IRIS RECOGNITION

Using Phase-Based Image Matching

Paper - K. Miyazawa, K. Ito, T. Aoki, K. Kobayashi and H. Nakajima, "An Effective Approach for Iris Recognition Using Phase-Based Image Matching," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 30, no. 10, pp. 1741-1756, Oct. 2008, doi: 10.1109/TPAMI.2007.70833.

Algorithm

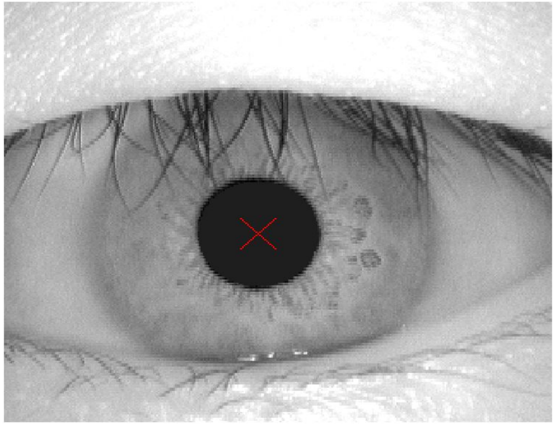
1) Preprocessing stage - to remove these irrelevant parts correctly from the given image and to extract only the iris region.

2) Matching stage - to get matching scores and identify the genuine and impostor attempts

Preprocessing stage

1) Iris Localisation

Convert to binary image for detecting pupil center



$$c_1 = \frac{\sum_{(m_1,m_2)\in W} m_1 f_{bin}(m_1,m_2)}{\sum_{(m_1,m_2)\in W} f_{bin}(m_1,m_2)},$$

$$c_2 = \frac{\sum_{(m_1,m_2)\in W} m_2 f_{bin}(m_1,m_2)}{\sum_{(m_1,m_2)\in W} f_{bin}(m_1,m_2)}.$$

2) Detecting iris boundaries

In this step we detect the inner boundary (the boundary between the iris and the pupil) and the outer boundary (the boundary between the iris and the sclera) in the original gray-scale image. Find boundary by minimizing difference

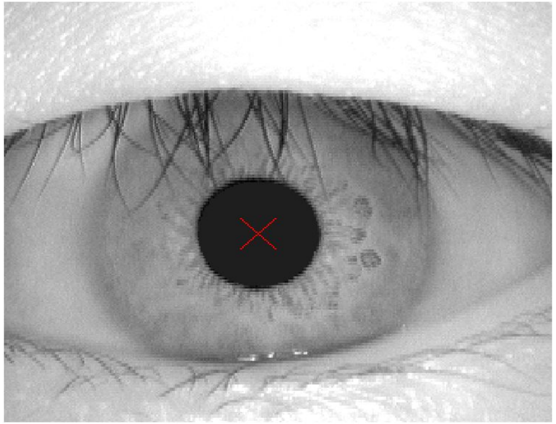
S denotes the N-point contour summation of pixel values along the ellipse

$$S(l_1, l_2, c_1, c_2, \theta_1) = \sum_{n=0}^{N-1} f_{org}(p_1(n), p_2(n)),$$

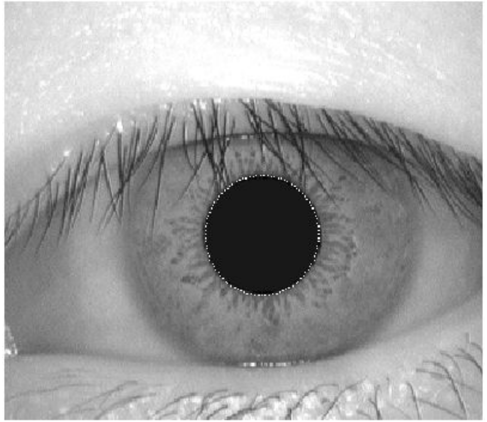
$$|S(l_1 + \Delta l_1, l_2 + \Delta l_2, c_1, c_2, \theta_1) - S(l_1, l_2, c_1, c_2, \theta_1)|.$$

Our results for this stage

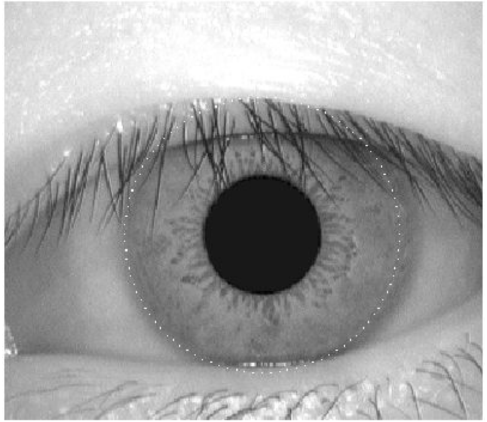
Preprocessed Image



Pupil Center



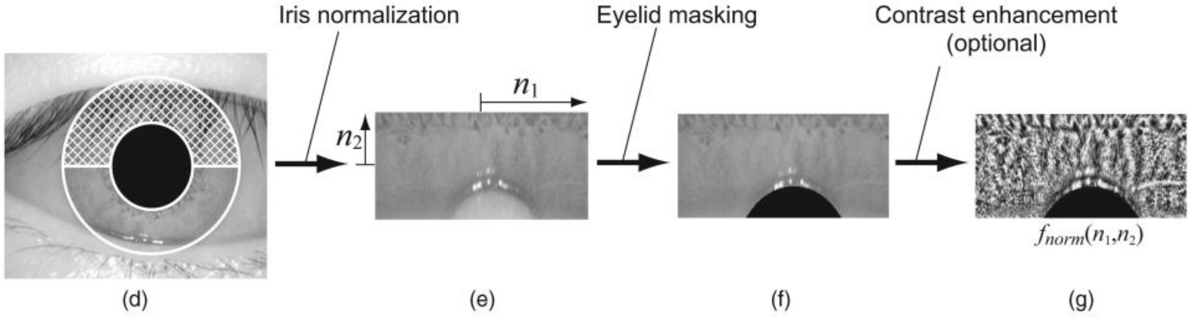
Inner Boundary

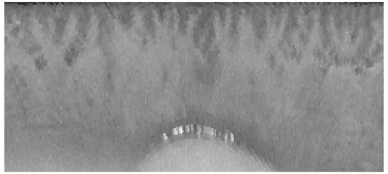


Outer Boundary

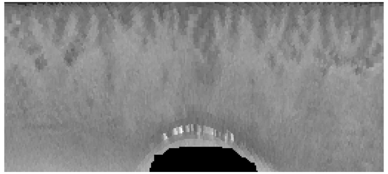
Preprocessing stage

Intermediate Images





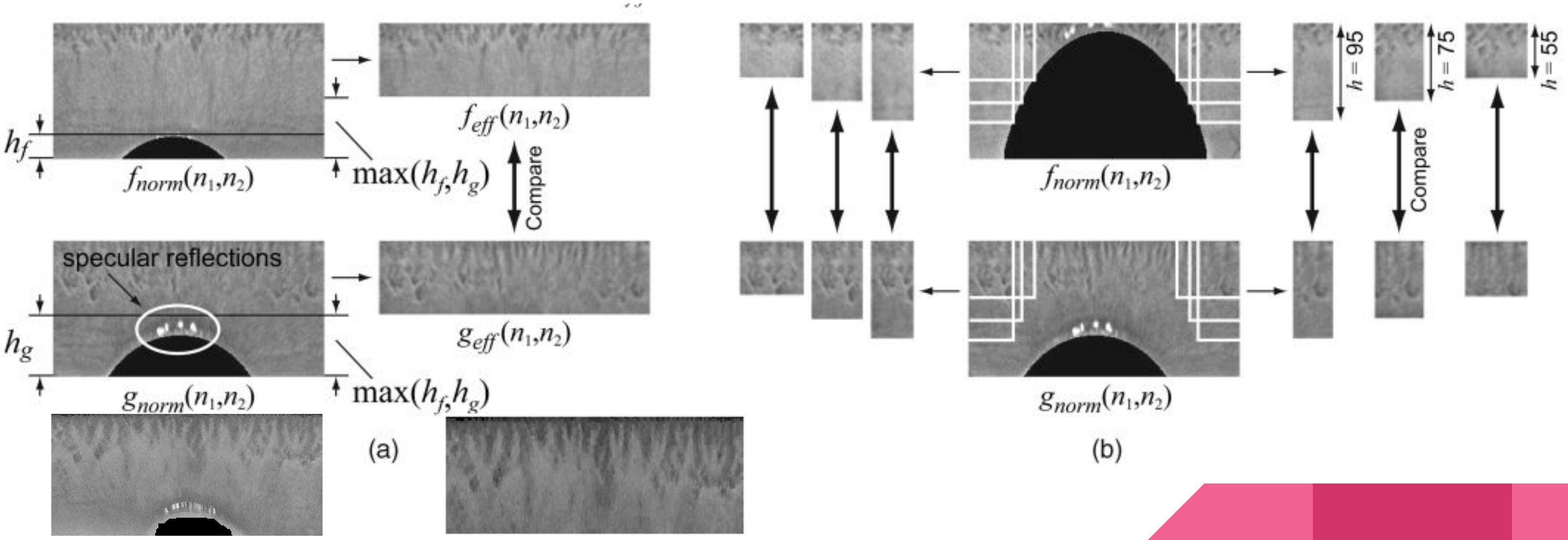
Before eyelid masking



After eyelid masking

Matching Stage

1) Effective region extraction



Phase-Only Correlation (POC) function

Let F(k1, k2) and G(k1, k2) denote the 2D DFTs of the two images.

The cross-phase spectrum R_{FG}(k1, k2) is

$$R_{FG}(k_1, k_2) = \frac{F(k_1, k_2)\overline{G(k_1, k_2)}}{|F(k_1, k_2)\overline{G(k_1, k_2)}|}$$

POC function r_{fg}(n1, n2) is the 2D Inverse DFT (IDFT) of R_{FG}(k1, k2)

$$r_{fg}(n_1, n_2) = \frac{1}{N_1 N_2} \sum_{k_1=-M_1}^{M_1} \sum_{k_2=-M_2}^{M_2} R_{FG}(k_1, k_2) \times W_{N_1}^{-k_1 n_1} W_{N_2}^{-k_2 n_2}.$$

(Original image size = N1 x N2,

N1 = 2*M1 + 1 and N2 = 2*M2 + 1)

Band-Limited POC (BLPOC) function

allows us to evaluate the similarity by using the inherent frequency band of the iris texture

The BLPOC function is

$$r_{fg}^{K_1 K_2}(n_1, n_2) = \frac{1}{L_1 L_2} \sum_{k_1=-K_1}^{K_1} \sum_{k_2=-K_2}^{K_2} R_{FG}(k_1, k_2) \times W_{L_1}^{-k_1 n_1} W_{L_2}^{-k_2 n_2},$$

the ranges of the inherent frequency band of iris texture are given by $k_1 = -K_1, \ldots, K_1$ and

$k_2 = -K_2, \ldots, K_2$

($L_1 = 2*K_1 + 1$ and $L_2 = 2*K_2 + 1$)

Matching Stage

2) Displacement Alignment

can be estimated from the peak location of the BLPOC function

Align the two images based on the displacement (t_1, t_2)

Hence, We extract common-region images:

Can increase the matching from around 0.09 to around 0.2

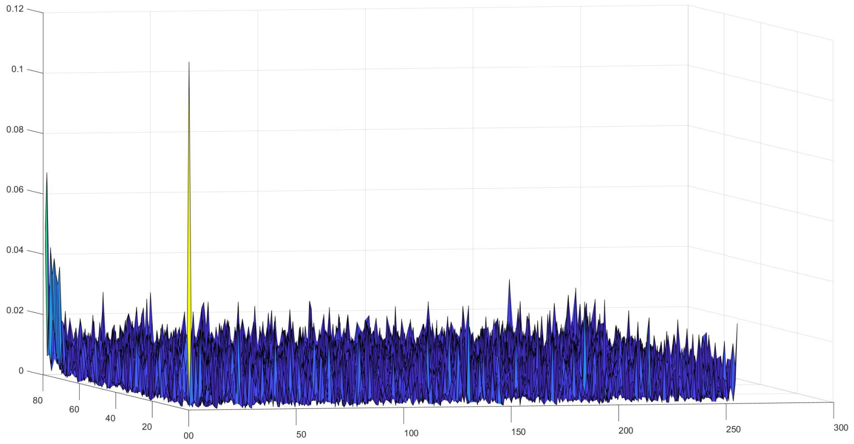
Thus helps reduces the false negatives(when genuine case but we would have got imposter otherwise)

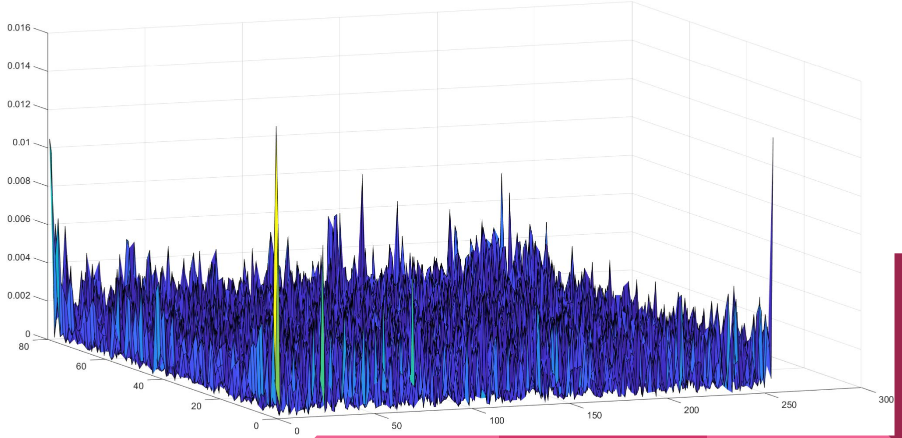
Matching Stage

3) Matching Score Calculation

Calculate BLPOC function between the aligned images

Matching score is calculated as the maximum peak value of the BLPOC function





Results

Typical Matching score for genuine cases in our experiments = 0.21

Typical Matching score for imposter cases in our experiments = 0.09

Threshold for checking precise matching algorithm is hence chosen 0.05

If the final score is more than 0.1, then it is called genuine.

In all other cases: imposter

Accuracy score for Genuine attempts = 77.22%

Accuracy score for imposter attempts = 89.52%

Shortcomings

In case of defocusing and blurring, it is difficult to achieve high performance by this algorithm

When much of iris is blocked by eyelids, the pre-processing algorithms doesn’t work properly

In conditions of very huge change in illumination pupil size changes resulting in