Advance Methodology in IRIS Recognition

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Abstract- *Over the years, iris recognition has gained importance in the biometrics applications and is being used in several large scale nationwide projects. Though iris patterns are unique, they may be affected by external factors such as illumination, camera-eye angle, may also pose a challenge to iris biometrics as it obfuscates the iris patterns and changes the inter and intraclass distributions. This paper presents an in-depth analysis of the effect of contact lens on iris recognition performance.*

The presence of contact lens, particularly color cosmetic lens, However, further research is required to build sophisticated lens detection algorithm that can improve iris recognition.

Keywords- Introduction, Iris Recognition, Contact Lens, Lens Detection, conclusion

I. INTRODUCTION

Iris recognition has drawn much attention due to its convenience and security. Compared with other biometric modality, iris pattern has been regarded as one of the most accurate biometric modalities for its uniqueness, stability and non-intrusiveness. However, as other biometric systems, iris system is also under threat of forged iris attack. Efficient iris spoof detection can improve security of iris recognition systems. Some artifacts have been considered to spoof iris recognition system, such as paper printed iris, cosmetic contact lens, and redisplayed videos. Cosmetic contact lens is a contact lens with color texture printed on it. Spoof caused by wearing a cosmetic contact lens is particularly dangerous.

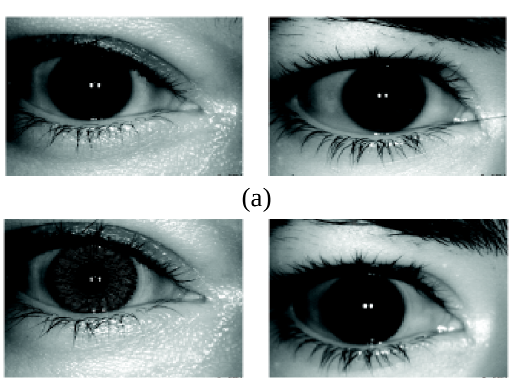

Figure 1. Iris image examples. (a) Genuine irises; (b) Irises with cosmetic contact lenses.

It is easily accepted by the system and hard to detect. Fig. 1 shows some genuine and fake iris images. This paper proposes a framework of contact lens detection. In previous studies on iris detection, several kinds of methods have been proposed.

1.1 Literature Review

Daugman proposed a FFT based method that checks the spectral energy in frequency domain, which uses the periodic characteristics of printer. Lee et al. proposed a method to distinguish genuine and fake iris based on the Purkinje image. Sung et al. [4] introduced a method of detecting fake iris by measuring the ratio of the reflectance measured at 750nm and 850nm illumination.

Though iris features are considered to be unique, recent research results suggest that they are affected by several covariates such as pupil dilation and sensor interoperability [1, 4].Another factor that may affect iris recognition and has received less attention, is the presence of transparent and texturedcolor cosmetic lenses. With recent developments in technology and low cost, the use of contact lens is becoming more prevalent. According to Nichols [10], the worldwide contact lens market in 2011 is estimated to be about 6.8 bil-lions. Contact lenses are generally used to correct eyesight as a replacement for spectacles/glasses. They are however, increasingly being used for cosmetic reasons also where texture and color of iris region is superimposed with a thin textured lens. As shown in Figure 1 (iris images with and without color cosmetic lens), it is apparent that the use of color cosmetic lens changes the appearance/texture of an eye in both visible and near infrared spectrums. Therefore, I believe that it is important to understand the effect of contact lens on the performance of iris recognition algorithms and how this effect can be mitigated. The discussion about fake iris images and images with contact lens effect was first initiated by Daugman [5] where frequency spectrum analysis was proposed to countermeasure against subterfuge. Lee et al. [9] later proposed a method to distinguish between genuine and fake iris based on the Purkinje image. On the other hand, He et al. [7] used features (mean and standard deviation of pixel values, contrast and the angular momentum) of the gray level co-occurrence matrix (GLCM) as a feature vector and Support Vector Machine (SVM) classifier for predicting if the iris image contained colored contact lens or not. Ring and

Bowyer [11] analyzed the iris bit code to detect regions of local distortions which can be due to contact lenses or occlusions. Ii et al. The first method is the edge sharpness detection where the sum of intensity values of inner boundary of the iris is subtracted from that of the outer boundary. The second feature is Iris-Textons computed using Gabor filters along with KMeans algorithm and counterfeit iris classification is performed using SVM. The third approach utilizes GLCM features and SVM classification for the same task.

The current literature primarily focuses on transparent contact lenses and limited studies with colored cosmetic lenses. To the best of my knowledge, the databases used in these studies are not publicly available except the one used by Baker et al. [3] that contains non-cosmetic lenses. Doyle et al. [6] conducted a three class lens detection problem, in which an ensemble of 14 classifiers was learnt to

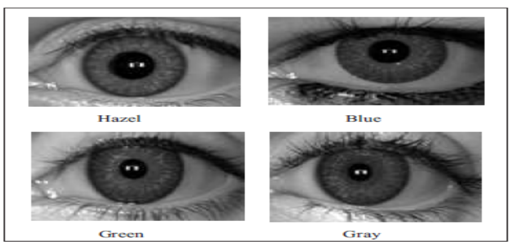

Figure 2. Iris images with different types of colored lenses from CIBA vision.

Achieve 97% accuracy. In this research, I attempt to bridge these gaps and present:

1. A new benchmark database that contains iris images with different kinds of contact lenses. This database is unique in terms of the types of images per subject, number of subjects, acquisition devices, contact lens colors, and manufacturers,
2. Baseline verification accuracies using a commercial iris recognition system to understand the effect of transparent and colored cosmetic lenses. I also present inter and intra class performance analysis of contact lenses and effect of different iris sensors,
3. Performance comparison of existing lens detection algorithms across different lens types and iris sensors.

II. EFFECT OF CONTACT LENSES ON IRIS RECOGNITION

With the increasing use of contact lenses, multiple types and colors of lenses are available with different textures byseveral manufacturers. To the best of my knowledge, there is no database that captures the variations across colors and textures in lenses. Further, different lens manufacturers may have different technologies for contact lens creation. To analyze the effect of these parameters on iris recognition, I have prepared the IIIT-D Contact Lens Iris (CLI) database.

2.1. IIITD Contact Lens Iris Database

The IIIT-D CLI database is prepared with three objectives:(1) capture images pertaining to at least 100 subjects,(2) for each individual, capture images without lens,With transparent (prescription) lens and with color cosmetic lens and (3) capture images with variations in iris sensors and lenses (colors and manufacturers).

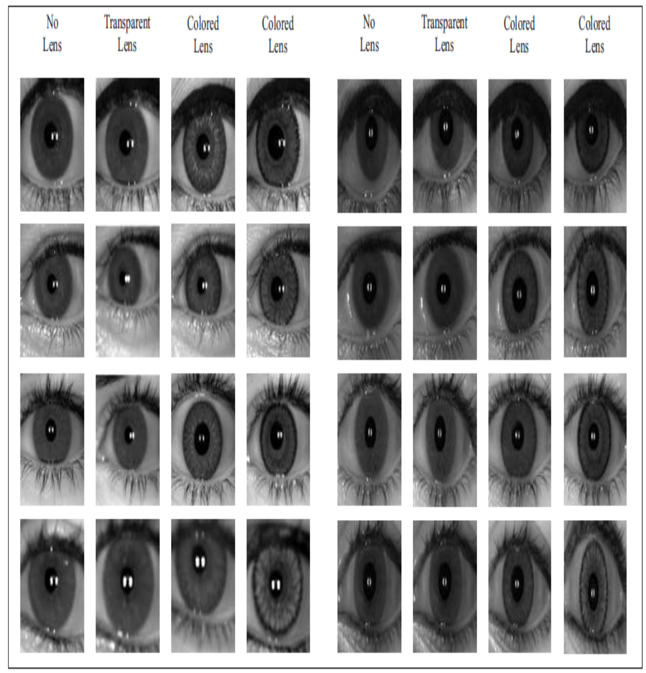

Figure 3. (a) images captured using Cogent iris sensor and (b) images captured using Vista iris sensor.

Table 1. Details of the IIIT-D Contact Lens Iris Database.

Number of subjects	101(202)
Types of contact lens	Without lens,transparent,and coloured
Lens manufacturer	CIBA Vision and Bausch and Lomb
Lens colour	Blue,Grey,Hazel,and Green
Number of subject per coloured lens types	Blue(20).gray(29)green(30)and Hazel(22)
Iris sensor used for acquisition	Cogent dual iris sensor and vista
Number of images per subject.	Minimum 5 images per eye class, per lens type

Table 1 summarizes the characteristics of the IIIT-D CLI database which comprises of 6570 iris images pertaining to 101 subjects. Both left and right iris images of each subject are captured and therefore, there are 202 iris classes. The lenses used in the database are soft lenses manufactured by either CIBA Vision or Bausch and Lomb. For color cosmetic lenses, colors are used and Figure 2 shows some iris images with different color lenses from CIBA Vision. To study the effect of acquisition device on contact lenses, iris images are captured using two iris sensors: (1) Cogent dual iris sensor (CIS 202) and (2) VistaFA2E single iris sensor.

2.2. Performance Evaluation of Iris Recognition

Verieyesoftware is used to understand the effect of contact lenses on iris verification. Two sets of experiments are performed on the IIIT-D CLI database to evaluate the iris verification performance:

1. Effect of color and transparent lenses: By varying the gallery probe combinations, the effect of different types of lenses on iris recognition is analyzed.

2. Effect of acquisition device: This experiment is performed to analyze whether iris acquisition using different Sensors have any effect on the performance with contact lens variations. Three experiments are performed:
   (a) Both the gallery and probe images are captured using the cogent sensor
   (b) Both the gallery and probe images are captured using the Vista sensor 3
   (c) cross sensor gallery – probe verification experiment.

III. EFFECT OF LENS DETECTION ON IRIS RECOGNITION

From the discussion in the previous section, it can be inferred that contact lens, especially color cosmetic lens, reduces the performance of iris recognition systems. It is my hypothesis that applying a lens detection algorithm to first reject the cases with obfuscated patterns and allowing only without lens iris images can potentially improve the performance of iris recognition algorithms and reduce the false matches at higher verification rates. To test this hypothesis, I have evaluated the performance of existing techniques: (1) iris edge sharpness, (2) textural features based on co-occurrence matrix, (3) GLCM based analysis , and (4) local binary pattern (LBP) and SVM based classification. These lens detection algorithms require segmented iris image as input. Since the commercial systems do not provide the flexibility of extracting the of iris regions, The problem of lens detection in an iris image is approached as a three class classification problem: without lens (or normal), transparent lens, and colored lens. However, the iris edge sharpness utilizes thresholding for classification and therefore, the three-class lens classification for this approach is converted into a two-class classification problem. To perform the experiments, images pertaining to the first 50 subjects are used for training and the remaining 51 subjects are used for testing. The classifiers (or parameters of lens detection algorithms) are first trained on the training set and the trained classifiers are used to classify the input image into one of the three classes. The test set is used to evaluate the performance of the trained classifiers on unseen images.

However, differentiating between without lens and transparent lens images is a challenging problem. Further, among all lens detection algorithms, LBP with SVM classifier yields the best classification performance, there are several instances when an image with colored/transparent lens is classified as either without lens (normal) or transparent lens and vice versa. This suggests that there is a need for a better lens classification approach that can delineate different lens classes correctly. To evaluate the hypothesis that “detecting and rejecting the iris samples with color cosmetic contact lens can improve the performance of iris recognition algorithms”, another experiment is performed in which the output of lens classification algorithm is provided as input to the iris recognition system.

IV. CONCLUSION AND FUTURE WORK

Contact lenses, especially color cosmetic lenses, obfuscate the iris texture and can be viewed as “disguise” for iris biometrics. This can potentially be an important covariate of iris recognition systems. This paper analyzes the effect of contact lenses on the performance of iris recognition using the IIIT-D Contact Lens Iris database. Analyzing the existing lens detection algorithms suggest that, though incorporating lens detection algorithms may improve the verification performance, designing better and improved lens detection algorithm is of paramount interest. It is my assertion that with the availability of the IIIT-D CLI database, other researchers may also undertake research in these directions.

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