IRIS Biometrics Survey 2010-2015

M R Rajput, G S Sable

Abstract – **This paper gives a survey on Iris Biometric recognition technique for past few years. Iris is one of the most promising, reliable, and robust biometric technology. In this paper, advancements in research methodologies used by different researchers for iris localization, iris segmentation, feature extraction, and classification are discussed. The limitations of existing algorithms and their results are also discussed. We also discussed here, existing difficulties in iris biometric, possible solutions on them, and future scope in this field. The vast progress in this field shows that iris biometric still needs fast, real time, reliable, and robust algorithms so as to have higher recognition rate and better accuracy. We hope that this paper will surely increase interest of new researchers towards this area with new opportunities and challenges.**

Keywords— Iris biometric technology, Recognition rate, feature extraction, iris segmentation, localization.

I. INTRODUCTION

Any biometrics technique refers to identification and authentication of persons depending on their physical and behavioral characteristics. One of the biometric that is highly reliable, robust and have high recognition accuracy is iris recognition. However the accuracy of iris recognition mostly affected by factors such as angle, pupil dilation, limbus occlusion, intensity variations, and improper focus. So in order to increase accuracy and to achieve high recognition rate, further research on iris recognition is required The various challenges in iris recognition include proper iris area localization, segmentation, local / global features extraction of the iris pattern, feature code size reduction, and fast computation so that no process will consume much time and resources . And the iris recognition will work in a real time.

The organization of paper is as follows Section I describes background and performance measures of Biometric. Section II describes detailed literature survey of different steps involved in iris biometrics. Various iris databases and performance result on them are explained in Section III. Section IV gives Security and Privacy aspects of iris biometrics. Finally we discuss about observations, future scope, and existing difficulties which are unsolved in iris biometrics in Section V.

II. BACKGROUND AND PERFORMANCE MEASURES OF BIOMETRICS

Commonly, the information required for verifying and identifying the user is generated based on data known to the user such as a password, Personal Identification Number, or answer of the secret question. These traditional authentication methods are subject to several serious security attacks such as guessing, eavesdropping, and dictionary attacks. Thus these problems encouraged the development and the adoption of other methods including biometric authentication which utilizes unique human static physical characteristics such as fingerprint palm, face, hand geometry, retina, and iris.

The main performance measures of a biometric system are FAR (False Acceptance Rate), FRR (False Rejection Rate) , and EER (Equal Error Rate). A false acceptance occurs when the system accepts an imposter to be a genuine individual. A false reject occurs when the system rejects a genuine individual to be an imposter. Biometric performance is also indicated by receiver operating characteristic (ROC) curve, which is a plot of False Acceptance Rate against False Rejection Rate. The EER is a point on the ROC curve where the False Acceptance Rate is equal to the False Rejection Rate. As, any biometric system require certain acceptable values of FAR and FRR , threshold value Ts can be determined. The performance of any two biometric systems can be compared by EER and by ROC curve. The lower the EER , the better is the system. The closer the ROC curve to the origin , the better is the system.

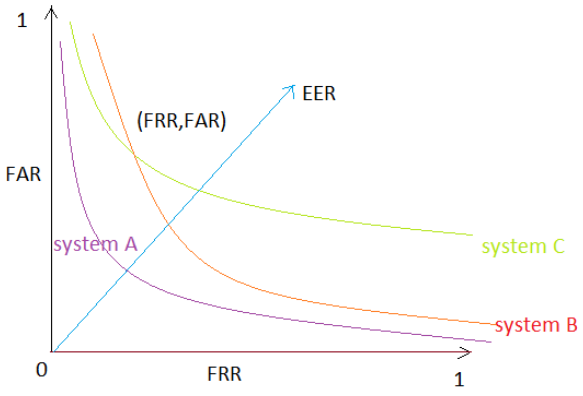

Fig.1: ROC Curves

Other error in Biometric systems is FTC (Failure to Capture). It is the time in percentage , when system cannot capture the biometric characteristic. FTC is only applicable to the systems, that has an automatic capturing function to count to such a failure. This is due to the device hardware problems itself or due to the improper biometric characteristics. FTE (Failure to Enroll) is the time in percentage, when system fails to enroll the user. When system rejects a poorly captured input characteristics, this type of error occurs. Total Success Rate +FRR+FAR=100%. There is interdependence and trade-offs among all these rates. To achieve highly efficient iris recognition, different

Ms. M. R. Rajput, IEEE Member, Dept. of ETC, PES college of Engineering, Aurangabad (MH), India(meenakshiutsav@gmail.com)

Dr. G .S. Sable, Professor, Dept. of ETC, Maharashtra Institute of Technology" ,Aurangabad, (MH), India(sable.eesa@gmail.com)

978-1-5090-0774-5/16/$31.00 © 2016 IEEE

researchers have proposed different algorithms to get better performance measures.

III. DIFFERENT STEPS IN IRIS BIOMETRICS

Iris recognition is divided into two phases. The first is enrollment phase and second is matching phase which can be either verification or identification process. In enrollment process captured iris image pattern is registered to the database. Quality of these images should be high, as it affects overall performance of the system. And in matching process input iris image pattern is compared with stored patterns. Both of these phases include the steps such as iris image acquisition, iris localization, iris normalization, iris image enhancement, and feature extraction. In enrollment process extracted feature vector is stored in the database. During the matching, the extracted or generated feature vector is compared with stored feature vectors also known as templates stored in a database [17].

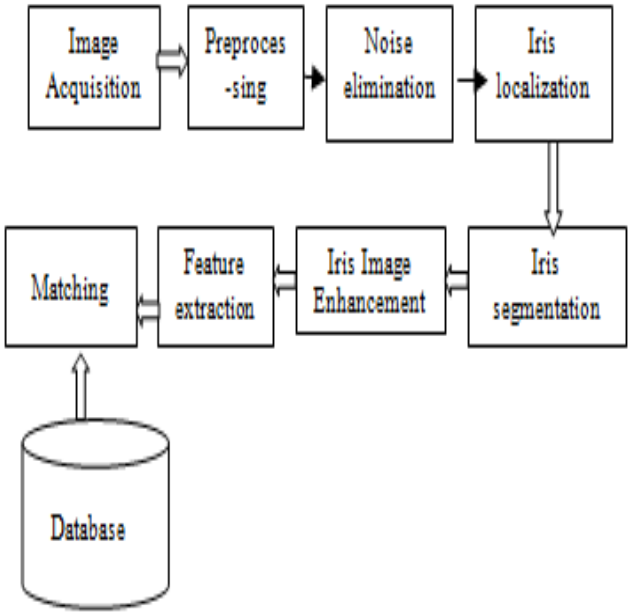

Fig.2: Block Diagram For Iris Recognition

A. *Iris Localization and Segmentation*

Iris image also captures the other parts of an eye such as the eyelid and eyelash, as a result, the iris texture gets distorted. These influencing factors must be eliminated through a process of preprocessing, which includes noise elimination and iris localization. In segmentation process, iris inner boundary is localized corresponding to iris/pupil boundary and iris outer boundary corresponding to iris/sclera boundary are found. It is not necessary that these two circles are concentric every time.

At the same time detecting inner boundary is easier as compared to outer boundary as pupil area is much darker than iris area. Detection of two circles is difficult due to occlusion of upper and lower part of iris region by eyelids and eyelashes. The segmentation process depends on the iris image quality [19]. Iris recognition processes such as iris localization and iris unwrapping feature extraction can be done in parallel by FPGA using VHDL on Altra Cyclone-II hardware implementation by dedicated hardware for each process[3]. Non ideal iris localization and segmentation is difficult as compared to normal iris images, as they are affected by motion blurring, camera diffusion, noise, out-of-focus imaging, occlusion from eyelids or eyelashes, head tilting, off-axis gaze or camera angle, specular reflection, poor contrast, and natural luminosity factors which results into a higher false nonmatch rate. Robust preprocessing algorithms are needed to enhance the quality of such images before processing them.

Off angle iris image acquisition results in to error. For off angle iris Least Square Ellipse Fitting Method and Geometric Calibration Method that is, LSEFGC algorithm can be used for iris segmentation[4]. Limbus occlusion also affects recognition and should be taken into consideration. Amount of limbus occlusion in iris texture changes, as limbus height and acquisition angle change. Ray tracing method is used on eye model to reduce effect of limbus impact and iris are segmented at an actual iris boundary instead of visible iris boundary [5]. In [7] iris image enhancement is done using retinex algorithm for contrast improvement between limbic and pupillary boundaries which is followed by low pass filtering. Random walker based algorithm is employed to perform coarse segmentation of iris region and median filtering is applied to reduce effect of noise artifacts. [34] gives an algorithm that concentrate on extracting iris part from an eye image under non ideal condition and for eyes covered with spectacles. They used decision tree classifier for segmentation. Recent research has attempted to deal with the problem of off-axis iris images by designing suitable calibration and geometric correction models. In [9], their approach is to fuse information from all low quality images in one video frame They used quality driven reconstruction based super resolution fusion scheme , where it recovers lost high frequency components. In [14] Integrodifferential operator suggested by J.Daugman used for iris localization. In [15], Interpolation and decimation in conventional normalization method are used to affect recognition. In [23],[27],[29], and [30] Circular Hough transform is used to decide the radius and center coordinates of pupil and iris regions. Canny edge detection technique is used to create edge map. In [22], Region growing segmentation algorithm is used to segment the interested part of the iris. In [23], gradient operator , which is a first order differential operator used to obtain edges in images. Also source image enhancement is done using histogram equalization and Gamma intensity correction. [26] used wavelet transform for eyelashes detection. For upper eyelid and eyelash detection Multilayer Perceptron with three layers is used. Lower eyelid is also segmented using edge detector and parabolic curve fitting. Automatic crop function is used for pupil localization in [27].

B. *Feature extraction*

From feature extraction method, iris recognition can be categorized as phase based method, zero crossing

representation method, and texture analysis method. Different wavelet transforms and their energy compaction properties can be well used for feature extraction. Gabor filter with carefully selected parameters have been shown to be the most discriminative band pass filters for iris image feature extraction. Edge descriptor such as a LOG filter can be used for feature extraction [1].

Feature extraction process starts by locating the pupil of the eye, which can be done using any edge detection technique. Extracted information may contain local , global , or both local and global information .Only the significant features of the iris must be encoded so that comparisons between templates can be made. Most iris recognition systems make use of a band pass decomposition of the iris image to create a biometric template. Different wavelet transforms and their energy compaction properties can be well used for feature extraction. Gabor filter with carefully selected parameters have been shown to be the most discriminative bandpass filters for iris image feature extraction. Edge descriptor such as a LOG filter can be used for feature extraction [1].

Neu wave network which is a combination of Haar wavelet decomposition and neural network can be used to extract features[4]. Zernike moment based encoding recovers discriminative feature from localized iris region pixels , which better accommodate noisy image and image variations[7]. 2D wavelet transform is used to obtain low resolution image then 1D DWT can be applied to reduce dimensionality of feature vector. Here Sobel operator is used to extract iris features[12]. Energy compaction property for feature extraction can be used where the concept of partial energies of transformed images is used , which reduces feature vector size. Low energy means low frequency components can be used to generate a feature vector. To transform images Cosine, Walsh, Haar, Hartley transforms, and their wavelets are used. Among this Walsh gives best performance with Genuine Acceptance Rate of 85% considering 99% and 98% partial energies[13]. In [14], combined Gabor and morlet wavelet are used for feature extraction, where extracted phase code information is encoded using gray scale code of 4096 phase bits is generated[14].

In [16], Radon transform identified circular boundaries of sclera, iris, and pupil. And triangular DCT is used to extract features, which reduces feature vector size. In [17],Gabor wavelet demodulates texture features and from low frequency data GLCM (Gray Level Co-occurrence Matrix) based Haralick features were computed which gives CCR of 97% for UBIRIS database. Walsh Hadamard transform is used for feature vector of only 16 coefficients, which gives accuracy of 94%[18]. Combination of DWT and ICA (Independent Component Analysis) extracted iris feature vector, which gives accuracy of 97% along with fuzzy classifier [19]. GHM multiwavelet transformation is applied to prefilterd iris image , where LL band contains low frequency information, which contains most of the energy. This method [21] gives FAR and FRR of 1.59% and 2.76% respectively. The experiment was carried out using Gabor, DCT, GLCM, and combination of these three. It is observed that when GLCM was used alone , gives better recognition accuracy of 96%. After Radon transform thresholding as a feature extraction technique and preprocessing technique using gradient based isolation , extracted features were applied to BPSO (Binary Optical Swarm Optimization) feature selector along with Euclidean distance for matching. It gives maximum recognition rate of 87.96% ,86.14%, and 60.01% for images of phoenix , IITD, and CASIA database respectively[23]. In [25], local iris feature were extracted using a LBP(Local Binary Pattern) and global information of iris texture were captured using radon transform and energy vectors of both are combined to get feature descriptor. In block based approach of [29], detailed time frequency information and multiresolution property of DWT is combined with energy compaction property of DCT to form feature vector coefficient. And using a standard deviation method, identification of individual is done. The experiment is carried on UBIRIS and recognition time was 0.2718sec and 0.9512 sec for DCT and DWT respectively for a block image size of 10 x 10. Recognition efficiency is highest for block 10 x10 and it is 98% for DWT and 96% for DCT respectively. Iris crypts are thin areas of iris may exist near the collarette or in periphery of iris. It has low homogenous intensity in the interior than that of the neighboring pixels in exterior. Key morphological operation is applied for segmentation. Equal Error rate found was 0.033 for ICE2005 database.

C. Classification

Classification is done by template matching against the stored template for verification by one-to-one matching or by identification one to many matching. In matching step, the feature vectors are classified through different algorithms like Hamming Distance, Euclidean distance, weight vector, dissimilarity function, or Neural network. And then verification and identification are carried out.

In [4], [5], [9], and [14] Hamming distance is used as a matching algorithm for recognition of two template comparison. Location of fragile bits is used for matching. A Fragile Bit Distance (FBD) is combined with hamming distance that is 0.6HD+0.4FBD and used as a matching score. It gives lowest EER. Low FBD stands for genuine comparison. Multiplication of two that is HD X FBD gives better result at 15% fragile bit masking[10].Support Vector Machine (SVM) is used to classify features [15].Euclidean distance is used as a matching score in [12] and [22].Similarity measure such as a Mean Square Error is used for matching in [13] and [16]. In [17], they used Probability neural network as a classifier. Neural network based on pattern recognition is used along with different neural network configurations including Multilayer Perceptron (MLP), Radial Basis Function (RBF), and a Support Vector Machine. It is observed that the performance of MLP based PR system was consistent and reliable [18]. To reduce heavy computation and to improve recognition rate, fuzzy based classifier approach is proposed in [19].

III. Databases Available And Performance On Them

TABLE I: COMPARISON OF IRIS BIOMETRICS ON DIFFERENT DATABASES

Ref. No	Database	No. of subject	No .of Images per subject	Accuracy in %	EER in %	FAR in %	FRR in %	Exec. Time in sec
[3]	CASIA	249	--	94				Zero
[4]	WVU:IBIDC		--	99.83	0.15	0.02	0.15	-
[37]	CASIA	249	--	99.69	0.303	0.313	0.229	15.5
[7]	UBIRIS		--	63	0.119	-	-	-
	FRGC		--	55.8	0.1986	-	--	--
	CASIA V4	108	--	95	0.029	-	--	--
[8]	NDB	-	----	98.94	0.6	0.01	--	--
[10]	Own dataset	686	108 (54 for each iris)	--	0.008	0.001	0.013	--
[11]	ND	676		99.15	--	--	--	--
	ICE2005	132		98.13	--	--	--	--
[12]	Own dataset	102		92.82	16.76	0	0.014	--
[13]	Palacky university database	64	6	85 with walsh wavelet transform	--	--	--	--
[15]	CASIA	54		96.3	--	--	--	--
[16]	phoenix			88.89	--	--	--	--
	MMU	45	10	78.04		--	--	--
	IITD	224	5	94	--	----	--	--
[17]	UBIRIS	190	2	97	--	2.74	3.15	--
[18]	Own dataset	10	7	90	--	--	--	--
[19]	UBIRIS	241	5	97	--	--	--	--
[21]	JLUBR-IRIS	200	--	--	--	1.59	2.76	--
[22]	UBIRIS.V1			96	--	--	--	--
[23]	PHOENIX	64	3	87.96	--	--	--	--
	IITD	224	5	86.14	--	--	--	----
	CASIA	48	>5	60.01	--	--	--	--
[24]	CASIA			99.95	0.055	-	--	9.5
[27]	Palacky university database	64	6	--	0.8	3	0.54	--
[29]	UBIRIS	100	5	98	--	--	--	--
[30]	CASIA				0.54	0.001	37.88	
[31]	ICE2005	122	--	--	0.033	--	--	--

TABLE I: COMPARISON OF IRIS BIOMETRICS ON DIFFERENT DATABASES

IV. Iris Biometrics - security and privacy

The use of iris biometric systems in large-scale government military and civilian based applications has raised the question of iris template's security. Security and privacy of centralized databases, which can store millions of iris templates is of important concern. Privacy-enhancing technology along with cancelable biometrics is likely to raise the privacy and security levels of such information. In [12] , idea of canceling biometrics is used. Sparse representation and recognition of iris image is used which protects original iris patterns as well reissue new patterns when old ones are lost or stolen. Cancelability is through random permutations of dictionary columns. They propose score level fusion approach, where they combine the recognition results of different sectors based on recognition confidence using corresponding Sparsity Concentration Index (SCI) values. They achieved recognition performance on ICE 2005 database as 98.13%. However, more research is required to include security schemes in an operational environment. The grid based watermarking algorithm uses a hybrid singular value decomposition (SVD). This method was strong and undetectable and resolves various watermarking attacks in robust manner [27].

V. Conclusion And Future Work

The research related to iris biometrics is growing rapidly with more challenges. This survey presents various methodologies used by different researchers for last few years. Different methods for iris localization, segmentation,

and feature extraction were discussed. Results of various iris recognition techniques are summarized. There is still a scope of improvement so that researchers can develop fast, efficient, reliable, and robust algorithms to improve recognition accuracy. Many of these will be related to make iris recognition ideal in less-controlled environments and also a real time process as correct as possible. To enhance security and privacy of existing iris recognition algorithms, if security algorithms were included in them, it will be a wide research area for new researchers. Future work need algorithm which should robust against rotation and extraction of local and global features. Dynamic texture descriptors of iris can also be considered as a possible direction of future work. Recognition rate should be improved by improving classification and distance measures. Off angle poor contrast iris images recognition is also a vast area for researchers. Few combined transforms for feature extraction and combination of two or more neural networks for classification can be implemented to improve recognition accuracy.

Iris recognition systems also have research and development opportunities in the areas of iris capturing sensors, lowering FTE and FTA rates, capturing and recognizing the iris at greater distances with movement of an individual also reducing the size of the hardware, increasing speed of computation. Iris biometrics security, integrity, and reliability is also can be considered as a emerging research area. Information security research is needed that addresses the problems of biometric systems, such as preventing attacks based on the fake biometrics, the reissue of previously captured biometric samples, and the concealment of biometric traits.

REFERENCES

[1] Chia-Te Chou, Sheng-Wen Shih, "on Orthogonal View Iris Recognition system" IEEE transactions on circuit and systems for video technology, 2010.

[2] Vishnu Boddeti, B.V.K. Vijay Kumar, "Extended depth of field Iris Recognition using unrestored wavefront coded Imagery," IEEE transactions on systems, MAN and cybernetics Part A: system and humans, vol.40, no.3, May, 2010, pp495-508.

[3] Amir shahram, Hematian, Aziazh, Abdul Manaf, "Field programmable gate array system for real time-Iris Recognition", IEEE conference on open systems , 2012.

[4] Hiew Moi, Hishammudi Asmuni, Rohyanti, Hassan, RazibM.Othman, "A Unified approach for unconstrained off angle Iris Recognition"IEEE sponsored International Symposium on biometrics and security technologies,2014,pp-39-44 .

[5] Osman M .Kurtunui, Mahmut Karkaya, "Limbus Impact removal for off- angle Iris Recognition using eye models" IEEE 7th International conference on Biometrics theory, applications and Systems,pp-1-6 .

[6] Kumal Hajari ,Kishor Bhoyar, "A review of issues and challenges in designing Iris recognition systems for noisy image environment, IEEE transaction on International conference on Pervasive computing 2015.

[7] Chun-weiTan, Ajaykumar, "Accurate Iris recognition at a distance using stabilized Iris encoding and zernike moment phase features",IEEE Transactions on image processing ,vol-23,no-9,September 201,pp-3962-3974.

[8] Dongdong Zhao, WenjianLuo, RanLiu,LihuaYue, "Negative Iris recognition", Proceedings of IEEE transactions on dependable and secure computing.,2015 pp-1-15.

[9] Kiennguyen,SridhaSridharan,Simon Denman, "Quality driven super resolution for less constrained iris recognition at distance and on the move." , IEEE transactions on information forensics and security,vol-6,no-4, December2011,pp-12481258.

[10] Karen P. Hollingsworth ,Kelvin W.Bower, Patrick J. Flynn. " Improved Iris recognition through fusion of hamming distance and fragile bit distance",IEEE transactions on pattern analysis and machine intelligence,vol-33,no-12,December2011,pp-2465-2476.

[11] Jaishankar K. Pillai, Vishal M.Patel, Rama Chellappa , Nalini Ratha, "Secure and robust Iris Recognition using random projections and sparse representations",IEEE transactions on pattern analysis and machine intelligence.vol-33,no.9,2011.

[12] Arjun Agarwal, Gundeep Singh Bindra,Priyanka Sharma, "Feature based Iris Recognition system functioning on extraction of 2D features",IEEE sponsored International conference on System engineering and technology 2012,pp-1-5.

[13] Sudeep Thepade, Pushpa Manchal , "Energy compaction based novel iris recognition techniquesusing partial energies of transformed Iris images with Cosine,Walsh,Harr,Kekre,Hartley transforms and their wavelet transforms", Annual IEEE India conference,2014.

[14] S.Hariprasath, V.Mohan, "Biometric Personal Identification based on Iris recognition using complex wavelet transforms. ",IEEE International conference on computing, communication and networking,2008.

[15] *Min Han ,Weifeng Sun, Mingyan Li., "Iris recognition based on a Novel Normalization method and contourlet transform , Proceedings of 2009 2nd International Congress on Image and Signal Processing 2009.*

[16] Mrinalini I.R., Pratusha B.P.,Manikanton K. S. Ramachandran, "Enhanced Iris Recognition using Discrete cosine Transform and radon transform.", IEEE sponsored,2nd International conference on electronics and communication system, 2015,pp-1-6.

[17] R.Meenakshi Sundaram, Bibhas Chandra Dhara, "Neural network based Iris recognition system using Haralick features, Procededings of 3rd International Conference on Electronics Computer Technology (ICECT) 2011, pp-19-23,2011.

[18] Mrunal M.Khedakar, S.A. Ladhake, "Neural network based Iris pattern recognition system using Discrete Walsh Hadamard transform features", IEEE sponsored International conference on Advances in computing ,communications and Informatics,2013 ,pp-388-393.

[19] Naresh Babu NT, Vaidehi V., "Fuzzy based Iris recognition system for person identification.", IEEE sponsored International conference on recent trends in information technology, 2011 pp-1005-1010.

[20] A. Aldhahab, G. Atia and W. Mikhail, "Supervised Facial Recognition based on Multiresolution Analysis with Radon Transform," 48th Asilomar Conference on Signals, Systems and Computers, Pacific Grove CA, Nov 2014.

[21] Yuanning Liu and FeiHe, Yonghua Zhao, Ning Wang, "An Iris recognition based on GHM multiwavelet transformation", IEEE 4th International conference on Innovative computing ,Information and control,2009,pp-793-796.

[22] Aalaa Albadarneh, Israa Albadarneh, Jafar Alquatawna, "Iris recognition system for secure authentication based on texture and shape feature."IEEE International Jordan conference on applied electrical engineering and computing technologies, 2015.

[23] B.V.Bharath,Vilas, S.,K.Manikantan,S.Ramachandran. "Iris Recognition using Radon transform thresholding based feature extraction with gradient based isolation as a preprocessing technique.", 9th International Conference on Industrial and Information Systems,2014,pp.1-8.

[24] Lin Zhonghua, Lu Bibo, "Iris recognition method based on the coefficients of morlet wavelet transform," IEEE sponsored International conference on Intelligent Computation technology and automation,2010 pp-576-580.

[25] Izem Hamouchene, Saliha,Aoqat, "Texture matching using local and global descriptor.", IEEE sponsored 5th European workshop on Visual image processing, (EUVIP), 2014.

[26] Mohammad Javed, Aligholizadeh Shahram Javedi, Kareh Kangarloo., "Eyelid and eyelash segmentation based on wavelet transform for Iris recognition.", IEEE sponsored 4th International congress on Image and signal processing, 2011, pp-1231-1235.

[27] Lydia Elizabeth, Duraipandi C, AnjuPratap, Rhymed Uthariraj W. " A Grid based Iris Biometric watermarking using wavelet transform.", IEEE sponsored International conference on recent trends in Information Technology 2014 ,pp.1-6,.

[28] Salim Lahmiri, Mounir Bhukadoum, "DWT and DT based approach for feature extraction and classification of mammograms with SVM",IEEE sponsored International conference on Biomedical Circuits and Systems Conference , 2011, pp-412-415.

[29] Ameya Deshpande, Sumitkumar Dubey, Satishkumar Chavan, Aditya Potnis, "Iris Recognition system using Block based approach with DWT and DCT", Annual IEEE India Conference, 2014.

[30] Prajoy Poddev, Tanvir Zaman Khan, Mamdulul Haque Khan, Rafi Ahmed ,MdSaifur Rahman, "An efficient Iris segmentation model based on eyelid and eyelashes detection in Iris recognition systems", IEEE sponsored International conference on Computer communication and Informatics,Coimbatore,India,2015.

[31] Jianxu Chen, Feng Shen, DannyZ.Chen, Patrick J.Flynn , "Iris recognition system based on Human Interpretable features", IEEE Transactions on Identity, Security , and Behaviour analysis, 2015,"pp 1-6.

[32] V.V. Satyanarayana, Tallapragada, Dr.E.G.Rajan, "Morphology based Non-ideal Iris recognition using decision tree classifier.", IEEE sponsored International conference on pervasive computing.," 2015,pp 1-14.

[33] Libor Masek, "Recognition of Human Iris Patterns for Biometric Identification",www.peterkovesi.com/studentprojects/libor/LiborMasekThesis.pdf

[34] Nitin K. Mahadeo, Gholamreza Haffari, Andrew P. Paplinski"Predicting Segmentation errors in an Iris recognition." International conference on Biometrics 2015,pp23 -30.

[35] Zhonghua Lin, "A Novel Iris recognition method based on the natural open eyes.", IEEE sponsored (ICSP) 2010 conference Proceedings , pp 1090- 1093.