**Isolating Iris Template Ageing in a Semi-controlled Environment**

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**Abstract**

Apparent template ageing effects are often attributed to changes during acquisition rather than the natural ageing of the iris. In this paper we attempt to remove apparent ageing from iris images (selecting a best subset from a larger database) and controlling as many factors as possible in the biometric toolchain. This includes manual segmentation and the use of a non-linear biometrical model to alleviate influence of pupillary dilation on the results.

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**THE CASIA IRIS AGEING DATABASE**

The database is a subset of the upcoming CASIA v5.0 Iris Database. The user images are from video recordings of both eyes and span four years (2009 and 2013). Based on:


and their quality based assessment of the database we chose the following user sessions:

- 2009: We based the selection of users on session 1 (images without glasses).
- 2013: Again we used the session without glasses.

We still had to remove some individuals as follows:

- 0204: 64% for session 2009
- 1004: No images without glasses in 2013
- 0190: No data in 2013

The database originally contained 120 images from an video sequence per eye (2009 and 2013). Since the images are from a video sequence of the eyes, temporal proximity results in almost equal images. Keeping in mind that manual segmentation would be performed, we chose ten images per eye, spaced apart as far as possible in the temporal domain. Images in which large parts of the iris were occluded by the eyelids due to blinking were eliminated.

The resulting database consists of 47 users with two eyes per user for a total of 1880 images. There are 10 images per eye and year. The manual segmentation is done by a single Operator A (G/H).

The inner and outer iris boundaries are segmented using elliptical boundaries and the lower and upper eyelids use polynomial boundary.

**APPARENT AGEING AND SEGMENTATION**

**Database—Effectual Processes**

Before we begin the experimental analysis of the database let us first consider a number of other circumstances which can lead to apparent template ageing. The objective is to minimize external influence which could lead to ageing-like results, within the possibilities determined by the data.

- **Rotation**: see Figure 2. This is compensated for in all tests.
- **Sensor ageing**: is not an effect with any significant influence as shown by et al. [2]. This database was chosen for their research is a superset of the database we are using, so the results clearly apply. They extracted an ageing model of the sensor based on the segmentation and applied the effects of an artificial sensor-ageing to the images, which produced a negligible influence for up to 96 years of sensor-ageing.
- **Segmentation with 2009 2013**

- The obfuscation of the iris by the eyelid, due to blinking or simulating effects, was minimized by selecting images from the database where this did not occur.
- **Obfuscation of the iris by glasses, which might introduce additional reflections and distortions**, was prevented by choosing images of subjects without glasses from the database.
- **Recording conditions** seem relatively stable over the two years, mainly a 1-bit shift is visible. Figure 1 shows the two histograms.
- **There are some blurring effects**, presumably due to the recording modalities and motion, as well as visible interfering. These effects appear in both the 2009 and the 2013 images and thus introduce no clear bias towards either.

The biometric quality is considered good since we used the analysis by Wild et al. [1] as a guide to select the subset. Regarding image quality, utilizing BRISKUE, a no-reference image quality assessment tool from Mittal et al. [3], we get a very similar range of qualities for both years. For 2009 we get average FMR = 78.93% and standard deviation \( \sigma_{FMR} = 12.288 \) while for 2013 we have \( \mu_{FMR} = 58.960, \sigma_{FMR} = 15.254 \).

**Figure 1**: Aggregate histogram of 2009 and 2013. The overlap coefficient between the aggregate histograms of 2009 and 2013 is 75.13% (no shift) and 94.87% (correcting the 1-bit shift).

**Figure 2**: Rotation compensations is set to +14 bits, i.e., the rotational range in the database is approximately in the range \( \pm 10^\circ \).

**Figure 3**: Range of image quality from 2009 and 2013.

**APPARENT AGEING AND PUPILLARY DILATION**

- **Does the change in pupilary dilation influence the recognition rate?**
- **Use a biomechanical model (BMM) to offset the non-linear normalization modification due to dilation based on?**
- **There is apparent template ageing.**
- **Segmentation is not the problem.**
- **There is a change in pupillary dilation.**

Normalization based on a biomechanical model cannot fix it.

**Main Results**

**Table 1**: Main Results of the database analysis.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gallery</th>
<th>FMR (OP 0.01)</th>
<th>FNMR (OP 0.01)</th>
<th>EER (OP 0.01)</th>
<th>Hamming score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>gallery–2009</td>
<td>53.43%</td>
<td>46.57%</td>
<td>79.524</td>
<td>0.016</td>
</tr>
<tr>
<td>2013</td>
<td>gallery–2013</td>
<td>87.87%</td>
<td>12.13%</td>
<td>88.360</td>
<td>0.016</td>
</tr>
</tbody>
</table>

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**Figure 3**: Range of image quality from 2009 and 2013.