Accuracy of iris recognition systems degrades with increase in elapsed time

Kevin Bowyer

Recent experimental results from two research groups show an increase in iris recognition error rate with increased time since enrollment, indicating a need for a re-enrollment scheme or new algorithms.

Iris recognition uses images of a person’s iris—the colored part of the eye (see Figure 1)—in a wide variety of successful biometric identification applications. Many researchers consider irises to be ideal for identification: they are well protected by the cornea, easily imaged, and believed to be unique to every individual. They may also be more accurate than other identification mechanisms such as fingerprint or face recognition. Moreover, up to now, enrollment in an iris biometric system was believed to be ‘once for life.’

‘Template aging’ refers to increases in error rate over time between the original image (the ‘enrollment image’) and later images taken for identification (the ‘recognition image’). While template aging is known to occur for biometrics that use the face and fingerprints, researchers have long believed that iris recognition was immune to this effect. However, both our research group and another group recently published results showing that template aging does occur in iris recognition. These results suggest that iris recognition systems need to implement some provision for re-enrollment.

Two parameters describe the accuracy of iris recognition systems. The ‘authentic distribution’ is the distribution of match values between two images of the same eye. The ‘impostor distribution’ measures that distribution between images of two different eyes. A change in the accuracy of a recognition system can show up as a change in the authentic distribution, the impostor distribution, or both. Our results did not show any change in the impostor distribution with increasing time-lapse between images. However, our results did show a change in the authentic distribution, resulting in an increase in the false non-match rate (FNMR), i.e., the fraction of authentic matches that are rejected.

Estimating the magnitude of the increase in the FNMR is difficult, since it varies based on the value of the decision threshold, the matching algorithm used, and other factors. For our

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The false non-match rate for iris images taken one month apart (‘short’) and three years apart (‘long’). The longer time interval consistently rejects authentic matches at a higher rate over a wide range of decision threshold scores.

In our work, we were able to control factors that may be difficult to control in an operational scenario. For example, we obtained all our match scores with the same version of the iris matcher. However, algorithm upgrades may occur over time, which could mask any template aging effect. A similar effect may occur as new sensors are introduced or as operational procedures evolve.

We have found that, contrary to common belief, iris recognition accuracy does degrade over time. The reason for this is not understood. The underlying cause is not as obvious to casual visual inspection as the signs of aging that we are used to seeing in face images. Therefore, future research will focus on why template aging occurs. For example, the average pupil dilation of an eye decreases over a person’s lifetime. Larger differences in pupil dilation between two images of the same iris increase the FNMR. However, while it is possible that changes in dilation contribute to template aging, our analyses suggest that this is not the main factor.

Another study by researchers from Clarkson University and West Virginia University showed a similar result. They found that the FNMR went from 2.5% for short-term matches (less than six months) to 6.7% for long-term matches (over two years). This corresponds to an increase in the FNMR of slightly over 150%. Furthermore, when they restricted their analysis to a subset of higher-quality images, they found an even larger increase in the FNMR.

Imagine that in an identity verification scenario, the observed short-time-lapse FNMR is 1% when the application is initially fielded. Our results suggest that it might increase to 2.5% after three years. While this is a small incremental change, the FNMR could continue to grow with additional time-lapse. There is not yet any published work that explores iris template aging for a period greater than four years. Consequently, the longer term behavior is unknown.

An obvious, practical solution to the growing FNMR is to establish a re-enrollment policy for iris recognition systems. Different applications might set different re-enrollment intervals, based on the relative impact of an FNMR result. Another alternative is to develop a ‘rolling re-enrollment’ scheme, a term coined by John Daugman, in which the enrollment template is updated whenever an identity verification is made with sufficiently high confidence.

Three-year data set, using the VeriEye iris matcher, and with a decision threshold that corresponds to a one in two million false match rate, we observed a 150% increase in the FNMR. The data plotted in Figure 2 shows that the FNMR is consistently higher for long time-lapse compared to short time-lapse across the range of decision threshold values.

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References


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