Multimedia Systems

WS 2009/2010

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Exercise 7.1

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.

→ only vertical frequency

→ only the first column of the DCT matrix is affected

→ the block is a composition the first column of the 2D basis "images"

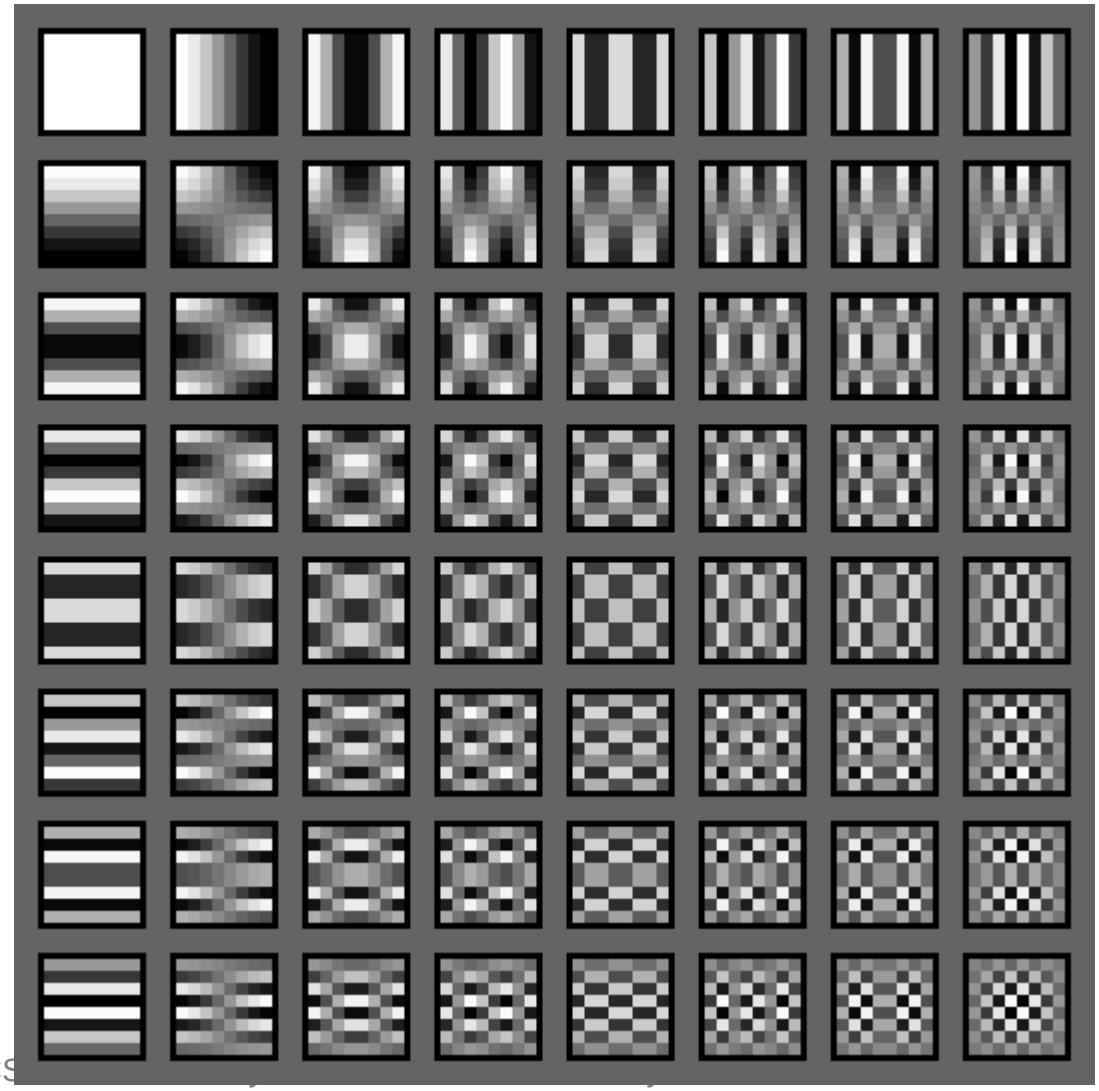
ii. The elements of the first column have a value of 255, all other elements have a value of 0.

→ only horizontal frequency

→ only the first row of the DCT matrix is affected

→ the block is a composition of the first row of the 2D basis "images"

Visualization of the 2D DCT basis



Exercise 7.1

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

→ similar to a) i.

c) What characteristics has the DCT matrix 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.

→ X is a scalar multiplication of the given value with the identity matrix: X = x * E

→ $D = A * (x * E) * A^t = x * A * E * A^t = x * A * A^t = x * E = X$

→ The DCT matrix is equal to the input matrix.

Exercise 7.2

- Examine the give DCT matrix D. Calculate the original matrix X.
  - → $D = A * X * A^t$, $A^t = A^{-1}$
  - → $A^t * D = X * A^t$
  - → $A^t * D * A = X$

$$X = \begin{pmatrix} 255 & 255 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 255 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 255 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 255 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 255 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 255 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 255 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 255 \end{pmatrix}$$

Exercise 7.3

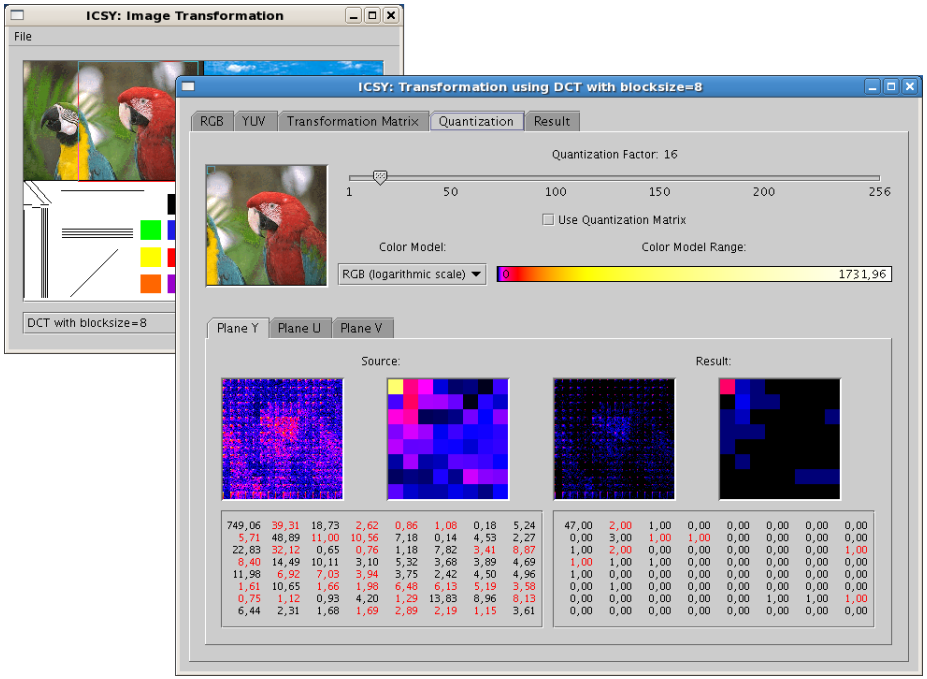
- In the lecture the basis of a 8x8 DCT was visualized by 64 images. The images are denoted by $alpha_{ij}$, i = 0,..,7, j = 0,..,7. Calculate the matrix $alpha_{11}$.

$$\boldsymbol{\alpha}_{i,j} = \left((\mathbf{A})_{i\cdot} \right)^T \bullet \left((\mathbf{A})_{j\cdot} \right)$$

$$\alpha_{1,1} = \begin{pmatrix} 0.49 \\ 0.42 \\ 0.28 \\ 0.10 \\ -0.10 \\ -0.28 \\ -0.42 \\ -0.49 \end{pmatrix} \cdot \begin{pmatrix} 0.49 & 0.42 & 0.28 & 0.10 & -0.10 & -0.28 & -0,42 & -0,49 \end{pmatrix}$$

Exercise 7.4

- **Interactive examples:**
  - Do it yourself with ImageTrans (*)



(*) This is a Java Webstart application; you'll probably need to install this software from http://java.sun.com/products/javawebstart .