CA7 Coding Example

Task: Code image $A = \begin{bmatrix} 129 & 130 & 131 \\ 132 & 133 & 134 \\ 135 & 136 & 137 \end{bmatrix}$. Use quality factor 2.

1. Subtract 128
$$B = A - 128;$$
which yields
$$B = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

2. DCT
$$C = \text{dct2}(B);$$
which yields
$$C = \begin{bmatrix} 15 & -2.45 & 0 \\ -7.35 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

3. Quantize
$$C_q = \text{round}(C./Q);$$
with $Q = \begin{bmatrix} 3 & 5 & 7 \\ 5 & 7 & 9 \\ 7 & 9 & 11 \end{bmatrix}$
which yields
$$C_q = \text{round}(C./Q) = \begin{bmatrix} 5 & 0 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}.$$  
This is the only step where information is lost. Usually you would multiply with $Q$ here in order to complete the quantization, but not in image coding, since the multiplication step will happen during the decoding process. This requires the decoder to know $Q$. In our example, we transmit the quality factor, with which $Q$ can be constructed.

4. Zig-Zag coefficient matrix into sequence (2D -> 1D)
$$\text{seq}=[C_q(1,1), C_q(1,2), C_q(2,1), C_q(3,1), C_q(2,2), ... C_q(1,3), C_q(2,3), C_q(3,2), C_q(3,3)] ;$$
which yields
$$\text{seq} = [5 \ 0 \ -1 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0]$$
Indices are in (row, column) format.
5. Write to file (simplified, without program structure)

To program this step will take most of your time, since you have to come up with an appropriate logic.

CA7 Decoding Example (cont’d)

6. Read from file (simplified, without program structure)

To program this step will take most of your time, since you have to come up with an appropriate logic.

7. Zig-Zag sequence into coefficient matrix (1D->2D)

8. Quantization (“de”-quantization)

With this step quantization is completed.

9. IDCT
which yields $\tilde{B} = \begin{bmatrix} 2.96 & 2.96 & 2.96 \\ 5.00 & 5.00 & 5.00 \\ 7.04 & 7.04 & 7.04 \end{bmatrix}$

10. Add 128

$$\texttt{ \textgreater \textgreater A\_tilda = B\_tilda + 128; }$$

which yields $\tilde{A} = \begin{bmatrix} 130.96 & 130.96 & 130.96 \\ 133.00 & 133.00 & 133.00 \\ 135.04 & 135.04 & 135.04 \end{bmatrix}$

**HW8**

Problem 1, you should get the following values $C_q = \begin{bmatrix} 37 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 0 \end{bmatrix}$. Fill in the blanks.

Problem 2, you should get $seq = \begin{bmatrix} 37 & -2 & \cdots & 0 \end{bmatrix}$

Problem 3, assume as an example that $seq = \begin{bmatrix} 129 & 120 & -128 & 50 & 0 & 0 & 0 \end{bmatrix}$. In that case your result should look like this: -128(1), 129(2), 120(1), -128(1), -128(2), 50(1), 0(1), 3(1). In parenthesis is the number of bytes. Underlined is the flag or “escape sequence”. Don’t use hexadecimal notation, if it is not asked for.

BTW: -128 in hex is 0x80 and not 0xff (which is -1) as stated wrongly in the forum. (Thanks Roy!)