Université de Genève

Chosen Chapter
14x060

TP 2 : Multimedia forensics: Lab2

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1 Step 1: generation of JPEG compressed and double JPEG compressed images

- Investigate properties of quantization matrix (QM) for different values of quality factor (QF):

Figure 1: Quality matrix

We can clearly see that the more the quality factor is close to 50 the more the quality matrix will be similar to the Q50 (Top left matrix in figure 1). The more the quality factor is big the less the coefficient in the corresponding matrix is big. Furthermore, we know that the bigger are those coefficient the bigger is the loss in the compression process. Moreover, we can see that when the quality factor is small the difference of value between the upper part and the lower part of the matrix appear earlier (earlier in the sense that it is more in the top left part).

- Generate JPEG compressed image with QF1.:
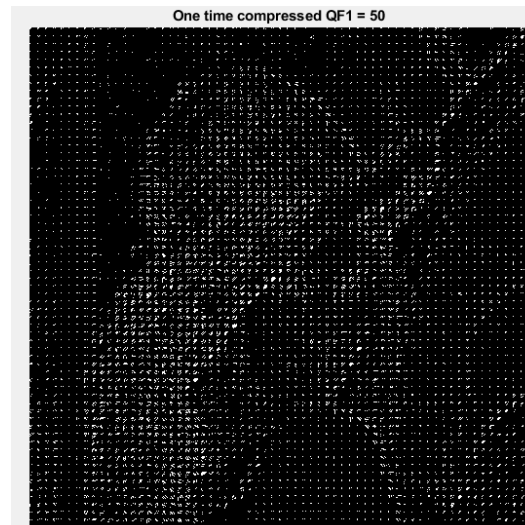
Figure 2: One time compressed image

Here we subtract each image's pixel by 128 to center it, then we do the encoding by computing the discret cosine transform and the quantization of the DCT coefficients.

- Decode JPEG image into spatial domain
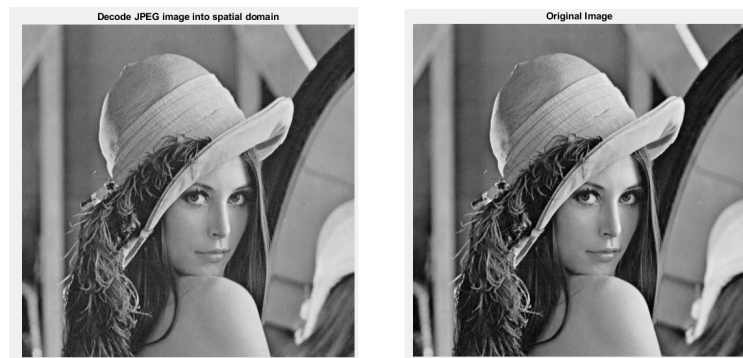
Figure 3: Decompression

Except the fact that there is less contrast in the decompressed image, we can see that the image is almost completely recomposed. To build this recomposition, we just do a dequantization of the DCT coefficients, compute the inverse discrete cosine transform and do a shift operation of 128 on the result.

- Generate double JPEG compressed image with QF2 (QF2 $\neq$ QF1).
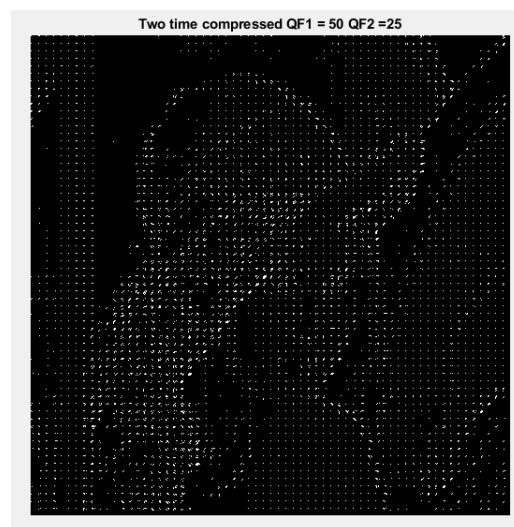
Figure 4: Double JPEG compressed image

After the decompression of the first compressed image we do again a compression with a different quality factor value. So we compute again the forward discrete cosine transform and the quantization of the DCT coefficients.

2 Step 2: analysis of DCT coefficients of JPEG compressed images

- Generate global histograms of DCT coefficients of one-time and double JPEG compressed images.
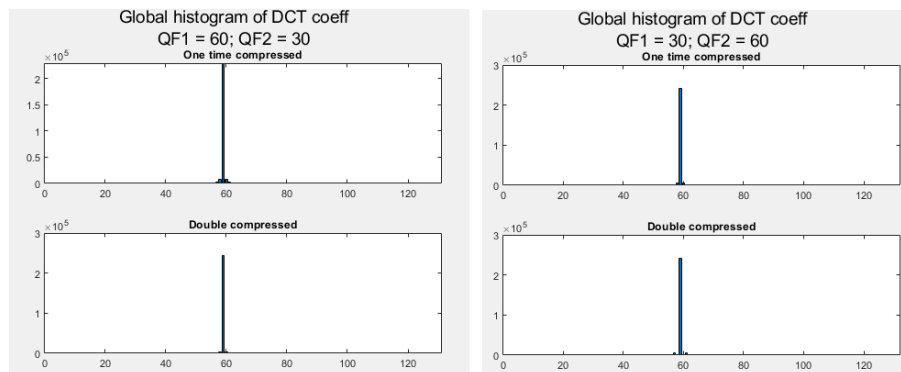
Figure 5: Global histogram

- Analyze the behavior of global histograms of DCT coefficients for QF2 > QF1 and QF2 < QF1.

  When we have QF1 < QF2, we can see that some bins are empty because the second quantization redistributes the quantized coefficients into more bins than the first one.

  When we have QF1 > QF2 some bins contain more samples because even bins receive samples from more original bins with respect to the odd bins. However those observation aren't totally clear in the total histogram but we can also analyse the histograms of DCT coefficients locally to have a better view of this phenomenon.

- Generate pairwise histograms of DCT coefficients of one-time and double JPEG compressed images.

  For example, we will take the 9th DCT coefficients:

Figure 6: Global histogram

- Analyze the behavior of pairwise histograms of DCT coefficients for QF2 > QF1 and QF2 < QF1.

  Here, at the left we can clearly see that there is missing bins in the double compression. At the right we see that some bins disappeared from the one time compressed image and that there is much more occurrences for the bin at the center of the histogram.

3 Step 3: detection of image manipulation based on double JPEG compression detection
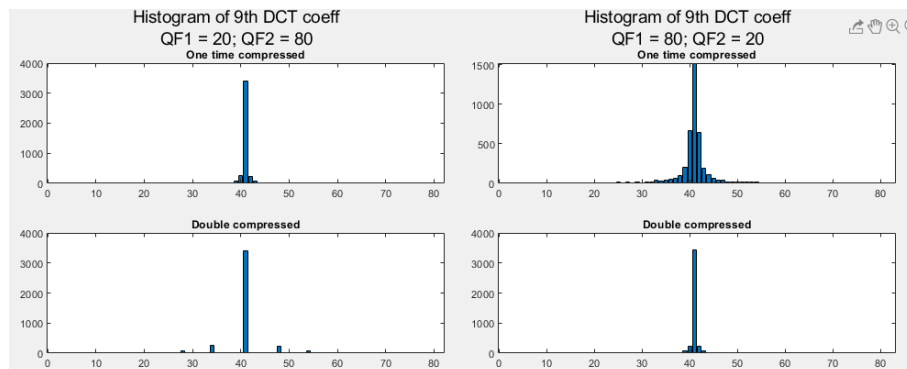
- Generate manipulated image in DCT domain by concatenation of DCT coefficients of one-time and double JPEG compressed images (ManImage1).
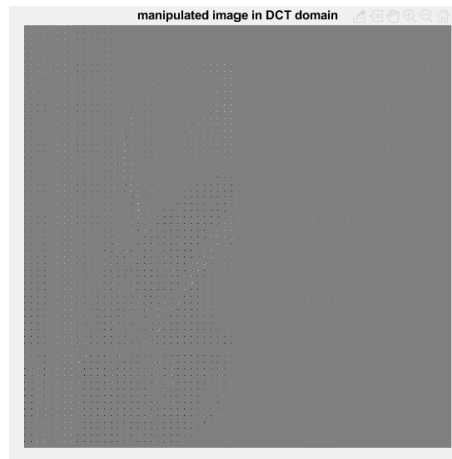
Figure 7: Manipulated image in DCT domain

This image is defined by the concatenation of half left part of the DCT quantized from the one time compressed image with the right part from the two time compressed image. We can clearly see the difference at the middle of the manipulated image in DCT domain.

- Generate manipulated image in spatial domain by concatenation of decoded of one-time and double JPEG compressed images (ManImage2).

Figure 8: Manipulated image in spatial domain

Here, we combine half of the decoded of one-time and two-time compressed image. However, we can't see any difference between this image and the original one. That is why, we will analyse the DCT coefficients of this two image to detect the presence of the double compression.

- Based on pairwise analysis of DCT coefficients detect presence of double compression in ManImage1 for QF2 > QF1 and QF2 < QF1.

  For this case we are already in DCT domain so I simply plot the histogram for each DCT coefficients, for example the first and third one:
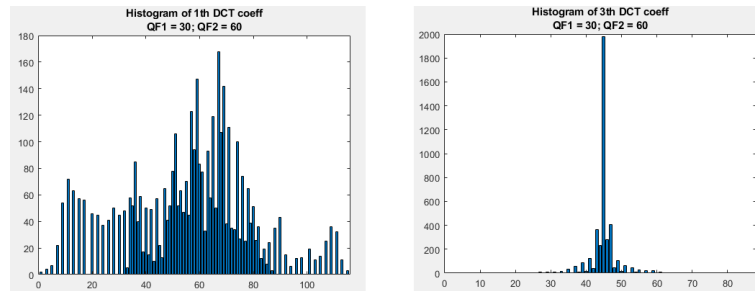
  For QF1 < QF2:

Figure 9: Dct histogram

We observe some empty bins on both of this image which is clearly a sign of double compression when QF1 < QF2. Furthermore, we also see that some bins contain more samples that neighbouring bins which is normally a sign of double compression when QF1 > QF2.

For QF1 < QF2:

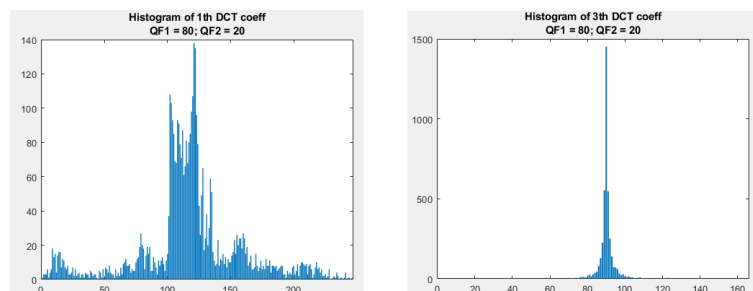

Figure 10: Dct histogram

Here, its not totally obvious that we have double compression because there isn't any empty bins and the neighbouring bins doesn't always contain more samples. So it's harder to determine image manipulation when QF1 < QF2.

- Based on pairwise analysis of DCT coefficients detect presence of double compression in ManImage2 for QF2 > QF1 and QF2 < QF1.

  Now, I will compute the DCT coefficients of the image without doing the quantification:

For QF1 < QF2:

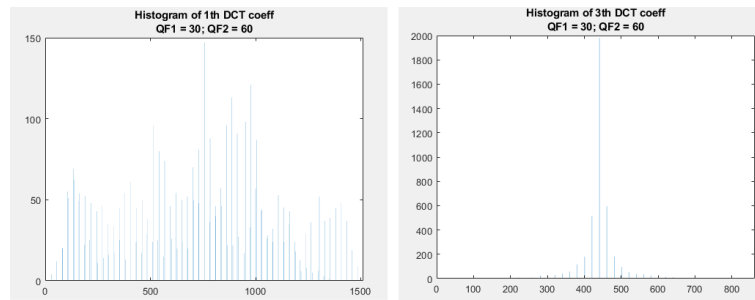Figure 11: Dct histogram

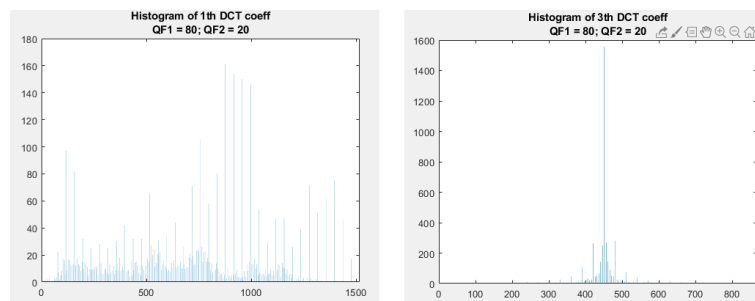Like the previous case we see some empty bins in both images. For QF1 < QF2:

Figure 12: Dct histogram

In this case we see the fact that some bins contain more samples than neighbouring bins.

- Compare the results of double JPEG compression detection in ManImage1 and ManImage2 for given values of QF1 and QF2 in case of QF2 > QF1 and QF2 < QF1

In almost every case we observe double compression but its harder to see it for ManImage1 when QF1 < QF2.