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

1. Iris image
2. Background removal
3. Iris image normalization
4. Generate a set of 1-D signals
5. Analyze the resulting signals using wavelet transform
6. Record the position of local sharp variation points
7. Feature vector
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 $S_i$.

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

$I$ is normalized image ($K \times L$)

$I_x$ denotes gray values of $x$th 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.
- $K \times 78\% = N \times M$
- 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

\[ f_i = \{d_1, d_2, \ldots, d_i, \ldots, d_m; d_{m+1}, d_{m+2}, \ldots, d_{m+n}; p_1, p_2\} \]

• Here,

\[ d_i = \text{position of sharp local variation point in } S_i \]
\[ m = \text{no. of components from first scale} \]
\[ n = \text{no. of components from the second scale} \]
\[ p_i = \text{property of first local sharp variation point at two scales: minima (+1) and maxima (-1).} \]

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

\[ f = \{f_1, f_2, \ldots, f_i, \ldots, f_N\} \]
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.
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.