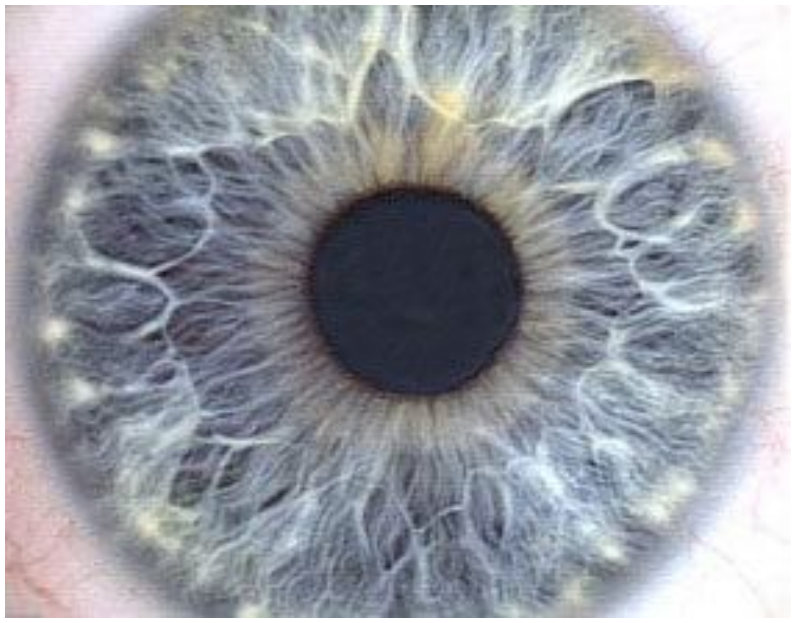
Iris Recognition



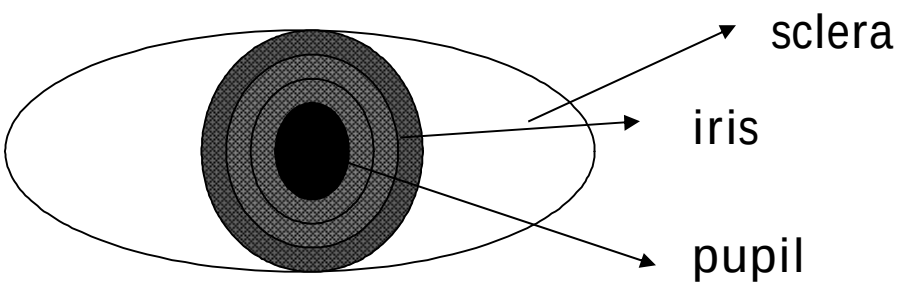
Why Iris Recognition?

- Iris patterns are unique.
- Iris patterns do not change with age.
- Non Contact approach.
- Simplicity and ease of implementation.
- Speed – the process of matching the iris patterns is very fast.

Technique

Step 1: Capturing the image of the eye using a camera.

Step 2: Differentiating the outline of the iris and the sclera, and the pupil from the iris.

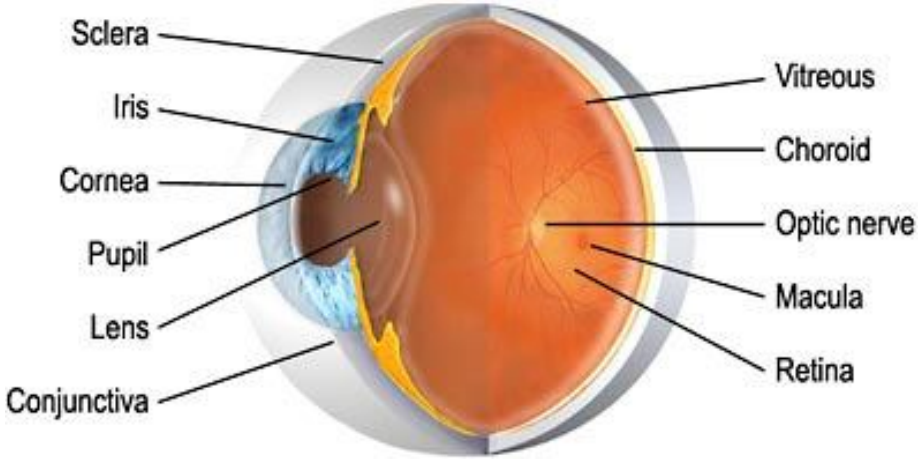


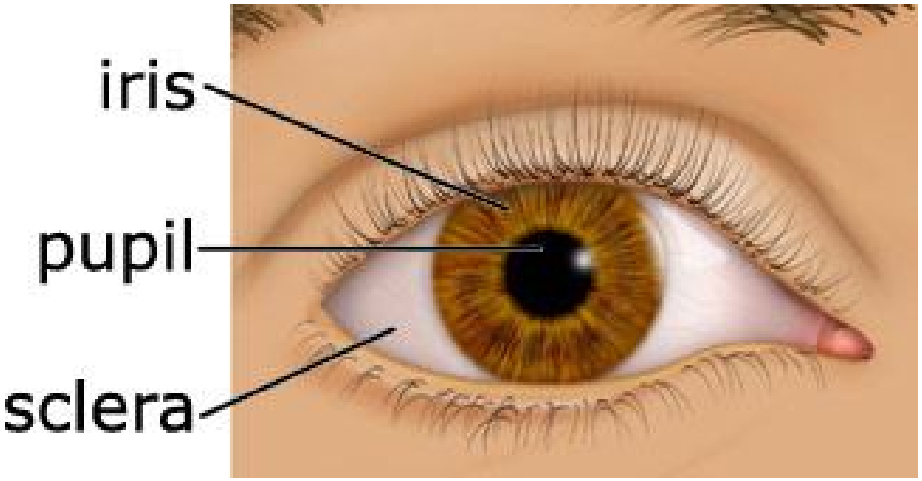
Step 3: Encoding the image using demodulation (also removes reflections, intrusion of eye lid lashes, contact lens outline etc.,). Code is 256 bytes.

Iris

- Iris is the area of the eye where the pigmented or colored circle,usually brown, blue, rings the dark pupil of the eye.

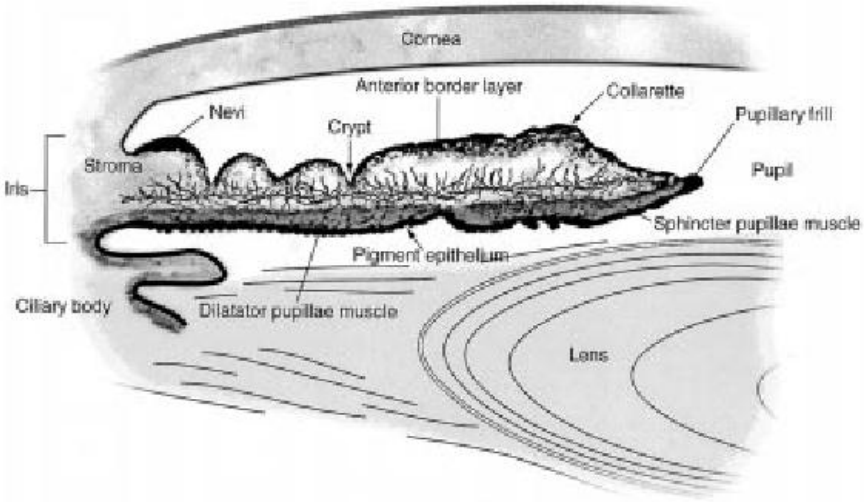
Anatomy of the Human Eye

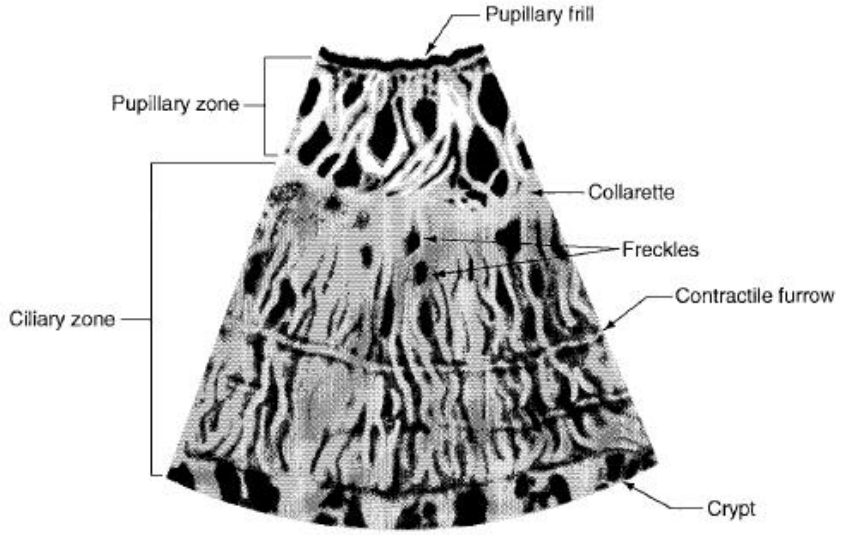




- **Eye** = Camera
- **Cornea** bends, refracts, and focuses light.
- **Retina** = Film for image projection (converts image into electrical signals).
- **Optical nerve** transmits signals to the brain.

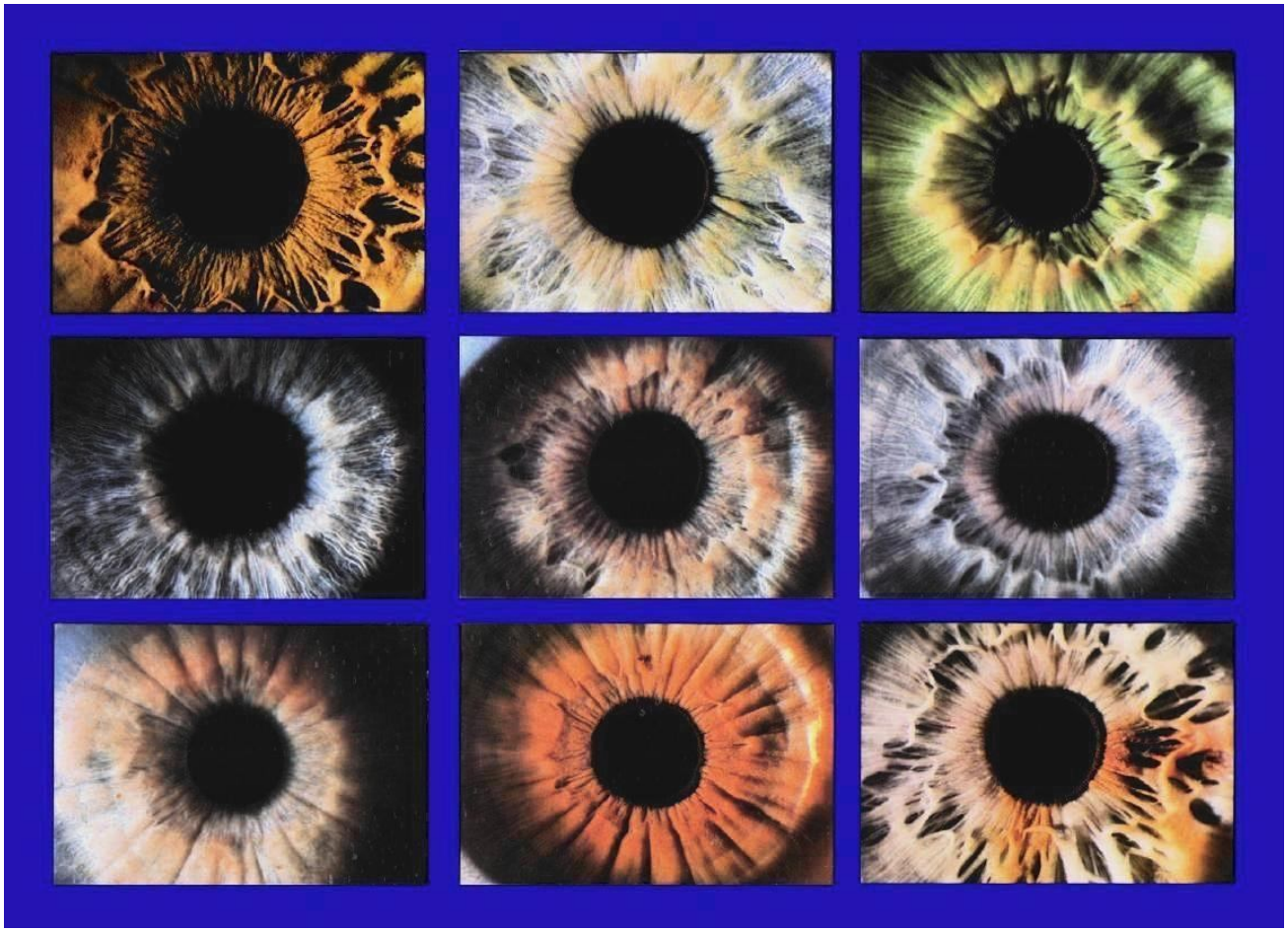
Structure of Iris





- **Iris** = Aperture
- Different types of muscles:
  - the **sphincter** muscle (constriction)
  - radial muscles (dilation)
- Iris is flat
- Color: pigment cells called **melanin**
- The color texture, and patterns are unique.

Individuality of Iris

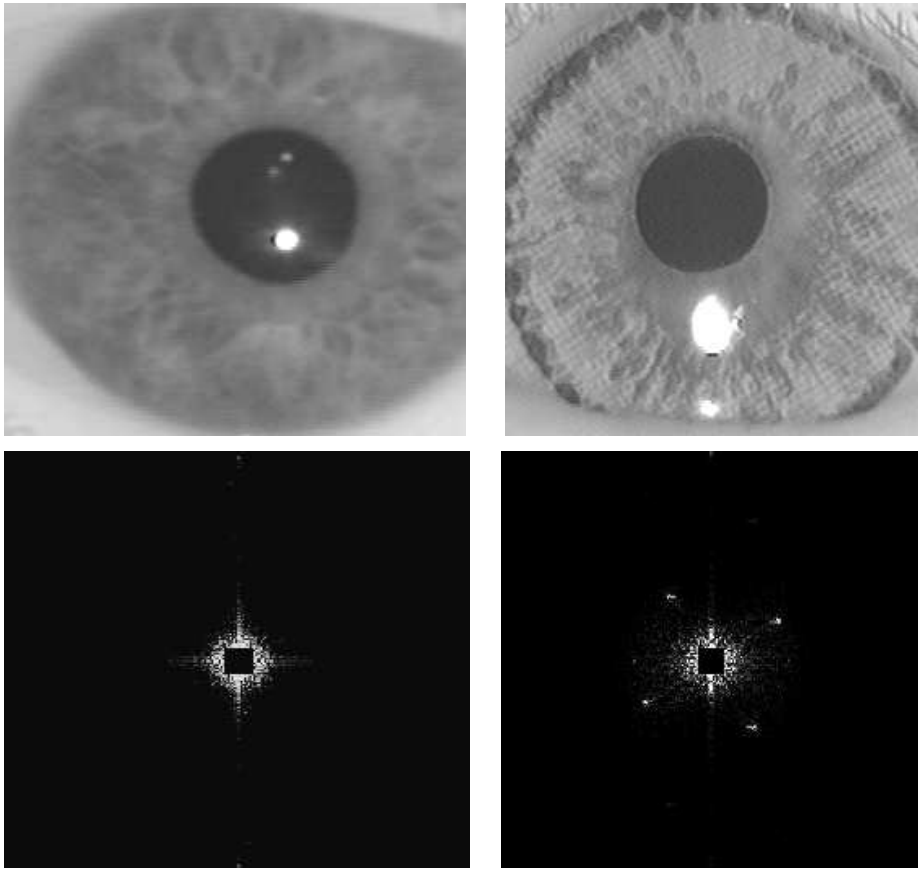


Left and right eye irises have distinctive pattern.

Attacks

1. Iris patterns printed on contact lens

   Countermeasure: 2D Fourier Transform



Attacks cont…

- Digital Replay attack

  Countermeasure: Encryption of iris code, database security.

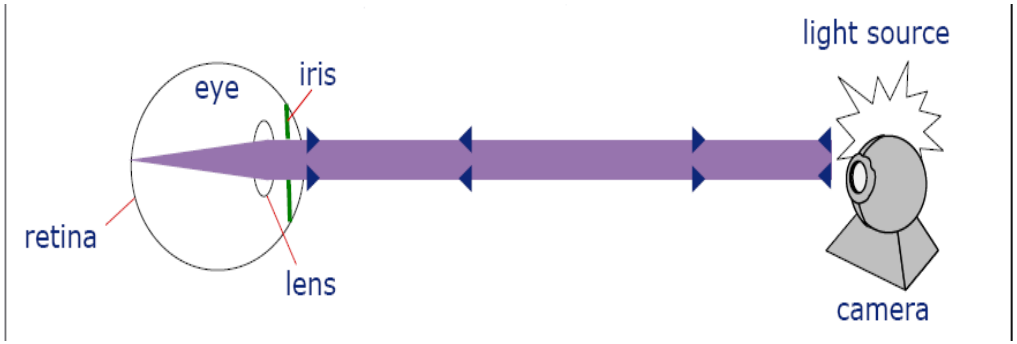
  Example: Iridian Technologies has established

  3DES Encryption as the standard.

Attacks cont...

- Picture of an iris

  <u>Countermeasure:</u> Liveness test (on command eye movement, pupillary light reflex , red eye effect, light absorption properties of living tissue, hippus etc.,)



RED EYE EFFECT

Iris Recognition systems

- The iris-scan process begins with a photograph. A specialized camera, typically very close to the subject, not more than three feet, uses an infrared imager to illuminate the eye and capture a very high-resolution photograph. This process takes 1 to 2 seconds.

Creating an Iris code

- The picture of eye first is processed by software that localizes the inner and outer boundaries of the iris.
- And it is encoded by image-processing technologies.

Iris recognition

- In less than few seconds, even on a database of millions of records, the iris code template generated from a live image is compared to previously enrolled ones to see if it matches to any of them.

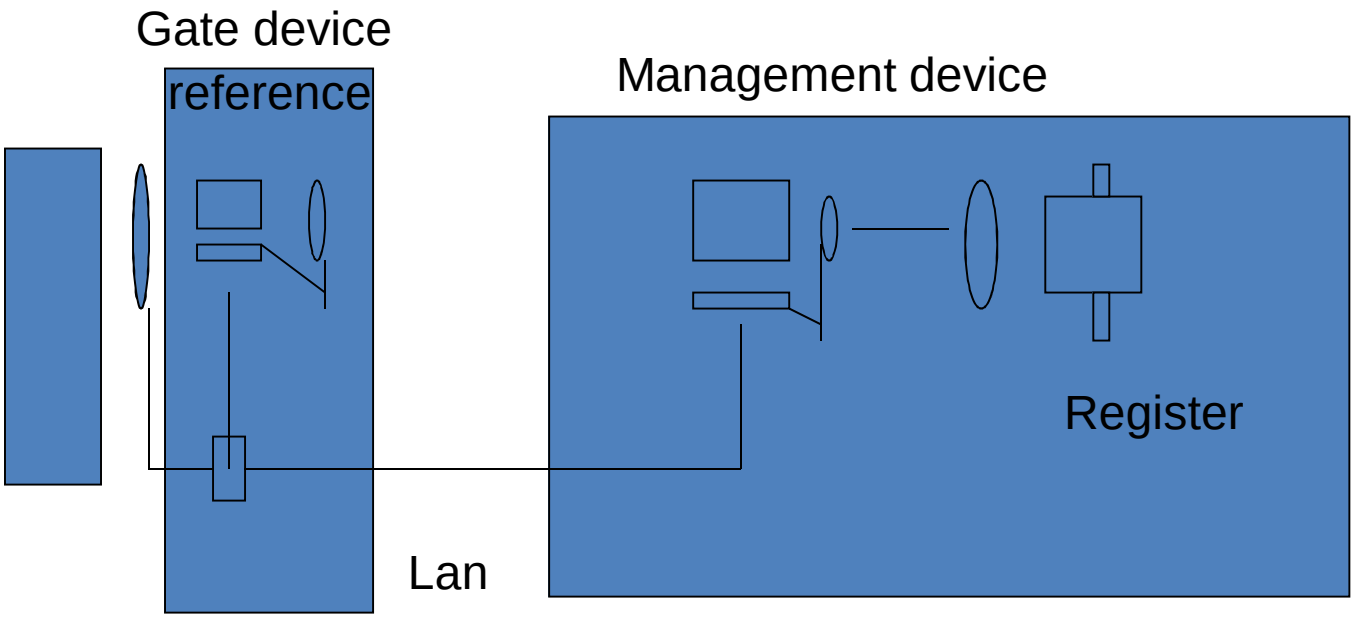
Major characteristics of iris recognition

- Iris is thin membrane on the interior of the eyeball.
- Iris pattern remains unchanged after the age of two and does not degrade overtime or with the environment.
- Iris patterns are extremely complex than other biometric patterns

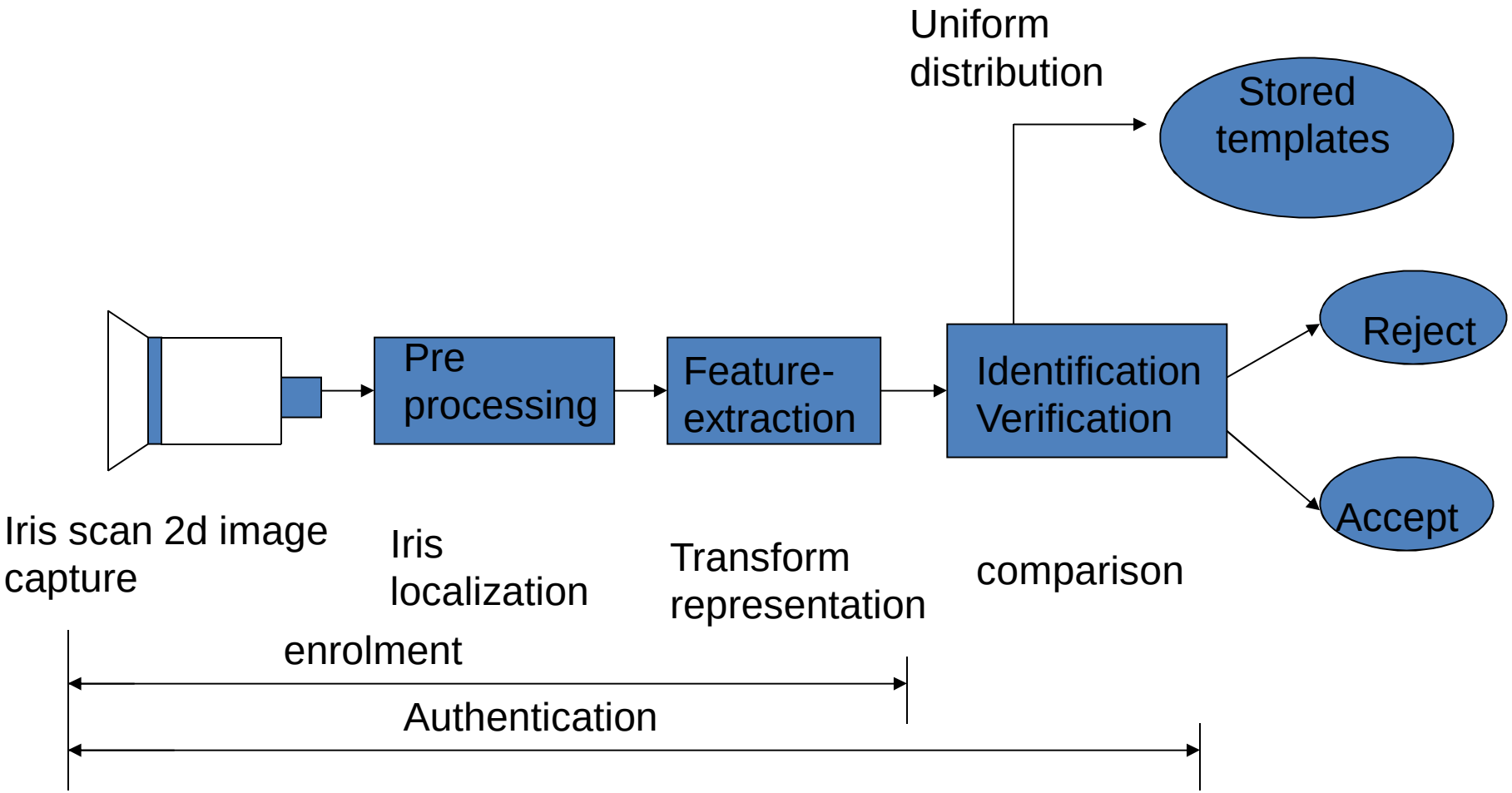
Typical iris system configuration for taking a picture

- An iris recognition camera takes a black and white picture from 5 to 24 inches away.
- The camera uses non-invasive, near-infrared illumination that is barely visible and very safe.
- And this iris recognition cannot take place without the person permission

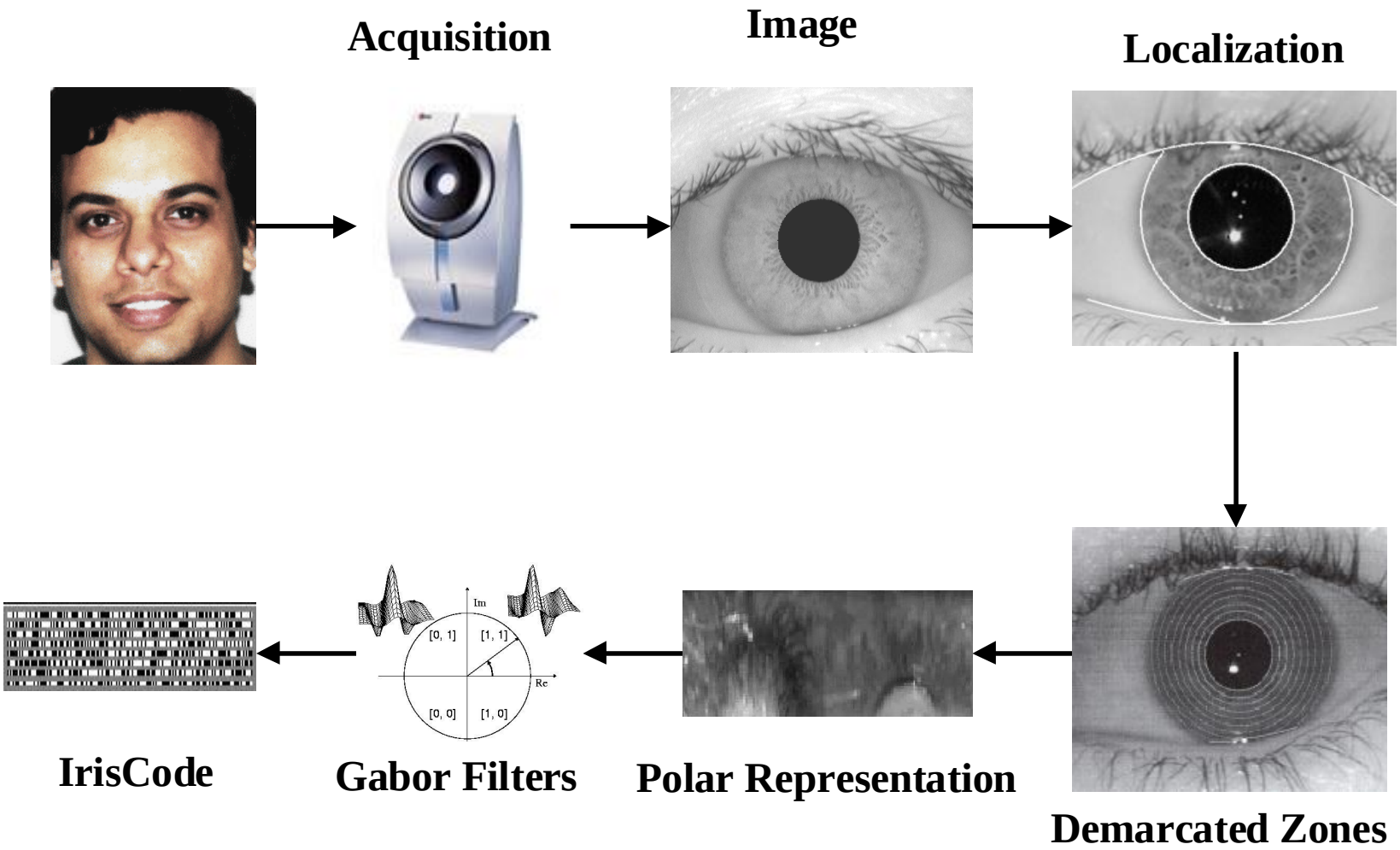
Example of iris recognition system



Typical iris system configuration



Iris Recognition System



Techniques used

- Iris Localization
- Iris Normalization
- Image Enhancement

Iris Localization

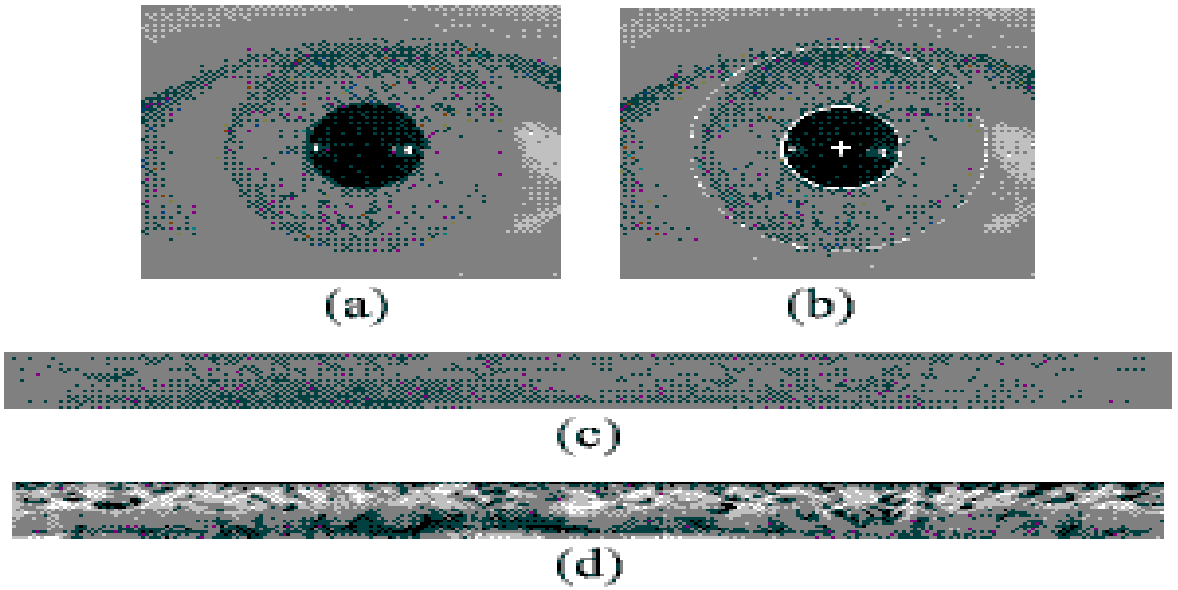
- Both the inner boundary and the outer boundary of a typical iris can be taken as circles. But the two circles are usually not co-centric. Compared with the other part of the eye, the pupil is much darker. We detect the inner boundary between the pupil and the iris. The outer boundary of the iris is more difficult to detect because of the low contrast between the two sides of the boundary. We detect the outer boundary by maximizing changes of the perimeter- normalized along the circle. The technique is found to be efficient and effective.

Iris Normalization

- The size of the pupil may change due to the variation of the illumination and the associated elastic deformations in the iris texture may interface with the results of pattern matching. For the purpose of accurate texture analysis, it is necessary to compensate this deformation. Since both the inner and outer boundaries of the iris have been detected, it is easy to map the iris ring to a rectangular block of texture of a fixed size.

Image Enhancement

- The original image has low contrast and may have non-uniform illumination caused by the position of the light source. These may impair the result of the texture analysis. We enhance the iris image reduce the effect of non-uniform illumination.



Iris preprocessing: (a) original eye (b) iris localization
(c) iris normalization (d) image enhancement

Feature Extraction

- Phase-based method
- Texture-analysis based method
- Zero-Crosssing representation method
- Approach based on intensity variations
- Approach using Independent Component Analysis

Phase-based method

- J.Daugman proposed phase based method.
- recognize iris patterns based on phase information
- Phase information is independent of imaging contrast and illumination
- The pupil and iris boundary was found using integro differential operator
- The visibility in the iris area is reduced and greater part of iris is occluded by eyelids which provide less information for iriscode generation.

Texture based method

- Wildes proposed iris recognition based on texture analysis
- The limbus and pupil are modeled with circular contours which is extended to upper and lower eyelids with parabolic arcs
- The particular contour parameter values x, y and radius r are obtained by the voting of the edge points using Hough transformation

Zero-Crossing method

- Boles represents features of the iris at different resolution levels based on the wavelet transform zero-crossing.
- The centre and diameter of the iris is calculated from the edge-detected image.
- The virtual circles are constructed from the centre and stored as circular buffers.
- The information extracted from any of the virtual circles is normalised to have same number of data points and a zero crossing representation is generated.

Approach based on intensity variations

- Li Ma is characterized by local intensity variations
- In the iris localization phase,the centre coordinates of the pupil are estimated by image projections in horizontal and vertical directions.
- The exact parameters of the pupil and iris circles are calculated using Canny edge detection operator and Hough transform
- generating 1D intensity signals considering the information density in the angular direction

Approach using Independent Component Analysis

- Ya-Ping Huang adopts Independent Component Analysis (ICA) to extract iris texture features
- Image acquisition is performed at different illumination and noise levels.
- The iris localization is performed using integrodifferential operator and parabolic curve fitting.
- From the inner to outer boundary of iris, fixed number of concentric circles n with m samples on each circle is obtained.

Comparison Of Iris Recognition With Other Biometrics

- Accurate
- Stability
- Fast
- Scalable

Advantages of the Iris for Identification

- Highly protected, internal organ of the eye
- Externally visible, patterns imaged from a distance
- Iris patterns possess a high degree of randomness
- Patterns apparently stable throughout life
- Encoding and decision-making are tractable

Disadvantages of the Iris for Identification

- Small target to acquire from a distance
- Moving target…within another…on yet another
- Located behind a curved, wet, reflecting surface
- Obscured by eyelashes, lenses, reflections
- Illumination should not be visible or bright

Why iris recognition is not so famous?

- Convenience
- Acceptance
- Cost