PCA AND CENSUS TRANSFORM BASED IRIS RECOGNITION WITH HIGH THROUGHPUT

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Abstract: The performance of existing algorithms is significantly affected when iris are captured with diverse acquisition settings such as multisession, multispectral, multi-resolution, with slap, and with latent iris. In this paper, present the multi-sensor optical and latent iris database of more than 1000 iris images with different intra-class variations during iris capture. Crypt based detection has gained more popularity, but it shows poor performance in case of low quality images. Whereas correlation based methods provides better results for such images. In this paper propose a new correlation method based on the sum of hamming distance between the reference iris in database and intruding iris. The proposed method involves bit level computing operations and less preprocessing steps, thus faster than other conventional correlation based matching.
Keywords*:* PCA-Principle Component Analysis, FAR-False Acceptance Ratio, FRR-False rejection ratio

I-INTRODUCTION

We are developing algorithms which are more robust to noise in iris images and deliver increased accuracy in real-time. A commercial iris-based authentication system requires a very low False Reject Rate (FAR) for a given False Accept Rate (FAR). This is very difficult to achieve with any one technique. We are investigating methods to pool evidence from various matching techniques to increase the overall accuracy of the system. In a real application, the sensor, the acquisition system and the variation in performance of the system over time is very critical. We are also field testing our system on a limited number of users to evaluate the system performance over a period of time.

Iris Image Enhancement/ PRE-PROCESSING: A critical step in automatic iris matching is to automatically and reliably extract crypt from the input iris images. However, the performance of a crypt extraction algorithm relies heavily on the quality of the input iris images. In order to ensure that the performance of an automatic iris identification/verification system will be robust with respect to the quality of the iris images, it is essential to incorporate a iris enhancement algorithm in the crypt extraction module. We have developed a fast iris enhancement algorithm, which can adaptively improve the clarity of furrows and furrow structures of input iris images based on the estimated local furrows orientation and frequency. We have evaluated the performance of the image enhancement algorithm using the goodness index of the extracted crypt and the accuracy of an online iris verification system. Experimental results show that incorporating the enhancement algorithms improves both the goodness index and the verification accuracy.

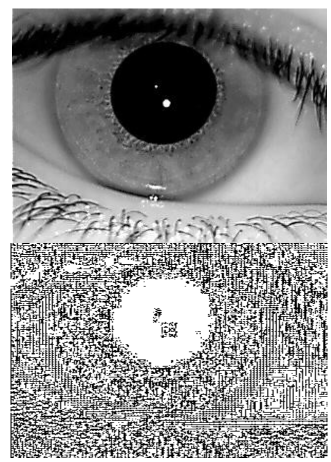

Figure 1 Pre-processing using census transform on iris images

II-METHODOLOGY

Proposed work use CASRA database, CASRA iris is a Standard Database images which are available in the public domain. The CASRA database contains 8 impressions each of 10 distinct eyes. Therefore we have total 80 iris in the database.

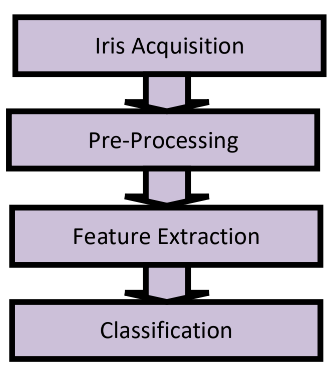

Figure 2: dataflow for system design

Database & Iris Acquisition: CASRA Iris standard database is been used, and Iris Acquisition can be done by iris sensors.

Pre-Processing: Census Transform is been used for pre-processing.

Feature Extraction: the output of census transform contains features of iris.

Classification: it is done with the help of PCA method.

Census Transform is a non-parametric local transform which is used to map the intensity values of the pixels within a square window to a bit string to capture the image structure. This type of local transformation relies on the relative ordering of local intensity values rather than the intensity values them. The idea is to order the information among data, rather than the physical data values. census model as given in the equation

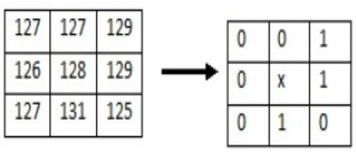

Figure 3 Census transform of 3x3 segment of image

Let I is the any image and the pixel with value 128 which is at centre position at I(x,y), Then

If I(x-1,y-1)= 1 when I(x-1,y-1)> I(x,y) else I(x-1,y-1)= 0

If I(x-1,y)= 1 when I(x-1,y)> I(x,y) else I(x-1,y)= 0

If I(x-1,y+1)= 1 when I(x-1,y+1)> I(x,y) else I(x-1,y+1)= 0

If I(x,y-1)= 1 when I(x,y-1)> I(x,y) else I(x,y-1)= 0

If I(x-1,y+1)= 1 when I(x-1,y+1)> I(x,y) else I(x-1,y+1)= 0

If I(x+1,y-1)= 1 when I(x+1,y-1)> I(x,y) else I(x+1,y-1)= 0

If I(x+1,y)= 1 when I(x+1,y)> I(x,y) else I(x+1,y)= 0

If I(x+1,y+1)= 1 when I(x+1,y+1)> I(x,y) else I(x+1,y+1)= 0

I(x,y)=1

The above process must be done for all 3x3 segment of iris and this must be done for the complete image. the aim of census transform is to modifies the original image and find its orientation as can be observe in the figure below the output of census transformed image has less value pixel as it is binary image all pixel of 8 bits converts into 1 bit image. the census transform is time domain transformation and can be used for any image it is exclusive for iris only.

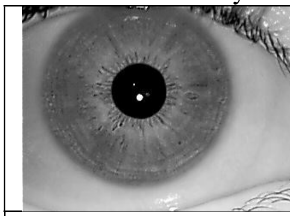	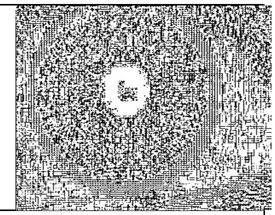
Before census transform	After census transform

Figure 4 census transform

PCA- PRINCIPLE COMPONENT ANALYSE: First principal component has largest possible variance (that is, accounts in order to as much in order to variability in data as possible), and each succeeding component in turn has highest variance possible under constraint that it is orthogonal to (i.e., uncorrelated with) preceding components. Principal components are orthogonal because they are eigenvectors in order to covariance matrix, which is symmetric. PCA is sensitive to relative scaling in order to original variables. Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components.

In order to recognize iris in this procedure initially need to Eigen iris database with help of PCA, then input new iris and again convert it into its Eigen iris using PCA and they compare basically Eigen iris only (principle components only) if there is match it will be recognition and if not it will not be recognition.

Here we are explaining the Calculation of PCA for Let B1 is the first 8x8 block of X. the singular value decomposition of an 8x8 real matrix B1 is a factorization of the form $\boldsymbol{USV^T}$, where U is an 8x8 real matrix, S is a 8x8 rectangular diagonal matrix with non-negative real numbers on the diagonal, and V is an 8x8 real or complex unitary matrix. The diagonal entries $\boldsymbol{\sigma_i}$ of S are known as the principal values of B1. The columns of U and the columns of V are called the left-singular vectors and right-singular vectors of B1, respectively.

$$\boldsymbol{W1 = B1xB1^T}$$

$$\boldsymbol{(W1 - \sigma_i I) = 0}$$

For a unique set of principal values to determinant of the matrix (W1-$\boldsymbol{\sigma_i}$) must be equal to zero. Thus from the solution of the characteristic equation,

$|W1-\boldsymbol{\sigma_i}|=0$ we obtain eight singular values of $\boldsymbol{\sigma_i}$ ***where*** $\boldsymbol{i = 1, 2, \ldots.. 8}$

$$S = \begin{matrix} \sigma 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \sigma 2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma 3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \sigma 4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma 5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \sigma 6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \sigma 7 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma 8 \end{matrix}$$

And if values of $\boldsymbol{\sigma_i}$ again put into equation we obtain x1, x2, x3, x4, x5, x6 x7 and x8 value

$$(W1 - \sigma_i I)x \ = 0$$

$$U = \begin{matrix} x1 & -x2 & -x3 & -x4 & -x5 & -x6 & -x7 & -x8 \\ x8 & x1 & -x2 & -x3 & -x4 & -x5 & -x6 & -x7 \\ x7 & x8 & x1 & -x2 & -x3 & -x4 & -x5 & -x6 \\ x6 & x7 & x8 & x1 & -x2 & -x3 & -x4 & -x5 \\ x5 & x6 & x7 & x8 & x1 & -x2 & -x3 & -x4 \\ x4 & x5 & x6 & x7 & x8 & x1 & -x2 & -x3 \\ x3 & x4 & x5 & x6 & x7 & x8 & x1 & -x2 \\ x2 & x3 & x4 & x5 & x6 & x7 & x8 & x1 \end{matrix}$$

And if

$$\boldsymbol{W2 = B1^T x B1}$$

$$\boldsymbol{(W2 - \sigma_i I)x \ = 0}$$

And if values of $\boldsymbol{\sigma_i}$ again put into equation we obtain x1, x2, x3, x4, x5, x6 x7 and x8 value

$$\boldsymbol{V} = \begin{matrix} x1 & x2 & x3 & x4 & x5 & x6 & x7 & x8 \\ -x8 & x1 & x2 & x3 & x4 & x5 & x6 & x7 \\ -x7 & -x8 & x1 & x2 & x3 & x4 & x5 & x6 \\ -x6 & -x7 & -x8 & x1 & x2 & x3 & x4 & x5 \\ -x5 & -x6 & -x7 & -x8 & x1 & x2 & x3 & x4 \\ -x4 & -x5 & -x6 & -x7 & -x8 & x1 & x2 & x3 \\ -x3 & -x4 & -x5 & -x6 & -x7 & -x8 & x1 & x2 \\ -x2 & -x3 & -x4 & -x5 & -x6 & -x7 & -x8 & x1 \end{matrix}$$

U, S and V computed for each 8x8 block of X , As explain above.

PCA works with Eigen value in which the Eigen values of test iris computed first, if x is the test iris then

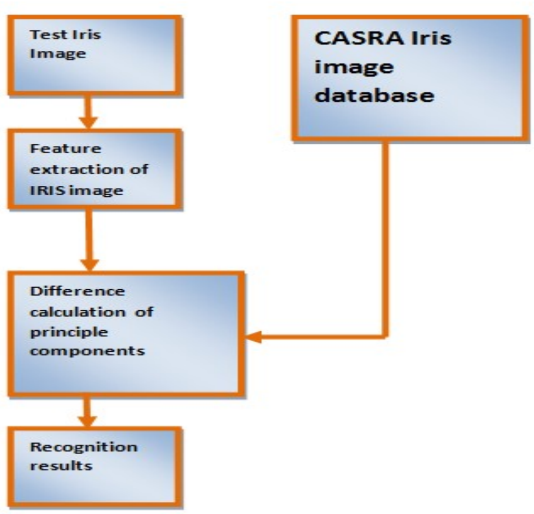

Figure 5 PCA based Recognition

A=eig(x)
Let say Ym is the CASRA Database
Bm=eig(Ym)
Cm=Bm-A
[val, pos]=Min(Cm)
Pos is the most matched iris

Figure 6 shown below shows block diagram of proposed design it may be observed in diagram that Iris Acquisition for database & iris which is to be recognised is shown, after iris & CASRA database acquiring pre-processing is been done on both CASRA database [10] & iris which is to be recognised. Pre-processing done with census transform and after census transform the iris features converted into Eigen iris features and this Eigen features gets compare not the full image which significantly reduces the time to compare, also because the Eigen values does not depends on the positions, location and image rotation so our proposed method will is from this type of problems and it works for all situations.

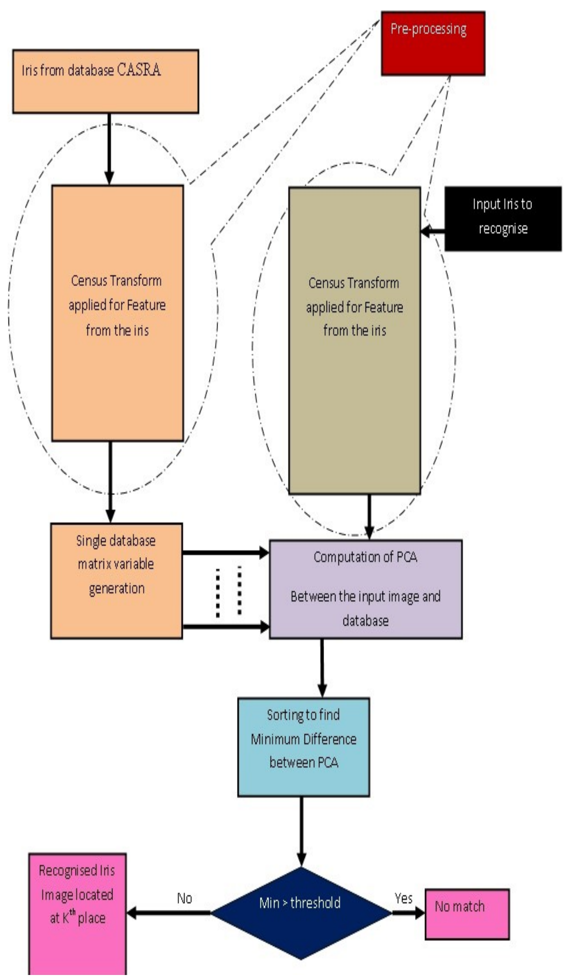

Figure 6: block Diagram of Proposed Design

Steps of the block diagram can be explained as below:-

Step 1: acquire the CASRA database for the drive.

Step 2: perform Census transform on all the CASRA database images and convert all transform images into an single column, as there are total 80 images available in census transform all the columns will be concatenated vertically and develop a database matrix with 80 columns.

Step 3: input the test iris and perform census transformed on it

Step 4: generate Eigen features of CASRA database matrix using applying PCA on database CASRA matrix where each columns is database iris.

Step 5: compute Eigen features of census transformed test iris.

Step 6: compute the difference between test iris Eigen feature and each column of Eigen feature CASRA database matrix

Step 7: Perform sorting to find minimum difference and find the column position in Eigen feature CASRA database matrix, that column will have maximum matching with the test iris Eigen feature.

Step 8: if the difference is more means less match and if difference is less means more matching, and if the difference is below than threshold level we can say it's a match of iris.

III-RESULTS

Throughput: throughput is rate of execution means number of bits processed in one second. It may be computed with help of time taken for processing & finding figure print.

$$throughput = \frac{number\ of\ bits\ processed\ for\ Execution}{Time\ delay}$$

Matching percentage: percentage of similar pixels in two images it can be measure sing formula below

$$Match\% = \frac{\{\sum_{i=1}^{R}\sum_{j=1}^{C} corr(p_{ij}, p_{ij}) - \sum_{i=1}^{R}\sum_{j=1}^{C} corr(p_{ij}, q_{ij})\}}{RxC}\ x\ 100$$

Let p is Eigen features of test iris and q is the Eigen features of CASRA database, R is the number of rows and C is the number of columns.

Acceptance ratio: A.R. is the correct match found out of total attempts

$$A.R. = \frac{total\ match * 100}{total\ attampt}$$

Rejection ratio: Rejection ratio R.R. is the total non match found out of total attampts.

$$R.R. = \frac{total\ non\ match * 100}{total\ attampt}$$

False Acceptance Ratio: FAR is the probability that the system will decide to allow access to an imposter.

$$FAR = \frac{False\ non\ matched}{Imposter\ attempts}$$

False Rejection Ratio: FRR is the probability that the system denies access to an approved user.

$$\text{FRR} = \frac{\text{False matched}}{\text{Enrolled attempts}}$$

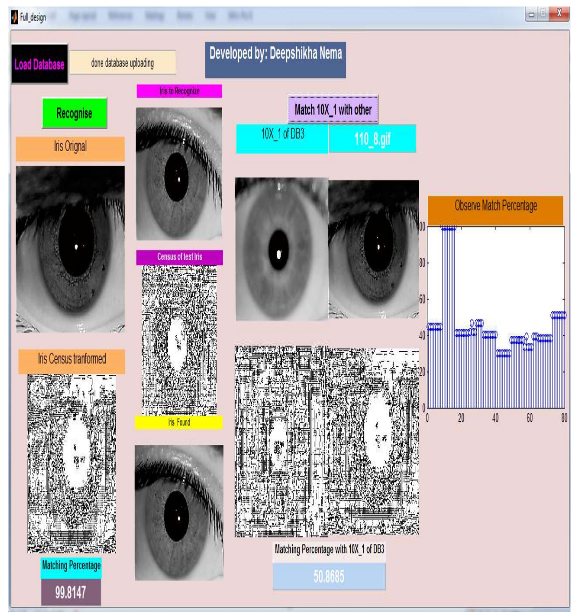

Figure 7: GUI after complete testing

Figure 7 above shows the GUI for developing results like R.R. , A.R. , FAR and FRR , it can be seen in the GUI that a iris of any specific person selected and it gets compare with all other person iris and matching percentage is also mention. Figure 7 above shows the GUI after all execution it can be seen in the iris matching percentage for 102_1 test iris is high when its gets compare with 102_x images only and it is less rest of iris.

	% match with 101_1		% match with 102_1		% match with 103_1		% match with 104_1		% match with 105_1
101_1	100	102_1	100	103_1	100	104_1	100	105_1	100
101_2	90.02	102_2	70.12	103_2	62.98	104_2	80.71	105_2	61.94
101_3	63.73	102_3	98.27	103_3	53.99	104_3	76.03	105_3	71.78
101_4	73.31	102_4	60.67	103_4	74.03	104_4	89.52	105_4	99.46
101_5	79.32	102_5	64.73	103_5	57.39	104_5	56.42	105_5	76.2
101_6	63.5	102_6	36.67	103_6	59.65	104_6	68.12	105_6	88.25
101_7	57.04	102_7	66.93	103_7	83.66	104_7	66.6	105_7	72.43
101_8	27.79	102_8	40.39	103_8	49.6	104_8	74.39	105_8	78.98

Table 1 matching percentage with similar iris

	% match with 106_1		% match with 107_1		% match with 108_1		% match with 109_1		% match with 110_1
106_1	100	107_1	100	108_1	100	109_1	100	110_1	100
106_2	79.39	107_2	82.95	108_2	98.89	109_2	43.76	110_2	68.85
106_3	79.66	107_3	62.62	108_3	99.05	109_3	74.77	110_3	69.23
106_4	97.88	107_4	83.44	108_4	93.38	109_4	80.22	110_4	73.32
106_5	80.3	107_5	83.94	108_5	18.93	109_5	92.35	110_5	71.12
106_6	94.55	107_6	89.65	108_6	83.47	109_6	88.75	110_6	87.16
106_7	88.55	107_7	88.2	108_7	85.73	109_7	97.4	110_7	87.79
106_8	72.32	107_8	82.91	108_8	65.43	109_8	65.37	110_8	92.44

Table 2 matching percentage with similar iris

Table 1, table 2 and above shows the results observe after comparison of following:-

101_1 with 101_1, 101_2, 101_3, 101_4, 101_5, 101_6, 101_7 and 101_8
102_1 with 102_1, 102_2, 102_3, 102_4, 102_5, 102_6, 102_7 and 102_8
103_1 with 103_1, 103_2, 103_3, 103_4, 103_5, 103_6, 103_7 and 103_8
104_1 with 104_1, 104_2, 104_3, 104_4, 104_5, 104_6, 104_7 and 104_8
105_1 with 105_1, 105_2, 105_3, 105_4, 105_5, 105_6, 105_7 and 105_8
106_1 with 106_1, 106_2, 106_3, 106_4, 106_5, 106_6, 106_7 and 106_8
107_1 with 107_1, 107_2, 107_3, 107_4, 107_5, 107_6, 107_7 and 107_8
108_1 with 108_1, 108_2, 108_3, 108_4, 108_5, 108_6, 108_7 and 108_8
109_1 with 109_1, 109_2, 109_3, 109_4, 109_5, 109_6, 109_7 and 109_8
110_1 with 110_1, 110_2, 110_3, 110_4, 110_5, 110_6, 110_7 and 110_8

This comparison are done because we need to check whether our proposed design is detecting correct iris, proposed work is set a threshold at 55% means the genuine iris must have comparison more than 55% and other iris must not go above 55%.

COMPARATIVE RESULTS: Table 3 below is the observation of iris recognition when iris 101_1 is compared with 101_1, 101_2, 101_3, 101_4, 101_5, 101_6, 101_7 and 101_8 because all of this are the iris of same person it must be more than 55%, the same results are also been computed by Shalendra tiwari et al [1] with their Hamming Score based method

Eye	Hamming Score Based Percent Match (101_1) Shalendra tiwari et al [1]	Proposed work Matching
101_1	100	100
101_2	56.36	90.02
101_3	44.31	65.73
101_4	46.31	75.31
101_5	34.71	79.32
101_6	34.8	65.5
101_7	34.34	57.043
101_8	35.19	27.79

Table 3 Comparison with Shalendra tiwari et al [1] for 101_1

From above it can be observe that proposed method has 7 match out of 8 and Shalendra tiwari et al [1] method has only one 5 match out of 8 if 35% threshold considered.

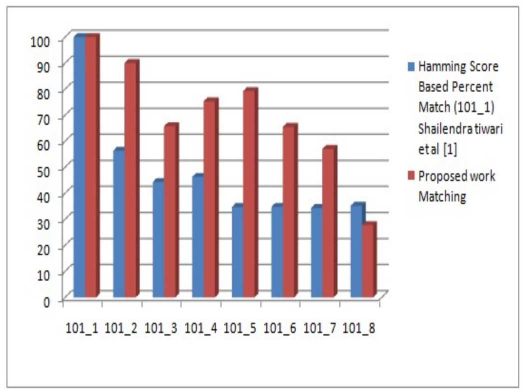

Figure 8 Comparison with Shalendra tiwari et al [1] for 101_1

Eye	Hamming Score Based Percent Match (101_1) Shalendra tiwari et al [1]	Proposed work Matching
102_1	100	100
102_2	52.63	70.12
102_3	42.31	98.274
102_4	41.47	60.61
102_5	35.03	64.73
102_6	34.93	36.67
102_7	33.78	66.93
102_8	34.62	40.39

Table 4 Comparison with Shalendra tiwari et al [1] for 102_1

Table 4.4 below is the observation of iris recognition when iris 102_1 is compared with 102_1, 102_2, 102_3, 102_4, 102_5, 102_6, 102_7 and 102_8 because all of this are the iris of same person it must be more than 55%, the same results are also been computed by Shalendra tiwari et al [1] with their Hamming Score based method

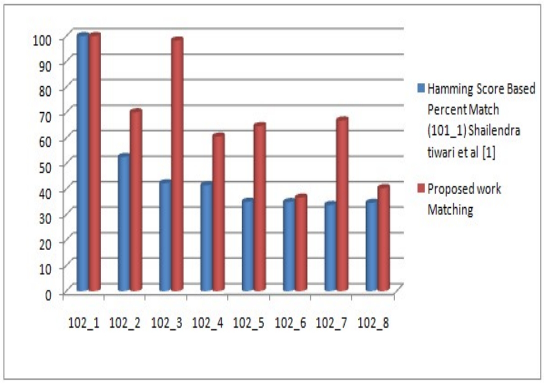

Figure 9 Comparison with Shalendra tiwari et al [1] for 102_1

Table 5 below are results observe for after simulation of all individual iris

Eye	Matched	Not-Matched
101_1	7	1
102_1	6	2
103_1	7	1
104_1	8	0
105_1	8	0
106_1	8	0
107_1	8	0
108_1	7	1
109_1	7	1
110_1	8	0

Table 5 iris match results

Table 6 and figure 10 and figure 11 below shows the comparative results with Shalendra tiwariet al [1] for the Acceptance ratio (AR) and rejection ratio (RR), it can be clearly observe that proposed PCA based work is showing better AR and less RR then Shalendra tiwari et al [1] Hamming score based work.

	Shalendra tiwari et al [1]		Proposed work	
Eye	Hamming Score Based A.R.	Hamming Score Based R.R.	PCA based A.R.	PCA based A.R.
101_1	62.5	37.5	87.5	12.5
102_1	62.5	37.5	75	25
103_1	62.5	37.5	87.5	12.5
104_1	50	50	100	0
105_1	50	50	100	0
106_1	87.5	12.5	100	0
107_1	87.5	12.5	100	0
108_1	37.5	62.5	87.5	12.5
109_1			87.5	12.5
110_1			100	0

Table 6 AR and RR comparative results observation

Table 7 below shows the comparative results with Shalendra tiwari et al [1] for the FAR and FRR, it can be clearly observe that proposed PCA based work is showing better FAR and less FRR then Shalendra tiwari et al [1] Hamming score based work

	Shalendra tiwari et al [1]		Proposed work	
Eye	Hamming Score Based FAR	Hamming Score Based FRR	PCA based FAR	PCA based FRR
101_1	0.0625	0.0375	0.0875	0.0125
102_1	0.0625	0.0375	0.075	0.025
103_1	0.0625	0.0375	0.0875	0.0125
104_1	0.05	0.05	0.1	0
105_1	0.05	0.05	0.1	0
106_1	0.0875	0.0125	0.1	0
107_1	0.0875	0.0125	0.1	0
108_1	0.0375	0.0625	0.0875	0.0125
109_1			0.0875	0.0125
110_1			0.1	0

Table 7 FAR and FRR observation and comparison

IV-CONCLUSION

Propose thesis work is a new PCA method based iris recognition. Proposed method uses Census transform for pre-processing. The proposed method involves bit level computing operations and less pre-processing steps, thus faster than other conventional matching methods. Proposed work also compared the results with the existing methods available in the literature to show its effectiveness

The match score comparison; acceptance and rejection ratios; FAR and FMNR for CASRA database is given above which depicts the effectiveness of the proposed method in iris identification system. Also it is to be noted that to store the reference iris huge amount of memory space is required.

REFERENCES

[1] shailendra tiwari, sudhakar tripathi,K.V. Arya,Score Level Fusion of Iris and Fingerprint using Wavelet Features, 2016 forth international conference on parallel distributed and grid computing(PDGC), IEEE 2016

[2] Rangaswamy Y, Raja K B, Straight-line Fusion based IRIS Recognition using AHE, HE and DWT, 2016 International Conference on Advanced Communication Control and Computing Technologies (ICACCCT), ISBN No.978-1-4673-9545-8, IEEE-2016

[3] Ayra Panganiban, Noel Linsangan and Felicito Caluyo, Wavelet-based Feature Extraction Algorithm for an Iris Recognition System, Journal of Information Processing Systems, Vol.7, No.3, September 2011 http://dx.doi.org/10.3745/JIPS.2011.7.3.425

[4] Ayra G. Panganiban, Noel B. Linsangan, and Felicito S. Caluyo, Implementation of Wavelet Transform-Based Algorithm for Iris Recognition System, International Journal of Information and Electronics Engineering, Vol. 2, No. 3, May 2012

[5] Adegoke, B. O., Omidiora, E. O, Ojo, J.A, and Falohun, S. A., Iris feature extraction: a survey, Computer Engineering and Intelligent Systems www.iiste.org, ISSN 2222-1719 (Paper) ISSN 2222-2863 (Online) Vol.4, No.9, 2013

[6] Harsha R , Dr. K. Ramesha, DWT Based Feature Extraction for Iris Recognition, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 4, Issue 5, May 2015, ISSN (Online) 2278-1021

[7] Kavita Anandrao Khobragade, Dr. K. V. Kale,Multi-wavelet based Feature Extraction Algorithm for Iris Recognition, ISSN: 2277-3754 ISO 9001:2008 Certified International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 12, June 2014

[8] Khattab M. Ali Alheeti, Biometric Iris Recognition Based on Hybrid Technique, International Journal on Soft Computing (IJSC) Vol.2, No.4, November 2011, DOI : 10.5121/ijsc.2011.2401 1

[9] RICHARD P. WILDES, MEMBER, IEEE, Iris Recognition: An Emerging Biometric Technology, 0018–9219/97/1997 IEEE, PROCEEDINGS OF THE IEEE, VOL. 85, NO. 9, SEPTEMBER 1997

[10] Abhineet Kumar, Dr. Anjali Potnis, Akhand Pratap Singh, Latest development in feature extraction techniques in iris recognition system, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 08 | Aug-2016

[11] Mateusz Trokielewicz, Iris Recognition with a Database of Iris Images Obtained in Visible Light Using Smartphone Camera, IEEE 2016, accepted for The IEEE International Conference on Identity, Security and Behavior Analysis (ISBA 2016), Feb 29 – Mar 2, 2016, Sendai, Japan

[12] Mahmoud Elgamal, Nasser Al-Biqami, An Efficient Feature Extraction Method for Iris Recognition Based on Wavelet Transformation, International Journal of Computer and Information Technology (ISSN: 2279 – 0764) Volume 02– Issue 03, May 2013

[13] Gargi Amoli, Nitin Thapliyal, Nidhi Sethi, Iris Preprocessing, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 6, June 2012 ISSN: 2277 128X

[14] Mahesh Patil, Raghuveer K, SVD and DWT Based Iris Recognition Using Beagleboard-xM, International Journal of Computer Science and Mobile Computing, IJCSMC, Vol. 4, Issue. 4, April 2015, pg.532 – 540