A low-cost video-based **iris recognition** system

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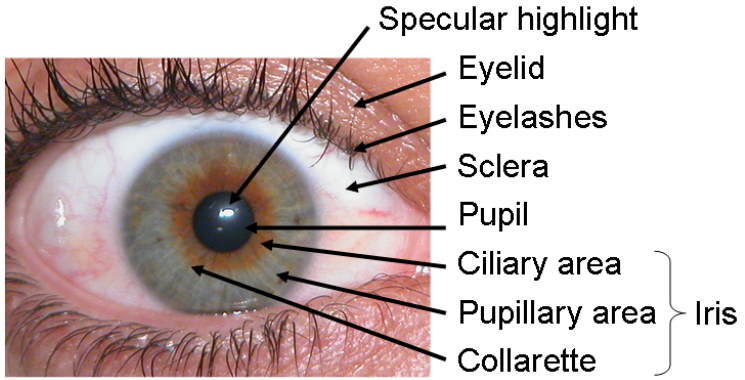
YESS'09, Washington
July, 8-9 2009

Motivations

Iris biometry

Iris biometry is recognized as one of the top accurate individual identification system. . .



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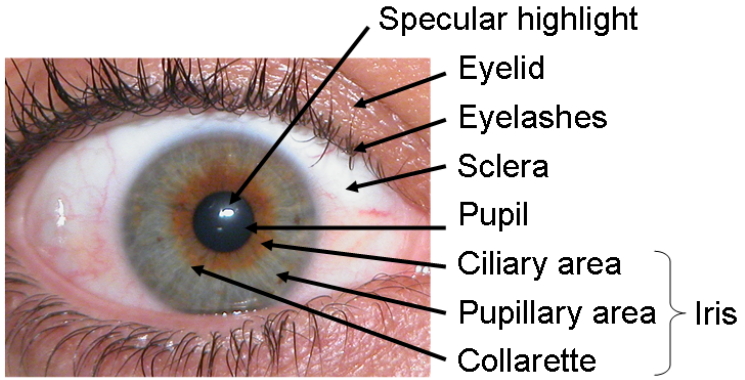
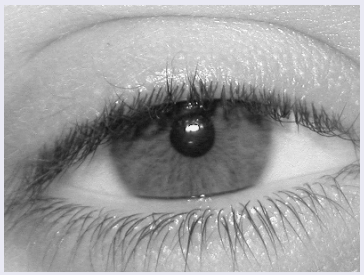
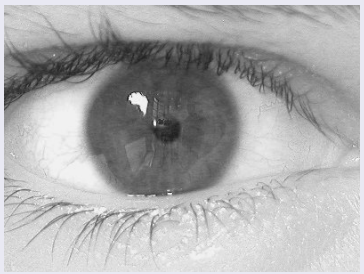


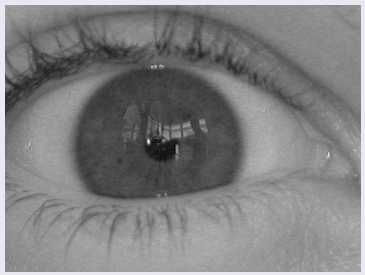
. . . but a workable image is hard to get !



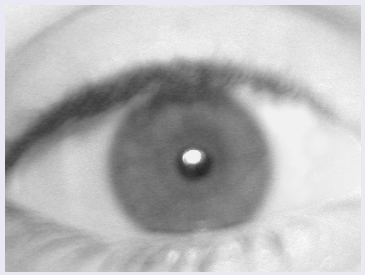
Obstructions by eyelash, eyelid



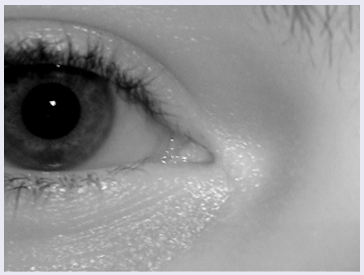
Lighting reflections



Specular reflections

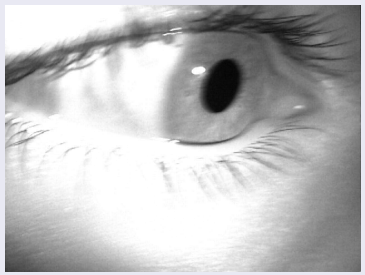


Poor focus

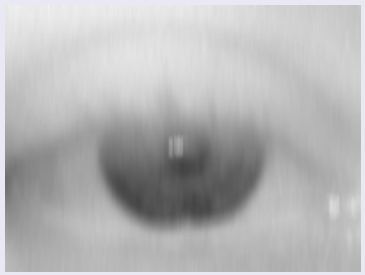


Partially captured

Out-of-iris



Off-angle



Motion blur

Actual developments in iris biometry try to make acquisition more “user friendly” (semi- or non-cooperative acquisition).

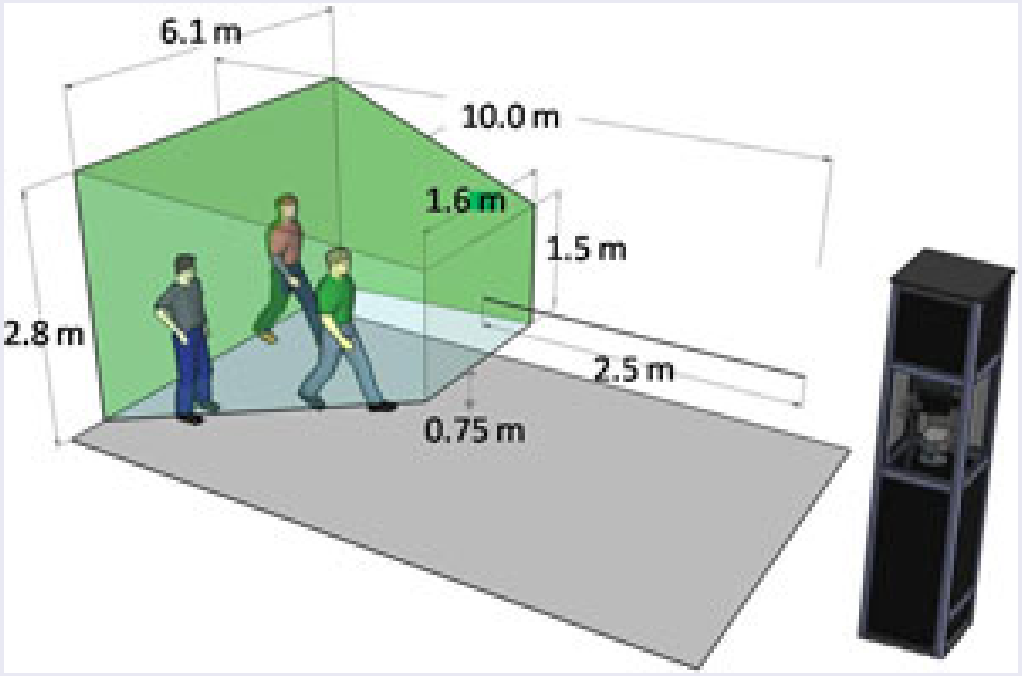
1- Wide public applications

Mobile phone and PDA
(Oki Electric)

“IRIBIO mouse”
(Qritek)

Actual developments in iris biometry try to make acquisition more "user friendly" (semi- or non-cooperative acquisition).

2- Gate-type checking systems



"Eagle-Eye"
(Retica)

"Iris-in-the-Move"
(Sarnoff corporation)

Actual developments in iris biometry try to make acquisition more “user friendly” (semi- or non-cooperative acquisition).

3- scanner-type control systems

“IRIS BM-ET200”
(Panasonic)

“PIER-T”
(L-1 Identity Solutions)

A low-cost video-based iris recognition system

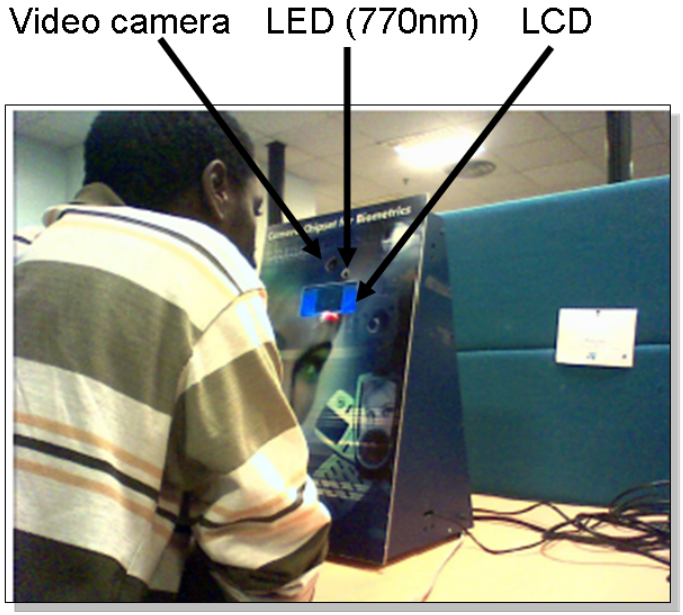
Our system

1. Replace the still camera by a video camera to acquire a continuous sequence of iris images.
2. Select "on the fly" the workable iris images for enrolment or recognition.

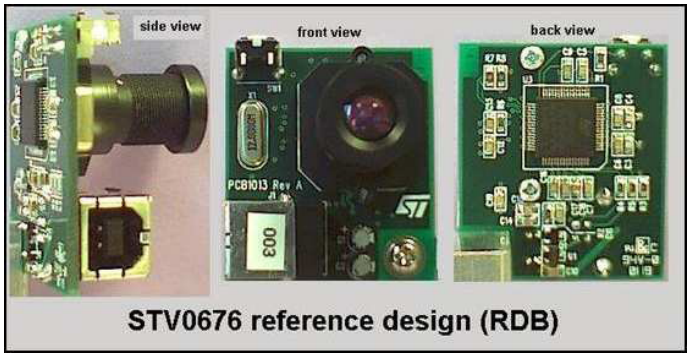
Constraints

- Low cost video camera (webcam-type, 640×480).
- Selection of iris images at the frame rate (25 images/sec.)
  $\Rightarrow$ low complexity.

$\hookrightarrow$ Embedded system
(PDA, mobile phone...)

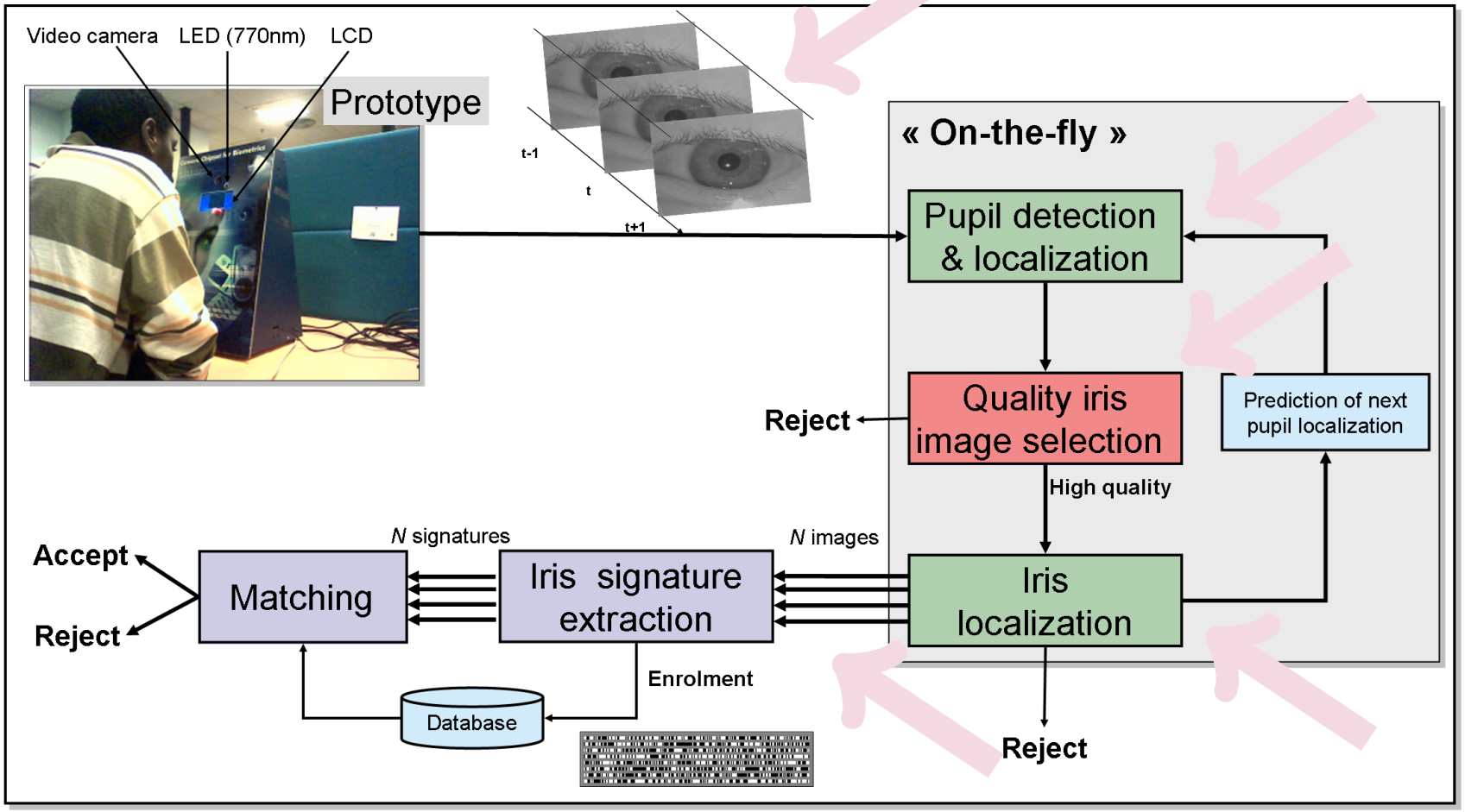


First prototype

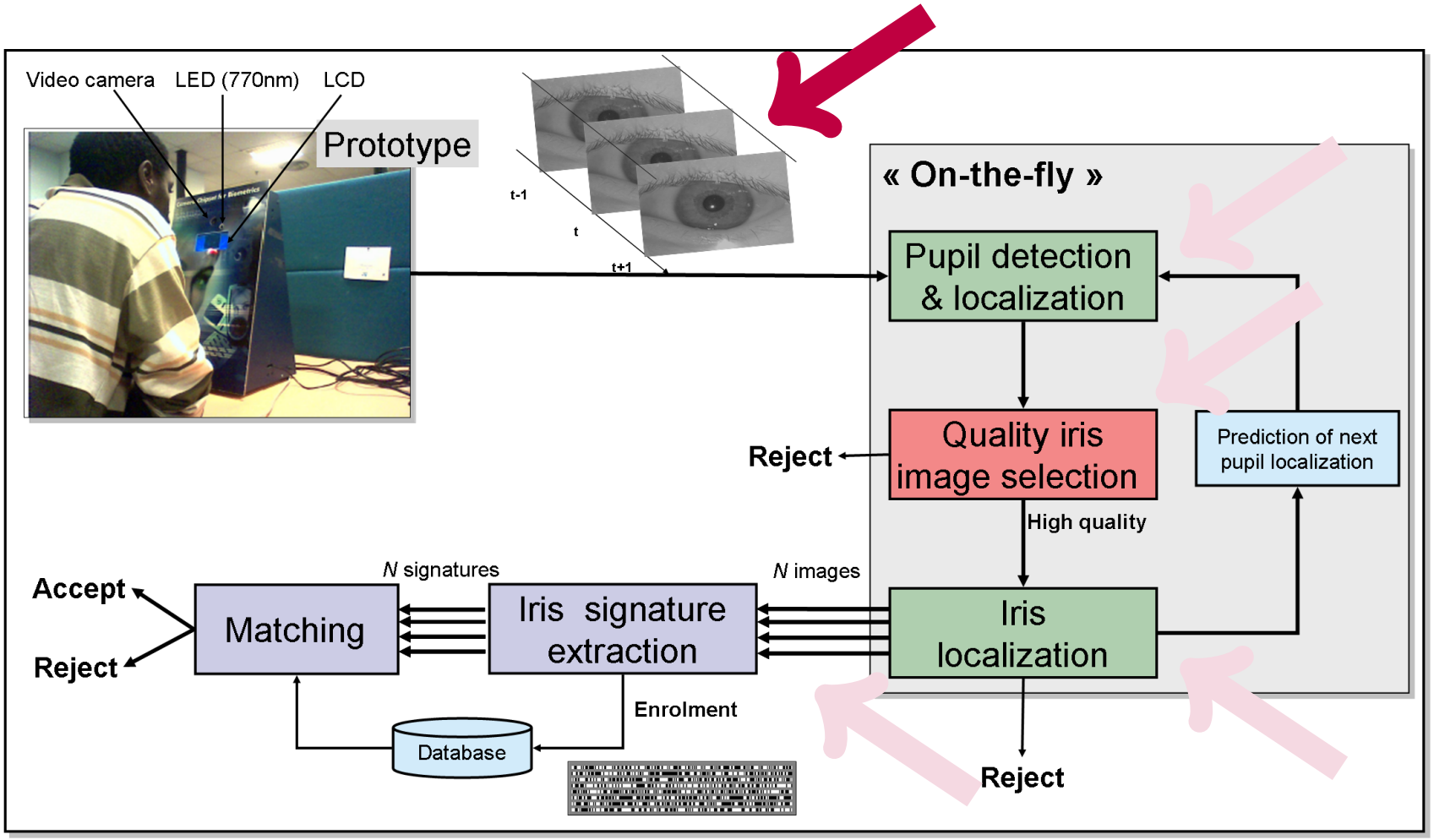


CMOS video camera
(ST Microelectronics)

Outline


Video camera
LED (770nm)
LCD
Prototype
t-1
t
t+1
« On-the-fly »
Pupil detection & localization
Quality iris image selection
Reject
Prediction of next pupil localization
High quality
N signatures
N images
Accept
Reject
Matching
Iris signature extraction
Iris localization
Enrolment
Database
Reject

Outline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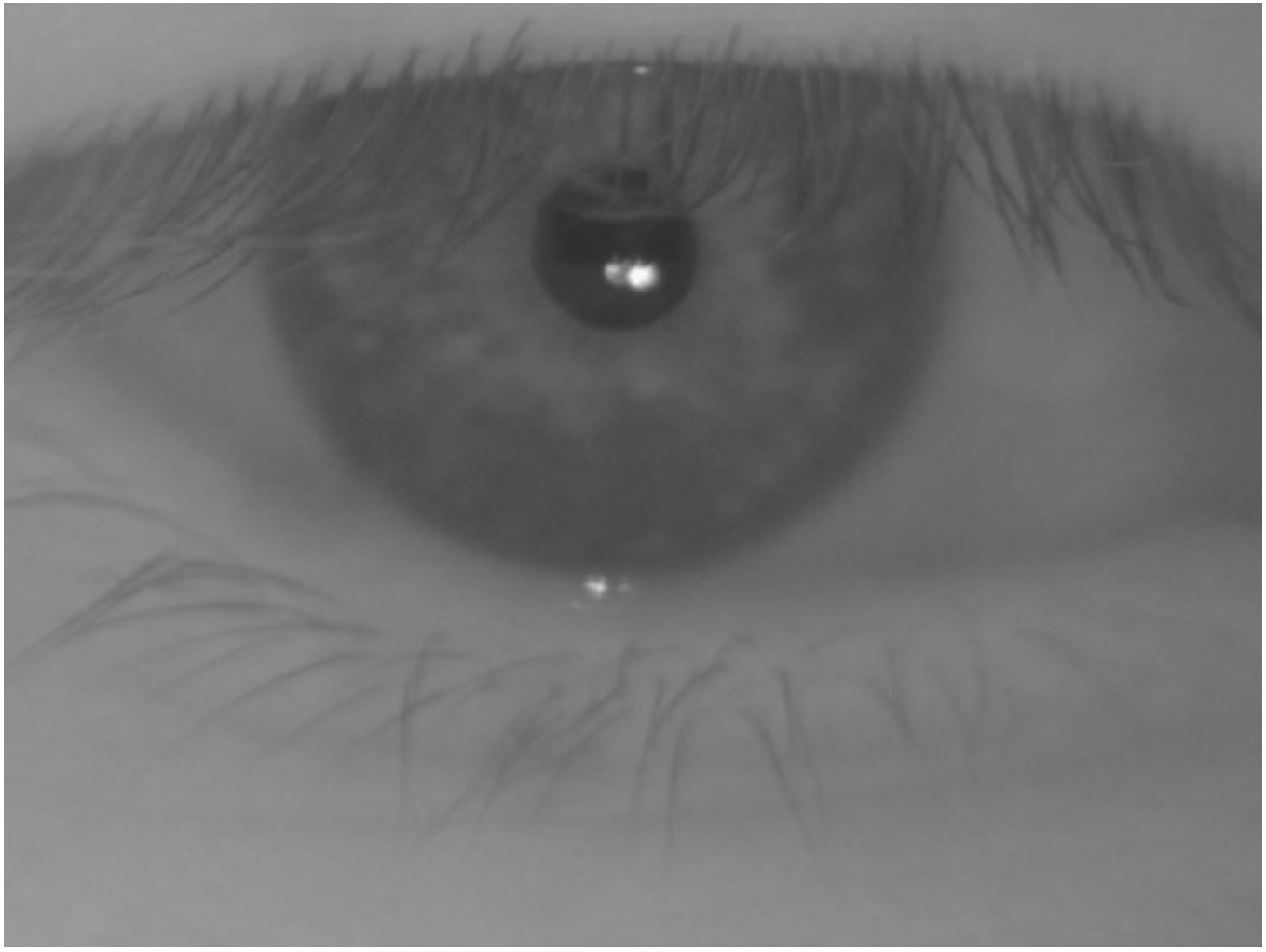
Typical video of an iris



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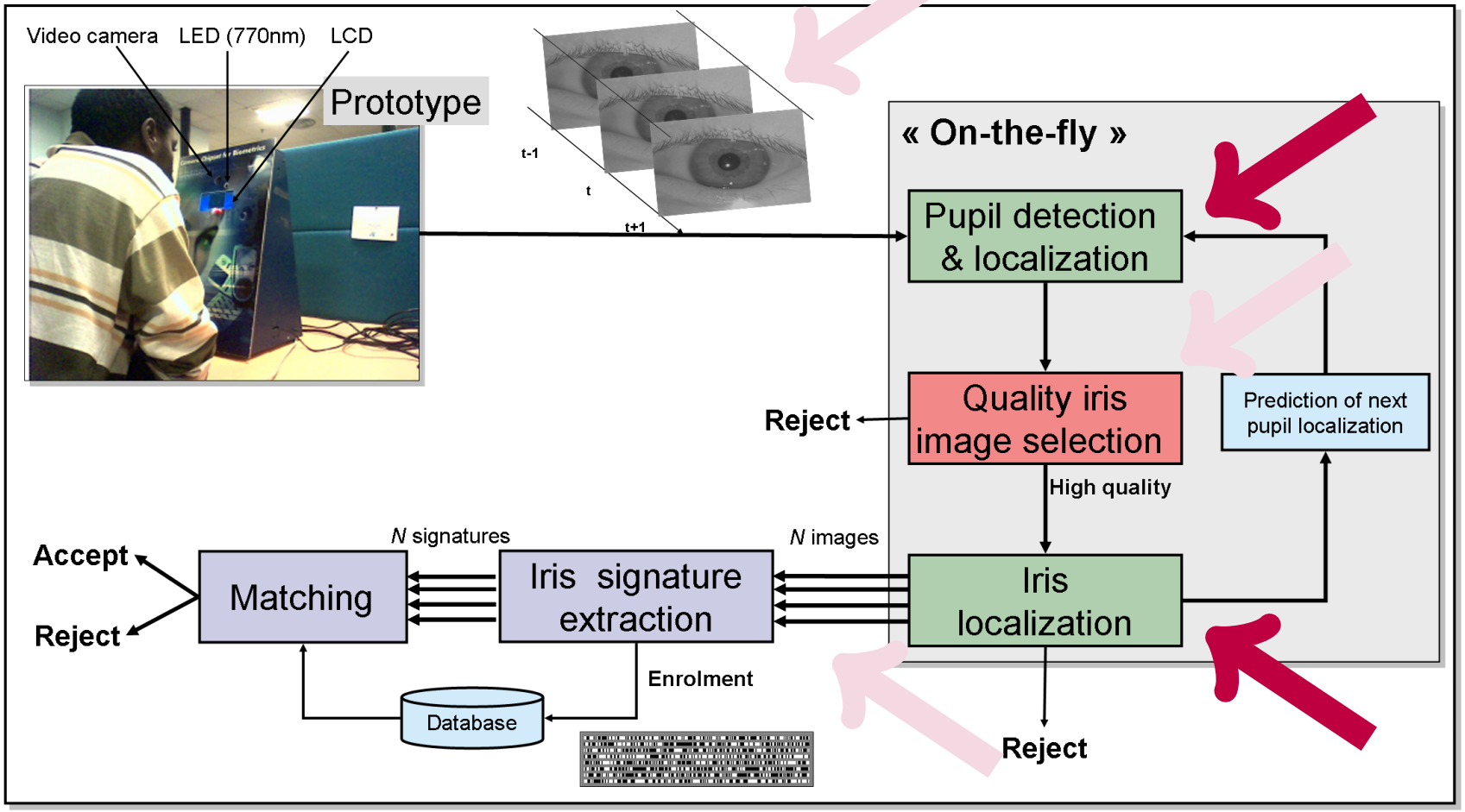
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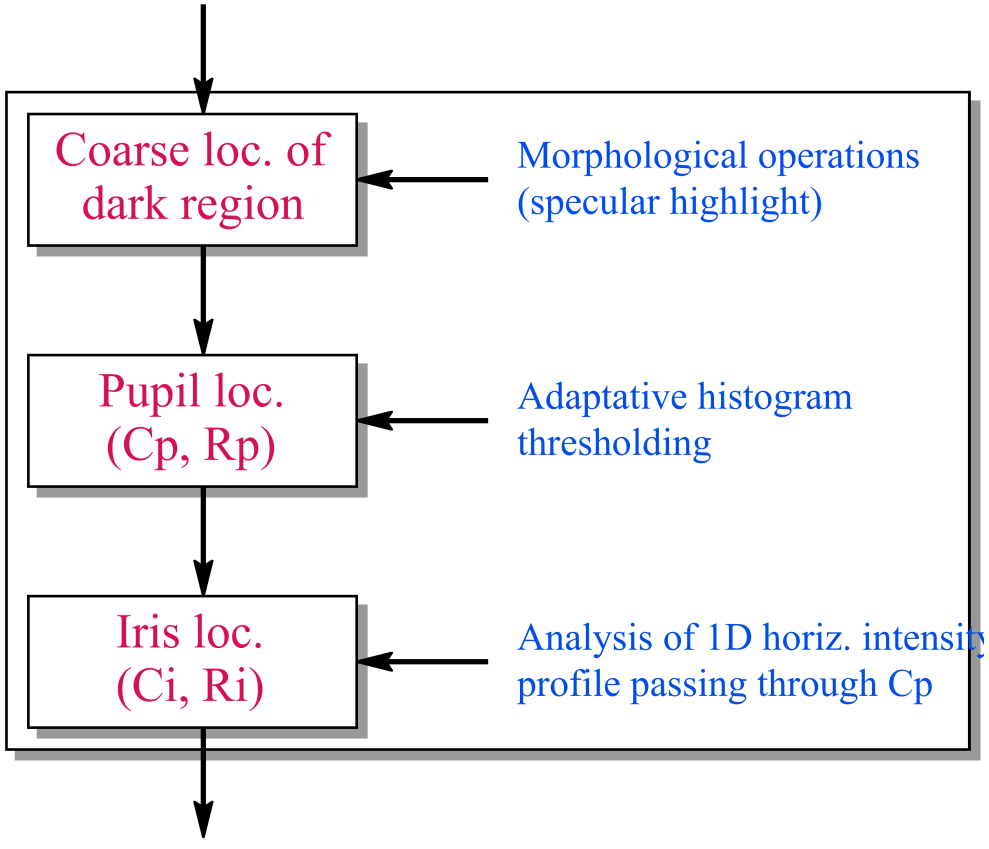
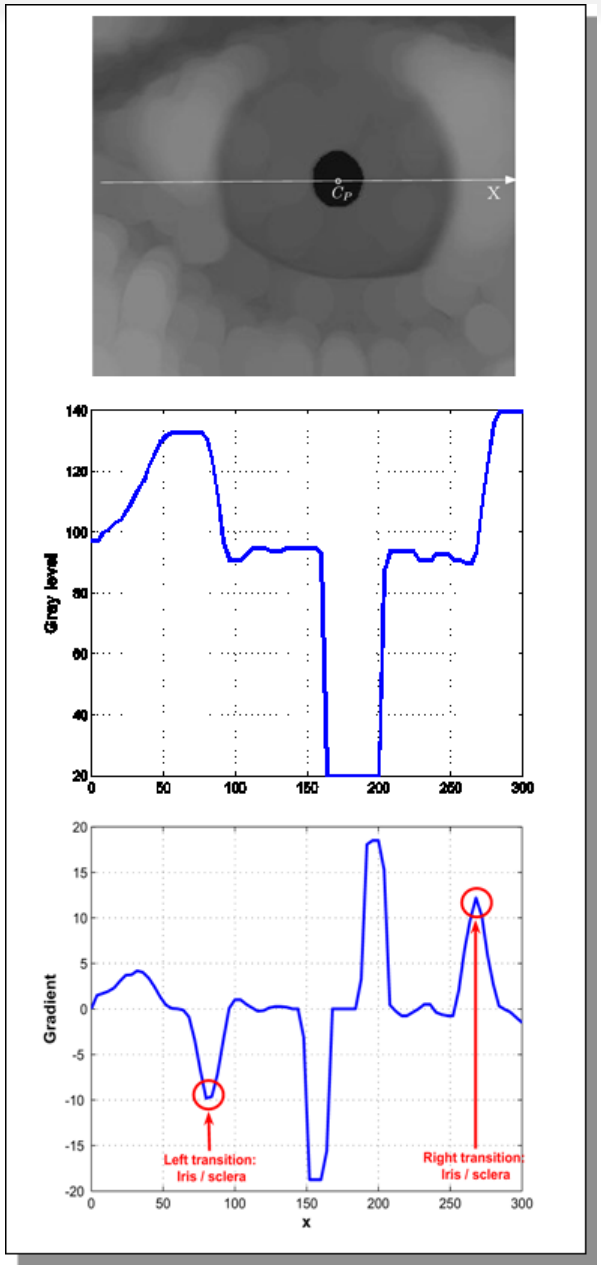
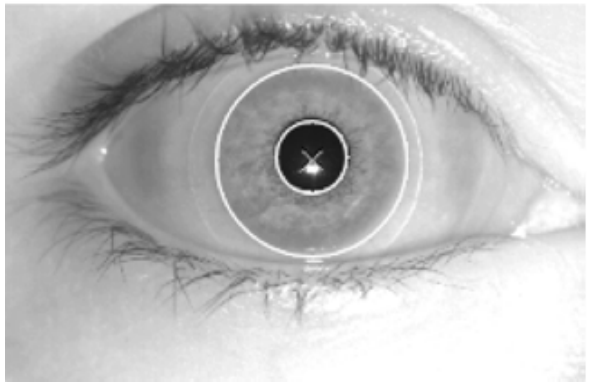
Algorithm


Coarse loc. of dark region
Morphological operations (specular highlight)
Pupil loc. (Cp, Rp)
Adaptative histogram thresholding
Iris loc. (Ci, Ri)
Analysis of 1D horiz. intensity profile passing through Cp

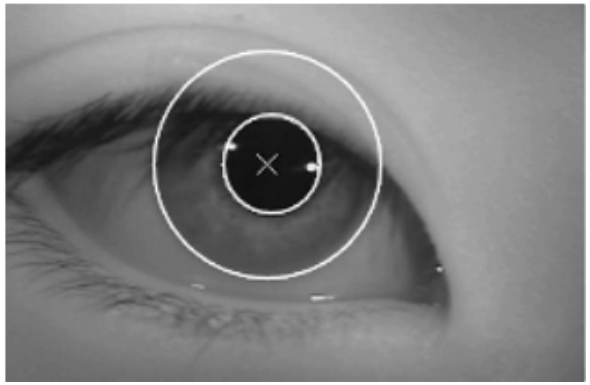

Cp
x
Grey level
Gradient
Left transition: Iris / sclera
Right transition: Iris / sclera
x

pupil and iris localization results

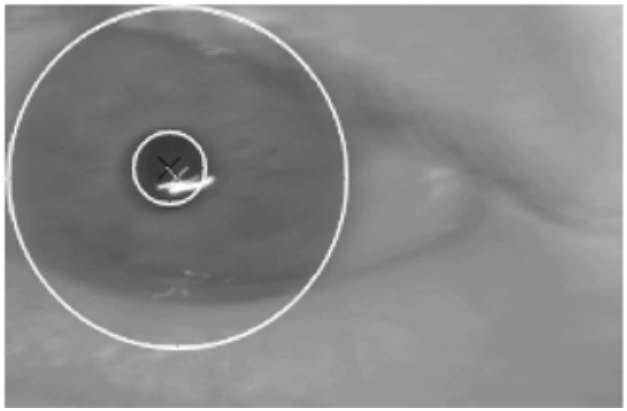
BATH

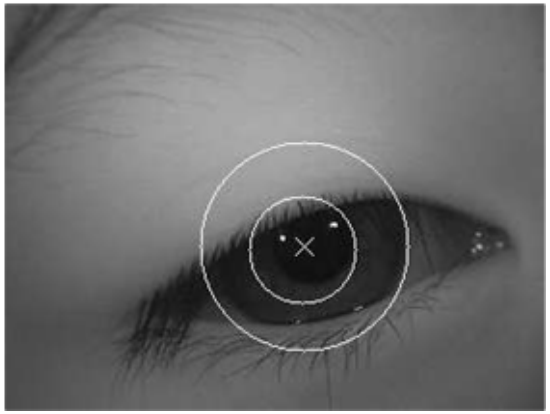


CASIA



ST MicroElectronics





US Patent Applications : L. Martin, G. Petitjean, S. Derrode, W. Ketchantang. *Method and device for locating a human iris in an eye image*, No. 2008/0273,763, ST Microelectronics SA ; Univ. Paul Czanne Aix-Marseille III. June 11, 2008.

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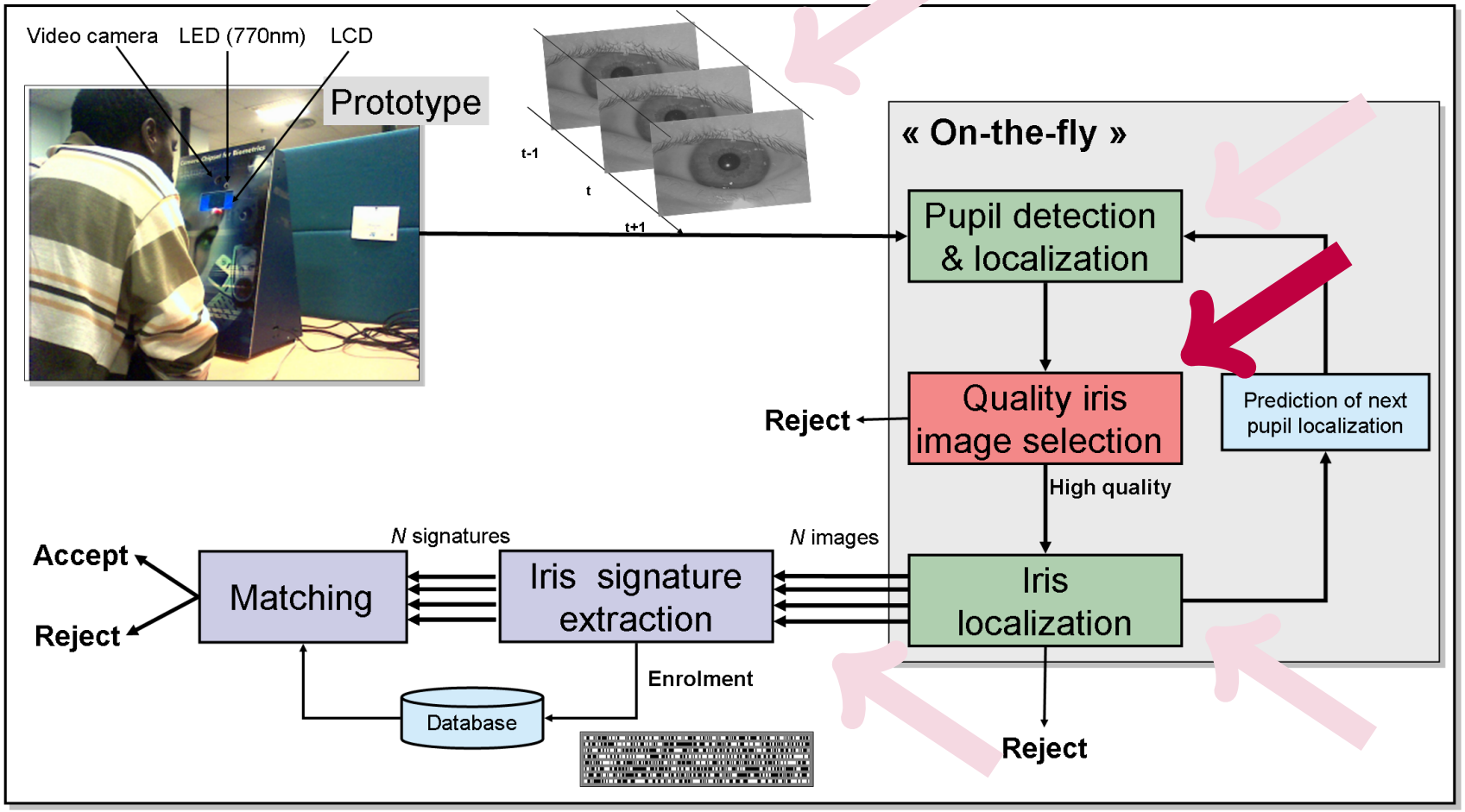
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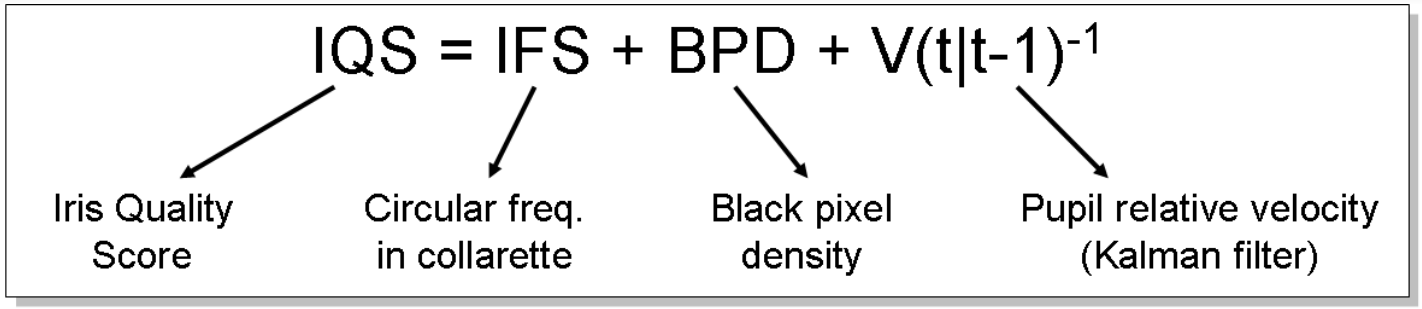
Iris quality check



US Patent Applications : L. Martin, W. Ketchantang, S. Derrode, *Method and device for selecting images in a sequence of iris images received in a stream*, No. 2008/0075,335, ST Microelectronics SA ; Univ. Paul Czanne Aix-Marseille III. March, 27 2008.

Iris quality check

$$IQS = IFS + BPD + V(t|t\text{-}1)^{-1}$$

- Iris Quality Score
- Circular freq. in collarette
- Black pixel density
- Pupil relative velocity (Kalman filter)

US Patent Applications : L. Martin, W. Ketchantang, S. Derrode, *Method and device for selecting images in a sequence of iris images received in a stream*, No. 2008/0075,335, ST Microelectronics SA ; Univ. Paul Czanne Aix-Marseille III. March, 27 2008.

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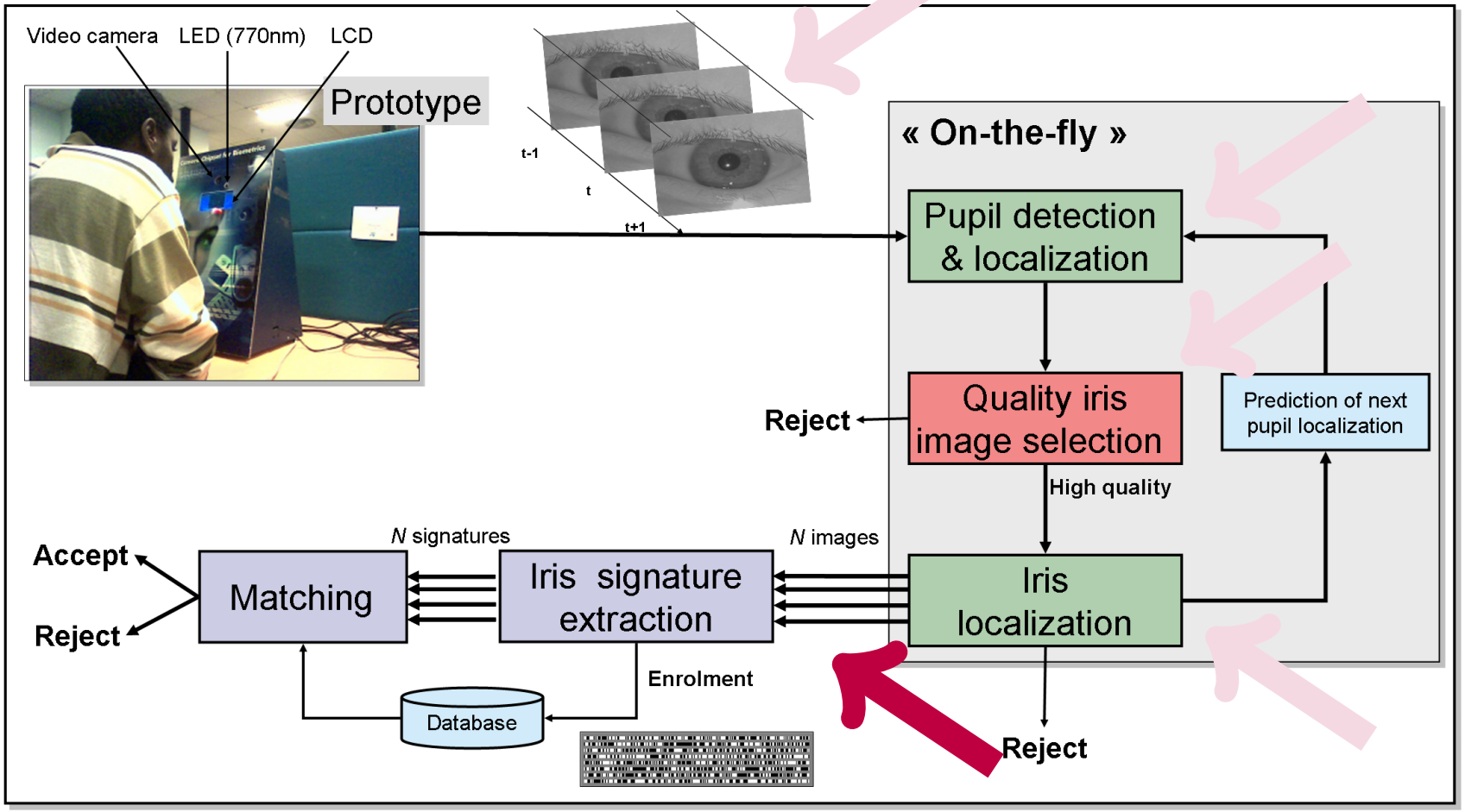
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Scale and rotation invariant coding of iris texture

Fourier-Mellin transform

- Direct transform ($k \in \mathbb{Z}$ et $v \in \mathbb{R}$)

$$\mathcal{M}_{f_\sigma}(k,v) = \frac{1}{2\pi}\int_0^\infty\int_0^{2\pi} f(r,\theta)\, r^{\sigma-iv}\, e^{-ik\theta}\, d\theta \frac{dr}{r}.$$

- Inverse transform (pour $r \in \mathbb{R}_*^+$ et $\theta \in [0, 2\pi]$)

$$f(r,\theta) = \int_{-\infty}^{+\infty} \sum_{k\in\mathbb{Z}} \mathcal{M}_{f_\sigma}(k,v)\, r^{-\sigma+iv}\, e^{ik\theta} dv,$$

Properties

- Scale and rotation invariance can be achieved
- Completeness of the description, which guaranties no loss of texture information

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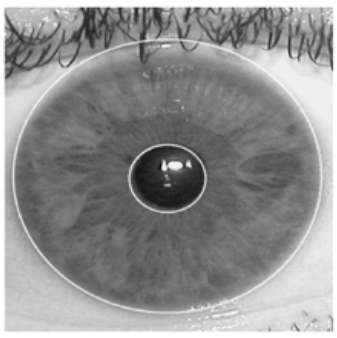
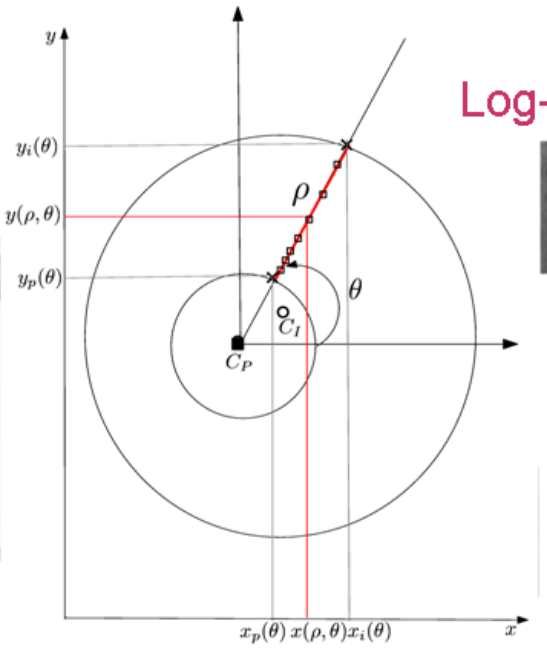
Journal paper S. Derrode et F. Ghorbel, *Robust and efficient Fourier-Mellin transform approximations for invariant grey-level image description and reconstruction*, Computer Vision and Image Understanding, Vol. 83(1), pp. 57-78, juillet 2001.

Iris texture coding with Fourier-Mellin invariants



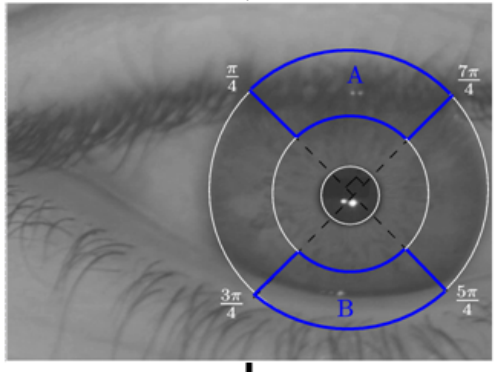


$\theta = 0, \frac{2\pi}{M}, ..., \frac{2\pi(M-1)}{M} \quad \rho = 1, 2, ..., N$

Log-polar resampling

Log-polar space

Area selection



FMT + Encoding (J. Daugman)

Iris code

Thanks and . . . projects

Project developed with

- W. Ketchantang (SAGEM Security)
- L. Martin (ST Microelectronics)
- S. Bourennane (Institut Fresnel)

with a grant from (2003 → 2008)

- ST Microelectronics
- PACA region, France

What next ?

- Improve tracking (switching Kalman Filter)
- Multi-images iris enrolment and recognition
- Soft-based iris resolution improvement

↬ To build a 2nd generation prototype (embedded into a mobile)

Whom ?

- N. Benletaief, PhD student
- and support from . . .

Acknowledgment

- YESS symposium comity,
- French Embassy and MAE.

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