Iris Recognition Using Dual tree complex transform

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***Abstract* - A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Unlike other biometric such as fingerprints, hand geometry and face recognition, the distinct aspect of iris comes from randomly distributed features. Iris recognition is regarded as the most reliable and accurate biometric identification system available [1]. Due to its reliability and nearly perfect recognition rates, iris recognition is used in high security areas. In this paper dual tree complex wavelet transform is used as the feature extraction technique and hamming distance is used for classification. The obtained result showed that the proposed approach enhances the classification accuracy.**

***Keywords* - Biometric, Iris Recognition, DTCWT, Hamming Distance**

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1. INTRODUCTION

In today's world, identity verification is an increasingly important process in all phases of our daily lives. In order to use our own equipment, or to gain access to physical places, we have to prove our identity and satisfy our claim. So, it is important to have a reliable and robust authentication and identification system to identify a user.

Traditional access control methods fall into two categories: (i) knowledge-based authentication (proving that you know something such as password and personal identification number), (ii) token-based authentication (proving that you own something such as passport and driver's license). But these classical methods are vulnerable because the passwords can be lost, stolen or shared. This motivated researchers to seek for reliable and accurate alternative for identity verification over the traditional password/ ID card based systems. A solution to these problems of identification comes from the performance-based biometric systems where a user is recognized using his own biometrics.

A physiological characteristic is relatively stable physical characteristics, such as fingerprint, iris pattern, facial feature, hand silhouette, etc. This kind of measurement is basically unchanging and unalterable without significant duress. A behavioral characteristic is more a reflection of an individual's psychological makeup as signature, speech pattern, or how one type sat a keyboard. The degree of intra-personal variation in a physical characteristic is smaller than a behavioral characteristic.

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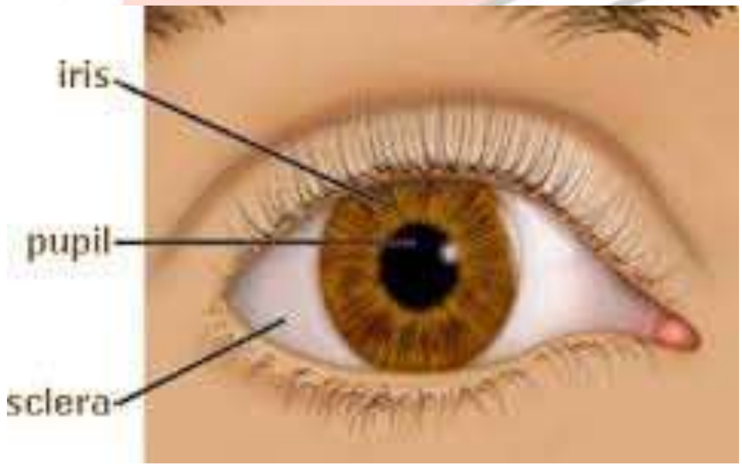


Figure1.Iris Image

There is world wide applications area of iris recognition system. National border controls as living passport, computer login: a password, secure access to bank account at ATM machine, ticketless travel, authentication in networking, permission access control to home, office, laboratory etc, driving licenses, and other personal certificates, tracing missing or wanted persons, anti-terrorism, security at airports, using as any type of password.

2. LITERATURE REVIEW

TITLE	AUTHOR & YEAR	ALGORITHM USED	CONCLUSION
1.Efficient Content Based Image Retrieval Using 2D Dual Tree Complex Discrete	Yogita Mistry Dr. D. T. Ingole M. D. Ingole	2D DTCWT Euclideance distance	Image retrieval using 2D complex dual tree DWT with four and six levels of decomposition is presented in this article.

Wavelet Transform			
2.Enhancement of IRIS Recognition Using Gabor Over FFBPANN	Shirke Swati, SuvarnaPansambal (shirke)(2015)	log 2D Gabor filter Hamming Distance	Iris recognition using log 2 D Gabor filter approach is define over FFBPANN to identify the authorized person. Gabor filter has more accuracy than ANN.
3.Iris Recognition System Using Circular Hough Transform	Mrigana walia Dr. Shaily Jain	Canny Edge Detector Circular Hough transformation	Tested using UBIRIS database of greyscale eye images in order to verify the claimed performance of Iris Recognition technology.
4. Iris Recognition System for Biometric Identification	Sowmya.B, Sreedevi.S.L	Hamming Distance	In this paper, an efficient method for personal identification and verification with iris patterns are presented.
5. A neural network based iris recognition system for personal identification	Usham Dias, Vinita Frietas, Sandeep P.S. Amanda Fernandes	circular hough transform, conjugate gradient algorithms	A biometric system based on Iris using Neural Network was presented. Canny edge detection gave the best results for threshold 0.2 and sigma between 2 and 4.
6.iris recognition using gabor	Shirke Swati D. . Prof.Gupta Deepak	Euclidean distance, 2-D Gabor	Novel iris recognition technique that minimizes false identification rates is discussed.
7. A coherent framework for multiscale signal and image processing (2005)	Ivan w. selesnick, Richard g.baraniuk, Nick g. kingsbury	Dual tree complex wavelet transform	The dual-tree cwt is a valuable enhancement of the traditional real wavelet transform that is nearly shift invariant and, in higher dimensions.
8.iris recognition system using biometric template matching technology (2010)	Sudha gupta, Viral doshi, Abhinav jain sreeram iyer	Hamming distance	The system performed with perfect recognition on a set of 40 eye images.
9. Image features extraction using the dual-tree complex wavelet transform	Stella vetova, Ivan ivanov	Dual tree complex wavelet transform	This paper introduces an algorithm for image feature extraction using dt cwt. It satisfies all modern requirements for optimum feature extraction rate.
10. Efficient biometric iris recognition using hough transform with secret key	Kriti sharma, Himanshu monga	Hough transform Canny algotithm	In this paper efficient biometric iris recognition using hough transform is presented.

3. PROBLEM IDENTIFICATION

Personal identification based on biometrics technology is a trend in future. Traditional approaches, for example, information keys, ID cards, username and password, are not satisfactory not reliable enough in security fields, biometrics authorizations based on iris, face, fingerprint have become a great research field. The iris recognition is regarded as a high accuracy verification technology, so that many countries have same idea of adopting iris recognition to improve safety of their key departments . Human iris can also be considered a valid biometrics for personal identification. Biometrics recognition based on iris patterns is a hotspot as face recognition and fingerprint recognition recently years. Iris is colored ring on human eye between pupil and the white sclera. And lots of physical biometric can be found in colored ring of tissue that surrounds pupil, such as filaments, corona, crypts, flecks, pits, radial furrows and striations. Iris features can be encoded by mathematical representation.
In real-time iris recognition software system, iris localization is a very important step for iris recognition. Iris regions segmentation accuracy and localization real-time performance will affect whole recognition system's correct rate and effectiveness for large-scale database.
Because iris region is a small object and has low grey value, this is very difficult to capture high contrast iris image clearly. In order to improve iris image contrast usually some illuminations such as near infrared light source are used to increase intensity; however these illuminations may result in some facular in iris image and affect iris segmentation and iris features.

4. METHODOLOGY

Iris Recognition System works in two phases i.e. training phase and testing phase. Both the phases go through Feature extraction and recognition step. In the training phase, extracted
features are stored in the database. In the recognition phase, test image is compared with images in database. Hamming distance is used for Classification and dual tree complex wavelet transform method is used for for feature extraction and circular hough transform is used for iris recognition.

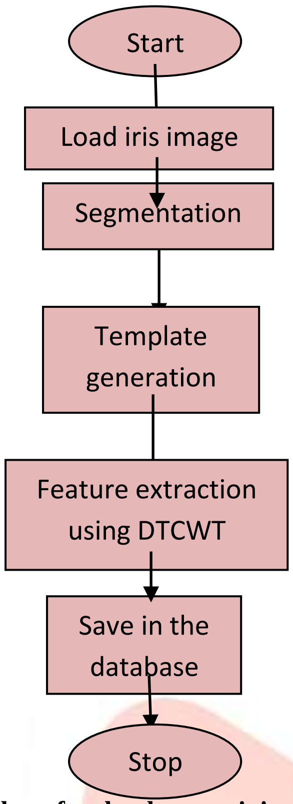
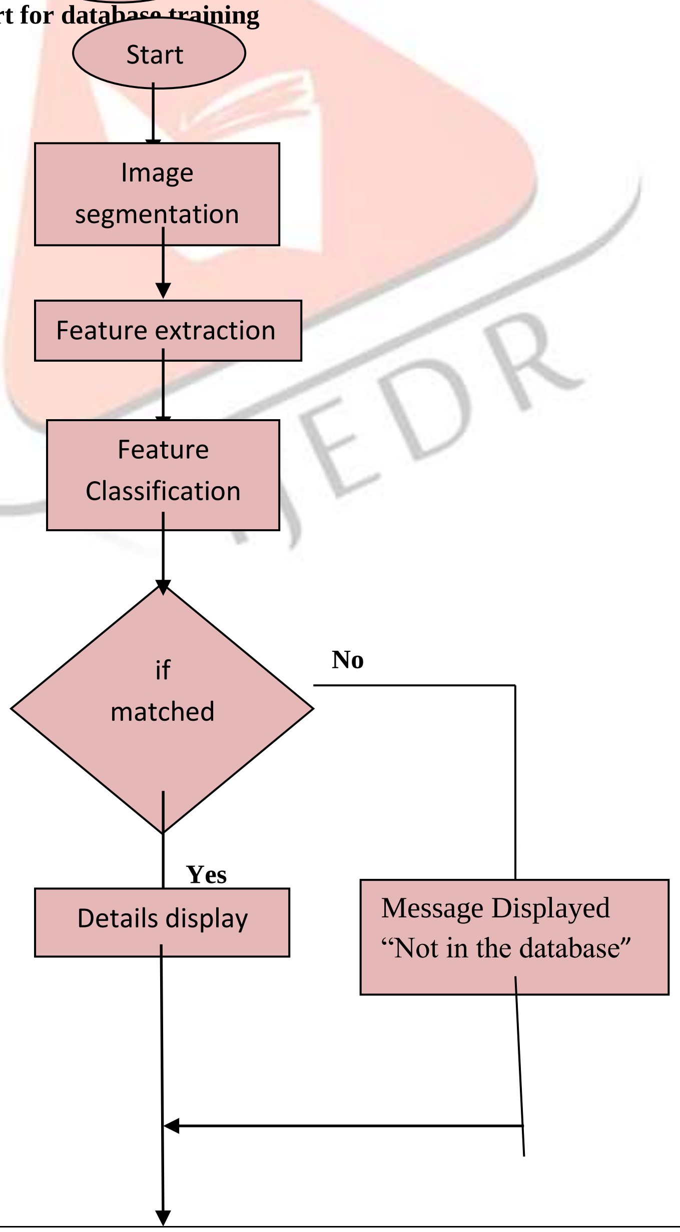


Figure 2: Flowchart for database training



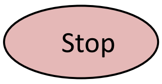


Figure 3: Flowchart for database testing

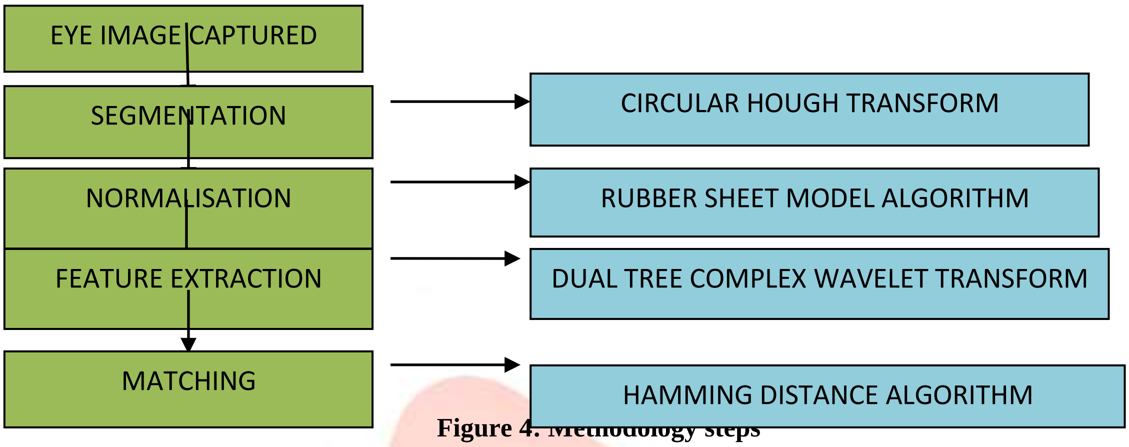


Figure 4: Methodology steps

A.Segmentation

In Segmentation process Circular Hough transform based approach is used for detecting the upper and the lower eyelids ofthe eye, and the iris and pupil boundaries. This procedure involves generation of an edge map, which is done through employing Canny Edge Detection technique. In this, gradients are biased in the vertical direction for the outer iris.

1. Canny Edge Detection

Canny edge detection is one of the basic algorithms used in shape recognition. The algorithm uses a multi-stage process to detect a wide range of edges in images. Steps for Canny Edge Detector algorithm are as follows:

1. Image smoothing: This is done to reduce the noise in the image.
2. Calculating edge strength and edge direction.
3. Directional non-maximum suppression to obtain thin edges across the image.
4. Invoking threshold with hysteretic to obtain only the valid edges in an image.

B.Normalization and Enhancement

Daugman's rubber sheet model technique was employed to demonstrate the normalization of the iris regions. The reference point here refers to the centre of the pupil, and the radial vectors that are considered pass through the iris region.

$$r' = \sqrt{\alpha\beta} \pm \sqrt{\alpha\beta 2 - \alpha - r_1^2}$$

Where

$$\alpha = o_x^2 + o_y^2$$

$$\beta = \cos(\pi - \arctan(\frac{o_y}{o_x}) - \theta)$$

C.Feature extraction

General complex wavelet transform couldsolve the limitations of traditional discrete wavelet. Howeverit was difficult to find the perfect reconstruction filter corresponding the complex wavelet transform because the import of complex wavelet transform is plural form when it

was resolved more than one layer. To solve this problem, Kingsbury put forward a dual tree complex wavelet transform (DT-CWT), which was designed using double tree filter form according to certain rulesand not only retained the advantages of general complex wavelet, but also tit could be completely reconstructed.

Complex wavelet can be expressed as;

$$\Psi(t) = \psi_r(t) + j\psi_i(t)$$

$\psi_r(t)$, $\psi_i(t)$ denotes the real and the imaginary part of complex wavelets respectively and they are real functions, DTCWT can be expressed as two separate real transforms, comprising two parallel decomposition tree: tree A and tree B. Tree A represents the real part of DTCWT and tree B represents the imaginary part If the low-pass filter and the high pass filter of Tree A are assumed as $h_0(n)$, $h_1(n)$ respectively, the low and highpass filter of tree B are $g_0(n)$, $g_1(n)$. If in the first layer of transform tree A had one sampling period time delay with respect to tree B, we could ensure that the first layer of the tree B got the sample value of tree A which was given up during the interval point of tree A sampling. Even long filter was used in more than two layers of decomposition with ¼ of the sampling period time-delay and each layer had a 0.5 time-delay of the sampling period inwhich way there did not need linear phase filter. Obviously, the wavelet function oftree A and tree B composed a Hilbert transform pair, so the DTCWT $\psi(t)= \psi_r(t) + j\psi_i(t)$ has the excellent feature of unilateral spectrum and also has no bias frequency and approximate shift invariance under two sampling which is he advantages of the Tree Complex Wavelet Transform.

D. Matching

For the comparison of the two iris codes, the hamming distance algorithm is employed. Since the iris region contains features with very high degrees of freedom, and each iris produces a unique bit-pattern which is independent to that produced by any another iris, whereas the codes produced by the same iris would be similar. If two bits patterns are completely independent,then the ideal Hamming distance between the two patterns will be equal to 0.5. It happens because independent bit pattern are completely random. Therefore, half of the bits will agree and half will disagree between the two patterns. The Hamming distance is the matching metric system employed by Daugman, and calculation of the Hamming distance is taken only in bits that are generated from the actual iris region.

The distance between the minimum Hamming distance value for inter-class comparisons and maximum Hamming distance value for intra-class comparisons could be used as a metric to measure separation; however, this is not a very accurate measure since outliers will corrupt the value calculated, and the measure is dependent on the number of iris templates compared. A better metric is 'decidability, which takes into account the mean and standard deviation of the intra-class and inter-class distributions.

$$d' = \frac{\mu_S - \mu_D}{\sqrt{\frac{(\sigma_S^2+\sigma_D^2)}{2}}}$$

The advantages of dual tree complex wavelet transform

Although the discrete wavelet transform has achieved great success in the field of signal and image processing, its own defects such as having no translation invariance and more direction selectivity which were significantly important for image manipulation treatment limited its delopment. The dual tree complex wavelet transforms not only overcome the above drawbacks of traditional discrete wavelet transform, but also had its own advantages: translation invariance,

More direction selectivity, limited data redundancy, Less amount of calculation. The dual tree complex wavelet transform was widely applied in the image processing fields such as image denoising, image enhancement, edge detection, pattern recognition, data compression, texture analysis and digital watermark and so on because of those above characteristics. [12]

5. RESULTS AND DISCUSSION

All images taken are in colour iris images. Features in the iris region are highly visible and there is good contrast between pupil, iris and sclera region. It was not possible to use all of the eye images from each database, since perfect segmentation success rates were not attained.

Table-5.1 Features for training database

S. No.	X_{CP}	Y_{CP}	R_P	X_{CL}	Y_{CL}	R_L	DTCWT feature Mean	DTCWT feature (SD)
1	87	78	8	92	73	70	99.3333	15.3731
2	106	138	28	108	134	62	101.3333	36.4600
3	75	147	14	73	145	62	93.33333	45.0814
4	170	92	28	175	93	78	115.3333	52.2143
5	108	99	7	110	96	62	89.3333	24.6847
6	82	94	7	78	96	66	80	15.0997
7	220	336	30	224	335	100	219.66667	117.5599
8	185	230	23	187	225	91	167.6667	69.0604
9	83	170	9	88	167	62	150.6667	54.6839
10	82	117	12	77	120	65	87.33333	28.9194
11	87	183	7	86	188	63	112.3333	66.5307
12	103	114	7	107	114	64	95	27.0740
13	84	143	23	85	140	67	97.33333	38.0607
14	67	130	14	68	132	62	87.33333	38.7986
15	80	80	8	79	75	62	72	8.8882
16	82	153	16	77	155	65	99	48.8672
17	110	131	7	112	126	62	110	33.6452
18	112	145	11	108	150	65	107.6667	42.5010

19	99	120	7	94	118	62	91.3333	28.0951
20	83	128	21	85	123	62	90	30.8058

Table 5.2 Features for testing of the iris images

S. No.	X_{CP}	Y_{CP}	R_P	X_{CL}	Y_{CL}	R_L	DTCWT feature Mean	DTCWT feature (SD)	Matching Yes/no
1	81	127	28	76	125	62	87.6667	33.0807	NO
2	80	143	23	85	138	65	96	37.7227	NO
3	83	150	20	87	152	73	104	42.1545	NO
4	107	160	47	109	162	71	114	45.7056	NO
5	126	188	7	130	188	65	78.3333	11.9304	NO
6	82	94	7	78	96	66	80	15.0997	YES
7	80	80	8	79	75	62	72	8.8882	YES
8	179	200	22	181	196	78	151.6667	64.2365	NO
9	83	170	9	88	167	62	150.6667	54.6839	YES
10	82	117	12	77	120	65	87.33333	28.9194	YES
11	73	159	7	75	164	62	100.3333	55.5188	NO
12	103	114	7	107	114	64	95	27.0740	YES
13	77	141	13	80	136	67	94.3333	36.6652	NO
14	67	130	14	68	132	62	87.33333	38.7986	YES
15	220	336	30	224	335	100	219.66667	117.5599	YES
16	79	163	7	84	167	65	105.3333	54.2433	NO
17	110	131	7	112	126	62	110	33.6452	YES
18	81	174	7	78	173	63	104.6667	59.6518	NO
19	88	115	13	88	111	66	86.6667	22.7230	NO
20	83	128	21	85	123	62	90	30.8058	YES

The key objective of an iris recognition system is to be able to achieve a distinct separation of intra-class and inter-class Hamming distance distributions. With clear separation, a separation Hamming distance value can be chosen which allows a decision to be made when comparing two templates. As per our methodology we calculate the feature of iris that is the center coordinate of pupil and limbic and mean of an iris and standard deviation of an iris by using DTCWT.
If the Hamming distance between two templates is less than the separation point, the templates were generated from the same iris and a match is found. Otherwise if the Hamming distance is greater than the separation point the two templates are considered to have been generated from different irises.

The distance between the minimum Hamming distance value for inter-class comparisons and maximum Hamming distance value for intra-class comparisons could be used as a metric to measure separation; however, this is not a very accurate measure since outliers will corrupt the value calculated, and the measure is dependent on the number of iris templates compared. A better metric is 'decidability, which takes into account the mean and standard deviation of the intra-class and inter-class distributions.

$$d' = \frac{\mu_S - \mu_D}{\sqrt{\frac{(\sigma_S^2+\sigma_D^2)}{2}}}$$

Decidability d' is a distance measured in standard deviations and is a function of the magnitude of difference between the mean of the intra-class distribution μ_s, and the mean of the inter-class distribution µs, and also the standard deviation of the intra-class and inter-class distributions, σ_s^2 and σ_D^2 respectively. The higher the decide ability, the greater the separation of intra-class and inter-class distributions, which allows for more accurate recognition. With a pre-determined separation Hamming distance, a decision can be made as to whether two templates were created from the same iris (a match), or whether they were created from different irises. However, the intra-class and inter-class distributions may have some overlap, which would result in a number of incorrect matches or false accepts, and a number of mismatches or false rejects.

Performance Parameters -

False acceptance rate(FAR):-The probability of accepting an outsider as an entrolled images in the data base.

False rejection rate(FRR):-The probability of rejecting an enrolled subjected by considering him/her as an outsider.

Accuracy:- The probability of correctly identifying a test user form enrolled users.

5.3 Performance evolution of FAR, FRR and ACCURACY by proposed method:-

Table 5.3.1 Testing table recognition and accuracy for 50 images

Testing for 50 images for 5 times	FAR	FRR
1	0.00	0.00
2	0.00	0.02
3	0.00	0.00
4	0.00	0.00
5	0.00	0.00

FAR=0.0 FRR=1/50 =0.02

Average FAR= $\frac{0+0+0+0+0}{5}$ =0.00

Average FRR= $\frac{.02+0.0+0.0+0.0+0.0}{5}$ =.004

Accuracy = 1- $(\frac{FAR+FRR}{2})$ = 1- $(\frac{0.00+0.004}{2})$ = .998 =0.998*100 = 99.8%

Table 5.3.2 Testing table recognition and accuracy for 100 images

Testing for 100 images 5 times	FAR	FRR
1	0.00	0.00
2	0.01	0.01
3	0.00	0.00
4	0.00	0.01
5	0.00	0.00

Average FAR = 0.002
Average FRR = 0.004
Accuracy = 1-$(\frac{0.002+0.004}{2})$ = 0.997*100 = 99.7%

Table 5.3.3 Testing table recognition and accuracy for 150 images

Testing for 150 images	FAR	FRR
1	0.000	0.006
2	0.006	0.006
3	0.000	0.006
4	0.000	0.006
5	0.000	0.006

Average FAR = 0.0012
Average FRR = 0.006
Accuracy = 1-$(\frac{0.0012+0.006}{2})$ = 0.9964*100 = 99.64%

Table 5.3.4 Testing table recognition and accuracy for 200 images

Testing for 200 images	FAR	FRR
1	0.000	0.005
2	0.005	0.005
3	0.005	0.005
4	0.005	0.005
5	0.005	0.005

Average FAR = 0.004
Average FRR = 0.005
Accuracy = 1-$(\frac{0.004+0.005}{2})$ = 0.9955*100 = 99.55%

Table 5.3.5 Recognition accuracy with DTCWT feature extraction technique

No. Of images in training dataset	FAR	FRR	ACCURACY
50	0.000	0.004	99.8
100	0.002	0.004	99.7
150	0.0012	0.006	99.64
200	0.004	0.005	99.55

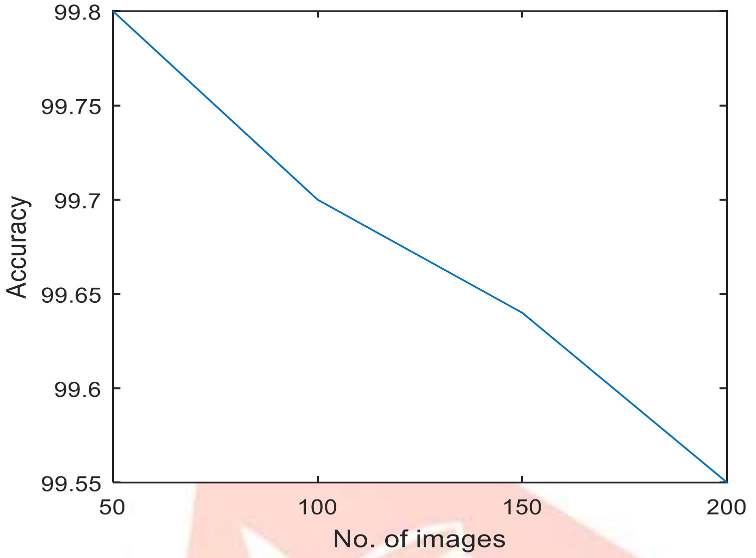


Figure 5 -Overall accuracy by graph

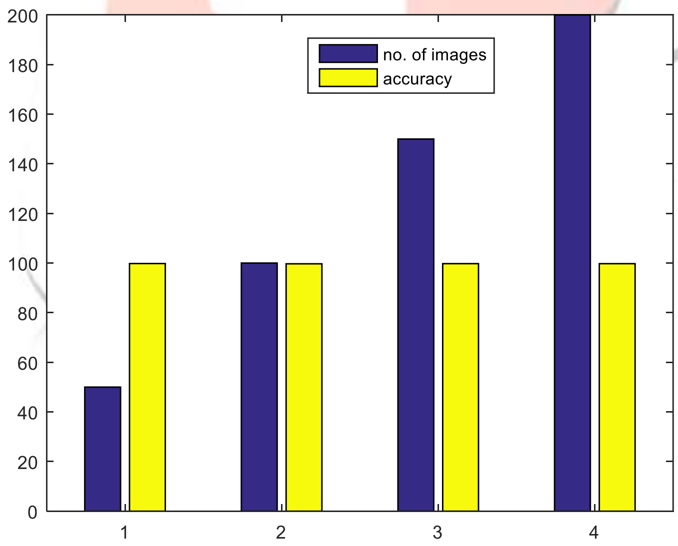


Figure 6 - Overall accuracy by bar graph

The graph shows that the accuracy decreases when no. of images increases. The accuracy (Accuracy = 100 – (FAR+FRR)/2) of the iris verification system is 99.8%, with zero false acceptance rate. It can be easily concluded that FRR has reduced though slightly by use of DT-DWT wavelet for feature extraction instead of using HAAR wavelet transform. With the 'colour database' data set perfect recognition is possible. With a false accept rate and false reject rate of 0.00 % and 0.004 % respectively is achieved.

CONCLUSION

In this, the performance of the iris recognition system as a whole is examined. Tests were carried out to find the best separation, so that the false match and false accept rate is minimised, and to confirm that iris recognition can perform accurately as a biometric for recognition of individuals. As well as confirming that the system provides accurate recognition, experiments were also conducted in order to confirm the uniqueness of human iris patterns . we found that dual tree complex wavelet transform gives the best result i.e 99% accuracy.

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