IRIS BASED TEXTURE ANLAYSIS FOR VERIFCATION AND DETECTION: REVISIT

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***Abstract* – Biometric verification and detection includes detection of biometric, tracking of active and inactive templates and assessment through data comparison and processing. To enhance accuracy of the biometrics, the dynamic multi-modal biometrics based applications systems framework dynamically couples image processing with statistical models to enhance system performance. Due to heterogeneity nature of biometrics from person to person, it is very challenging to build an efficient biometric authentication system, which could either be a performance bottleneck or the single point of failure. Henceforth due to complexity of IRIS biometric and image processing technology, this paper introduces a theoretical overview of different techniques that incorporate a decentralized area selection within the IRIS for template formulation and authentication to enable effective protection. To achieve secure identity authentication, the image processing leverages the texture detection to create virtual trust blocks, in which distributed components could identified and update the template. A detail comparison between the existing systems and shortcomings in the approaches would be presented.**

Keywords* – Biometric, IRIS, texture detection, authentication, image processing

I. INTRODUCTION

In the current era of digitalization, the need for protecting the data/information of a particular individual has evolved into a growing concern on one-side while confirming the authenticity of the individual has become a complex task for various security firms and e-commerce platforms. The most common scenarios that are commonly employed for the authentication of the individual can be classified into what they know; what they have and what they are (different researchers present these classes in their perspective but this stands as basis for all) [1-3]. Authentication process have been evolving over the decades but still a fool proof system that could produce 100% percent accuracy in different conditions and environments is still an open research.

It is a commonly known theory that the individuals tend to forget what they know and tend to lose what they have making them a subsidiary authentication process to what they are based authentication system [2]. Based on the evolving spoofing techniques and digital processing updates ahs paved easy means to crack the things we know (i.e. pins, passwords and etc) and while the physical things we have can reduplicated (i.e. keys, cards and etc). Due to these shortcomings that concept "what we are" has evolved in significant research encompassing security access control and authentication in the recent few decades while other two have been incorporated based on additional security and/or convenience needed [1-2]. Biometrics (comes from Latin wherein "Bio" stands for "Life" and "Metrics" stands for "Measurement") traditionally defines various characteristics of the person that can be measured/verified and maintain certain level of consistency. Over the years there are several biometrics that have been developed for authentication of the person that a majorly classified into two classes behavioral and non-behavioral (physiological) as presented in the table 1(while other researchers classify them as contact or contactless and etc). In this paper, we discuss on the physiological biometrics to verify the authenticity of the person in consideration with the corresponding developments and shortcomings [4].

Table 1 Behavioral/Physiological characteristics

Physiological	Behavioral
1. Finger print 2. Hand print 3. Iris 4. Face 5. DNA 6. Vein	1. Gait (Walking) 2. Body temperature 3. Keystroke 4. Voice 5. Signature 6. Odor

Physiological Biometrics:

The demand for hassle-free security is in great demand as the individuals believe that they need a complex security system for malicious and/or attackers but at the same time they want it to be convenient to use. In addition, the behavior characteristics changes based on the mood (anger, happy, sad, frustrated and/or etc) making FER (false error rate) and FAR (false acceptance rate) high which led to extreme focus on the physiological behavior [4-6]. Physiological Biometrics are often consistent in every aspect but at the same time it has it owns set of issues that are addressed in the Table 2 which presents a detail constraints and advantages on each biometric.

Table 2 Comparison of Biometric Technologies [3]

Requirement	Fingerprints	Hand Geometry	Retina	Iris	Face	Signature	Voice
Ease of Use	High	High	Low	Medium	Medium	High	High
Factors Increasing Error Incidence	Dryness, Dirt, Age	Hand Injury, Age	Glasses	Lighting	Lighting, Age, Glasses, Hair	Changing signatures	Noise, Colds
Accuracy	High	High	Very High	Very High	High	High	High
User Acceptance	Medium	Medium	Medium	Medium	Medium	High	High
Long-Term Stability	High	Medium	High	High	Medium	Medium	Mediu

This led to rapid escalations in the biometrics field that have paved ways for various organizations and researchers around to exploit, manipulate, process, utilize and share biometric information for integrity, security and assurance-based applications [5]. Digital analysis and feature extractions from biometric information has become a vital and much needed research area among the organizations and researchers with security and assurance-based authentication a hot topic. Even after a several decades of research interest and analysis of various algorithms associated with biometric identification and verification among users of computer systems grows up. The volumes of research that exploit the current technologies for identification and verification are not bounded by scope or applications associated with authentication, assurance and security [6]. It is a well know technology for which both the government and private organizations are active participants as biometric (combination with others) allows enhanced level of protection of one's identity. The prime goals of any biometric based security systems presented are based on protocols designed for authentication, immune to fake impersonators and the covertness required they are [5-6]:

- Is the system able to identify the authorized personals in all possible environments and scenarios with high accuracy?
- Is the system able to identify the unauthorized personals in all possible environments and scenarios with high accuracy?
- Is the system immune against spoofing and tampering?

Now-a-days fusion of the above systems has evolved into exemplary research that is addressing the modern requirements of the organization [1]. But the focus at large is to use IRIS as basic system has been gaining the ground in the current while other biometrics would act as ancillary to the IRIS system for improved security while maintaining FAR and FER within the constraints.

The rest of the paper is divide into following sections i.e. section 2 deals with background and existing research for detection and verification of IRIS Biometric while section 3 deals with research gaps and project the need of the new research to enable a secured means of extracting the IRIS template that can offer accuracy consistently throughout the research focus. And the paper is concluded in the section 4 of the paper

II. IRIS BIOMETRICS

The inaccuracy of biometrics to identify a person is the main cause for the adoption of these algorithms in the past has been difficult and has long been a source of frustration and research for last two decades. In the current digital era the need for secured authentication and management has increased, there is a need for identity authentication and access control strategy to ensure the integrity of exchanged data as well as to grant authorized entities access right to data and services. In general, an assessment expert judges the accuracy of the biometric system solely based on the common employed feature extraction and comparison of the existing feature metric [7-11]. Unfortunately, this method does not emphasize on the feature extraction i.e. pre-processing of the biometric during the image processing operation cycle, which is considered as a vital part as it allows the algorithms to estimate the features in an improved manner based on the texture, edge detection, point estimation and etc[12-13].

By comparison, other biometrics such as signatures, face, fingerprints, voice prints, and retinal blood vessel patterns all have significant drawbacks as presented in the table 2. Although signature, fingerprint and facial biometrics are cheap, easy to obtain and store; they are impossible to identify automatically with high assurance, and are easily forged [7-8]. Electronically recorded voice prints are susceptible to changes in a person's voice, and they can be counterfeited [7-8]. Fingerprints or hand prints require physical contact, and they also can be counterfeited and marred by artifacts.

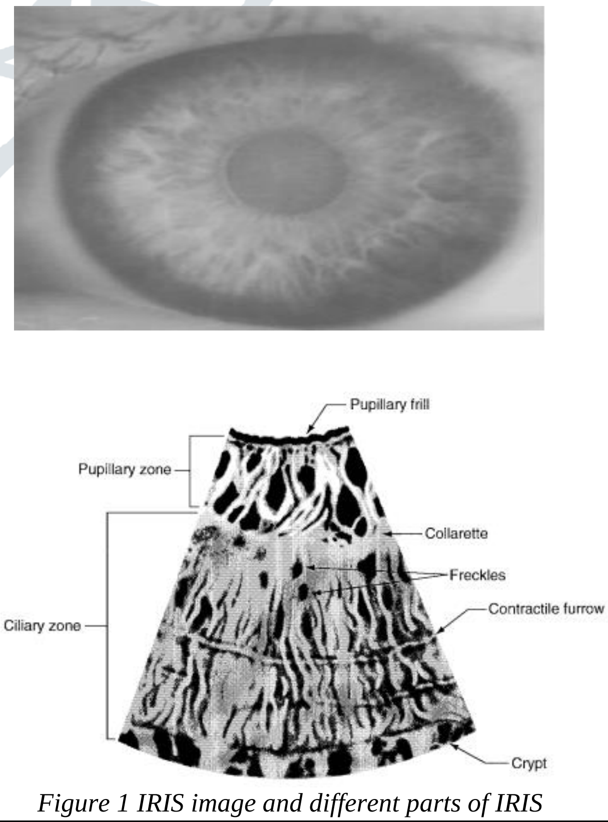

Figure 1 IRIS image and different parts of IRIS

It is a well known fact in the non-research communities that they often get confused between retinal and Iris identification. It is a fact that both are different IRIS is visible region that can be easily be captured by a video recording device (i.e. camera, web cam or etc) while retina is hidden and difficult to be captured. The main reason for the strong emphasis on understanding the IRIS verification and detection engineering is that it provides the general conceptual model and techniques of secured analysis and particular enhance authentication based operational and transitional phase characteristics. It is evident fact that there is no clear definition of the IRIS template process which could calculate and perform accuracy analysis without some reasonably FER and FAR parameters employed in calculation [8]. The IRIS images can classified based on color (i.e. based on Martin-Schulz scale) which is classified in to 20 classes based on the eye color from light blue to black [14].

Recent advances in IRIS Biometric have focused research on the unwrapping the IRIS texture detection and extraction, affine transforms, template matching and matching patterns of dynamic IRIS data. These developments enable new opportunities in biometrics management; image processing, segmentation, machine learning, and template/image areas fusion that have potential implications for IRIS based biometric detection and verification. In biometric based authentication systems, the biometric data can be collected and processed to determine key points for the formulation of the biometric template (metrics) that could be normalized for verification of biometric on consistent basis and also update [15].

A. BACKGROUND: IRIS BIOMETRIC SYSTEMS

To reduce error rate and other security risks such as false positive detection or true negative detection, and it requires that only authenticated features and tabulated entities of the IRIS are allowed to form the template information and use these metric for identification system. The conventional IRIS texture access control approaches have been widely used in the IRIS biometric systems use a combination of segmentation and enhancement to identify texture region within the eye captured [16]. However, the existing solutions are not fully adapted to image processing ecosystem due to the constrained resources of space and frequency transformation of the image processing. The combination of multiple approaches and technologies can led to a solution of improved accuracy, smaller template and speedy detection IRIS biometric system. Furthermore, today's access control solutions often rely on centralized architecture, which not only demonstrates enormous scalability issues in an distributed environment composed of large number of templates, but also can be a performance bottleneck or the single point of failure.

Authors	Detection process	Extraction Process	TemplateMatching	Limitations
John G. Daugman [7] filed in 1991 approved in 1994	Identify the boundaries between iris and pupil, iris and sclera. The area lying between intermediate are branded as iris image of concern	polar coordinates, to generate an iris code of fixed length and having a universal format for all irises	XOR Comparison with hamming distance based computation	Length of the template has been defined for all IRIS universally.
R P Wildes [17] 1997	Increasing pixel captured so that we have more information but the process is same in above approach	Same approach and incorporate histogram analysis	Same approach and incorporate Laplacian based Gaussian filtering	Length of the template and process is not automated ROI is manual
Boles, W. W., & Boashash, B. [18] 1998	Edge detection for identifying the diameters of two regions to estimate the prospective IRIS region	Normalization of data and incorporation of wavelet on the IRIS template	Dissimilarity measure introduced for the wavelet information	Subject able to quantization errors and FER and FAR needed to be improved
Gifford, M. M., McCartney, D. J., & Seal, C. H. [19] 1999	The authors present an approach wherein the detection and extraction process are similar to the process of J. G. Daugman [7] while matching of the templates (iriscode) is conducted via network so they employ distance based measure for comparison.			Network security is addressed while using biometrics
Schneier, B. [20] 1999	The author presents the pro and cons of the biometric based system in terms of security and limitations i.e. the system at enrollment needs to get template from authorized personnel and also verification process the data base should have the template of the person if either has been tampered the biometric system is useless			
Zhu, Y., Tan, T., & Wang, Y. [21] 2000	Soft Threshold based approach is used for detection of inner circle outer circle through edge detection block wise	Normalization, Affine transforms histogram equalization, Gabor filtering ,2D-wavelet transform	Weighted Euclidean distance measure	translation, rotation, and scale invariant algorithm but FAR & FER issues are there
Lim, S., Lee, K., Byeon, O., & Kim, T. [22] 2001	Edge detection, centroids analysis and averaging on centroid. Prospective IRIS region detection	Polar coordinates transformation, Gabor filtering, 2D-wavelet transforms	Learning vector quantization and winner selection by Euclidean distance	FAR and FER issues are addressed but not at par as desired
Sanchez-Reillo, R., & Sanchez-Avila, C. [23] 2001	The detection process are similar to the process of J. G. Daugman [7] with incorporation of region detection	Polar coordinates transformation, Gabor filtering, 2D-wavelet transforms	Template size reduced and binary search is introduced	Template size reduced and FAR and FER issues results promising
Ma, L., Wang, Y., & Tan, T. [24-25] 2002	Edge detection and Hough transform with centroids analysis and averaging on centroid. Prospective IRIS region detection	Normalization, anti-clock unwrap, histogram equalization, low-pass Gaussian filtering	Modified Nearest feature line technique	FAR and FER issues results promising
Huang, Y. P., Luo, S. W., & Chen, E. Y [26] 2002	Edge detection, centroids analysis and averaging on centroid. Prospective IRIS region detection	Polar coordinates transformation, Independent Component Analysis	Competitive learning Mechanism and Euclidean distance	interference of eyelids and eyelashes
González T, I., González A, B., MartinezA., F., &Seara-Paz, S. [27] 2017	Iris zigzag is extracted by means of circular Hough transform	Median filter is applied along with linear Hough & Gabor transform	Modified hamming distance	address eye lids and iris circular problems
Zhang, K., Huang, D., Zhang, B., & Zhang, D. [28] 2017	Filtering based on Gaussian filters and ROI between upper and lower eyelids	Speeded Up Robust Features based on invariant transformations	hamming distance	address eye lids and enhance accuracy and speed on the system
Llano, E. G., et. al. [29] 2017	the quality evaluation with Laplacian pyramid fusion method	Normalization & low-pass filter in successive levels of a Gaussian pyramid	hamming distance	Equal error rate is used as a metric for comparison
Ahmadi, N., &Nilashi, M. [30] 2018	Local and Global features analysis with edge detection to produce ROI for IRIS	Normalized and multilevel 2-D wavelet decomposition	Hamming distance measure	In corporation of wavelets
Hamouchene, I., &Aouat, S. [31] 2014	The detection process are similar to the process of J. G. Daugman [7] with incorporation of region detection	polar coordinates, to generate an iris code of fixed length and having a universal format for all irises	Neighborhood based binary pattern over overlapped image blocks and distance matrix	New measure for comparison has been introduced
Umer, S., Dhara, B. C., & Chanda, B. [32]2015	Restricted circular Hough transform to determine both contours	Normalization, polar coordinates, toggle filter	Similarity score between the templates	Application of Hough Transform
Umer, S., Dhara, B. C., & Chanda, B. [34] 2016	median filter and Circular Hough transformation	Normalization, polar coordinates, bi-variant statistics	K-means clustering and SVM for similarity score	K-Means clustering
Spasić, S. Z. [33] 2014.	Local and global entropy over a series of iris images captured to localize the IRIS region	Radial normalization and angular normalization of the region	Linear Discriminative analysis and distance measure	LDA
Ko, J. G., Gil, Y. H., Yoo, J. H., & Chung, K. I. [35] 2007.	effective intro-differential operator and smoothing function	Normalization, polar coordinates, histogram-based stretching, cumulative sums	Hamming distance	Cumulative means
Nabti, M., &Bouridane, A. [36] 2008	An approach based on multiscale edge detection based localized gradient	Unwarping in terms of vertical and horizontal details with wavelets and Gabor filter bank	Statistical + moment invariants mapped to binary with hamming distance	Two templates for comparison
Seung-In, N., Bae, K., Park, Y., & Kim, J. [37] 2003	2D – Gabor filter and wavelet transforms	1. Local features 2. Global features	Hamming distance on global features is less then local feature hamming distance is calculated	Two feature set for analysis
Zhang, P. F., Li, D. S., & Wang, Q. [38] 2004	2D Log Gabor filter and wavelets decomposition	Global and local iris features	Hamming distance and weighted Euclidean distance	Two feature set for analysis
Nam, K. W., Yoon, K. L., Bark, J. S., & Yang, W. S. [39] 2004.	Polar coordinates, region classifier based on 16x16 window	Directional properties (increasing, decreasing, crossover)	Binary transformation and hamming distance	Complete data has been used without any cropping
Rathgeb, C., &Uhl, A. [40] 2010	The detection process are similar to the process of J. G. Daugman [7] with incorporation of region	Normalization, Polar coordinates, Gaussian filter and contrast limited adaptive	Binary patterns and hamming distance	Mapping of binary patterns from enhancement

Rathgeb, C., &Uhl, A. [40] 2010	The detection process are similar to the process of J. G. Daugman [7] with incorporation of region detection	Normalization, Polar coordinates, Gaussian filter and contrast limited adaptive histogram equalization	Binary patterns and hamming distance	Mapping of binary patterns from enhancement image
Ng, T. W., Tay, T.L., & Khor, S. W. [41] 2010	The detection process are similar to the process of J. G. Daugman [7] with incorporation of region detection	Normalization, Polar coordinates 4 level haar wavelet	Mapping of coefficients to binary and hamming distance	Mapping of coefficients from Haar wavelet decomposition
Yao, P., Li, J., Ye, X., Zhuang, Z., & Li, B [42] 2006	The detection process are similar to the process of J. G. Daugman [7] with incorporation of region detection	Normalization, Polar coordinates modified log gabor	Hamming distance	Modified log Gabor against complex Gabor transform

II. RESEARCH ANALYSIS AND GAPS

Fundamentally, even though biometric technology has been around a while but because of J. G Daugman [7] work and its accurate features and characteristics, such as supporting localization of IRIS (most of researchers focused automation of the detection) and conversion of the IRIS region from Polar co-ordinates form to Cartesian co-ordinates form (several works have been published on the analysis and processing it for extraction of feature set). Finally the comparison between the templates has been limited different form of weighted Euclidian distance or Hamming distance based measuring techniques [7-42].

In this paper, we focused on the three stages of the biometric recognition system and its capabilities, short-comings and probable scope of research i.e.

1. Localization of IRIS information (Detection)
2. Extraction of features from IRIS information (Extraction)
3. Comparison of feature set template to database template (Template Matching)

Localization of IRIS information (Detection):

This initial stage of the recognition system i.e. segmentation of IRIS region which is considered as a vital aspect of the system as the accuracy highly depends on how well the IRIS could be segmented. There are several kinds of external factors that affect this process (namely eyelids, eyelashes, lamination-reflections and pupil). Henceforth most of the work focuses on the identification of circular boundaries of both quadrants so as to limit system to focus on IRIS ROI only through Hough transform and edge detection. We have found in most cases the prediction of the boundaries has very often several errors and valuable information needed for recognition is lost which has to be addresses which is still an open area [43-44]

We found that information of IRIS needs to maximum available it is structure and pixel distribution from other areas is different enabling us to incorporate overlapping 3x3 block-level technique to cover image as select the all possible pixels pertaining to IRIS ROI. This process would ensure we have complete information of the IRIS.

Extraction of features from IRIS information (Extraction):

This is the second stage of the recognition system i.e. analysis of the IRIS region which also considered as a vital stage of the system as the template formulation is carried out in this stage and the accuracy highly depends on how well the IRIS could be analyzed. There are several kinds of process available that could be incorporated to attain the desired results (namely enhancement, filtering, time and frequency analysis via transforms and etc). Henceforth most of the work focuses on the conversion of the circular IRIS information into rectangular template with needed buffering to ensure the size if the fixed. We have found in most cases that the information is normalized, filtered and enhanced to ensure all the data is available in the needed format for extraction of changes in the formulation of template. The changes are analyzed based on the transforms (Gabor and others), wavelets (wavelet decomposition), and image processing operations which have necessary information needed for template formulation [45-47].

We found that information of by considering the pixels in circular format offers maximum available gradients in 2D perspective as its structure and pixel distribution are not altered. We can further apply the needed image processing techniques to extract the global feature set and inherit localized feature set essential for template formation. The scope of applying a combination of transforms, wavelets and/or image processing operation is available to improve the accuracy.

Comparison of feature set template to database template (Template Matching):

To achieve secure identity authentication, a decentralized authentication mechanism needs to be implemented on the template, and aims at virtual trust areas to allow all distributed features to identify each other (within the vicinity of the template). A similarity-based capability strategy is presented and the federated authorization delegation mechanism that is incorporate with high accuracy are

- ✓ Euclidean Distance (including weighted)
- ✓ Hamming Distance (including modified)

The major contributions of this work are as follows

- ➢ Leveraging the biometric recognition system with inherent generated feature set with a decentralized segmentation, extraction and matching solution is proposed to address both the identity authentication and access authorization issues
- ➢ Using virtual segmentation based the authentication mechanism ensures that only need information based entities in the domain could formulate the template, meanwhile the features-based extraction model provides a scalable, flexible, fine-grained and lightweight scheme.
- ➢ A complete architecture of a biometric IRIS-enabled system is properly designed, which includes identity authentication, features management and validation.

IV. CONCLUSION

In this paper, we presented a detail progress in the IRIS based biometric system's structures for identity authentication and management. A concept-proof prototype based on existing algorithms is illustrated on segmentation, extraction and validation fronts with comprehensive study has been conducted that evaluates the computational fit and corresponding limitations at each stage of the operation. We conclude the following points

- Leveraging the biometric recognition system with inherent generated feature set with a decentralized segmentation, extraction and matching solution is proposed to address both the identity authentication and access authorization issues
- Using virtual segmentation based the authentication mechanism ensures that only need information based entities in the domain could formulate the template, meanwhile the features-based extraction model provides a scalable, flexible, fine-grained and lightweight scheme.
- A complete architecture of a biometric IRIS-enabled system is properly designed, which includes identity authentication, features management and validation.

The following features need to be compared for standardizing and biometric algorithm those are

- correct recognition rate (CRR) and with minimal
    - false acceptance rate (FAR) and
    - false rejection rate (FRR)

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