Custom Design of JPEG Quantisation Tables for Compressing Iris Polar Images to Improve Recognition Accuracy

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Abstract

Custom JPEG quantisation matrices are proposed to be used in the context of compressing iris polar images within iris recognition. These matrices are obtained by employing a Genetic algorithm for the corresponding optimisation. Superior matching results in iris recognition in terms of average Hamming distance and improved ROC are found as compared to the use of the default JPEG quantisation table.

Motivation

Compression can be required in biometric systems, e.g. for storage of compressed templates on IC cards. For sample data, compression technology may be applied in two stages of the processing chain in classical biometric recognition for example:

- Transmission of sample data after sensor data acquisition and
- Optional storage of (encrypted) reference data in template databases.

The distortions introduced by lossy compression artifacts usually interfere with subsequent feature extraction and may degrade the matching results. In particular, FRR or FNMR will increase (since features of the data of legitimate users are extracted less accurately from compressed data) which in turn affects user convenience and general acceptance of the biometric system. In extreme cases, even FAR or FMR might be affected. Therefore, careful selection and optimization of compression schemes is a must.

Iris Image Compression

ISO/IEC 19794-6 allows iris image data to be stored in lossy manner in the JPEG and JPEG2000 [1, 2] formats. Two types of iris image data are considered: *rectilinear images* (i.e. images of the entire eye [4]) and *polar images* (which are basically the result of iris detection and segmentation), the latter much smaller in terms of storage requirement (e.g. 2kB vs. 25-30kB for rectilinear images).

WHY JPEG ?

- significantly lower computational demand as compared to JPEG2000 and
- in the medium to high quality range, JPEG delivers subjectively comparable image quality [5, 3].

JPEG [6] allows to use custom Q-tables in case image material with special properties is subject to compression. Two reasons support the idea to use custom Q-tables:

1. Iris imagery might have different properties as compared to common arbitrary images, and
2. A pleasant viewing experience as being the aim in designing the default tables, might not deliver optimal matching results in the context of biometric recognition.

Iris Image Properties and JPEG Q-Tables

Fig. 1 visualizes image properties of common images vs. polar iris image images. Obviously, there is more energy in the horizontal direction in case of polar iris image.

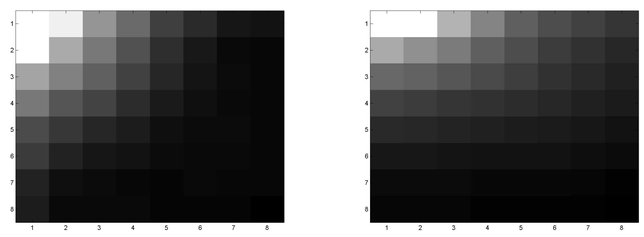

Fig. 1 Averaged 8x8 DCT blocks: aritrary images vs. polar iris image blocks.

We may exploit the direction bias of iris texture in compression directly. Additionally, we conjecture that the highest and medium frequencies might not be required for the matching stage due to the coarse quantisation used for template generation. Fig. 2 shows the Q-tables for which we present experimental results.

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

10	10	76	255	255	255	255	255
85	112	255	255	255	255	255	255
151	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255

16	11	10	16	255	255	255	255
12	12	14	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255

16	11	10	16	24	246	255	255
12	12	14	29	26	255	255	250
14	13	16	24	255	255	255	224
14	17	22	255	255	255	242	255
18	255	255	255	255	255	255	255
24	247	255	255	255	255	255	255
255	255	255	255	255	255	255	255
255	255	255	241	255	241	255	244

15	6	17	19	255	255	255	255
5	15	13	255	255	255	250	255
255	255	247	255	248	255	255	255
255	250	248	255	255	250	255	255
255	222	237	255	251	255	255	250
255	252	251	250	220	249	229	232
254	246	255	251	255	255	255	248
255	255	247	252	255	255	248	255

Fig. 2 JPEG Quantisation tables: STQ, Qtable22, Qtable24 (first line), QTOptk05, and QTOptk10 (second line).

Qtable22 and Qtable24 have been obtained by large scale trial and error experimentation, setting a large amount of entries to 255 (which causes the corresponding coefficients to be divided by 255 and results in most of them being quantised to zero). Both matrices are asymmetric in the sense that they "protect" more coefficients in horizontal direction. QTOptk05 and QTOptk10 have been found using a Genetic optimisation approach.

Experimental Study

The employed iris recognition system is Libor Masek's Matlab implementation of a 1-D version of the Daugman iris recognition algorithm. We considered 50 persons (3 - 4 images per eye resulting in 334 images) with 320x280 pixel images having 8-bit grayscale information per pixel from the CASIA 1.0 iris image database. Fig. 3 shows examples of iris templates extracted from uncompressed (first line) and JPEG compressed iris texture patches of one person.

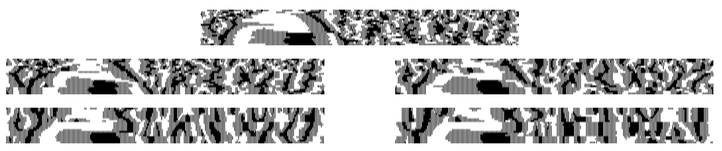

Fig. 3 First line uncompressed, second line: compressed with rate 10 using STQ and QTOptk10, third line: compressed with rate 15 using STQ and Qtable22.

Experimental Results

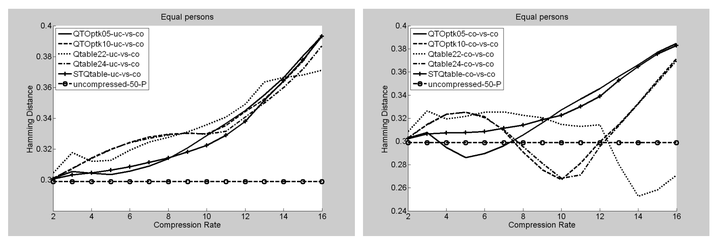

Fig. 4 Impact of varying compression rate on HD of genuine users' matches (one image vs. two images compressed.

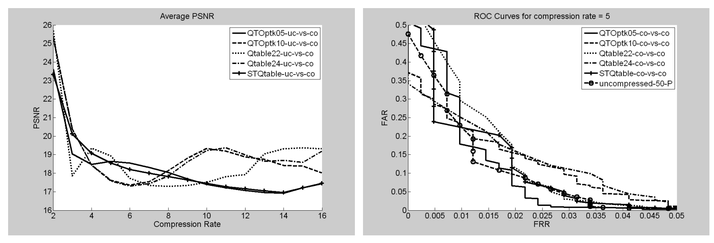

Fig. 5 Rate/distortion and ROC performance for compression ratio 5 (both images compressed).

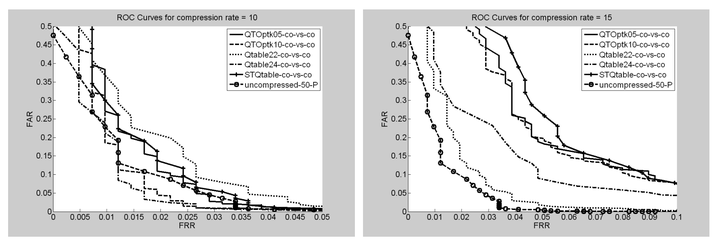

Fig. 6 ROC at compression ratio 10 and 15 (both images compressed).

Conclusion and Future Work

- Custom designed quantisation tables in JPEG can improve matching results in terms of average HD and ROC behaviour significantly.
- Effect is more pronounced for higher compression rates and two compressed images.
- Optimzation has to be done with respect to a specific target bitrate.
- Future work: consider alternative iris recognition algorithms to identify possible interference between compression technique and iris recognition system. Optimisation of GA parameters.

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