Multimedia Systems

Exercise No. 7

Discrete Cosinus Transform

Preparation: Calculate the transformation matrix A and the transpose A^t with the formulas given on lecture slide “Frequency Transforms (9)”.

Note:

- It holds: $A * A^t = E$ (identitiy matrix)
- Notation: a_{ij} determines the element in row i and column j of matrix A.
- We recommend to solve this exercise with help of a spread sheet which implements basic matrix functions, e.g. OpenOffice Calc or Microsoft Excel. Here the matrix multiplication is given by *=MATMULT(A1:B8;A9:B16)*, wich can be applied by selecting an appropriate area and confirming the formular input with CTRL+SHIFT+ENTER.
- The DCT (coefficient) matrix is calculated by: $D = A * X * A^t$

1. Characteristics of the DCT transformation

   a) What are the characteristics of the DCT matrix when X is defined by:

      i. The elements of the first row have a value of 255, all other elements have a value of 0.
      ii. The elements of the first column have a value of 255, all other elements have a value of 0.

   b) What are the characteristics of the DCT matrix when all elements of X have a value of 255 and only the elements of the first row have a value of 0.

   c) What chacteristics has the DCT matrx for an input matrix X, in which all diagonal elements a_{ii} have the same value and all other elements have a value of 0.

2. Exermine the DCT matrix D given in
   http://www.icsy.de/studium/vorlesung/ws0910_MMS/exercise/dct-coefficients.xls
   (alternative: http://www.icsy.de/studium/vorlesung/ws0910_MMS/exercise/dct-coefficients.csv)
   Calculate the original matrix X.

3. In the lecture the basis of a 8x8 DCT was visualized by 64 images. The images are denoted by $alpha_{ij}$,i = 0, .., 7, j = 0, .., 7. Calculate the matrix $alpha_{11}$.

4. Use the tool *Imagetrans* to experiment with the image
   http://www.icsy.de/studium/vorlesung/ws0910_MMS/exercise/demoimage.jpg.
