Tutorial 8

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COMP435p
Biometrics Authentication

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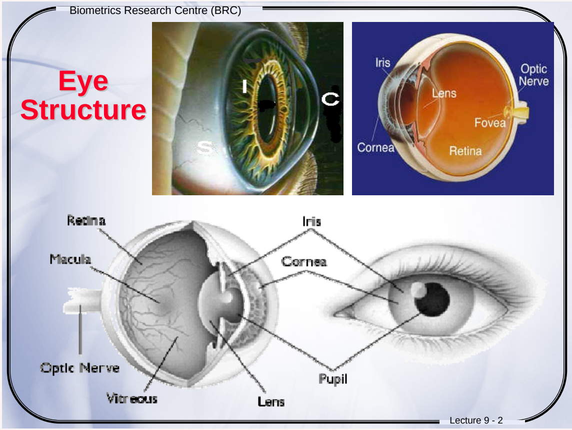
Outline

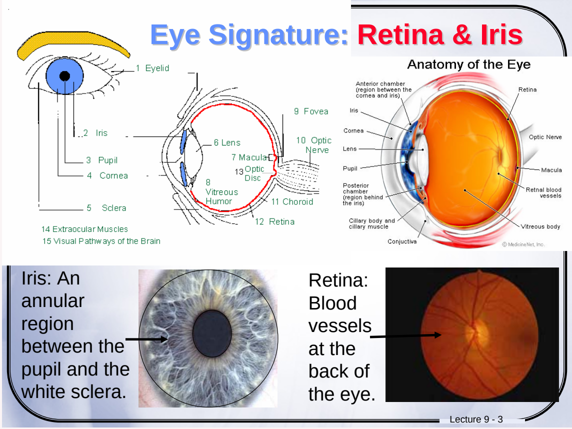
Problem 1.1 Compare Retina and Iris

Please compare two different kinds of biometrics technologies: Retina and Iris. (P9:2-3)

Problem 1.1 Compare Retina and Iris



Problem 1.1 Compare Retina and Iris



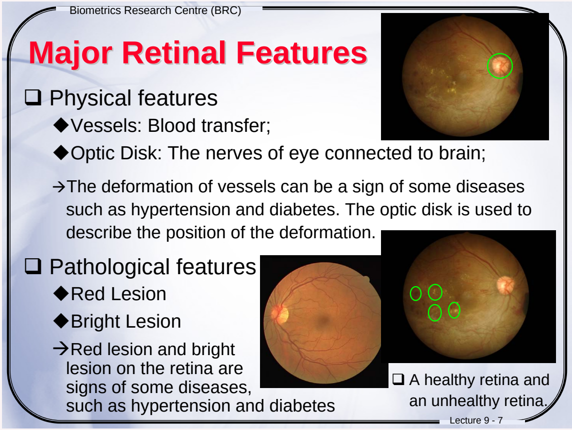
Problem 1.1 Compare Retina and Iris

- Differences
  - Location: inner round region for Retina, outer annular region for Iris.
  - Sensor: fundus camera is very expensive and large; general cameras or industrial camera would be fine for the Iris recogntion.
  - Features: geometries for Retina and texture for Iris.
  - Extraction method: Syntactic based features for Retina and Statictical based features for Iris.
  - Performance: Iris is much better than Retina.

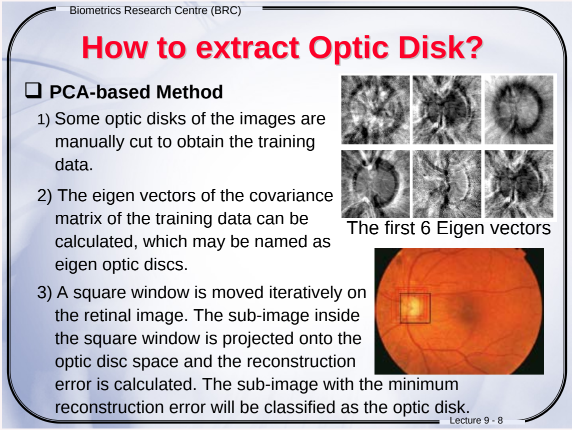
Problem 1.2 Two Kinds of Features

There are two kinds of features, Physical feature (Vessels and Optic Disk) and Pathological feature (Red lesion and Bright lesion), in Retina. Please understand how to extract them (P9:7-11).

Problem 1.2 Two Kinds of Features



Problem 1.2 Two Kinds of Features



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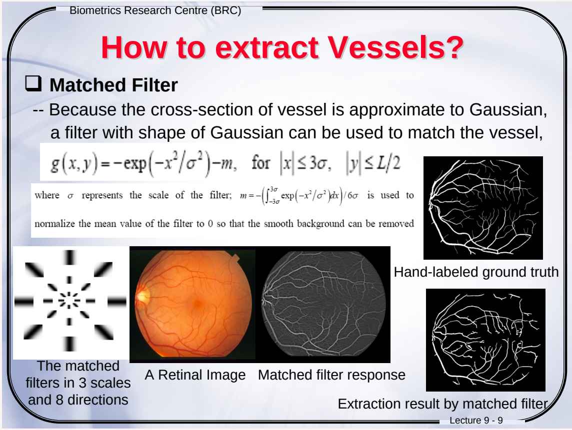

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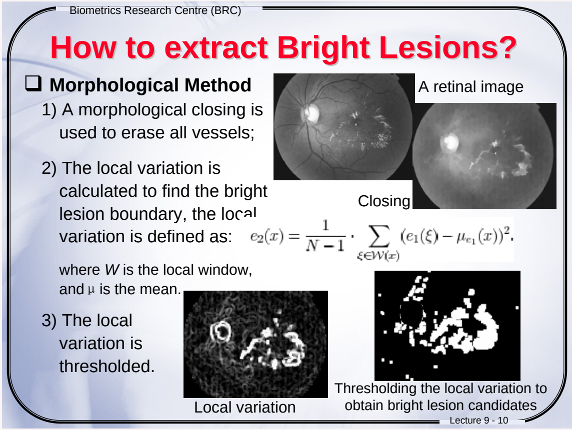

Problem 1.2 Two Kinds of Features

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How to extract Red Lesions?

❑ **SVM based Method**

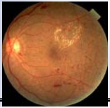
1) Some red lesions of the images are manually cut to obtain the red lesion feature.

2) The eigen vectors of the covariance matrix of the training data are calculated to reduce the feature dimension.

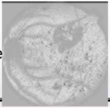
The first 10 Eigen vectors (Eigen redLeions)

3) SVM evidence is calculated and the optimal separating hyper-plane is defined as $f(x) = \mathrm{sgn}\left(\sum_{i=1}^{l} y_i \alpha_i K(x_i, x) + b\right)$

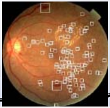
A retinal image



SVM evidence map



Red lesions located



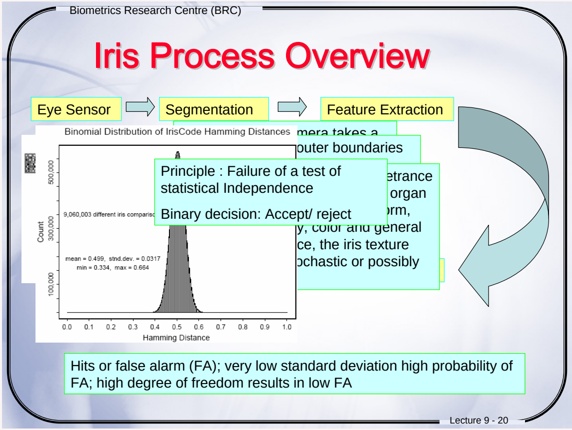
Problem 1.2 Two Kinds of Features

- Physical features
  - PCA based matching method to extract the region for the optic disk
  - Gaussian filters based line extraction for the vessels
- Pathological features
  - Morphological method for the bright lesions
  - SVM based method for the red lesions

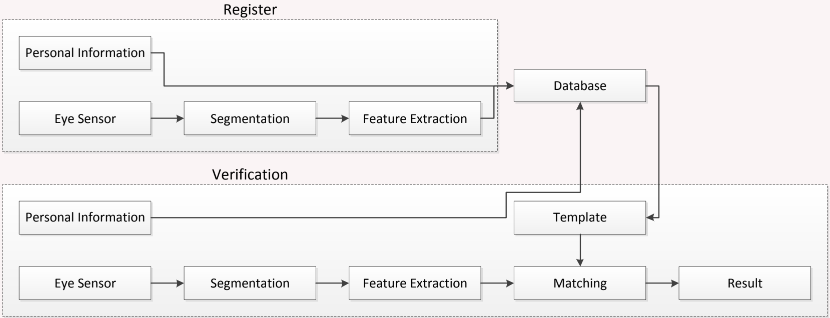
Problem 1.3 Example of Verification System

P9:20 show a representative example of identification system. Please give another example of verification system.

Problem 1.3 Example of Verification System



Problem 1.3 Example of Verification System

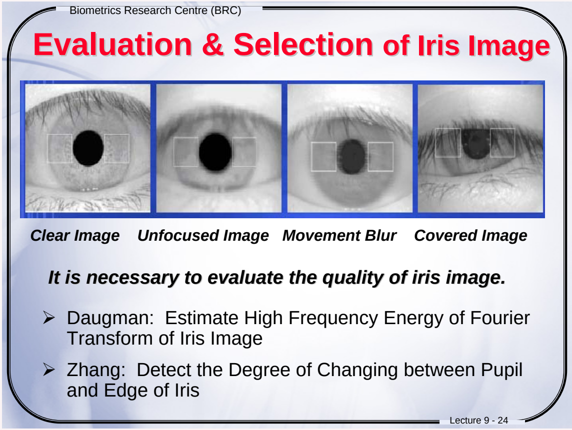


Personal information: name, ID, smart card, etc.

Problem 1.4 Iris Recognition System

Please understand the iris recognition system. (P9: 24-38)

Problem 1.4 Iris Recognition System



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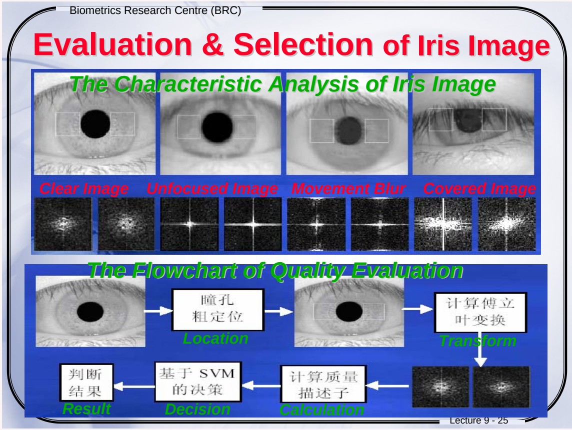
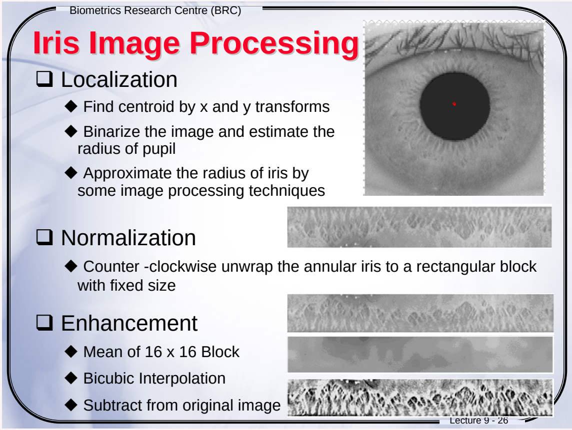


Problem 1.4 Iris Recognition System



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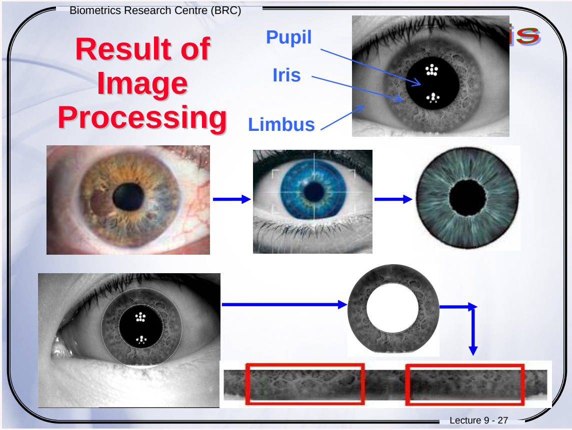

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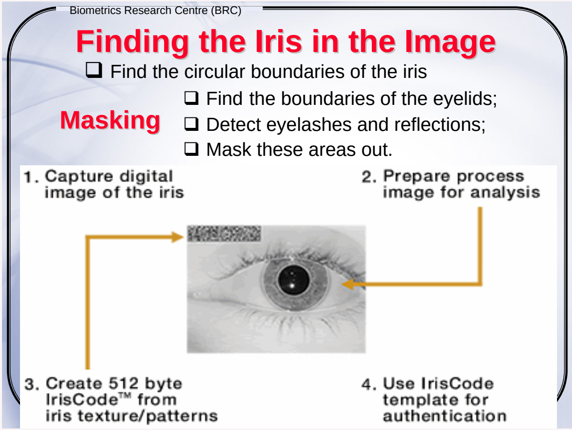

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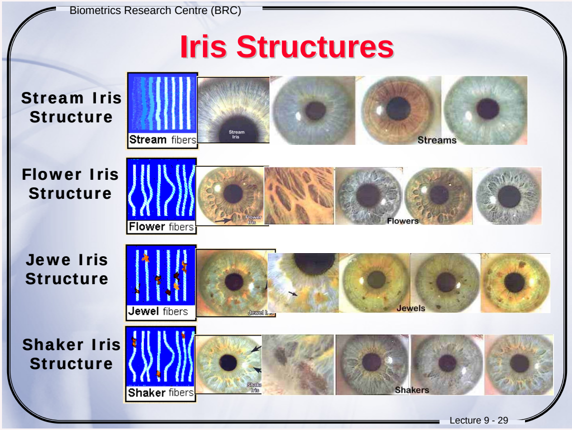

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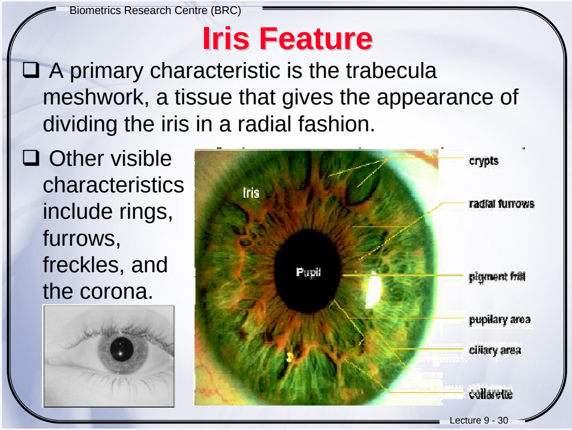

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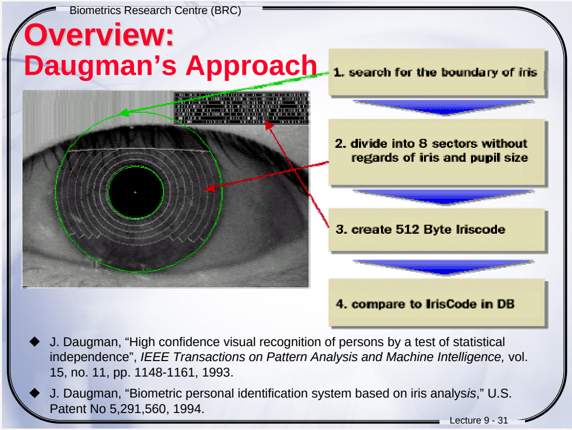

Problem 1.4 Iris Recognition System

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Gabor Wavelets

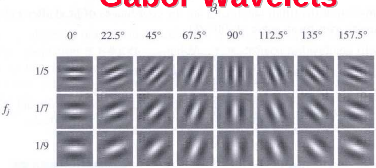
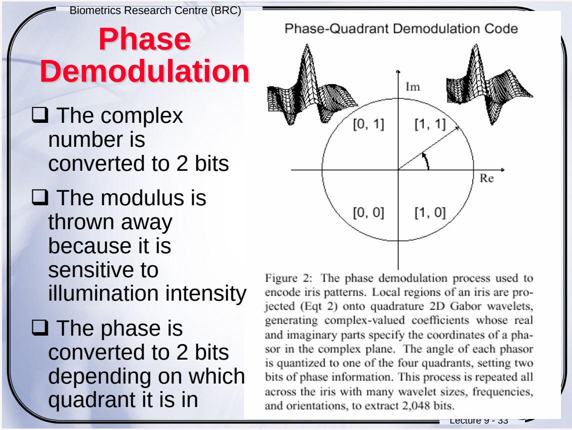


Figure 3.29. A graphical representation of a bank of 24 ($n_o = 8$ and $n_f = 3$) Gabor filters where $\sigma_x = \sigma_y = 4$.

- Gabor Wavelets filter out structures at different scales and orientations
- For each scale and orientation there is a pair of odd and even wavelets
- A scalar product is carried out between the wavelet and the image (just as in the Discrete Fourier Transform)
- The result is a complex number

Lecture 9 - 32

Problem 1.4 Iris Recognition System



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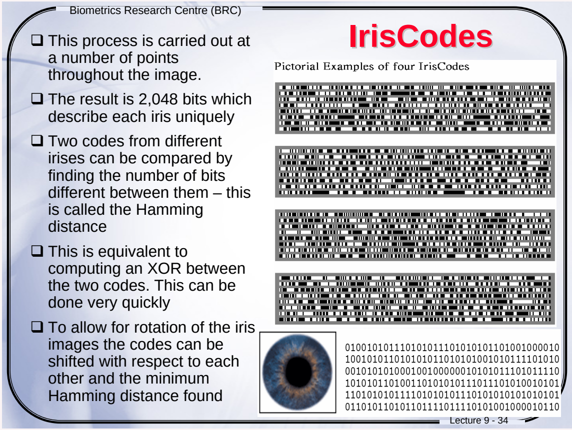

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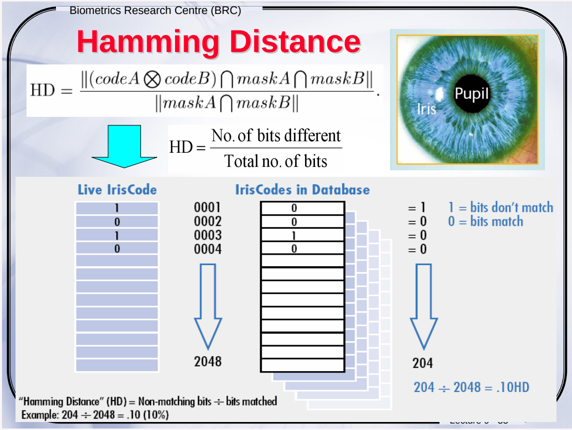

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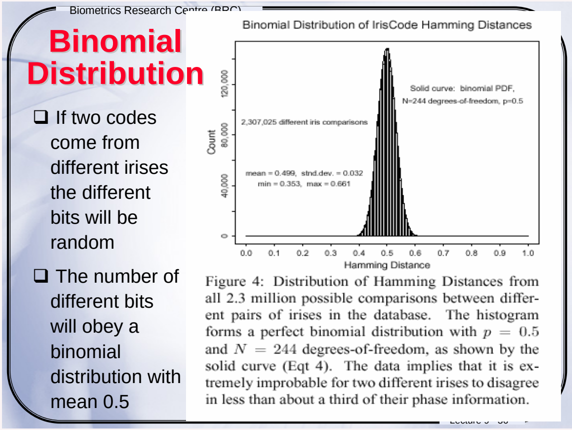
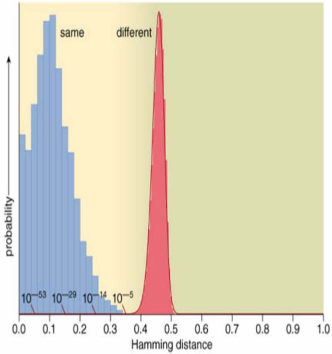


Problem 1.4 Iris Recognition System

Biometrics Research Centre (BRC)

Identification

- If two codes come from the same iris the differences will no longer be random
- The Hamming distance will be less than expected than if the differences were random
- If the Hamming distance is < 0.33 the chances of the two codes coming from different irises is 1 in 2.9 million
- So far it has been tried out on 2.3 million people without a single error



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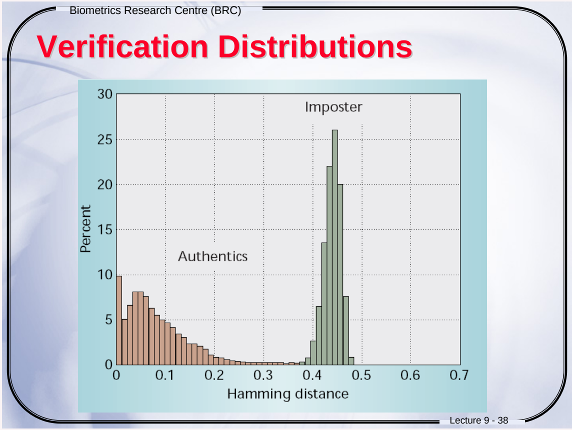
Problem 1.4 Iris Recognition System



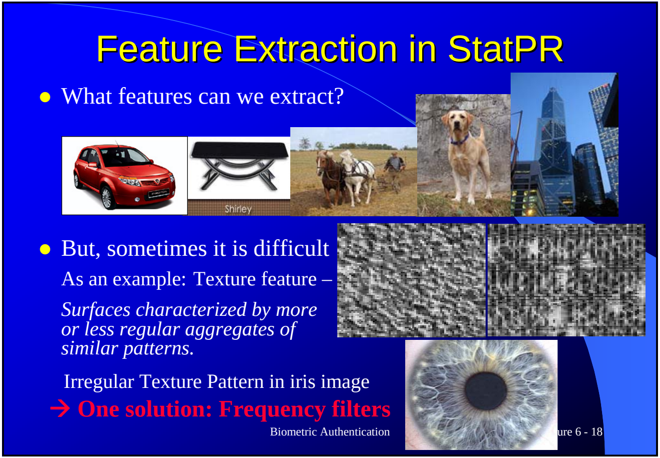
Problem 1.4 Iris Recognition System

- procedures
  - Evaluation of images
  - Processing of images
  - Locating the Iris
  - Feature extraction (Daugman's approach)
    - Dividing the Iris to eight sectors
    - Gabor wavelets filters to extract features
    - Coding by the output of the phase demodulation result
    - Encoding to IrisCodes
    - Matching by Hamming distances
    - The distribution of the Codes
    - Identifying by threshhold
    - Or verifying

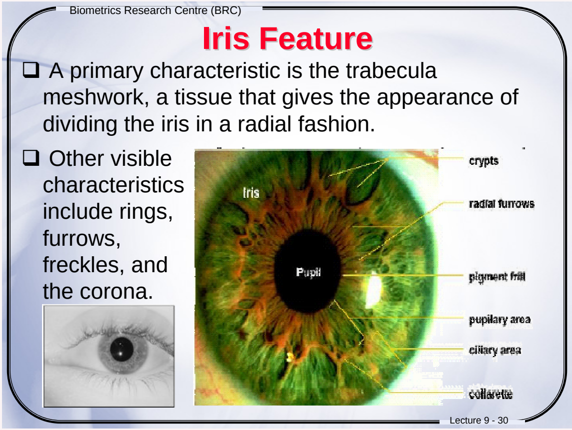
Problem 1.5 Texture Feature

What is texture feature (P6:18)? Why we can use texture feature in iris recognition (P9:30)?

Problem 1.5 Texture Feature



Problem 1.5 Texture Feature



Problem 1.5 Texture Feature

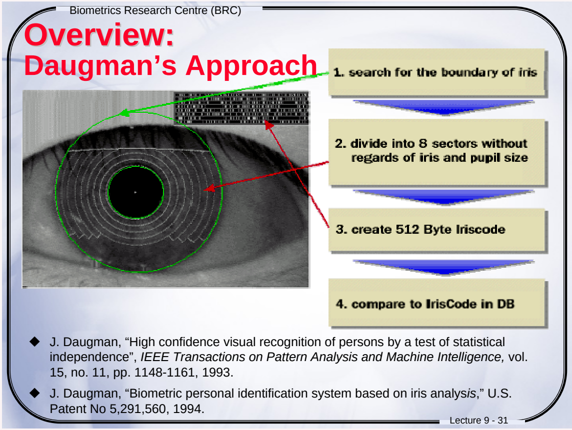
- Texture features
  - Repeating similar patterns
- Texture features in Iris
  - Trabecula meshwork is a kind of texture in a radial distribution.

Outline

Problem 2: Daugman’s Method

There are four steps in the Daugman’s approach (P9:31-35). The third step generates IrisCode with 512 bytes. If 2 bits represent a feature, please compute the total number of features.

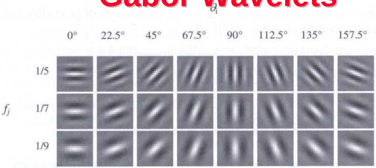
Problem 2: Daugman's Method



Problem 2: Daugman's Method

Biometrics Research Centre (BRC)

Gabor Wavelets



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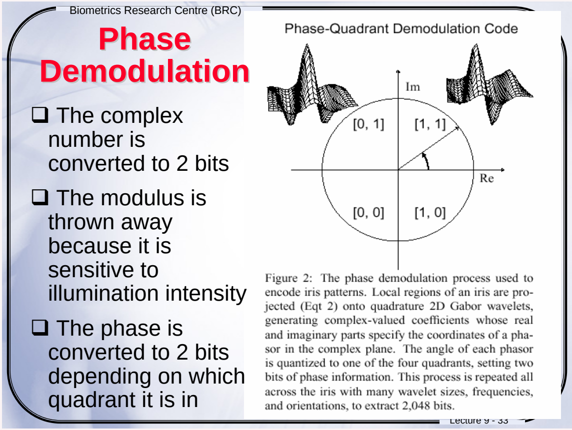
Lecture 9 - 32

Problem 2: Daugman's Method



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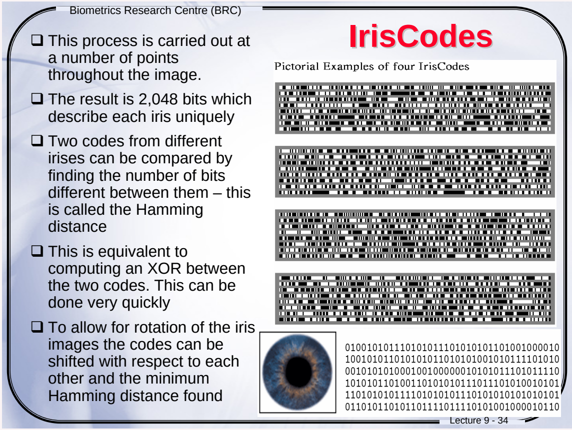

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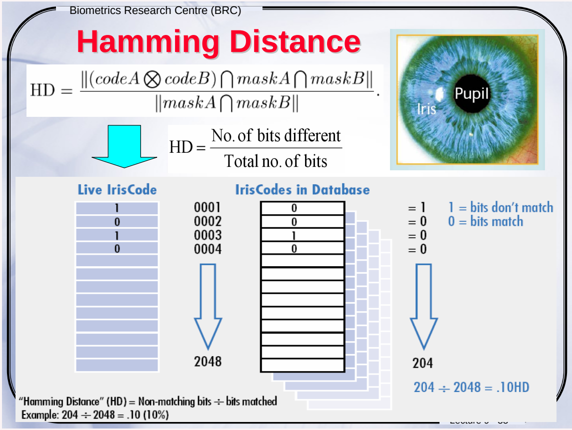


Problem 2: Daugman's Method

- The IrisCode is 512 bytes
- then total bits is 512×8 bits
- and two bits represent one feature
- so the total number of features should be $\frac{512 \times 8}{2} = 2048$

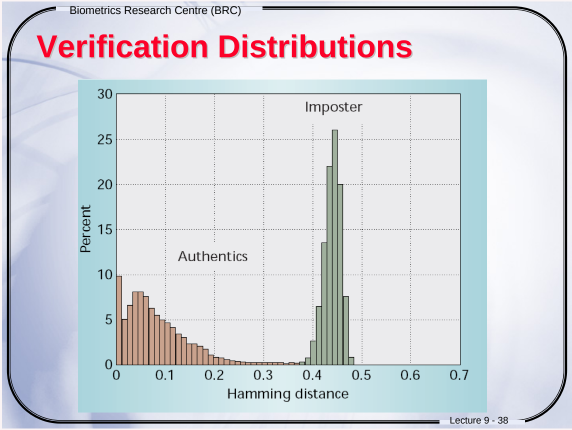
$\square$

Outline

Problem 3: Seperating IrisCodes

In P9:38, an example of iris verification distributions is given. Notice that Hamming distance is defined to measure the dissimilarity of two IrisCodes. Which value in the figure can separate two parts, authentics and imposters? If the dissimilarity between two IrisCodes is taken as 0.5, can you say they are identical? How about the comparison result when the dissimilarity is 0.2? What conclusion will you get from the hamming distance used to compute dissimilarity of IrisCodes?

Problem 3: Seperating IrisCodes



The threshold should be 0.38. Hamming distance of 0.5 should not be from the same eye and 0.2 should.

Problem 3: Seperating IrisCodes

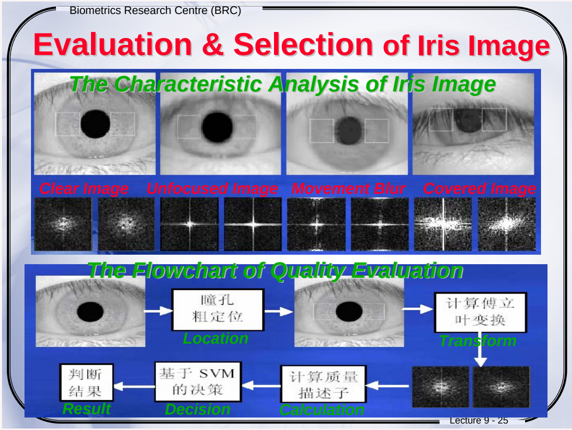
- Hamming distance
  - The larger the hamming distance, the further two candidates seperate away.
  - Imposters tend to be larger the hamming distance; the authentics tend to be smaller.

Outline

Problem 4: Fourier Transforms of Irises

P9:25 shows the corresponding Fourier transforms of iris images with different quality. Please give the property of Fourier transform of good quality iris images.

Problem 4: Fourier Transforms of Irises



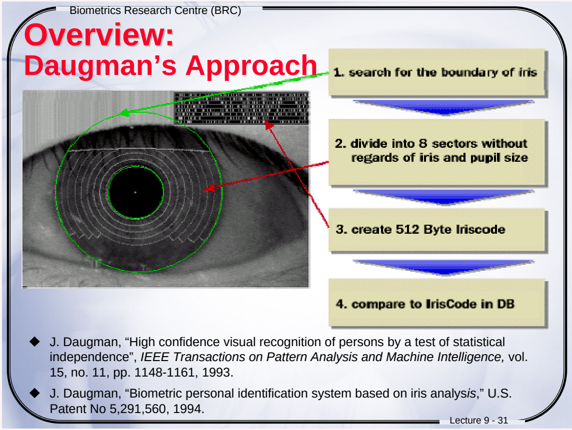
The distribution should be even. □

Outline

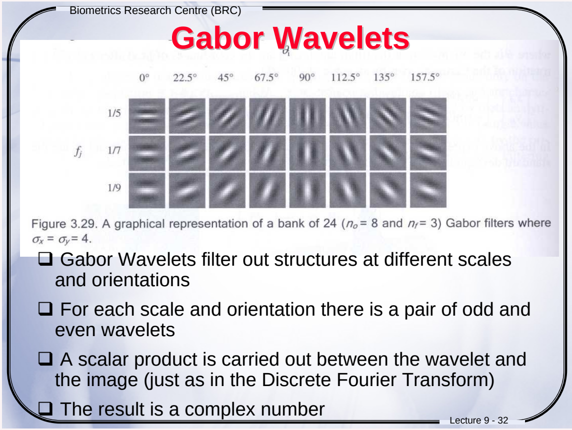
Problem 5: Another pattern of Iris

In Daugman's approach iris is regarded as a circular pattern (P9:31-34). In fact we can also take the iris as other pattern, as shown in P9:27. Please try to design the corresponding scheme.

Problem 5: Another pattern of Iris



Problem 5: Another pattern of Iris



Problem 5: Another pattern of Iris

Phase Demodulation

- The complex number is converted to 2 bits
- The modulus is thrown away because it is sensitive to illumination intensity
- The phase is converted to 2 bits depending on which quadrant it is in

Phase-Quadrant Demodulation Code

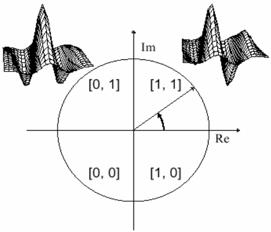
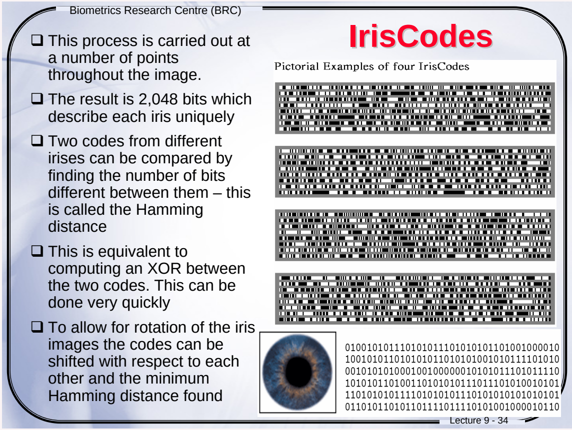
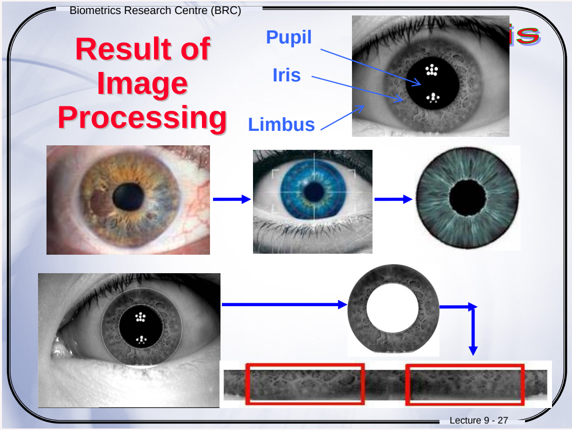


Figure 2: The phase demodulation process used to encode iris patterns. Local regions of an iris are projected (Eqt 2) onto quadrature 2D Gabor wavelets, generating complex-valued coefficients whose real and imaginary parts specify the coordinates of a phasor in the complex plane. The angle of each phasor is quantized to one of the four quadrants, setting two bits of phase information. This process is repeated all across the iris with many wavelet sizes, frequencies, and orientations, to extract 2,048 bits.

Problem 5: Another pattern of Iris



Problem 5: Another pattern of Iris



Problem 5: Another pattern of Iris

- Scheme
  - Generally the procedure should be the same
  - Instead of eight annular sectors, we divide the Iris to eight bar-like sectors
  - and other procedures should be the same
  - To divide the iris to eight sectors, to use Gabor filters to encode the image to IrisCode, then to match the IrisCode by Hamming distances.
- Advantages
  - Horizontal localization error could be adjusted along the horizantal direction.
- Disadvantages
  - The spreading-out of the image will take in more noises or even fake patterns.

Q & A

Any questions?