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Review of IRIS recognition methods

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Abstract **Iris recognition is well established biometric method which has received lot of attention in past few years. Over few decades well known techniques and methods are devised for effective iris recognition under various scenarios. IRIS recognition in constrained environment is still an area where still work needs to be done. This paper talks about various techniques proposed, the constraints under which the methods are suitable for is studied and summarized. The issues affecting iris recognition accuracy are discussed. In this paper we are also suggesting some novel methods to overcome the factors impacting the iris recognition accuracy.**

***Keywords* - Biometrics, human identification, Iris recognition, , feature extraction, Zernike moments, rotation invariance, patches, shift invariance, Filter banks, dual tree complex wavelet, local radon transform, sub image.**

I. INTRODUCTION

Amongst all biometric systems iris recognition is the popular and prominent system for gaining access, based on unique features and characteristics [3]. As compared to other biometric technologies, such as fingerprint, face, hand-geometry, etc., iris recognition is effective method of biometric. The reason for that is human iris has lots of textural information and color. It can also aid to differentiate ethnicity and races. However, some of the challenges and problems are still unadrressed. Therefore significant work needs to be done before such systems are applied on large-scale. [8]. The Iris recognition system has many real life use cases such as access control, forgery detection, credit card, internet security authentication, defence security[20]. It is one of three biometric methods (face, finger, Iris) which is internationally standardized for its use in e-passports Usually most of the Iris recognition system has following architectural blocks, acquiring human eyes , separating the Iris region ,carrying out normalization on captured image to decide the unique feature of IRIS image for person recognition during the verification phase and matches it with the database formed during enrolment phase. There are common steps involved in design and implementation part of Iris recognition methods. These steps are as shown in figure. All of the steps involved have the more or less impact on the accuracy. For instance segmentation should not over segment and under segment the Iris region, otherwise texture information needed to extract the features is lost away

This paper has been organized in following way: Section II details the related work so far done in Iris recognition, openly y available Iris datasets.

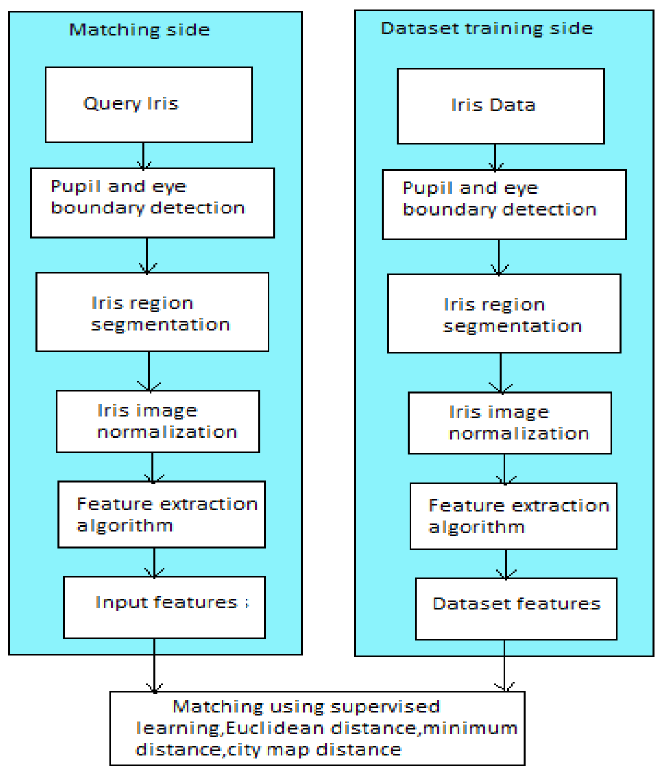

Figure 1: General sequence and major steps of IRIS recognition systems

These observations points are detailed in section III. Section IV discusses about comparison of various IRIS recognition methods and algorithms. Section V concludes with future

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work. The issues such as time required to compute the features, matching time in large dataset for new query, consistency in the performance needs to be addressed..

II. REVIEW OF RELATED WORK

A. Publicly available database

Many Iris datasets are available for research and to evaluate algorithm performance, for prototyping. CASIA (the most popular amongst researchers owing to its clarity), UPOL, Bath, MMU, and UBIRIS are freely available for research purpose. UBIRIS is the dataset of noisy images constructed by University of Beira Interior taken from 241 subjects during acquisition. CASIA-IrisV4,which is newly launched dataset is on basis of biometrics ideal test. The initial version of that has some advantages since the images are synthetically edited to make the pupil of uniform intensity. Images from BATH: are similar to that of MMU having similar properties. There is also an Indian dataset from IIT Delhi (IITD) made available for research purpose .This dataset is having total 1120 iris images from 224 persons. It is made up of low resolution images captured using JIRIS, JPC1000, and a digital CMOS camera. Figure 2 shows the scaled down images of iris from various datasets. It can be seen that cassia has the highest resolution of iris image followed by UBRIS_800_600 and UBIRIS_200_150

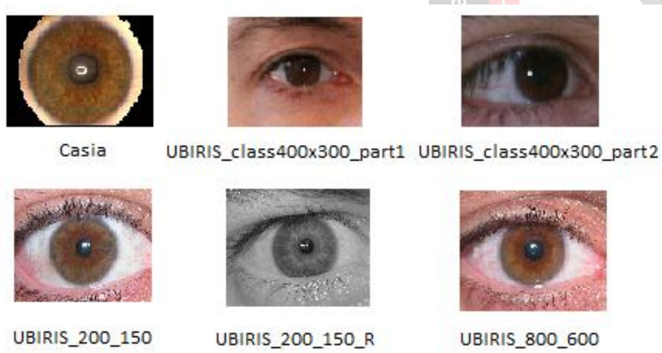

Figure 2: Images from various publicly available datasets

B. Past work

As seen in figure 2,3,4 the eye images which are captured are classified into i] Near IRIS ii] Far or distant IRIS images. Therefore the accuracy and complexity of the algorithm is varied from dataset to dataset.

Figure 3: Far or distant Iris images

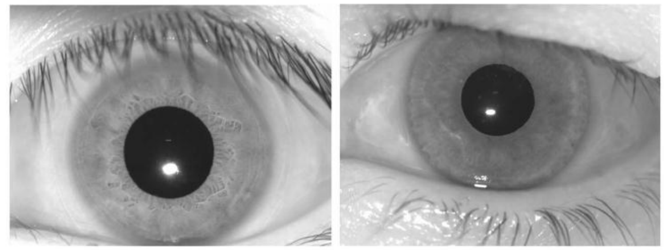

Figure 4: Near distance Iris images

j He used gabor wavelets for extracting IRIS features. Wildes [6], Boles and Boashash [6], [13] and Monro and Zhang [2] have developed new methods based on the PCA and ICA to iris images [22], [19].

Donald M. Monro et al [28] used angular patches of normalized Iris images.To retain features they overlapped the patches and applied hanning window. This normalized image post to angular patching and hanning window is converted to frequency domain by applying 1-D discrete cosine transform (DCT).Figure 5 gives the idea about the intermediate results obtained after applying angular patching on overlapped window of normalized IRIS image. After applying 1D DCT to angular patching results zero crossing of DCT coefficients coefficients is taken. Across this difference transition from

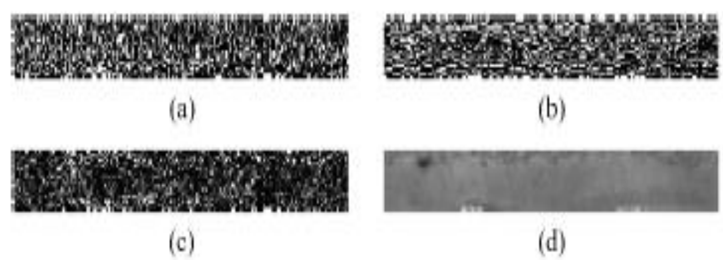

Figure 5: THFB and its 1 level decomposition results obtained on normalized Iris images (CASIA Iris v3 image)

zero to non-zero is marked as 1 and remaining cases are marked as 1.This is shown in figure 7. This generates the unique binary code for Iris image. Matching is done by using hamming distance. The data base which is used to test the algorithms is CASIA. Their method provides slight rotation invariance to image. Also the accuracy is slightly reduces on UB-Iris dataset as, this dataset doesn't reveal the vey finer details of IRIS texture as opposed to CASIA.

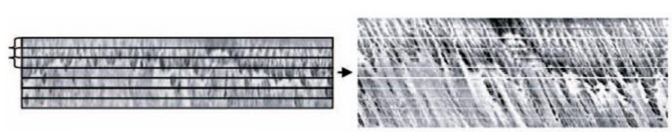

Figure 6: Angular Iris patches used by Monro

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Figure 7: Feature vectors of zeros crossing of DCT coefficients

Zhen et al [27] proposed a novel texture representation method called Hierarchical Visual Codebook (HVC) to encode the texture primitives of iris images. Their proposed HVC method is an integration of two existing Bag-of-Words models, namely Vocabulary Tree (VT), and Locality-constrained Linear Coding (LLC). The HVC adopts a coarse-to-fine visual coding strategy and takes advantages of both VT and LLC for accurate and sparse representation of iris texture. Extensive experimental results demonstrate that the proposed iris image classification method achieves state-of-the-art performance for iris liveness detection, race classification, and coarse-to-fine iris identification. A comprehensive fake iris image database simulating four types of iris spoof attacks is developed as the benchmark for research of iris liveness detection.

Amol D, Raghunath H [23] filter banks and fused its coefficients post classifier to enhance the accuracy and speed of recognition. This approach is based on deriving scale, rotation invariant features of IRIS. The approach has advantages of being able to work in occlusion, eyelid shadow, and over segmentation, under segmentation cases. This method is more powerful for discriminating IRIS textures. First half of Iris image is divided in six sub images. And only first four sub images were used to apply triplet half band filter bank. The feature which is used to compute feature vector is obtained by estimating the energies in THFB channels.

Ajay Kumar et al[25] inspired from sparse representation of iris features. Their work is inspired from simplicity of computation of radon transform and radon transform based local information. To compute the spatial features at different orientations they formed local radon transform (LRT) dictionary .This also avoided computational complexity of computing this requires computing image patches of normalized iris images and sampling them at regular intervals. They constructed the orientation patches using local radon transform, in six different directions. For Iris image patch of size 10x10 pixels they found the dominant orientation using convex optimization problem. After finding the dominant angle patch, its angle is stored as the feature for that particular Iris sub regions. For matching they simply used the Euclidean distance strategy. They got around 90% accuracy on CASIA v4 and 33.3% being lowest on FRCG dataset.

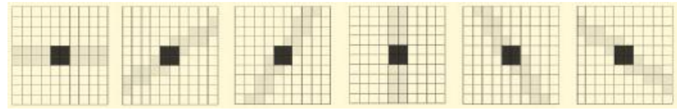

Figure 8: Computing the orientation of IRIS texture shapes using binarized LRT masks [26].The pixel region is chosen to be 10x10 and six different angles are considered $(0, \frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}, \frac{2\pi}{3}, \frac{5\pi}{6})$

Kingsbury's Complex wavelet transform is used by Sandip Narote,M B Kokare et al[31].This method overcomes disadvantages of traditional wavelet transform based methods, applied for feature extraction. It provides shift invariance and slight rotation invariance. For testing the algorithms they used the CASIA dataset. This method is used to extract the features of far IRIS images from CASIA dataset.. Figure 8 details out the typical tree bifurcation (tree a and tree b) of dual tree complex wavelet transform

Chun-Wei Tan and Ajay Kumar[24] used Zernike moments as a prominent feature extraction technique to extract IRIS features. Their method is particularly effective in extracting distant IRIS features and Iris images which are captured during normal day conditions which introduce noise and feature loss. They used phase information obtained from normalized IRIS images in addition to stable IRIS encoding technique which is based on applying nonlinear weighing to bits during matching process. Their method is fast enough to cope up with the matching in large dataset system. The only disadvantage is that, method needs very accurate segmentation otherwise can introduce error during matching process. In normalized Iris image at different angles the maximum information is retrieved at the center and become less when moving towards radially outward. This makes Zernike as popular technique to retrieve the radial features.

III. OBSERVATIONS

The observations from this literature review are cited in table 1. Locating iris is done using canny edge detection, circular hough transform [14], [16.] and daughmans integro differential operator.Table 1 enlists the Iris recognition techniques and related segmentation techniques.

• Normalization is done to bring the circular form of IRIS image to rectangular form using radial to rectangular conversion. [14][16]

• Iris image features are extracted from 2D Gabor wavelets [29] [17], 1D Log-Gabor wavelets [17] ,local radon transform dictionary[25], zero crossing of difference of 1D DCT coefficients[28],dual tree complex wavelet transform[31],triplet half band filter banks[23],Zernike moments [31], computing the optimum orientation of LRT patches and making the orientation angle as a feature[25].

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• For Iris feature matching metric generally adapted distance is hamming distance [29] [14] [17] [9] [1] [23], Elastic similarity metric [18] and Euclidean distance [18] [21] [4].is used. Hamming distance is used in few papers to match features [18][28].It is particularly useful when feature is in the form of binary code of 1's and 0's. Euclidean distance is a measure used when features consist of integer values and features are strong. Normalizing IRIS image which is scale invariant, tilt invariant, local feature extraction, which is invariant to intensity of the image along with an efficient feature matching technique, need to be seen and there seems to be good scope for it.The approaches and matching measure is covered in table 1.

IV. Conclusion

This paper has provided the various methods and techniques from recent literature .Iris image feature extraction, preprocessing, segmentation, normalization are the part of basic IRIS recognition system. In table 1 the paper has covered feature extraction, segmentation, matching approaches. Iris classification and recognition is still a relatively open area where significant work has not happened.. There is still some scope to improve the accuracy which is hampered due to over segmentation and under segmentation of IRIS. Table 1 compares the various recognition methods we studied in terms of segmentation, feature extraction and matching process.

V. COMPARISON OF DIFFERENT APPROACHES

Iris recognition technique	Segmentation	Feature extraction	Matching process
DCT [28]	Hough transform	Zero crossing of DCT coeffecients	Hamming distance/ Learning and classification
Wavelet [20]	Integro differential operator	Wavelet coeffecients	Correlation/Euclidean distance
Zernike [24]	Canny edge/Gray scale	Phase values from Zernike moments	Learning and classification
DUAL TREE COMPLEX Wavelet [31]	Canny	Code generated based on difference between tree a and tree b	Weighted Euclidean distance
Far distance Iris recognition [25]	Radon features	Radon transform of image patches	Euclidean distance

Table 1: Comparison of Different Iris recognition techniques

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