Homework

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1. Iris Recognition System Description

Gallery

All subjects and their eligible images in `2008-03-11_13` are used to create a gallery. An enrolled subject has multiple entries in the gallery. For example, suggest that subject A has 2 left eye images and 2 right eye images, there will be 4 entries in the gallery.

Probe

Subjects in folder `LG2200-2010-04-27_29` and `LG4000-2010-04-27_29` are used to create probes. Probe 1 refers to all subjects in `LG4000-2010-04-27_29`, and probe 2 refers to all subjects in `LG2200-2010-04-27_29`. All images, except ineligible ones as stated below, are used to create probes.

Verification Decision Making

Suppose the probe P has p left eye images and q right eye images. The claimed subject G in gallery has m left eye images and n right eye images. We denotes the difference score between image i and image j as $f(i, j)$. Suppose we have a threshold t. The difference score of left eye of P and G will be

$$score_{l,P,G} = \sum_{i}^{p} \sum_{j}^{m} f(i, j)$$

, and the difference score of left eye of P and G will be

$$score_{r,P,G} = \sum_{i}^{q} \sum_{j}^{n} f(i, j)$$

Suppose we have a thresholding function a

$$a(score, t) = \begin{cases} \text{True}, & \text{if } score \leq t \\ \text{False}, & \text{otherwise} \end{cases}$$

, the decision made by the system will be

$$a(score_{l,P,G}, t) \wedge a(score_{r,P,G}, t)$$

Recognition Decision Making

Suppose we have a probe P who has p left eye images and q right eye images. For rank N recognition (assume in a closed-set setting), the system returns the N subjects in the gallery that have the highest similarity to this probe. Similarity is defined as

$$similarity(P, G) = 0.5 \times (score_{l,P,G} + score_{r,P,G})$$

, where G denotes a subject in the gallery.

Handling occlusions

When matching a probe with a gallery entry, it is possible that the occlusion parts of their templates have a bad match and explose different parts of the iris. In extreme cases, the exposed part of irises are completely different, and therefore there is no way to compare the two images. In this case, we skip this pair of templates and only use comparable pairs. In occasian where all template pairs are incomparable, which is rare, the system does not make any decision.

2. Source Code Description

To regenerate the distributions, ROC curves, and CMC curves, please first unzip the three data file as `2008-03-11_13`, `LG2200-2010-04-27_29`, and `LG4000-2010-04-27_29`, place them in the same directory as other `.m` files, and run `demo.m` in command line or MATLAB. No arguments are needed. Note that:

1. If this program is run on a Linux/Windows operation system, line 39 in `create_gallery.m` should be uncommented, and line 40 in the same file should be commented out. If this program is run on a OS X operating system, nothing should be changed. This is due to an extra `.DS_Store` file generated by OS X operating system.
2. The patent code should be placed under a folder named `irisrecog_functions`. The folder should be placed in the same directory as other `.m` files. If `undefined function createiristemplate.m` error is thrown, please replace the path in line 36 in `create_gallery.m` with the absolute path of the folder `irisrecog_function`.
3. Ineligible images, either have low resolutions or bad iris capture, will not be processed. `create_gallery.m`

will record the image's file name in a `error.txt` file and skip them. There is no need to recognize and delete these images manually.

4. All successfully processed images will be recorded in a `log.txt` file.

3. Results Report

Genuine and Impostor Distribution

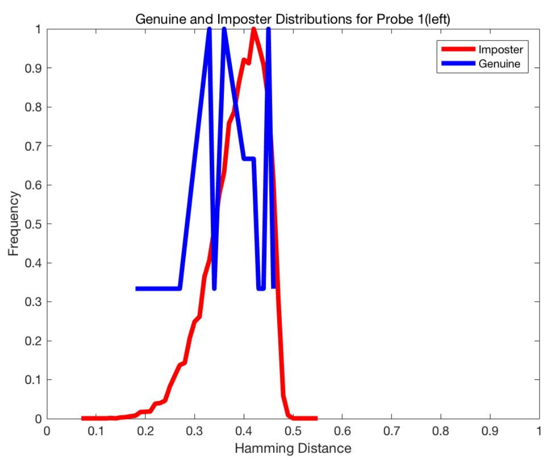

Figure 1: genuine and impostor distribution, probe 1, left eye

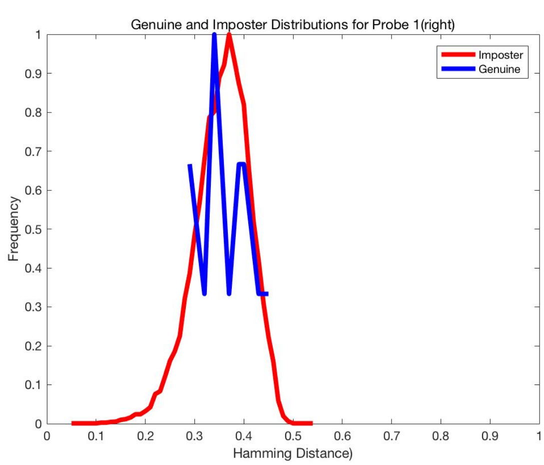

Figure 2: genuine and impostor distribution, probe 1, right eye

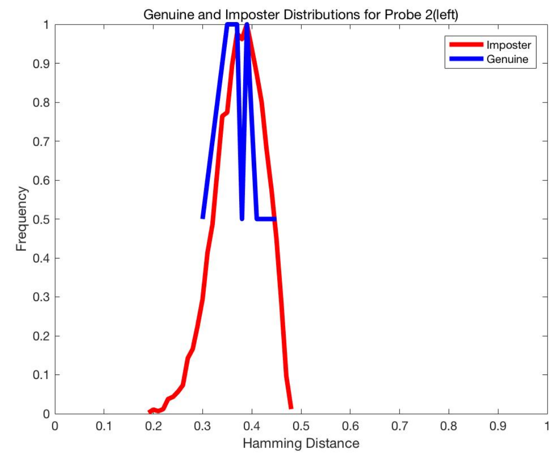

Figure 3: genuine and impostor distribution, probe 2, left eye

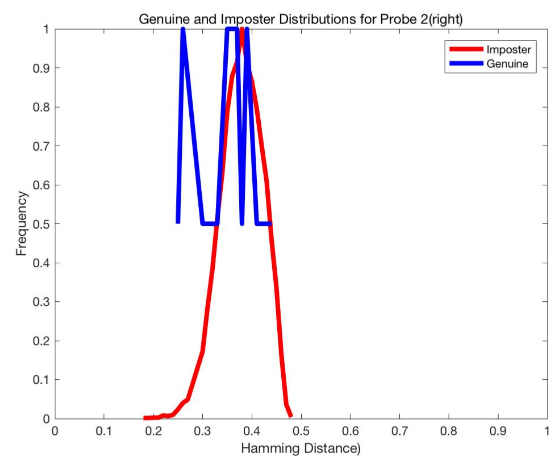

Figure 4: genuine and impostor distribution, probe 2, right eye

Figure 1 and 2 shows the genuine and impostor distribution by matching subjects in `LG4000-2010-04-27_29` with subjects in `2008-03-11_13`. Figure 3 and 4 shows the genuine and impostor distribution by matching subjects in `LG2200-2010-04-27_29` with subjects in `2008-03-11_13`. In these four figures, the curves of impostor distributions are of higher quality than those of genuine distributions, since there are more examples of false claims than true claims. These figures suggest that the recognition system is not very precise. An ideal system should employ a method that maximizes inter-class difference and minimizes within-class difference. That is, we should maximize something like

$$\frac{(\mu_{genuine} - \mu_{impostor})^2}{(\sigma_{genuine} - \sigma_{impostor})^2}$$

, where $\mu_{genuine}$ and $\sigma_{genuine}$ denote the mean and standard deviation of the genuine distribution, and $\mu_{impostor}$ and

$\sigma_{impostor}$ denote the mean and standard deviation of the impostor distribution. The ideal distribution curves should be as far away as possible from each other, and as thinner and taller as possible. However, in the above figures, the genuine distribution curve and impostor distribution curves almost compeletely overlap with each other, meaning that the inter-class difference is small and within-class difference is relatively huge.

ROC Curves

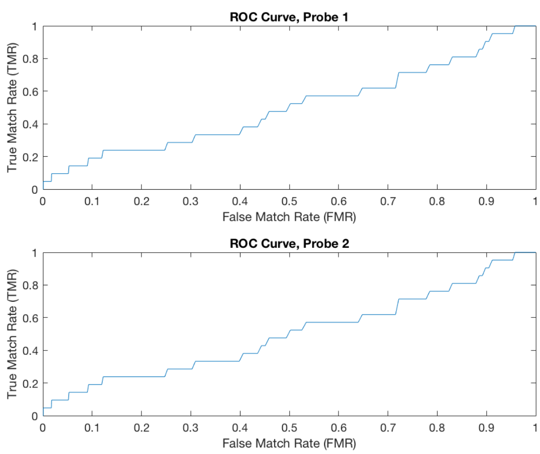

Figure 5: ROC Curve

Figure 5 shows the ROC curves generated by using subjects in `LG4000-2010-04-27_29` and `LG2200-2010-04-27_29` as probes. The accuracy of this biometric system is measured by the area under the ROC curve. An area of 1 represents a perfect system which can classify all possible probes correctly. An area of 0.5 represents a worthless system which basically randomly classify any probe. Approximately, the area under both curves is $\approx \frac{1 \times 1}{2}$. Therefore this biometric system is of very low accuracy.

CMC Curves

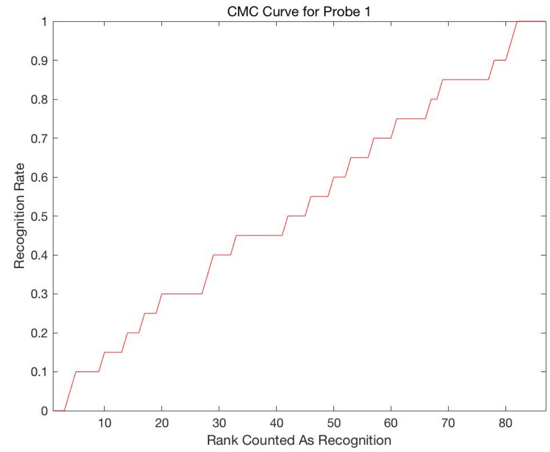

Figure 6: CMC Curve, probe 1

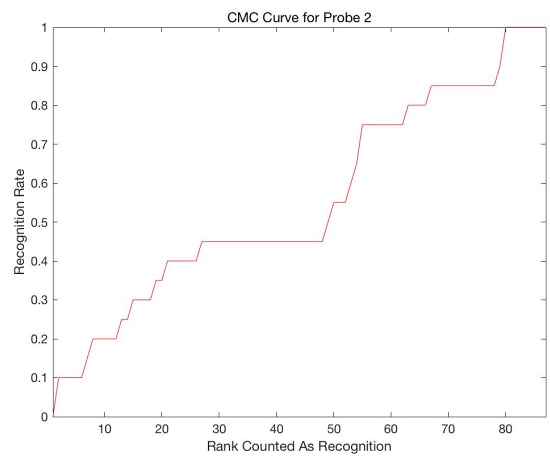

Figure 7: CMC Curve, probe 2

Figure 6 and Figure 7 show the CMC curves generated by using subjects in `LG4000-2010-04-27_29` and `LG2200-2010-04-27_29` as probes respectively. Figure 6 shows that, approximately, the recognition rate reaches 0.5 when top 50 matches are returned. Figure 7 shows that approaximately the recognition rate reaches 0.5 when top n (n is somewhere between 50 and 60) matches are returned. Both figures suggest that the accuracy of this biometric system is very low.

Conclusion

Based on the genuine and impostor distributions, ROC curves and CMC curves, this biometric system is very low in accuracy.