A NOVAL APPROACH TO IRIS RECOGNITION BASED ON FEATURE LEVEL FUSION USING CLASSIFICATION TECHNIQUES

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***Abstract*: Now a days, Security demands are increasing in networked society. With these increases in biometric systems for accurate user authentication are becoming more popular. Iris Recognition System is one of the most popular authentication approach based on Iris of an individual. Every Iris has fine unique texture and does not change overtime. This project proposes a new iris recognition system based on feature level fusion using PCA to improve speed and accuracy of authentication. The iris textures are extracted from 2DGabor filters and Haar wavelet. In this textures are fused and then used to identify genuine users. In order to classify the extracted features process this project is using different classification techniques like KNN, Decision Trees, Multilayer Perceptron, Support Vector Machine (SVM) and Navie Bayes techniques. The proposed Iris recognition system is evaluated basing on Equal Error Rate using FAR and FRR.**

***Keywords*: Filters, PCA, SVM, KNN Classifications.**

INTRODUCTION:

Computer vision is one of the most important areas of research, which provides efficient solutions to many problems. Pattern recognition is mainly used to recognize automatically different entities from an image. The security field has shown a real interest in computer vision, particularly for identification. Modern security sciences use these differences to control access to restricted places, which is one of the fundamental problems in the security field. The security plays an important role in any type of organization in today's life. Iris recognition is one of the leading automatic biometric systems in security which is used to identify the individual person. Biometric systems include fingerprints, facial features, voice recognition, hand geometry, handwriting, the eye retina and the most secured one is the iris recognition. Biometric systems has become very famous in security systems because it is not possible to borrow or steel or forgotten the physical or behavioral characteristics. Recognition systems which use biometric are believed to be very accurate, and hence efforts are being put to improve their accuracy and reliability.
There are also many existing multimodel systems which deal with the combination of different biometric traits. There exists a multi modal biometric system where the biometric traits are collected from the same eye and features are extracted using different algorithms. Then those features are fused to get template. But the fusion of the feature vectors leads to high dimension data which reduced the performance of the system. The proposed system concentrated on the reduction at feature level and classification based matching

RELATED WORKS:

Among the various traits, iris recognition has various advantageous factors like greater speed, simplicity and accuracy compared to other biometric traits. Iris recognition refers to the automated method of identifying or confirming the identity of a subject by analyzing the random pattern of the iris. The iris is the colored, thin, circular structure in the eye. The iris is responsible for controlling the diameter and size of the pupil.
The iris is a muscle within the eye, which regulates the size of the pupil and thus controlling the amount of light that enters the eye. The iris is the colored part of the eye i.e., brown or blue. Iris recognition uses the random, colored patterns within the iris. These patterns are unique for each individual and has unique pattern from eye to eye and person to person. Iris pattern are formed by six months after birth, stable after a year and remain the same for life time.
In authentication system, iris features need to record. The iris feature recording is referred as an enrolment process. In matching process the authentication system attempts to confirm an individual's claim identity by comparing a submitted sample to previously enrolled templates.
Iris recognition relies on the unique patterns of the human iris to identify or verify the identity of an individual. This method of biometric authentication that uses pattern-recognition techniques based on high resolution images of the irises of an individual's eyes. Iris recognition uses camera technology, with subtle infrared illumination reducing specular reflection from the convex cornea, to create images of the detail-rich, intricate structures of the iris.
Converted into digital templates, these images provide mathematical representations of the iris that yield unambiguous positive identification of an individual. Iris recognition efficacy is rarely impeded by glasses or contact lenses. Iris technology has the smallest outlier (those who cannot use/enrol) group of all biometric technologies. Because of its speed of comparison, iris recognition is the only biometric technology well-suited for one-to-many identification. A key advantage of iris recognition is its

stability, or template longevity, a single enrollment can last a lifetime.
The biometrics trait IRIS – the colored circle that surrounds the pupil, contains many randomly distributed immutable structures such as freckles, coronas, stripes, furrows, crypts and so on, which makes each iris distinct from another.

PROPOSED METHODOLOGY:

Preprocessing:
This stage of iris recognition is to enhance and isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary.

Steps involved in Pre-processing:

I. Image enhancement
II. Iris localization
III. segmentation
IV. Normalization

In this system, initially eye image is preprocessed where Circular Hough transform method has been applied for segmentation and Daugman's Rubber Sheet model for Normalization. Then by using two methods 2D Gabor filter and HAAR wavelet, the texture features are extracted from the segmented iris. These features are fused by using feature level fusion which results in high dimensionality in space. So that PCA has been applied to reduce the dimensionality of the feature vectors. Then feature vectors are matched by using Euclidean distance in one to one matching and by using different classification techniques like SVM, KNN, MLP, Navie Bayes, decision tree classifiers.
The results are then estimated and compared using performance metrics like False Acceptance Rate (FAR), False Rejection Rate (FRR) and Accuracy
Iris recognition system mostly proceeds in five major steps:
(1) Image acquisition
(2) Segmentation to localize the iris,
(3) Normalization in which the annular iris region is "unwrapped" from Cartesian to polar coordinates,
(4) Feature extraction from iris texture and finally
(5) Matching the iris features robustly. Each step affects overall performance. Thus, recognition performance of a system can be improved when each step is accurate.

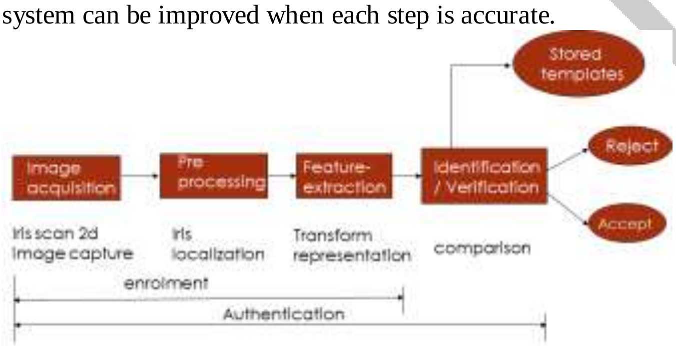

Fig 1: Iris Recognition System

This project proposes a new iris recognition system based on feature level fusion using PCA to improve speed and accuracy of authentication .The iris textures are extracted from 2DGabor filters and Haar wavelet. In this textures are fused and then used to identify genuine users. For classification process this project is using Support Vector Machine(SVM) and Neural Network techniques.

The main modules of the Iris recognition system are:

- Image loading
- Preprocessing
- Feature Extraction
- Feature level fusion
- Matching
- Classification

Feature Extraction:
Features are extracted using normalized iris image. The most discriminating information in an iris pattern must be extracted. Feature extraction techniques in iris can be roughly classified into four broad categories:

- Texture based method
- Phase based method,
- Zero crossing based method and
- Intensity variation method

Filters used in Feature Extraction:

a. 2D –Gabor Filters
b. Haar wavelet

Levels of Fusion:

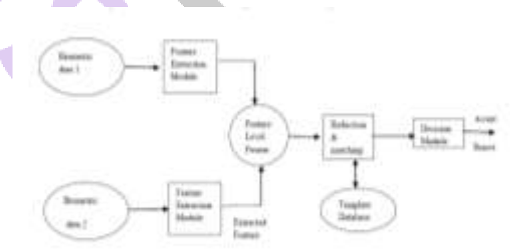

Fig 2: Levels of Fusion

Dimensionality Reduction Using PCA:
To reduce the dimensions of the features and speeding up the computation, the matrix of feature extraction was given to a principal component analysis algorithm to separate more important features. It 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. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components. The resulting vectors are an uncorrelated orthogonal basis set. The principal components areorthogonal because they are the eigenvectors of the covariance matrix, which is symmetric.

Feature Matching:
The fused features are matched to identify the correct or authorized iris. The matching can be done using the classifier and 1-1 matching.

Performance of Biometrics:

- False Acceptance Rate (FAR)
- False Rejection Rate (FRR)

Image Classification Techniques:

- **SVM Classifier**
- **K-Nearest Neighbour Classifier**
- **Naive Bayes**
- **Decision Trees.**

Classification is done in weka tool:

Weka support several standard data mining tasks, more specifically data pre-processing, clustering, classification, regression, visualization and feature selection. All of Weka's techniques are predicated on the assumption that the data is available as a single flat file or relation, where each data point is described by a fixed number of attributes (normally, numeric or nominal attributes, but some other attribute types are also supported). Weka provides access to SQL databases using Java Database Connectivity and can process the result returned by a database query. It is not capable of multi-relational data mining, but there is separate software for converting a collection of linked database tables into a single table that is suitable for processing using Weka.The Pre-process panel has facilities for importing data from a database, a CSV file, etc., and for pre-processing this data using a socalled filtering algorithm. These filters can be used to transform the data (e.g., turning numeric attributes into discrete ones) and make it possible to delete instances and attributes according to specific criteria. The classify panel enables the user to apply classification and regression algorithms (indiscriminately called classifiers in Weka) to the resulting dataset, to estimate the accuracy of the resulting predictive model, and to visualize erroneous predictions, ROC curves, etc., or the model itself (if the model is amenable to visualization like, e.g., a decision tree).

Experimental Results:

Fig 3: Original Image

Fig 4: Segmented Image

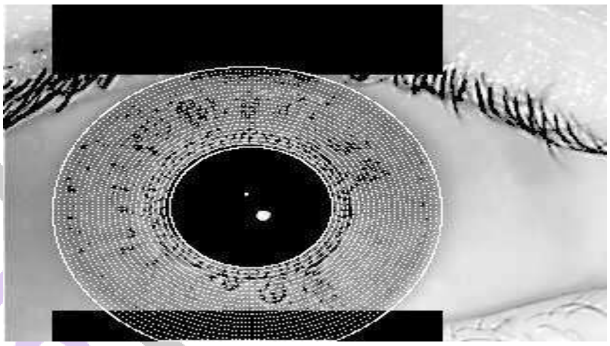

Fig 5: Segmented Image with Noise Mask

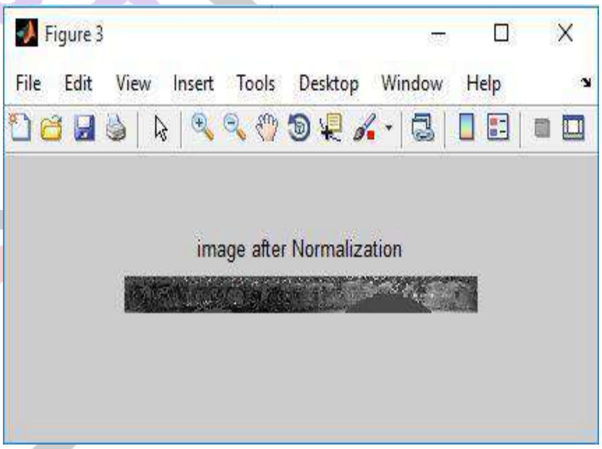

Fig 6: Normalized image

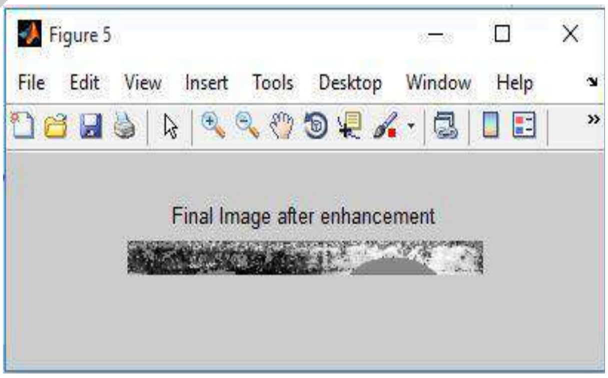

Fig 7: Enhanced image

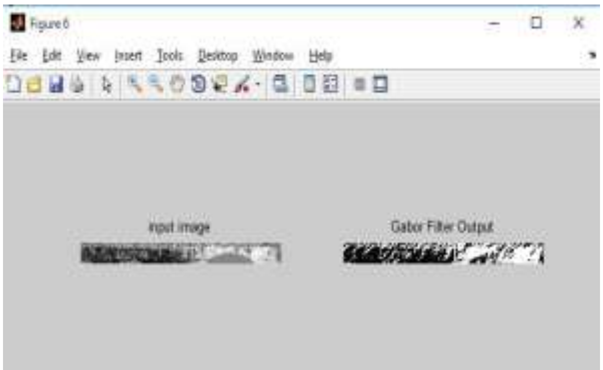

Fig 8:2D Gabor Filter Features

fus_en
216x4914 double

	1	2	3	4	5	6	7
1	-0.0796	-0.0025	-0.0203	-0.0288	0.0338	0.1083	0.0878
2	0.1318	0.1120	0.1148	0.0933	0.0892	0.0683	0.0714
3	0.0273	0.0808	0.1125	0.1100	0.0204	-0.0254	-0.0183
4	0.0108	-0.0675	-0.0327	-0.0217	-0.0961	-0.0512	-0.0213
5	0.0361	0.0272	0.0342	0.0928	0.0830	0.0452	0.0095
6	-0.0194	0.0322	0.0722	0.0249	-0.0663	0.0787	0.1600
7	0.0821	0.0718	0.1184	0.0982	0.0225	-0.0965	-0.0891
8	-0.0223	-0.0107	-0.1918	0.1476	-0.1007	-0.0174	-0.1375
9	0.0723	0.1195	0.1006	0.0841	0.1355	0.1505	0.1059
10	-0.0740	0.1189	0.1771	0.1921	0.2205	0.2138	0.1415

Fig 9: Fusion array size

fus_en pca_en
216x99 double

	1	2	3	4	5	6	7
1	-0.2461	-0.2674	-0.2927	-0.2797	-0.2568	-0.2559	-0.2597
2	0.2415	0.2848	0.3136	0.3150	0.2657	0.2757	0.2894
3	0.1046	0.1264	0.1351	0.1371	0.1017	0.1022	0.1110
4	-0.4728	-0.5418	-0.5807	-0.5607	-0.5132	-0.5180	-0.5255
5	-0.3634	-0.4174	-0.4490	-0.4459	-0.3937	-0.4021	-0.4168
6	-0.1069	-0.1082	-0.1154	-0.1210	-0.1381	-0.1129	-0.0856
7	-0.0870	-0.1163	-0.1195	-0.1204	-0.1194	-0.1385	-0.1418
8	0.1810	0.2184	0.2239	0.2626	0.2028	0.2204	0.2237
9	0.1127	0.1438	0.1530	0.1544	0.1264	0.1318	0.1430
10	0.1263	0.1757	0.1975	0.1962	0.1668	0.1728	0.1812

Fig 10: PCA array size Reduced

METHOD	FRR	THRESHOLD	FAR	ACCURACY
2D GABOR	0.0208	0.4030	14	78.8
		0.2288	9	87
		0.1968	8	89.1
		0.1569	7	91.1
		0.0329	5	97.3
		0.0015	3.9	98.8
HAAR WAVELET	0.0208	0.4543	0.4	76
		0.3247	0.33	82.7
		0.2675	0.3	85.5
		0.1151	0.2	93.2
		0.0279	0.1	97.5
		0.0016	0.016	98.8
FUSION	0.0208	0.5385	9	72.03
		0.3571	9	81.1
		0.1595	7	90.9
		0.0333	6	97.2
		0.0028	5	98.8
		0.0013	4.7	98.8
		0.4515	4	76
		0.3454	3	81.6
PCA	0.0208	0.2326	2	87.3
		0.1119	1	93.36
		0.0039	0.2	98.7
		0	0.08	98.9

Fig 11: Accuracy measures

2D GABOR	65.22 sec	23,182KB
HAAR WAVELET	0.456 sec	20.7KB
FUSION	0.024 sec	22,665KB
PCA	0.733 sec	931KB

Fig 12: CASIA -Time and size analysis

CLASSIFICATION TECHNIQUES	ACCURACY	TIME
SVM	97.91 %	0.02sec
KNN	96.5 %	0.01 sec
MLP	97.91 %	227.15 sec
DECISION TREES	97.9 %	0.13 sec
NAVIE BAYES	65.9 %	0.14 sec

Fig 13: Classification techniques after PCA-CASIA database

Fig 14: Graphs showing Threshold and FAR values for CASIA database

Fig 15: Graphs showing classification techniques accuracy for CASIA database

CONCLUSION AND FUTURE WORK

This work proposes a intra model feature level fusion technique and a linear dimensionality reduction technique with PCA which is applied on the fused feature set extracted from 2 dimensional Gabor filtering as has been widely used over past two decades since Daugman had first proposed it and Haar Wavelet Decomposition. Unimodel systems have low performance and vulnerable to spoofing attacks. So, the proposed technique acquired the advantages of multimodel biometric system by considering multiple algorithms like Haar Wavelet Decomposition based feature extraction and 2D Gabor filter based feature extraction. The Gabor parameters are decided by verifying with different values on different data sets.

Results shows that the overall accuracy of the system is near **98.9%** on CASIA IRIS database. The performance is better when applying PCA since it results in **95.89 %** of template storage size reduction and the speed increased is **97.37%** for CASIA database with maintaining FRR as 0.0208.
As the proposed system is based on linear dimensionality reduction so many possible cases are there in which FRR can be more due a line of acceptance that either an image will be accepted or rejected, which can be further tested and compared by classifiers like KNN,Decision Trees , MLP, Navie Bayes and kernel based classifier like SVM, this will provide a range of acceptance for each image.

The implemented system is a multi-algorithmic system with in the model i.e., with a single biometric trait, IRIS. It can be extended by implementing the system using other feature extraction techniques available such as wavelet encoding or 2D log Gabor and can be fused by using different fusion techniques which may results in better performance. And depending on the level of information that is fused, the fusion scheme can be classified as Sensor level, feature level, score level and decision level fusion. And it can be extended by implementing as a multi model biometric system in combination of other biometric traits such as face, ear, fingerprint, palm print, finger-knuckle etc. There is scope to further improvement in system accuracy by considering dimensionality reduction technique ICA. Or instead of using dimensionality reduction algorithms, optimal feature sub set selection algorithms can be implemented and used for best results.

REFERENCES:

[1] Sanderson, S., and J. H. Erbetta. "Authentication for secure environments based on iris scanning technology." (2000): 8-8.

[2] Daugman, J. "How iris recognition works. Proceedings of 2002 International Conference on Image Processing." (2002).

[3] Daugman, John G. "High confidence visual recognition of persons by a test of statistical independence." *IEEE transactions on pattern analysis and machine intelligence* 15.11 (1993): 1148-1161.

[4] Wildes, Richard P. "Iris recognition: an emerging biometric technology." *Proceedings of the IEEE* 85.9 (1997): 1348-1363.

[5] Daugman, John G. "Biometric personal identification system based on iris analysis." U.S. Patent No. 5,291,560. 1 Mar. 1994.

[6] Ma, Li, et al. "Personal identification based on iris texture analysis." *IEEE transactions on pattern analysis and machine intelligence* 25.12 (2003): 1519-1533.

[7] Wildes, Richard P. "Iris recognition: an emerging biometric technology." *Proceedings of the IEEE* 85.9 (1997): 1348-1363.

[8] Boles, Wageeh W., and Boualem Boashash. "A human identification technique using images of the iris and wavelet transform." *IEEE transactions on signal processing* 46.4 (1998): 1185-1188.

[9] Lim, Shinyoung, et al. "Efficient iris recognition through improvement of feature vector and classifier." *ETRI journal* 23.2 (2001): 61-70.

[10] Masek, Libor. "Recognition of human iris patterns for biometric identification." (2003): 1-7.

[11] Ma, Li, et al. "Efficient iris recognition by characterizing key local variations." *IEEE Transactions on image processing* 13.6 (2004): 739-750.

[12] Tisse, Christel-loic, et al. "Person identification technique using human iris recognition." *Proc. Vision Interface*. 2002.

[13] Monro, Donald M., and Z. Zhang. "An effective human iris code with low complexity." *Image Processing, 2005. ICIP 2005. IEEE International Conference on*. Vol. 3. IEEE, 2005.

[14] Kong, W. K., and D. Zhang. "Accurate iris segmentation based on novel reflection and eyelash detection model." *Intelligent Multimedia, Video and Speech Processing, 2001. Proceedings of 2001 International Symposium on*. IEEE, 2001.

[15] Ma, Li, Yunhong Wang, and Tieniu Tan. "Iris recognition using circular symmetric filters." *Pattern Recognition, 2002. Proceedings. 16th International Conference on*. Vol. 2. IEEE, 2002.

[16] Daugman, John. "New methods in iris recognition." *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)* 37.5 (2007): 1167-1175.

[17] Ross, Arun. "Iris recognition: The path forward." *Computer* 43.2 (2010).

[18] Sastry, A. V. G. S., and B. Durga Sri. "Enhanced Segmentation Method for Iris Recognition." *International journal of computer trends and technology* 4.2 (2013): 68-71.

[19] Ng, Tze Weng, Thien Lang Tay, and Siak Wang Khor. "Iris recognition using rapid Haar wavelet decomposition." *Signal Processing Systems (ICSPS), 2010 2nd International Conference on*. Vol. 1. IEEE, 2010.

[20] Chirchi, Vanaja Roselin E., and L. M. Waghmare. "Feature Extraction and Pupil Detection Algorithm Used for Iris Biometric Authentication System." *International Journal of Signal Processing, Image Processing and Pattern Recognition* 6.6 (2013): 141-160.

[21] Ma, Li, Yunhong Wang, and Tieniu Tan. "Iris recognition using circular symmetric filters." *Pattern Recognition, 2002. Proceedings. 16th International Conference on*. Vol. 2. IEEE, 2002.

[22] Zhang, Peng-Fei, De-Sheng Li, and Qi Wang. "A novel iris recognition method based on feature fusion." *Machine Learning and Cybernetics, 2004. Proceedings of 2004 International Conference on*. Vol. 6. IEEE, 2004.

[23] Chenhong, Lu, and Lu Zhaoyang. "Efficient iris recognition by computing discriminable textons." *Neural Networks and Brain, 2005. ICNN&B'05. International Conference on*. Vol. 2. IEEE, 2005.

[24] Hoyer, Patrik O., and Aapo Hyvärinen. "Independent component analysis applied to feature extraction from colour and stereo images." *Network: computation in neural systems* 11.3 (2000): 191-210.

[25] Yuen, Pong C., and Jian-Huang Lai. "Face representation using independent component analysis." *Pattern recognition* 35.6 (2002): 1247-1257.

[26] Son, Byungjun, et al. "Discriminant iris feature and support vector machines for iris recognition." *Image Processing, 2004. ICIP'04. 2004 International Conference on*. Vol. 2. IEEE, 2004.

[27] Jain, Anil K., Arun Ross, and Salil Prabhakar. "An introduction to biometric recognition." *IEEE Transactions on circuits and systems for video technology* 14.1 (2004): 4-20.

[28] Jain, Anil K., and Arun Ross. "Multibiometric systems." *Communications of the ACM* 47.1 (2004): 34-40.

[29] Ross, Arun, and Anil Jain. "Information fusion in biometrics." *Pattern recognition letters* 24.13 (2003): 2115-2125.

[30] Hong, Lin, and Anil Jain. "Integrating faces and fingerprints for personal identification." *IEEE transactions on pattern analysis and machine intelligence* 20.12 (1998): 1295-1307.

[31] Ross, Arun, and Rohin Govindarajan. "Feature level fusion using hand and face biometrics." *Proceedings of SPIE conference on biometric technology for human identification II*. Vol. 5779. 2005.

[32] Trunk, Gerard V. "A problem of dimensionality: A simple example." *IEEE Transactions on pattern analysis and machine intelligence* 3 (1979): 306-307.