Exercises on MMDB
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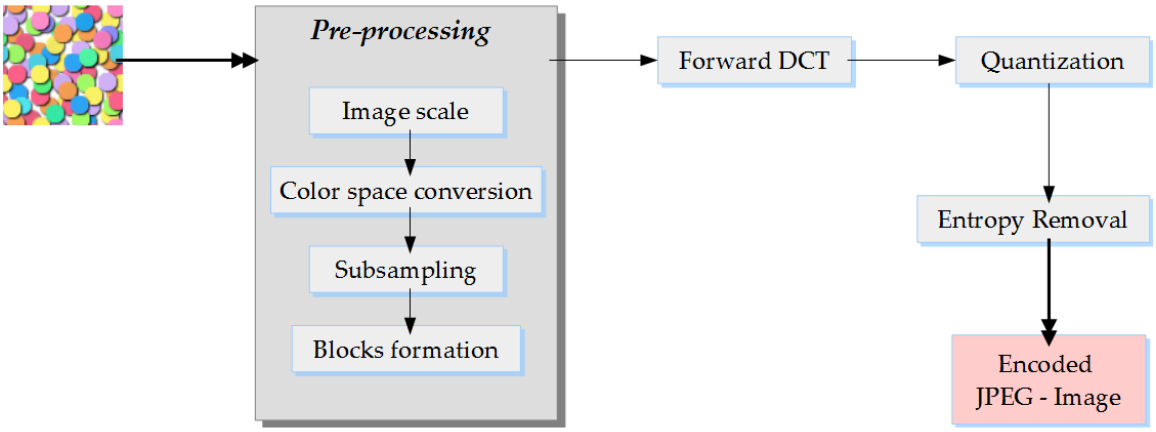
Exercise Sheet 5

Subject: JPEG Image Compression

Aufgabe 1: JPEG Baseline Process

The following figure shows the workflow of the lossy sequential DCT-based JPEG compression algorithm (also called *Baseline Process* or *Basis mode*).



1. What are the main goals of the baseline process?
2. Shortly summarize the function of each step, and outline which ones are *lossy*.

Aufgabe 2: Pre-processing

1. What are the advantages of converting the color space from RGB to YUV (or. YC_bC_r)?
2. What does subsampling of chrominance elements mean? *(Consider the ratios 4:4:4, 4:2:2 and 4:2:0).*
3. Why should the size of the image be scaled first before encoding? And how does scaling work with respect to image blocks and minimum coded units (MCUs)?

Aufgabe 3: Discrete Cosinus Transformation

1. What is the task of the *Forward Discrete Cosine Transform* (F-DCT) during the JPEG compression?
2. In a DCT-transformed block, which parts are most useful for compression?
3. In this context, explain the notions *DC coefficient* and *AC coefficient*

Aufgabe 4: Quantization

The following figure shows a common quantization matrix.

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

1. What are the general advantages and disadvantages of quantizing DCT coefficients? Which characteristics of DCT coefficients have to be kept in mind when selecting the 64 quantization values?
2. How can the values of the quantization matrix (and quantization factor) influence the perceived quality?

Aufgabe 5: Entropy coding

1. Describe in general the purpose of entropy coding as a last step of JPEG compression. Is it a *lossy* or a *lossless* process?
2. What is the main contibution of (*Run Length Encoding* (RLE)) to data compression? How is a data block processed at this stage?
3. Why are *DC*- and *AC*-coefficients entropy coded differently? Which procedure is generally recommended for encoding *DC*-coefficients, and which one for *AC*-coefficients?