IRIS RECOGNITION FAILURE IN BIOMETRICS: A REVIEW

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Abstract

More than twenty years iris has been claimed to be the most stable modality in human lifetime. However, the iris recognition produces 'failure to match' problem which made the known is unknown user or the genuine is recognized as imposter in the biometric systems. Apparently, failure to recognize the real user as in the database is due to a few assumptions: aging of the sensor, changes in how a person uses the system such as the threshold settings and template aging effect. This paper focuses on template aging effect since it is on ongoing problem faced in iris recognition. Many studies attempted several techniques to overcome the problem in every phase which consists of three general phases: the pre-processing, feature extraction and feature matching. Therefore, the purpose of this paper is to study and identify the problems in iris recognition that lead to failure-to-match in biometrics.

Keywords*: Iris Recognition System, Feature Extraction, FAR, FRR and PSNR.*

1. Introduction

Biometrics is the study of authentication of human measurements by their physical and behavioral attributes or traits that can be used to recognize a person. Within the field of biometrics, fingerprint, face and iris are often deliberated as the current and major modalities. The research activities in iris recognition of biometrics have increased dramatically in recent years, which pioneered by the work of (L. Flom and A. Safir, 1987), and later followed by (J. G. Daugman, 1994). In iris recognition, two general phases to be accomplished are a) recognizing a human that is based on the iris texture and b) performing the feature extraction and matching processes in order to measure the performance and accuracy parameters of biometrics system.

2. Iris Recognition Problems in Biometrics

The iris modality is declared by (J. Daugman & Downing, 2013) to be high in accuracy, stable and not changing in a human lifetime. However, the system prone to 'failure to match' as number of attempts occur during the matching or verification phase, although he or she is the same person as in first time of enrollment. 'Failure to match' issue does not contribute to the total failure of iris recognition system. Nevertheless, the next generation of iris recognition demands a 'room for improvement' to the existing system. The big question is what are the problems in the existing iris recognition that leads to 'failure to match'? Therefore, the present study aims to identify the problems in iris recognition. Two ongoing issues related to 'failure to match' are identified; head tilt or cyclotorsion and template aging in iris.

A. Head Tilt or Cyclotorsion

a. Definition

The biology online (Victoria & Canalon, 2001) defines the meaning of head tilt as an abnormal position of the head adopted to prevent double vision resulting from under action of the vertical ocular muscles. It is also includes rotation and deviation.

b. The issues in head tilt

The effect of head tilt would altered the images and influenced the temporal comparisons (Rankin, Scotney, Morrow, & Pierscionek, 2013) since the human head and eye movements. Due to this, head rest and chin bar really prevent from the cyclotorsion (in medical application). Otherwise, in biometrics, the cyclic rotation function is implemented (Masek, 2003) as a mechanism for registration in the matching process in order to explanation for any possible head tilt differences between images. Therefore, it is sufficient to avoid the unstable coordinate alignments which cause to low in matching scores.

B. Template Aging in Iris

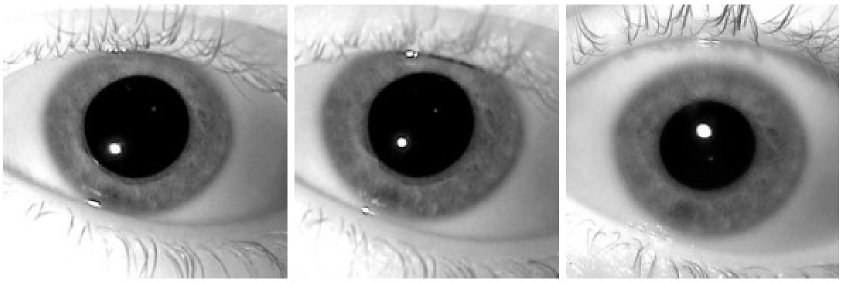
a. Definition

The term 'template aging' refers to degradation of biometric performance that occurs with increased time between the acquisition of an enrollment image and acquisition of the image compared to the enrollment (Burge & Bowyer, 2013).

b. The issues in template aging

A considerable work has been done to cater template aging problem especially for face modality (Lanitis, 2009) (Ramanathan, Chellappa, & Biswas, 2009). However, it has received little or no attention for other modalities, such as iris and fingerprint. This is due to the assumptions that iris codes is stable over time (J. Daugman & Downing, 2013). As opposed to this assumption, this study found that iris is also prone to the aging effect due to increase error rates in false non match rates.

It is found that the error rates have been increased between the enrollment and verification phases. (Mansfield & Wayman, 2002) explains that the increase in error rates is affected by time related as changes in the biometric pattern, its presentation, and the depreciation value of sensor create a low quality of iris image. (Baker, Bowyer, & Flynn, n.d.) contribute the first experimental results on iris biometrics regarding on template aging. The study involved 26 irises (13 persons) with images acquired over the time period 2004-2008 using an LG 2200 iris sensor yet the LG 2200 is no longer in the market. Baker et al. used a version of the IrisBEE matcher that was distributed as a baseline matcher in the Iris Challenge Evaluation (National Institute of Standards and Technology, 2006). This matcher does not have state-of-the-art performance. Thus, the authentic user is compared against impostor distributions for short-term and long-term matches. Short-term matches were between two images taken in the same academic semester but not on the same day. Long-term matches were between an image taken in spring of 2004 and one taken in spring of 2008 as in figure 1.



(a) Enrollment Image from Spring 2004 (b) Verification Image from Spring 2004 (c) Verification Image from Spring 2008

Figure 1: Subject 04233 Left iris-HD for spring 2004 versus spring 2004 probe was 0.156. HD for spring 2004 gallery versus spring 2008 probe was 0.285. (Baker et al., n.d.)

There was no significant change in the impostor distribution for long-term matches compared to short-term matches. However, it was found that the authentic distribution for long-term matches shifted in a way that resulted in an increase in the false non-match rate. As an example, they reported that, “at a false accept rate of 0.01%, the false reject rate increases by 75% for long time lapse”. In other hand, short time lapse, use of visible light images and iris matcher with poor absolute performance makes it difficult to draw any firm conclusions about template aging effect in iris biometrics. Rather presenting only a point estimate of the change in the false non-match rate (FNMR), that the bootstrap method is used to compute 95% of confidence intervals. This allows an assessment of the degree of uncertainty involved in the estimate of the FNMR. The illustration of this explanation could be viewed as in figure 2.

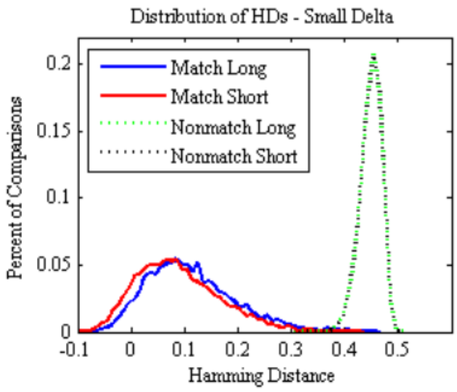


Figure 2: The distributions of non-match is higher while the match distributions are separated (Fenker & Bowyer, 2011)

3. Discussions

(J. Daugman & Downing, 2013) stated that the iris texture is stable; every iris in human eye has a unique texture of high complexity, which proves to be essentially immutable over a person's life (J. G. Daugman, 1994). Nevertheless, the iris is a biological tissue subject to physiological processes and under control of the autonomic nervous system. Iris alteration happens as increase in age and changes over time (Fenker, Dame, & Bowyer, 2010). Regardless of the continual critique of iris texture being immutable, (J. Daugman & Downing, 2013) acknowledge that various features, such as ‘freckles, pigment blotches and color can change with time. These are features associated with texture as these are generally characteristics of pigmentation: clumps of pigment, uneven distribution, variations in density. In fact, these important features are importance for iris recognition (Rankin et al., 2013).

(L. Flom and A. Safir, 1987) in their patent, stated that the texture features of the iris were relatively stable over time and do not change over a period of many years. In the other hand, they also acknowledged that the iris texture is subject to change over time, and the process of re-enrollment after some period of time might be needed. In fact, features do develop over time and usually build up rather slowly. This is a strong argument that an updated iris image will permit ID for a substantial period. A renewal of driving license for a period of time may be a good example of explaining this concept.

Experiments conducted by (Fenker et al., 2010) present results of template aging in iris biometrics. They proved through analyze datasets involving one, two, and three years of time lapse between acquisition of enrollment and verification images. In order to find that there is a template aging effect, the percentage of false non-accept rate increased with the time increasing since enrollment, over the length of time in dataset. The bootstrap methods are used to estimate 95% confidence intervals for the change in false non-match rate (FNMR) with increase in time lapse. For a state-of-the-art iris matcher, and three years of time lapse, at a decision threshold corresponding to a one in two million false match rate (FMR), it is observed that 153% increase in the false non-match rate (FNMR), with a 95% confidence interval of 85% to 307%. Masek's iris matcher implementation used by (Sazonova et al., n.d.) stated that the overall performance is weak. At a false match rate of 0.01%, they report false non-match rates of 8.5% to 11.3% for within-session matches, versus FNMRs of 22.4% to 25.8% for across session matches. This is essentially a same-session versus not-same-session comparison, rather than a longitudinal template aging experiment, but it does show that iris match quality depends on factors that may change with time.

A vital part of related background is that human perception of similarity in iris texture patterns implies the closeness of iris biometric match. Recent work done by (Hollingsworth, Bowyer, Lagree, Fenker, & Flynn, 2011) demonstrates this. In one experiment, they demonstrated subjects' pairs of iris images that were either from identical twins or from unrelated persons. In another experiment, the pairs of images were either from the left and right eyes from the same person, or from unrelated persons. In both cases, subjects were highly accurate at categorizing pairs of images that belong together versus pairs that do not. This shows that humans can perceive a similar in the iris texture pattern between left and right eyes of the same person, or between eyes of identical twins. However, using the same images, the average biometric match score was no closer for identical twins, or the left and right eyes of same person, than it was for unrelated persons. This shows that humans perceive similarities in iris texture that are not reflected in iris biometric match scores.

4. Future Research Directions

The existing iris recognition in biometrics suffers from a major incompatibility between the unstable iris codes and with something which demand for stability and correctness in every single bit. Some of the researchers suggest that in dealing with this problem, a new method of iris recognition is needed to overcome the template aging phenomena. New mechanisms that are capable of simulating or eliminating aging effects on biometric templates are in demand. Aging simulation can be performed based on data driven approaches or methods based on modeling physiological mechanisms that cause the process of aging (Lanitis, 2009).

According to (Al-qatawneh & Al-naimi, 2013) automatic age estimation is favourable since the facial images estimator provide robust and fast detection, since the age classifiers learn the pattern in training dataset and it was essential to have available information about the exact age of each subject in the database. The iris codes matching gives coordinate alignments problem which lead to imprecision in matching process and produce low match score. In other hand, a self-learned and bio-inspired computing based algorithm is needed in the next iris recognition system for better extraction in enrolment and matching (verification) phases.

5. Conclusion

A new algorithm which is more humanized, self-learned and based on bio-inspired computing is in demand for future iris recognition. Besides, an intelligent automatic detection is important to implementing the processes such as translation, rotation, and scale invariant. It uses only a few selected intermediate resolution levels for matching, thus making it computationally efficient and less sensitive to noise and quantization errors. The algorithm must be smart enough to learning the similarity from the training data set in order to extract the similar iris feature for robust and fast iris recognition. This mission is intensely complicated because aging in mixture with external factors that influence the process of aging, since compounded effects that are difficult to predict and model. For this reason modeling aging variation in the new algorithm of iris recognition requires state of the art. Thus human perception of a stable iris texture pattern over time does not necessarily imply anything about iris biometric template aging. Studies of iris biometric template aging must be done in the context of biometric match scores.

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