

A Hybrid Approach for Iris Recognition Using Gamma Correction and Hough Transform

Harpreet Kaur, Mandeep Singh, Navjot Kaur*

Department of Information Technology, Chandigarh Engineering College, Landran, Punjab, India

Department of Information Technology, Chandigarh Engineering College, Landran, Punjab, India

Department of Information Technology, Chandigarh Engineering College, Landran, Punjab, India

ABSTRACT

In biometric identification, the Iris recognition system is a most popular research field in recent years. Due to iris biometric recognition reliability and nearly perfect recognition rates, used in high security areas. An Iris recognition system is designed in order to verify both the uniqueness of the human iris and performance as a biometric identification. This Iris recognition system consists of an automatic segmentation system that is based on the Hough Transform Gamma Correction and Histogram Thresholding method and is able to localize the circular Iris and pupil region, reflection, occluding eyelid and eyelashes. In this paper, we will discuss the different steps to recognize an Iris image which mainly include acquisition, segmentation, normalization, feature extraction and matching. We overcome the user's cooperation constraints in the biometric Iris recognition. However, it is highly probable that images captured at a distance, without user's cooperation and within highly dynamic capturing environments lead to the appearance of extremely heterogeneous images, with several other types of information in the captured Iris regions (e.g. iris obstructions by eyelids or eyelashes and reflections). The algorithm is implemented over CASIA v4.0 database, IIT Delhi Database and ICE 2005 database and the accuracy of 99.08%, 99.86% and 98.17% is achieved respectively which is seen better from other literature studied and cited in the work.. The experimental results provide significant improvement in the segmentation accuracy. For the implementation of this proposed work we use the Image Processing Toolbox under MATLAB software.

KEYWORDS: Iris Recognition, Biometrics, Iris Segmentation, Gamma correction, Histogram Thresholding, Growing based segmentation, Gabor filter, Matching, Normalization, and Image Processing.

INTRODUCTION

Since the beginning of civilization, identifying human beings has been crucial to the fabric of human society. Consequently, person identification is an integral part of the infrastructure needed for diverse business sectors such as finance, health care, transportation, entertainment, law enforcement, security, access control, border control, government, and communication. As our society becomes electronically connected to form one big global community, it has become necessary to carry out reliable person identification often remotely and through automatic means. Surrogate representations of identity such as passwords (prevalent in electronic access control) and cards (prevalent in banking and government applications) no longer suffice. Further, passwords and cards can be shared and thus cannot provide non-repudiation. Biometrics, which refers to automatic identification of people based on their distinctive physiological (e.g., face, fingerprint, iris, retina, hand geometry) and behavioral (e.g., voice, gait) characteristics, should be an essential component of any effective person identification solution because biometric identifiers cannot be shared, misplaced, and they intrinsically represent the individual's identity. Information security is concerned with the assurance of confidentiality, integrity, and availability of information in all forms. There are many tools and techniques that can support the management of information security and systems based on biometrics that have evolved to support some aspects of information security. Biometric systems support the facets of identification/authorization, authentication and non-repudiation in information security.

Biometric systems have many traits among which iris is the newest and gives more prominent result against other kind of biometric system. Securing biometrics databases from being compromised is an important research challenge that must be overcome in order to support widespread use of biometrics based authentication. Much has been reported on attempts to fool biometric sensors with false fingerprints, facial overlays and a myriad of other spoofing approaches. Biometric system based on iris gives more efficient result than compared to others. Iris recognition is the process of recognizing a person by analyzing the random pattern of the iris. The automated method of iris recognition is young than other traits based systems. We present a general framework for image processing of iris images with a particular view on feature extraction. The method uses the set of geometrical and texture features and based on the information of the complex vessel structure of the retina and sclera. The feature extraction contains the image preprocessing, locating and segmentation of the region of interest (ROI). The image processing of ROI and the feature extraction are preceded, and then the feature vector is determined for the human

recognition and ophthalmology diagnosis. In the proposed method we implement “Iris Recognition using Hough’s Transform Gamma correction and Histogram Thresholding”.

Iris recognition systems are divided into four blocks, iris segmentation, iris normalization, and feature extraction and matching. Iris segmentation separates an iris region from the entire captured eye image. Iris normalization fixes the dimensions of segmented iris region to allow for accurate comparisons. Feature extraction draws out the biometric templates from normalized image and matches this template with reference templates. The performance of an iris system closely depends on the precision of the iris segmentation. The existing methods assume that pupil is always central to an iris; hence both pupil and iris share a central point. This inaccurate assumptions results in wrong a segmentation of an iris region. The upper and the lower parts of the outer iris boundary are generally obstructed by eyelids and eyelashes, this provides problems during segmentation. These eyelids and eyelashes act as noise which needs to be eliminated to achieve optimum segmentation results.

In order to improve the effectiveness of iris recognition for biometric recognition, the Hough transform using Histogram thresholding the gamma correction method is proposed. Daugman [2] makes use of an integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the upper and lower eyelids. The operator searches for the circular path where there is maximum change in pixel values, by varying the radius and centre x and y position of the circular contour [3]. The operator is applied iteratively with the amount of smoothing progressively reduced in order to attain precise localization. Eyelids are localized in a similar manner, with the path of contour integration changed from circular to an arc.

Ritter et al. [17] make use of active contour models for localizing the pupil in eye images. Active contours respond to preset internal and external forces by deforming internally or moving across an image until equilibrium is reached. The contour contains a number of vertices, whose positions are changed by two opposing forces, an internal force, which is dependent on the desired. For localization of the pupil region, the internal forces are calibrated so that the contour forms a globally expanding discrete circle. The external forces are usually found using the edge information. In order to improve accuracy Ritter et al. use the variance image, rather than the edge image. A point interior to the pupil is located from a variance image and then a discrete circular active contour (DCAC) is created with this point as its centre. The DCAC is then moved under the influence of internal and external forces until it reaches equilibrium, and the pupil is localized.

Kong and Zhang [15] present a method for eyelash detection, where eyelashes are treated as belonging to two types, separable eyelashes, which are isolated in the image, and multiple eyelashes, which are bunched together and overlap in the eye image. Separable eyelashes are detected using 1D Gabor filters, since the convolution of a separable eyelash with the Gaussian smoothing function results in a low output value [16]. Thus, if a resultant point is smaller than a threshold, it is noted that this point belongs to an eyelash. Multiple eyelashes are detected using the variance of intensity. If the variance of intensity values in a small window is lower than a threshold, the centre of the window is considered as a point in an eyelash. The Kong and Zhang model also makes use of connective criterion, so that each point in an eyelash should connect to another point in an eyelash or to an eyelid. Specula reflections along the eye image are detected using thresholding, since the intensity values at these regions will be higher than at any other regions in the image.

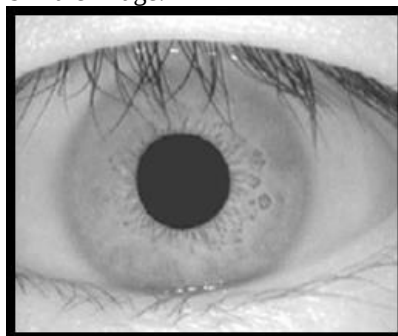


Fig.1 The eye image sample

The remainder of this paper is organized as the following. At first, in Section II we illustrate the various components of our proposed technique to Iris Recognition. Further, in Section III we present some key experimental results and evaluate the performance of the proposed system. At the end we provide conclusion of the paper in Section IV and state some possible future work directions.

PROPOSED TECHNIQUE

This section illustrates the overall technique of our proposed “An Efficient Biometric Iris Recognition using Hough’s Transform Gamma Correction & Histogram Thresholding”. We present an extensive survey of iris recognition methods and also give a brief review of related topics. The main objective of this implementation is given:

- [1] Canny’s edge detection algorithm is computationally more expensive compared to Sobel, Prewitt and Robert’s operator. However, the Canny’s edge detection algorithm performs better than all these operators under almost all scenarios.
- [2] Histogram Thresholding based image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze.
- [3] Histogram Thresholding-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image.
- [4] Compared with other biometric technologies, such as face, speech and finger recognition, Iris recognition can easily be considered as the most reliable form of biometric technology.
- [5] The gamma correction is an image-processing algorithm that compensates for the nonlinear effect of signal transfer between electrical and optical devices.

Gamma Correction

The gamma correction is an image-processing algorithm that compensates for the nonlinear effect of signal transfer between electrical and optical devices. The image processing performed by video applications, such as CRTs, digital cameras, color printers, and scanners, includes a gamma correction for the output. Gamma correction, gamma nonlinearity, gamma encoding, or often simply gamma, is the name of a nonlinear operation used to code and decode luminance or tristimulus values in video or still image systems. Gamma correction is, in the simplest cases, defined by the following power-law expression:

$$V_{\text{out}} = AV_{\text{in}}^{\gamma}$$

Where A is a constant and the input and output values are non-negative real values; in the common case of A = 1, inputs and outputs are typically in the range 0–1. A gamma value $\gamma < 1$ is sometimes called an encoding gamma, and the process of encoding with this compressive power-law nonlinearity is called gamma compression; conversely a gamma value $\gamma > 1$ is called a decoding gamma and the application of the expansive power-law nonlinearity is called gamma expansion.

Gabor filter

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. J. G. Daugman discovered that simple cells in the visual cortex of mammalian brains can be modeled by Gabor functions. Thus, image analysis by the Gabor functions is similar to perception in the human visual system. Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter’s impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

Complex

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \exp\left(i\left(2\pi\frac{x'}{\lambda} + \psi\right)\right)$$

Real

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \cos\left(2\pi\frac{x'}{\lambda} + \psi\right)$$

Imaginary

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \sin\left(2\pi\frac{x'}{\lambda} + \psi\right)$$

Where $x' = x \cos \theta + y \sin \theta$

And $y' = -x \sin \theta + y \cos \theta$

In this equation, λ represents the wavelength of the sinusoidal factor, θ represents the orientation of the normal to the parallel stripes of a Gabor function, ψ is the phase offset, σ is the sigma/standard deviation of the Gaussian envelope and γ is the spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function. Gabor filters are directly related to Gabor wavelets, since they can be designed for a number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of bi-orthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex. Jones and Palmer showed that the real part of the complex Gabor function is a good fit to the receptive field weight functions found in simple cells in a cat's striate cortex. The Gabor space is very useful in image processing applications such as optical character recognition, Iris detection and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation.

EVALUATION AND RESULTS

To verify the effectiveness (qualities and robustness) of the proposed iris recognition, we conduct several experiments with this procedure on several images.

In this work we load an iris image and apply the different technique on loaded image in the Image Processing Toolbox under the Matlab Software. The results are tabulated as under:

Database	No. of IRIS Images in Database	Images Detected accurately	Accuracy of Previous Algorithm	Accuracy of present Algorithm
CASIAv4.0	2400 images	2378	98.17%	99.08%
IIT Delhi	350 images	346	-----	98.86%
ICE2005	2300 image	2258	96.40%	98.17%

Table: Comparison of ICE2005, CASIA v4.0 and IIT Delhi databases

Below steps of our proposed work is given:

Phase 1: Firstly we develop a particular GUI for this implementation. After that we develop a code for the loading the iris image file in the Matlab database.

Phase 2: Develop a code for the edge detection using canny edge detector and apply on the image.

Phase 3: Develop a code for the gamma correction with histogram thresholding for the segmentation and normalization. When code is develop then apply on the image for detection. We develop the code for the finding region of iris using Histogram thresholding.

Phase 4: After that we develop code for the iris matching using PCA. The main figure window of our proposed method is given below:



Fig.2 Main Figure Window

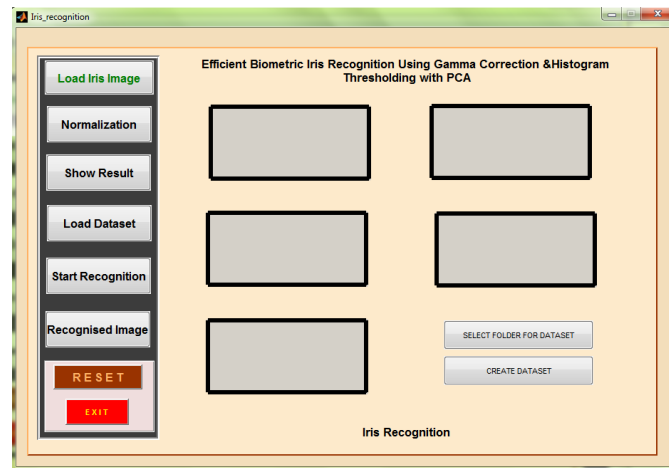


Fig.3 Work Panel Figure Window

RESULTS

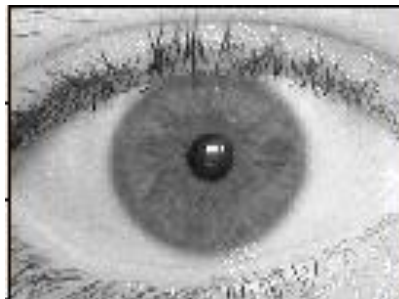


Fig.4 Original Iris Image



Fig.5 Edge Image

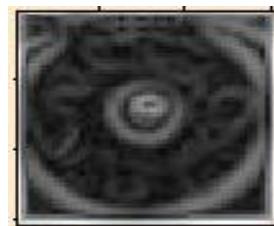


Fig.6 Gamma Correction Image

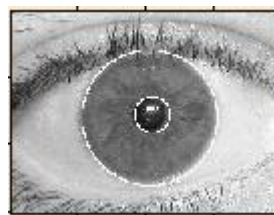


Fig.7 Region of Iris

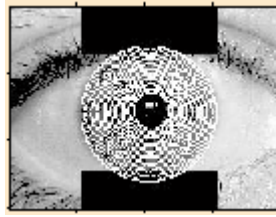


Fig.8 Normalized Image

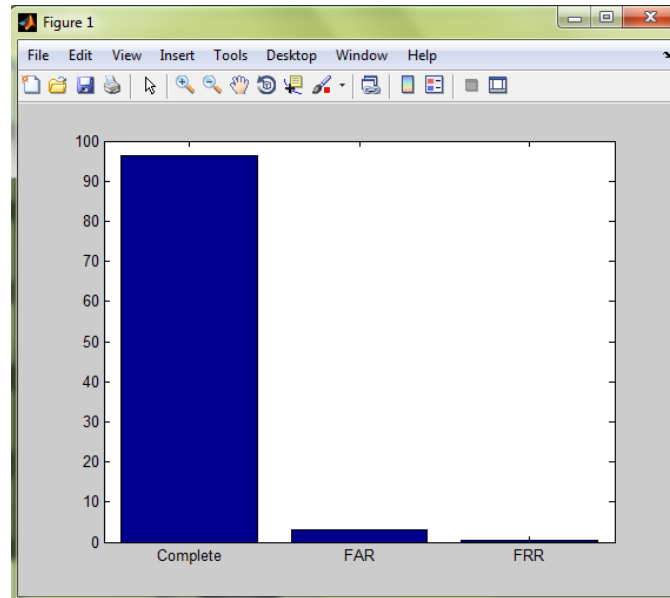


Fig. 9 Comparison of FAR, FRR and complete%

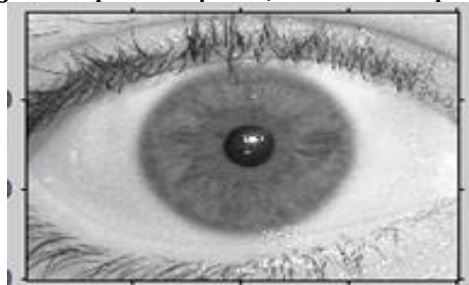
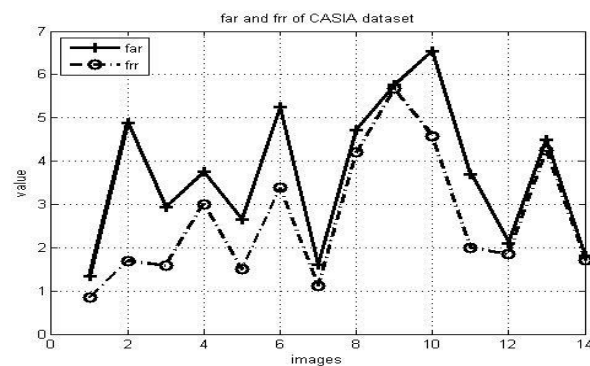
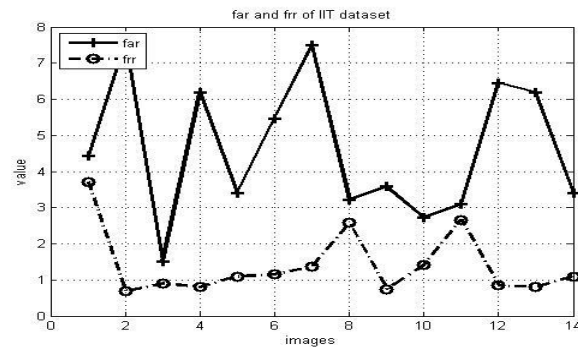


Fig. 10. Result Image

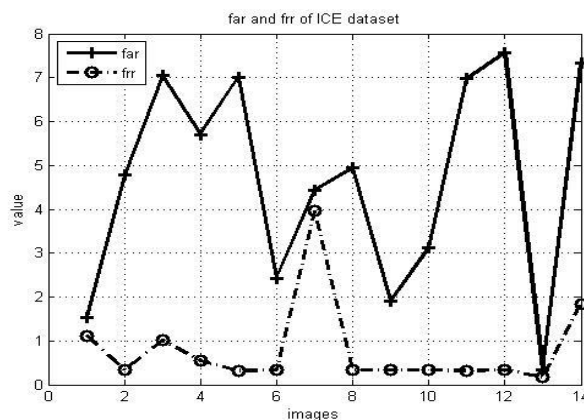
The FAR and FRR plotted for the databases are as shown:-



Graph1: FAR and FRR plot of CASIA v4.0 database



Graph2: FAR and FRR plot of IIT database



Graph1: FAR and FRR plot of ICE2005 database

CONCLUSION AND FURURE SCOPE

In this paper, we present proposed “An Efficient Biometric Iris Recognition using Gamma Correction & Histogram Thresholding with PCA”. Iris recognition is most accurate and reliable biometric identification system. This paper described ocular detection which is very useful in biometric recognition. Image denoising is used for eliminating noise which gives better result. First step is to filter out any noise in the original image before trying to locate and detect any edges. As the Gaussian filter can be computed using a simple mask, it is used exclusively in the Canny algorithm. Once a suitable mask has been calculated, the Gaussian smoothing can be performed using standard convolution methods. A convolution mask is usually much smaller than the actual image. Segmentation of iris is the main stage of iris recognition, because if areas that are wrongly identified as ocular regions will corrupt biometric templates resulting in very poor recognition. So the ocular region should be identified very accurately. The Specular reflection are observed and eliminated. A system is designed for enhancing and matching the conjunctival structure. This conjunctival structure is used in biometric recognition, which is also known as Iris Recognition System. The experiments presented in the paper demonstrate that at its best, the iris region holds a lot of promise as a novel modality for identifying humans with a potential of influencing other established modalities based on ocular and face. At the very least, the results suggest a potential for using iris region as a soft biometric. Future work includes evaluation of more iris features, comparison of iris based recognition performance to a commercial face recognition algorithm, exploration of how the capture conditions and the image quality such as uncontrolled lighting, or subjects wearing cosmetics affect the Periocular skin texture and color, among others.

REFERENCES

- [1] S. Sanderson and J. Erbetta, “Authentication for secure environments based on iris scanning technology”, IEE Colloquium on Visual Biometrics, pp 1-6, 2000.
- [2] J. Daugman. How iris recognition works. Proceedings of 2002 International Conference on Image Processing, Vol. 1, pp 16-22 2002.
- [3] E. Wolff. Anatomy of the Eye and Orbit. 7th edition. H. K. Lewis & Co. LTD, 1976.
- [4] R. Wildes, “Iris recognition: an emerging biometric technology”. Proceedings of the IEEE, Vol. 85, No. 9, pp 1349 13-60, 1997.
- [5] J. Daugman, “Biometric personal identification system based on iris analysis”, United States Patent, Patent Number: 5,291,560, 2010.

- [6] J. Daugman. High confidence visual recognition of persons by a test of statistical independence. IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 15, No. 11, pp 1148-1160 , 2011
- [7] R. Wildes, J. Asmuth, G. Green, S. Hsu, R. Kolczynski, J. Matey and S. McBride, "A system for automated iris recognition", Proceedings IEEE Workshop on Applications of Computer Vision, Sarasota, FL, pp. 121-128, 2011.
- [8] W. Boles and B. Boashash, "A human identification technique using images of the iris and wavelet transform", IEEE Transactions on Signal Processing, Vol. 46, No. 4, pp 1185-1188 ,1998.
- [9] Lim, K. Lee, O. Byeon and T. Kim, "Efficient iris recognition through improvement of feature vector and classifier", ETRI Journal, Vol. 23, No. 2, Korea, pp 1220-1225, 2001.
- [10] S. Noh, K. Pae, C. Lee and J. Kim "Multiresolution independent component analysis for iris identification", The 2002 International Technical Conference on Circuits/Systems, Computers and Communications, Phuket, Thailand, 2002.
- [11] Y. Zhu, T. Tan and Y. Wang "Biometric personal identification based on iris patterns", Proceedings of the 15th International Conference on Pattern Recognition, Spain, Vol. 2, 2000.
- [12] C. Tisse, L. Martin, L. Torres and M. Robert, "Person identification technique using human iris recognition", International Conference on Vision Interface, Canada, 2002.
- [13] Chinese Academy of Sciences – Institute of Automation. Database of 756 Greyscale Eye Images. <http://www.sinobiometrics.com> Version 1.0, 2003.
- [14] Indian Institute of Technology Delhi, iris Database for research. http://web.iitd.ac.in/~biometrics/Database_Iris.html ,2013
- [15] W. Kong and D. Zhang, "Accurate iris segmentation based on novel reflection and eyelash detection model", Proceedings of 2001 International Symposium on Intelligent Multimedia, Video and Speech Processing, Hong Kong, 2001.
- [16] L. Ma, Y. Wang and T. Tan, "Iris recognition using circular symmetric filters", National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences, 2002.
- [17] N. Ritter, "Location of the pupil-iris border in slit-lamp images of the cornea", Proceedings of the International Conference on Image Analysis and Processing, 1999.
- [18] M. Kass, A. Witkin, D. Terzopoulos and Snakes, "Active Contour Models", International Journal of Computer Vision, 2008.
- [19] D. Field, "Relations between the statistics of natural images and the response properties of cortical cells", Journal of the Optical Society of America, 2011.
- [20] J. Chen, F. Shen and D. Z. Chen," Iris Recognition Based on Human Interpretable Features", IEEE Transactions on Information Forensics and Security, 2016.