**CM0669 Machine Learning and Computer Vision**

**Lab 7** Digital Image Transforms, DCT, DFT, DWT.

**1. Colour transforms**

Open up Matlab and Type in ‘help rgb2ntsc’ and ‘help rgb2ycbcr’. A helpful description will be given on the built-in functions ‘rgb2ntsc’ and ‘rgb2ycbcr’ for transforming a colour RGB image into another colour space. Download the colour images in a folder (Week7).

1. Create a Matlab code which reads a colour image (‘image1.jpg’), transforms the colour space into YCbCr, displays the luminance and chrominance images and saves the luminance plane in a jpg file. Execute the code for the other colour images.

The Matlab code has been uploaded on blackboard.

1. Amend the previous code to display the NTSC planes for each colour image.

The Matlab code has been uploaded on blackboard.

1. The Matlab function getEnergy.m is a function which calculates the energy of a signal.

The energy *E* of an image of size *M*×*N* is given by

*f*(*i*,*j*) is the value of the image at coordinate (i,j)

1. Execute the Matlab function and record the energy of images in the following table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Energy | | | | | |
|  | Red | Green | Blue | Y | Cb | Cr |
| Image1.jpg | 8.1175e+09 | 6.9620e+09 | 5.7357e+09 | 6.8403e+09 | 7.8480e+09 | 9.1486e+09 |
| Image2.jpg | 8.2043e+09 | 8.5081e+09 | 8.9182e+09 | 7.6479e+09 | 6.5244e+09 | 6.0736e+09 |
| Image3.jpg | 5.7705e+09 | 4.9228e+09 | 4.3238e+09 | 4.5984e+09 | 3.8599e+09 | 4.8030e+09 |

Discuss the results. Overall, the energy of the image after transformation is slightly smaller compared to its energy in the RGB representation. Note that energy cannot be used to describe the content of the picture (textured or not textured) but can be used to measure the amount of information.

**2. Fourier, cosine, and wavelet transforms – De-correlation, Energy Compaction.**

1. Create a Matlab code which does the following
2. Read a greyscale picture
3. Display the pixel values in a 5×5 square region.
4. Calculate the Discrete Fourier Transform of the full image.
5. Calculate the energy of the spectrum.
6. Display a set of coefficients in a 5×5 squared region of the spectrum.
7. Calculate the energy of a squared region at the centre of the spectrum of size (100 × 100).
8. Run the code on all greyscale pictures and discuss the results.

**Hints**: use ‘fft2’ to transform the image and ‘abs’ to get the spectrum.

Matlab code has been uploaded on blackboard. The displayed 5×5 region shows that the neighbouring pixels are similar in the spatial domain. However, the neighbouring coefficients are very different in the Fourier domain. Also, note that the energy of the squared region at the centre is almost the same as the energy of the whole image. This suggests that most of the information is concentrated in the central area of the DFT spectrum.

1. Create a Matlab code which does the following
2. Read a greyscale picture
3. Display the pixel values in a 5×5 square region
4. Calculate the Dsicrete Cosine Transform of the full image.
5. Calculate the energy of the spectrum.
6. Display a set of coefficients in a 5×5 squared region of the transformed image.
7. Calculate the energy of a squared region at the top left corner of the DCT (of size 100×100).

g. Reconstruct and display the picture by using only coefficients in the squared region (100 × 100).

1. Run the code on all greyscale pictures and discuss the results.

**Hints**: use ‘dct2’ to transform the image and ‘idct2’ to get the inverse transform.

Matlab code has been uploaded on blackboard. The displayed 5×5 region shows that the neighbouring pixels are similar in the spatial domain. However, the neighbouring coefficients are very different in the DCT domain. Also, note that the energy of the squared region at the top left corner is almost the same as the energy of the whole image. This suggests that most of the data is packed on the top left hand side of the DCT image.

1. Create a Matlab code which does the following

a. Read a greyscale picture.

b. Display the pixel values in a 5×5 square region.

c. Calculate the Discrete Wavelet Transform of the full image at two levels using the wavelet ‘Daubechies 2’.

d. Calculate the energy of the transformed image (all sub-bands).

e. Display a set of coefficients in a 5×5 squared region of the transformed image.

f. Calculate the energy of the approximation sub-band A1.

g. Reconstruct and display the picture by using only coefficients in the approximation sub-band A1.

h. Run the code on all greyscale pictures and discuss the results.

**Hints**: use ‘dwt2’ to transform the image and ‘idwt2’ to get the inverse transform.

**Note:** Once they are read, the images should be converted into ‘double’ for processing. Also, ensure that the reconstructed images are converted into ‘uint8’ before they are displayed.

Matlab code has been uploaded on blackboard. The displayed 5×5 region shows that the neighbouring pixels are similar in the spatial domain. However, the neighbouring coefficients are very different in the DWT domain. Also, note that the energy of the approximation sub-band is almost the same as the energy of the whole image. This suggests that most of the data is packed in the approximation sub-band of the DWT image.