Efficient Iris Recognition by Characterizing Key Local Variations

by

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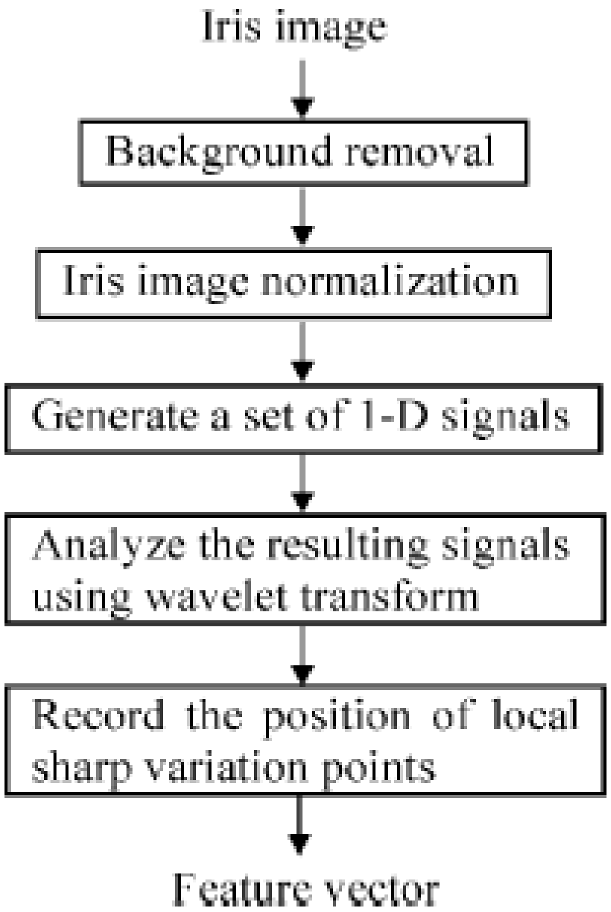
ABSTRACT

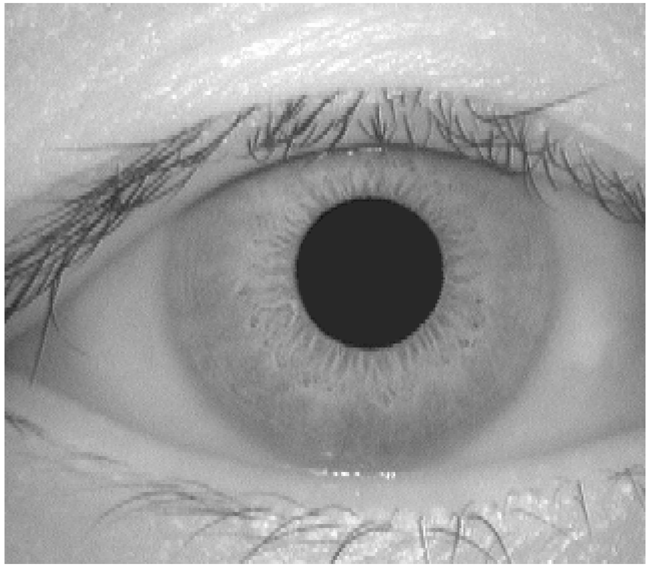
1) a set of **one-dimensional intensity signals** is constructed to effectively characterize the most important information of the **original two-dimensional image**

2) using a particular class of wavelets, a position sequence of **local sharp variation points** in such signals is recorded as features.

3) **matching scheme** based on euclidean distance to compute the similarity between a pair of position sequences.

Diagram of approach

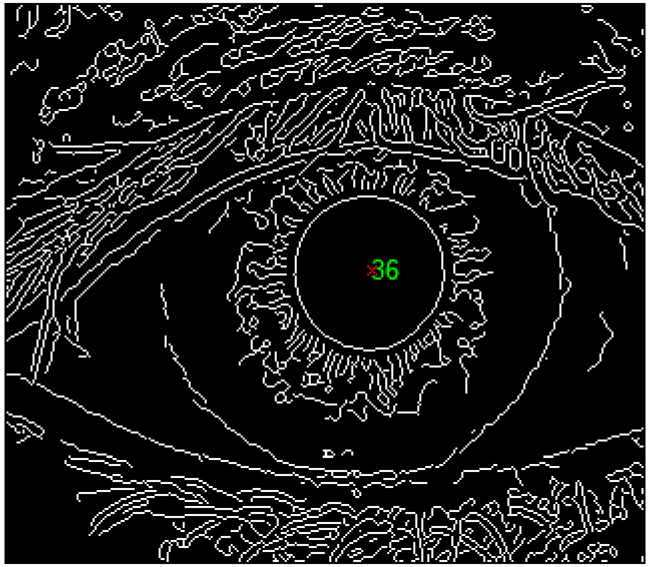




Preprocessing - Localization

- Project the image in vertical and horizontal directions
  - Pupil generally darker than surroundings
  - Minima of the two projection profiles gives centre of pupil (X_p Y_p).
- For more accuracy
  - Binarize a 120X120 region around (X_p Y_p)
  - Centroid of resulting region is new centre
  - Repeat for more accurate result
- Exact parameters of the two circles found using edge detection and Hough transform.

Circle Detection



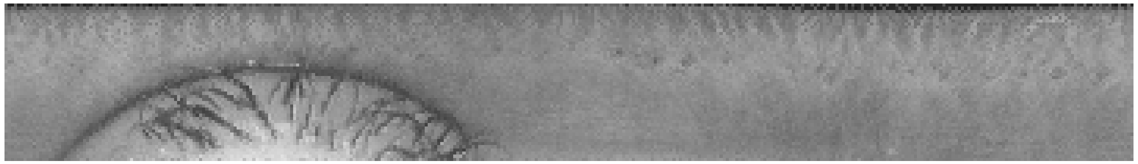
Preprocessing- Normalization

- Irises may be captured in different sizes.
- Size may also change due to illumination variations.
- Annular Iris is un-wrapped counter clockwise to a rectangular texture block with a fixed size
- Helps in reducing distortion of iris caused by pupil movement
- Also simplifies subsequent processing.

Preprocessing - Enhancement

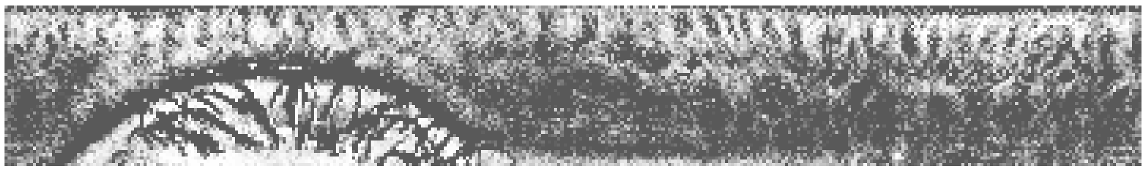
- Normalized image has low contrast and may have non-uniform brightness.
- An estimate of intensity variations is found using bicubic interpolation using 16X16 blocks.
- This estimate is then subtracted from the normalized image.
- More enhancement is done using Histogram Equalization in each 32X32 region.

Pre-processing



Normalized image

Local average intensity



Enhanced

Feature Extraction

- The 2-d normalized image is decomposed into 1-D signals $S_{i.}$

$$S_i = \frac{1}{M}\sum_{j=1}^{M} I_{(i-1)*M+j} \quad i = 1, 2, \ldots N$$

$$I = \begin{pmatrix} I_1 \\ \vdots \\ I_x \\ \vdots \\ I_K \end{pmatrix} = \left(I_1^T, \cdots I_x^T, \cdots I_K^T\right)^T$$

I is normalized image (K X L)

I_x denotes gray values of xth row

M is total no. of rows used to form S_i

N is total no. of 1-D signals

Feature Extraction

- A set of such signals contains most of the local features.
- Such representation reduces computational costs.
- Iris regions close to sclera contain few texture characteristics
- So features are extracted from the top 78% of the image
- K x 78% = N x M
- Recognition rate regulated by changing M.

Feature Vector

- There is an underlying relationship between information at consecutive scales
- The signals at finer scales are easily contaminated by noise.
- Hence only scales are used
- For each intensity signal S_i, the position sequences at two scales are concatenated to form the corresponding features.

Feature Vector

$$f_i = \{d_1, d_2, \cdots d_i, \cdots d_m; d_{m+1}, d_{m+2}, \cdots d_{m+n}; p_1, p_2\}$$

- Here,

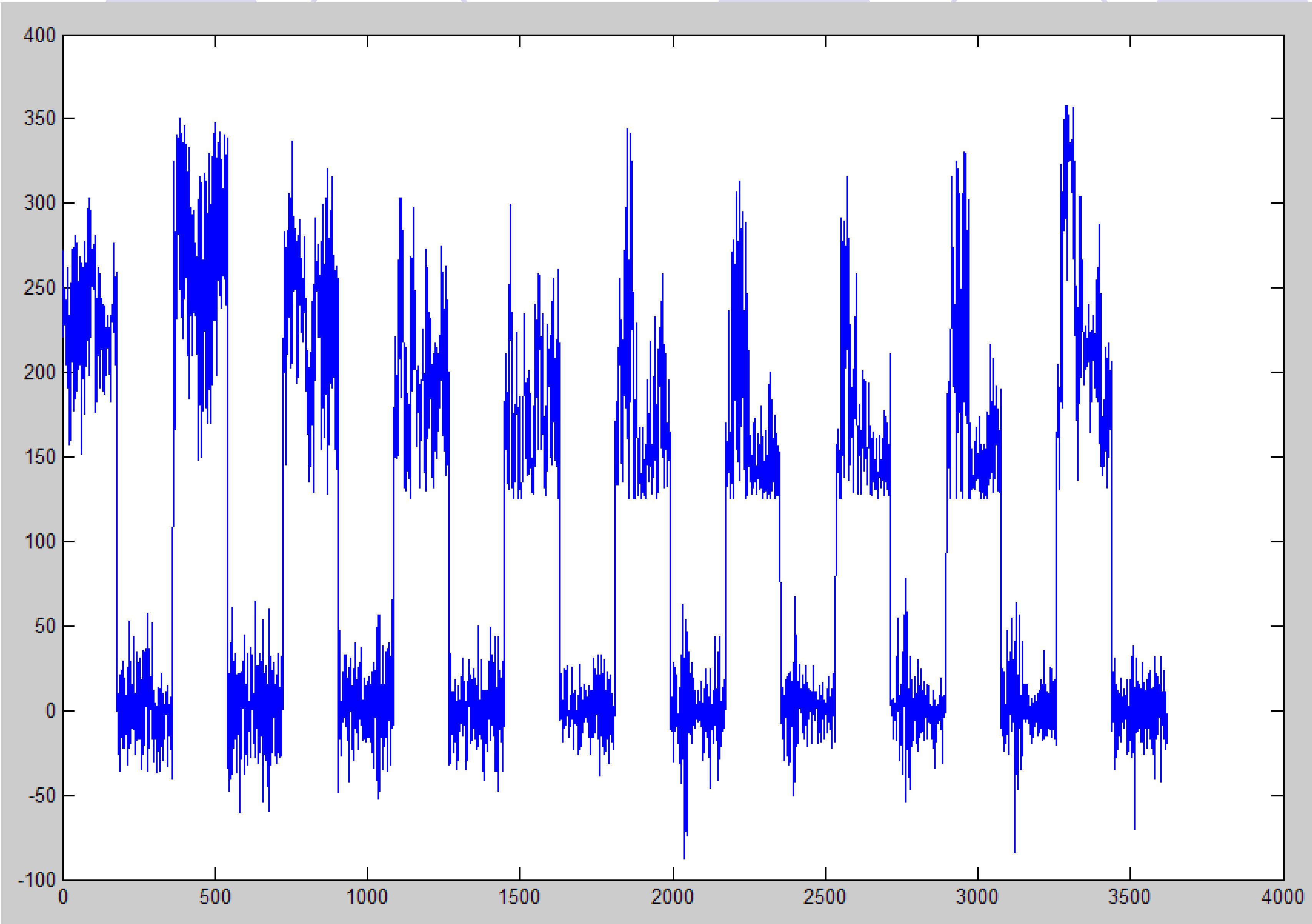
  d_i = position of sharp local variation point in S_i

  m = no. of components from first scale

  n = no. of components from the second scale
  p_i = property of first local sharp variation point at two scales : minima (+1) and maxima (-1).

- Features from different 1-D intensity signals are concatenated to constitute an ordered feature vector

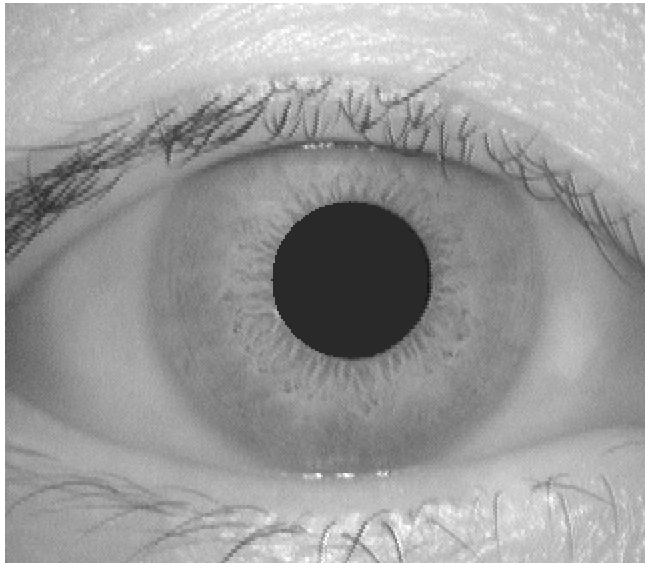
$$f = \{f_1, f_2, \cdots f_i, \cdots f_N\}$$

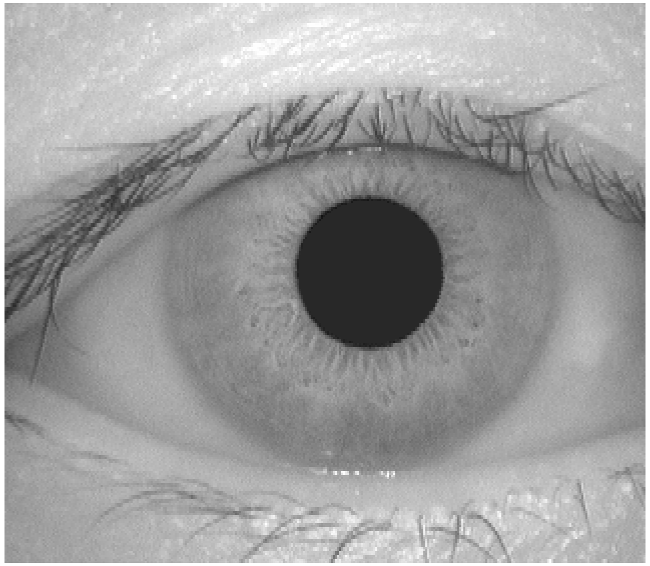

400
350
300
250
200
150
100
50
0
-50
-100
0
500
1000
1500
2000
2500
3000
3500
4000

Matching

- The similarity between a pair of expanded feature vectors is calculated using the euclidean distance
- Distances below a threshold of 50 were found to be of the same person.

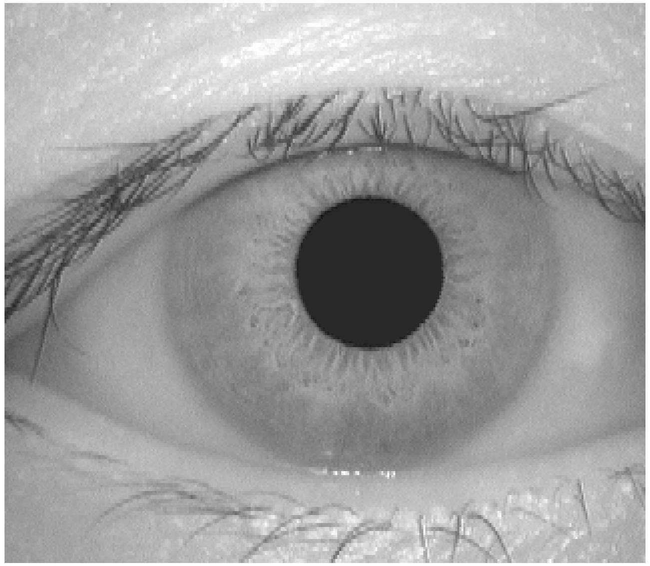
Result

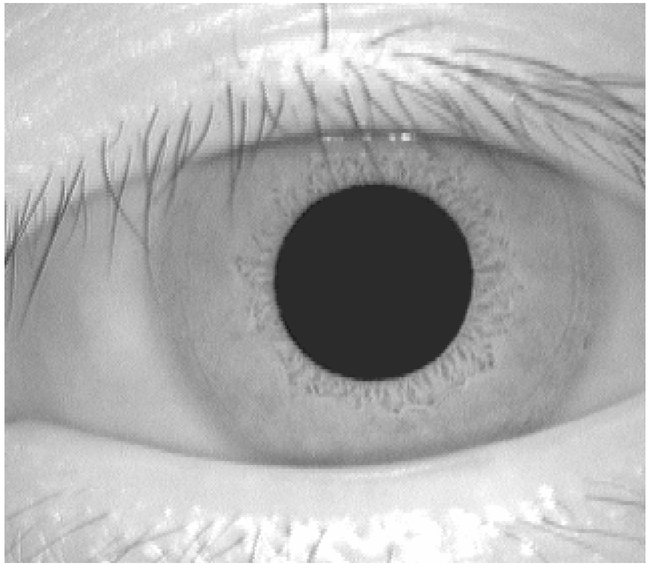




Distance = 31.4072
Implying ‘acceptance’

Result





Distance = 123.7437
Implying ‘rejection’

Thank You

Translation, Scale and Rotation

- Translation invariance is inherent because the original image is localized before feature extraction.
- To achieve approximate scale invariance, normalize irises of different size to the same size.
- Rotation in the original image corresponds to translation in the normalized image.
- The binary sequence at each scale can be regarded as a periodic signal, hence we obtain translation invariant matching by circular shift
- After several circular shifts, the minimum matching score is taken as the final matching score.