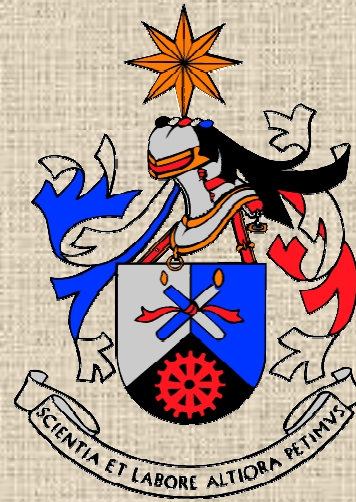Hugo Proença
http://www.di.ubi.pt/~hugomcp

Iris Recognition

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IEEE Symposium CIB 2009

- **<u>Outline</u>**
  - Iris Recognition
  - Deployed Recognition Systems
    - IRIS System: United Kingdom Border Control
    - IrisGuard: United Arab Emirates Border Control
  - Imaging Constraints
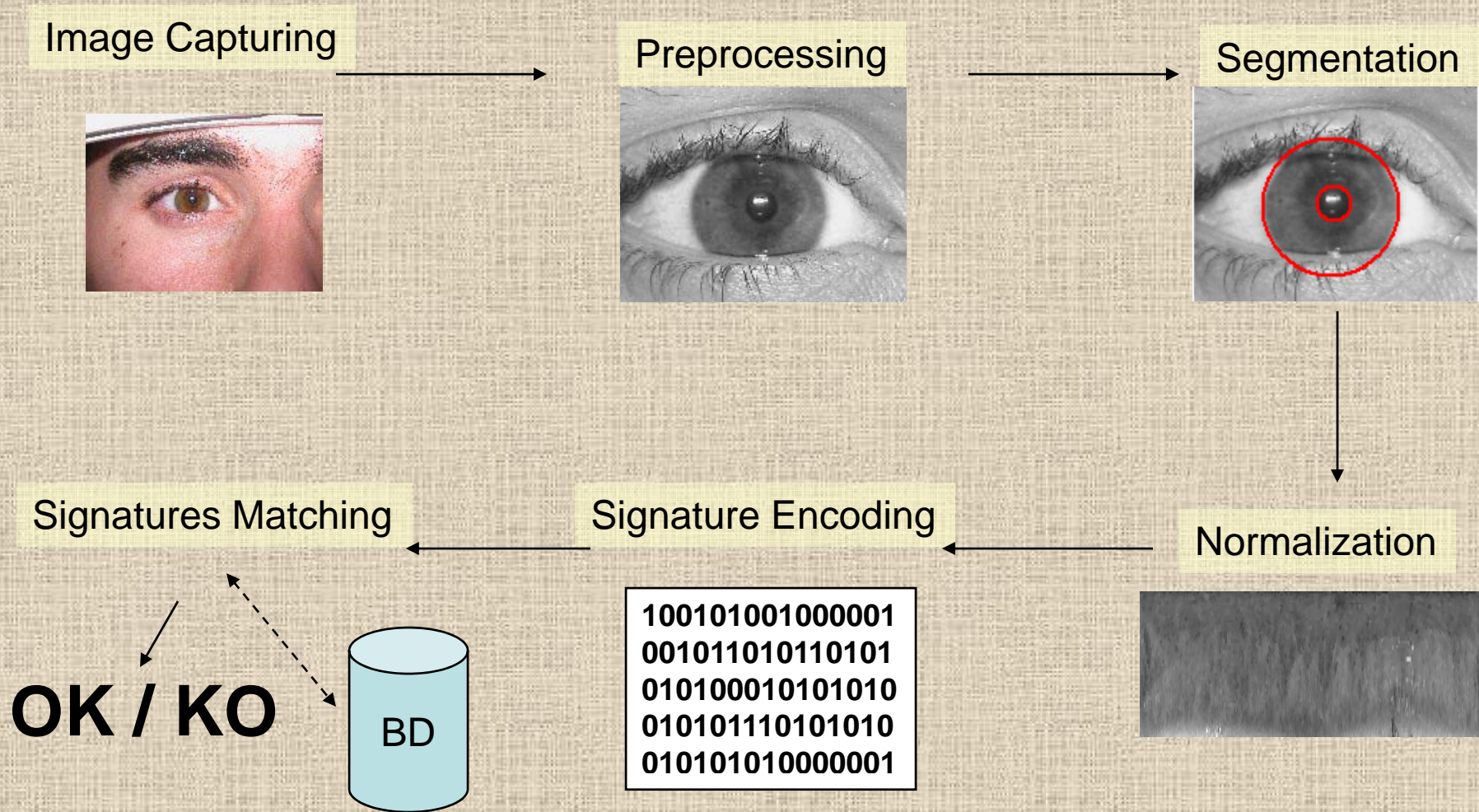   - Further Directions
  - References

- Can be regarded as one of the "best" biometric traits, considering the usual properties of *Uniqueness*, *Universality*, *Permanence*, *Collectability*, *Performance*, *Acceptability* and *Circumvention*

Trait	Uniqueness	Universality	Permanence	Collectability	Performance	Acceptability	Circumvention
DNA	87%	95%	94%	19%	19%	15%	55%
Ear	46%	58%	85%	50%	53%	100%	50%
Face	44%	92%	50%	84%	25%	99%	37%
Facial Thermogram	95%	100%	25%	100%	69%	85%	100%
Finger Geometry	23%	58%	70%	75%	47%	70%	50%
Fingerprint	78%	47%	91%	62%	98%	49%	71%
Gait	25%	50%	25%	100%	21%	100%	50%
Hand Geometry	54%	57%	54%	78%	50%	67%	59%
Hand Vein	57%	52%	53%	52%	50%	56%	97%
Iris	96%	93%	97%	62%	98%	50%	95%
Keystroke	17%	23%	28%	56%	25%	67%	50%
Odor	70%	89%	85%	25%	21%	50%	37%
Palmprint	96%	50%	100%	50%	97%	50%	50%
Retina	94%	86%	66%	29%	98%	23%	100%
Signature	35%	39%	34%	83%	23%	97%	33%
Voice	39%	49%	31%	59%	23%	99%	33%

(Adapted and averaged from [1], [2], [3], [4], [5], [6], [7], [8], [9] and [10])

Iris Recognition: Block Diagram

Image Capturing

Preprocessing

Segmentation

Signatures Matching

Signature Encoding

Normalization

OK / KO

BD

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010100010101010
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Iris Recognition

- Due to the afore mentioned properties and favourable comparisons with other traits, the use of the iris has been increasingly encouraged by both governamental and private entities.

- Nationwide applications are starting to be deployed.

- This type of applications is regarded as "*the grand challenge*" [11] for the Pattern Recognition commmunity itself.

- Near 50% of the publications cited in a recent survey [12] were – at most – from 2005.

- The **IRIS** (Iris Recognition Immigration System) is a means of border control that allows registered passengers to enter the United Kingdom quickly through automated barriers at certain airports.

- It is presently working in:
  - All five Heathrow terminals;
  - Manchester terminals 1 and 2;
  - Birmingham terminal 1;
  - Gatwick North and South terminals.

- The policy is to open its use to as many people (adults) as possible: British and non-British citizens, permanent United Kingdom residents and short-term visitors, ...

Source:http://www.ukba.homeoffice.gov.uk/managingborders/technology/iris/registeriris/caniregisteriris/.

- Although requiring high levels of cooperation, the recognition process performs relatively quick (about 2 seconds).

- It usually takes between 5 and 10 minutes to register for IRIS.

- Other European airports have installed the Daugman-based recognition systems for passenger screening and immigration control in lieu of passport presentation: Amsterdam Schiphol, Frankfurt and Athens.

Source: http://www.cl.cam.ac.uk/~jgd1000/iris_recognition.html

- However, there remain several **<u>Imaging Constraints</u>:**
  - Glasses are not allowed during enrollment.
  - No sunglasses are allowed during the enrollment nor recognition.
  - Plain contact lenses are allowed either for enrollment / recognition.

This leaflet describes how to use the UK's IRIS system at London Heathrow Airport.

Source: http://www.computer.org/ portal/cms_docs_security /security/2007/n3/j3sec02 .jpg

IrisGuard: United Arab Emirates Border Control

– The United Arab Emirates (UAE) Ministry of Interior has used iris recognition of foreigners entering the UAE at 35 air, land, and sea ports.

– Each traveler is compared against about a million IrisCodes on a watch-list;

– The time required for an exhaustive search through the database is about 1 second.

Source: http://www.cl.cam.ac.uk/~jgd1000/deployments.html

IrisGuard: United Arab Emirates Border Control

–   So far not a single False Match has been made, despite some 2.7 billion iris cross-comparisons being done every day [13].

–   More than 9 500 persons have been caught by this system, travelling with forged identities [13].

–   It is the largest deployed system in the world, both in terms of number of signatures enrolled (more than 840,751) and number of iris comparisons performed daily 6,225,761,155 (6.2 billion) in 'all-against-all' search mode [14].
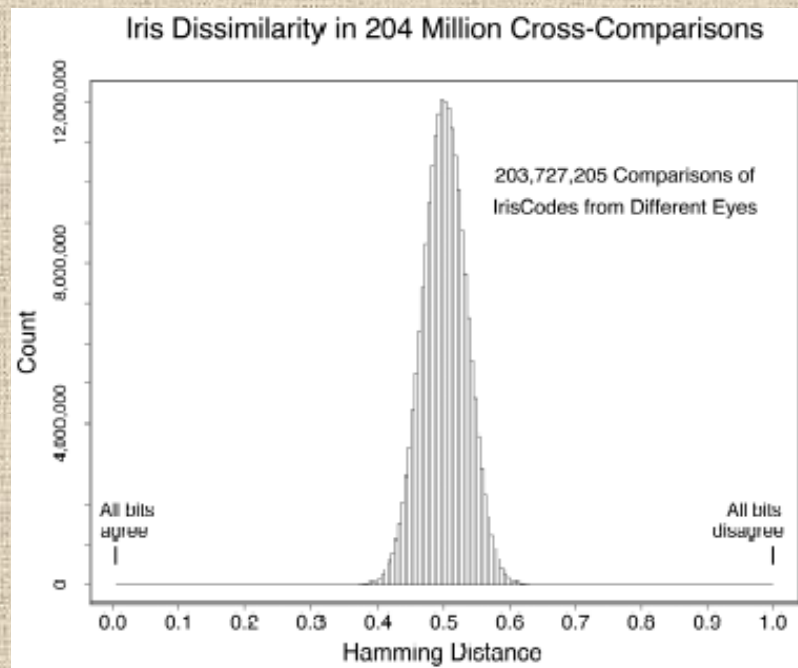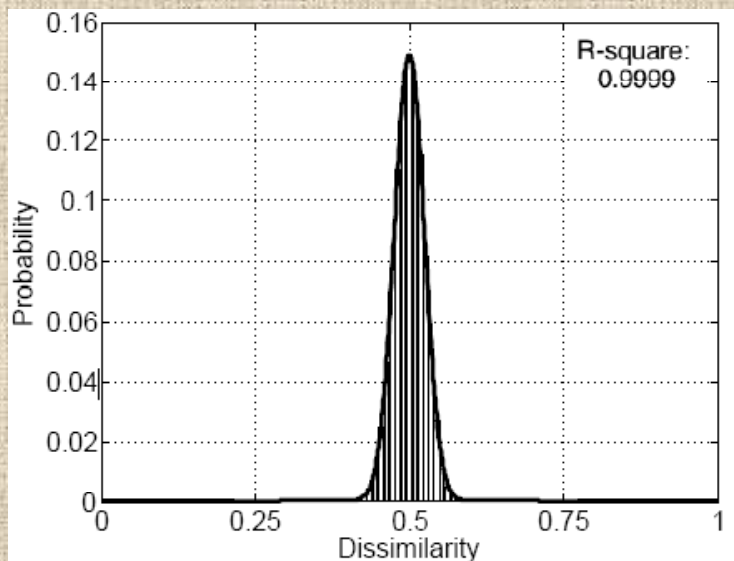
- The iris has two extremely important advantages, when compared with other biometric traits:
    - Uses the lower and middle low frequency components to encode most of the discriminating information between individuals.
        - Propitiates **higher robustness to noise**.

    - It was largely reported an extremely low (almost infimum) probability for the occurence of false matches (even on high degraded data)
        - Increases the **confidence on any match** reported

Main Result: "Any reported match should be genuine":

Histogram of the dissimilarities between 204 Million Cross Comparisons (source: http://www.cl.cam.ac.uk/~jgd1000/UAEdeployment.pdf)

Iris Dissimilarity in 204 Million Cross-Comparisons

203,727,205 Comparisons of IrisCodes from Different Eyes

R-square: 0.9999

Histogram of the dissimilarities between 1000 iris templates and 20 000 samples extracted from non-iris, partial and degraded iris data [15]
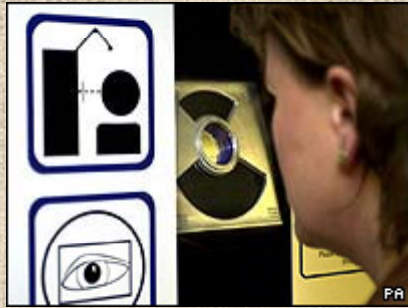
Imaging Constraints

- – In addition to performance, it should be considered the high subjective levels of users' satisfaction with the recognition system.

- – Often, systems that impose long/heavy physical contact or mental workload are found to be distasteful.

- – The system shouldn't negatively affect users' physical and mental well-being, either immediately or with longer-term use.

- – As reported in a recent study conducted by Aton Origin for the United Kingdom Passport Service, "*the imaging constraints are a major obstacle for the nationwide deployment of iris recognition systems*".

  - • Here, when compared with other traits, the iris scored relatively low, due to excessive efforts demanded to subjects in the image acquisition process.

- **Imaging Constraints: Illustration** _{(source:} "Googled" images)

Conclusion: At **close** imaging distances, **stop-and-stare** interfaces and constrained **lighting** conditions, deployed iris recognition technology achieves **remarkable low error rates**.

- **Further Directions**
  - What if the images are aquired in less constrained conditions?
    - Moving subjects
    - At large imaging distances
    - Without requiring cooperation
    - Within dynamic lighting environments
  - These conditions lead to the apperance of heavily degraded data:
    - Poor foccused, motion blurred, off-angle data, heavy occluded due to eyelids, eyelashes, glasses, specular and gloxy reflections.

- **Further Directions**
  - A growing number of research works concern about the minimization of the image acquisition constraints to perform iris recognition with enough condidence.
  - Examples:
    - Iris-on-the-Move [16], Fancourt *et al.* [17], Narayanswamy and Silveira [18], He *et al.* [19], Boyce *et al.* [20] Chen *et al.* [21], Schuckers *et al.* [22]...
  - Is it possible to move one steap ahead (now?, in a near future?) toward reliable covert iris recognition?
    - Extremely challenging conditions!

- Degraded Data: Examples of visible wavelength images captured at-a-distance and on-the-move: which ones enable biometric recognition?

(a) Good quality iris image.

(b) Off-angle iris image.

(c) Poor focused iris image.

(d) Rotated iris image.

(e) Motion-blurred iris image.

(f) Iris obstructions due to eyelids.

(g) Iris obstructions due to eyelashes.

(h) Iris obstructions due to glasses.

(i) Iris obstructions due to contact lenses.

(j) Iris obstructions due to hair.

(k) Iris imaging in poor lighting conditions.

(l) Iris with specular reflections.

(m) Iris with lighting reflections.

(n) Partial captured iris.

(o) Out-of-iris image.

- **Further Directions**
  - What are the specific circunstances that enable reliable recognition? (remains mostly to be done)
    - Acquisition distances?
    - Types of allowed movements?
    - Minimal lighting conditions constraints?
  - Is the use of visible wavelength realistic? (partially to be done)
  - **Major Motivations for Covert Iris Recognition**

    (1) Any reported match should be genuine.

    (2) Any reported match results from completely human-free efforts.

    (3) Any match should be regarded as an overplus, due to (1) and (2).

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