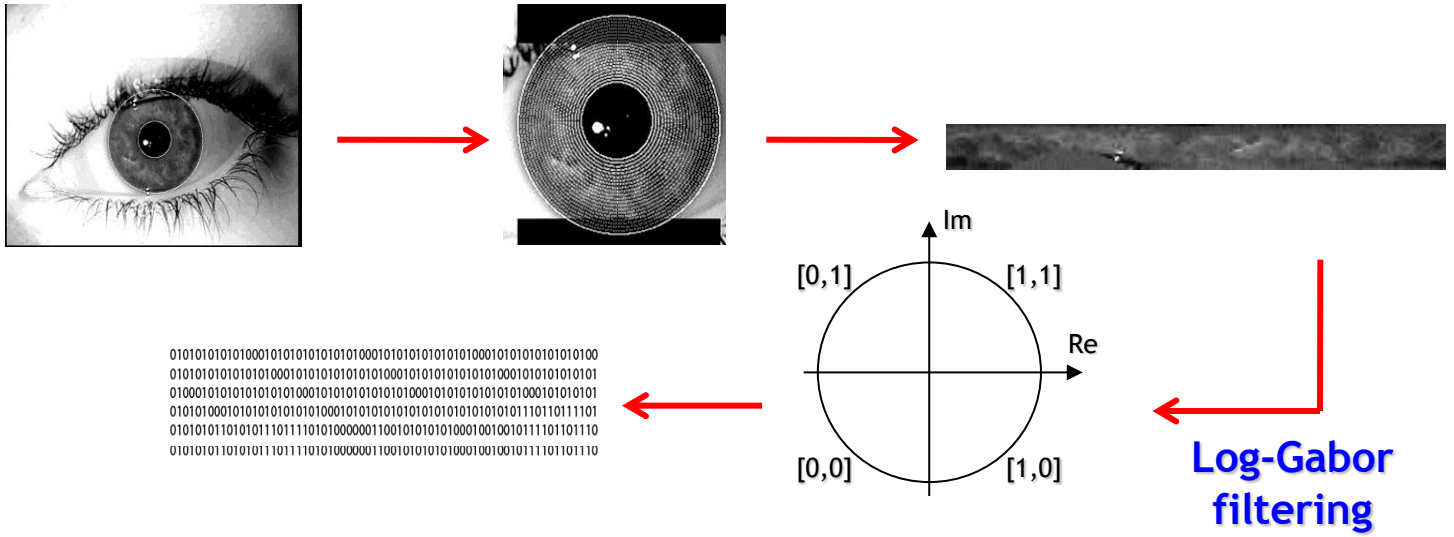
Orientation Certainty Level (OCL)

Pupil: 0.57, Sclera: 0.90

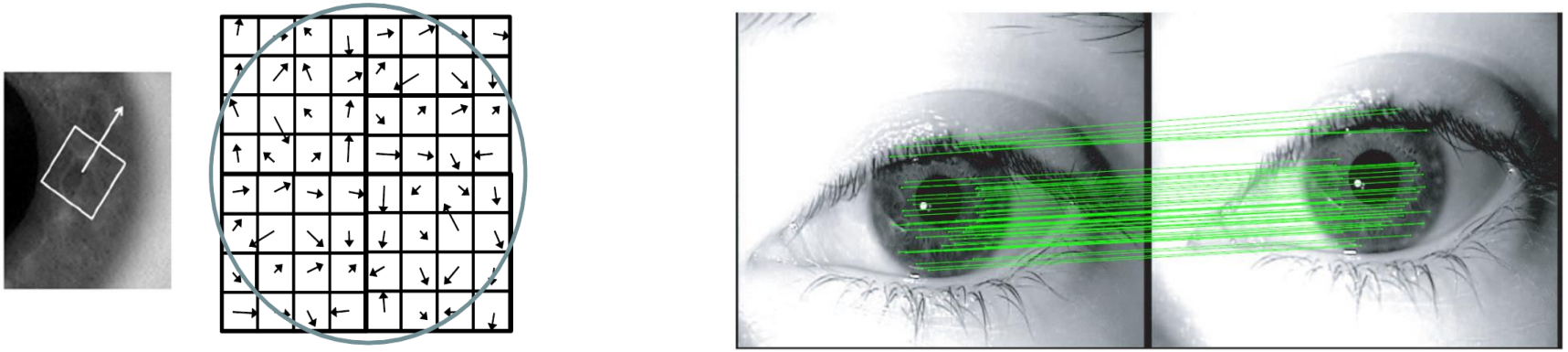


Some iris matchers evaluated

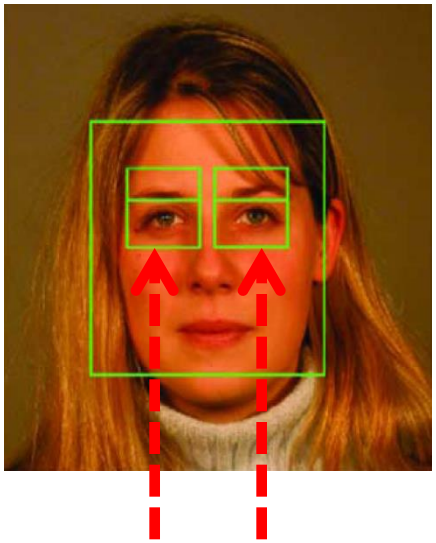
Log-Gabor wavelets



SIFT operator adapted to iris matching



Periocular recognition



PERIOCULAR REGION

face region in the immediate vicinity of the eye

(including eyes, eyelids, eyelashes and eyebrows)

Levels of facial analysis:

"Far": whole face

- Subject to occlusion (close distances, occluding objects, forensics, surveillance)

"Close": iris texture

- Reliable acquisition (resolution, off-angle…)
- Works better in NIR range

"Medium": periocular

- Expected to be available over a wide range of distances, even when the iris texture cannot be reliably obtained or under partial facial occlusion
- Revived attention (mobile devices, distant acquisition, surveillance…)

Periocular recognition

right eye

left eye

- Periocular region can be easily obtained with **existing setups for face/iris**
  - Images in the visible range
- The requirement of high user **cooperation** can be relaxed
- Availability over a **wide range of acquisition distances** even when the iris texture cannot be reliably obtained (low resolution, off-angle, etc.) or under partial face occlusion (close distances)

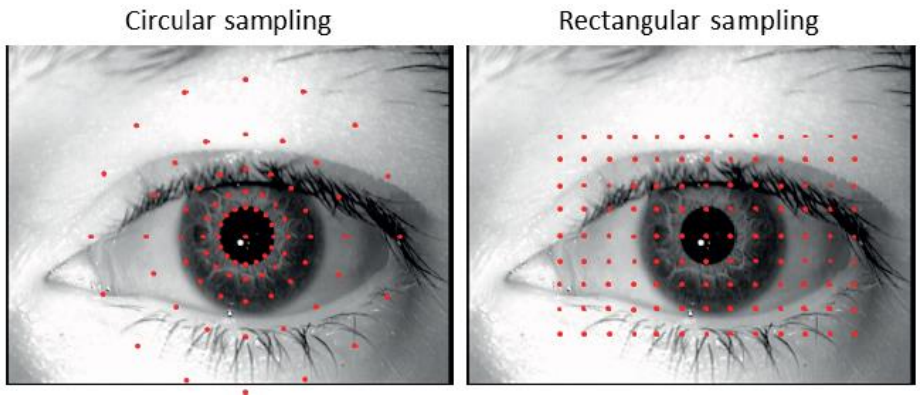
Our proposal for periocular recognition

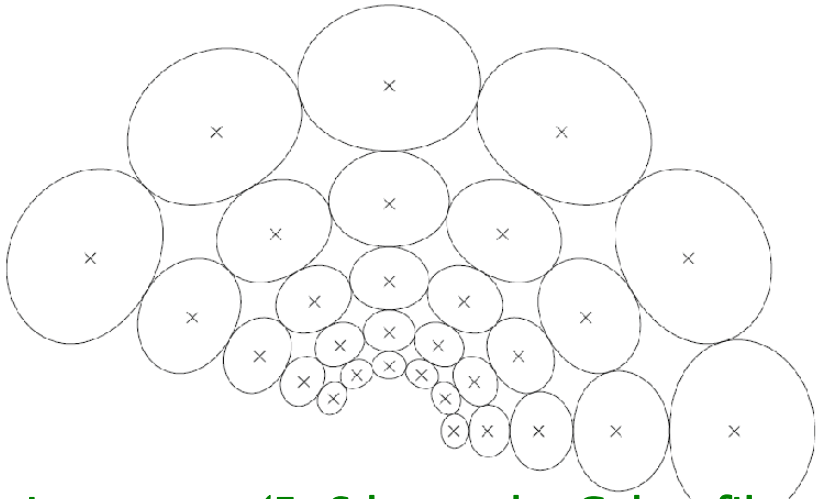
Retinotopic sampling

- Sampling grid centered on the pupil center
- Points arranged in concentric circles or in a squared grid of equidistant points

Gabor decomposition

- At each point of the grid, a Gabor decomposition is done with several frequency and orientation channels





Iso-curves (5x6 log-polar Gabor filters)

- The circular grid imitates the arrangement of **photoreceptors** in the human retina
- The Gabor decomposition mimic the simple cells of the primary **visual cortex** having the same receptive field but different spatial directions and frequencies
- **Competitive performance** in comparison with results reported in the literature for other approaches (LBPs, SIFT…)

ICIR2013, the First ICB Competition on Iris Recognition

- Participation with iris detection and recognition developments of this project
- http://iris.idealtest.org/2013/ICIR2013.jsp

Testing Results of The First ICB Competition on Iris Recognition (ICIR2013)

Rank	Developers	Organization	Country	FNMR@ FMR=0.0001	EER
1	Wu Su	Zhuhai YiSheng Electronics Technology Co. Ltd	China	7.09%	2.75%
2	Fernando Alonso-Fernandez Josef Bigun	University of Halmstad	Sweden	9.24%	3.19%
3	Stephane Derrode	Institut Fresnel (CNRS UMR 7149)	France	42.16%	9.33%

Number of participants: 8 developers from 6 countries **Number of algorithms: 13**