Experiment 2
Application of 2-D DCT to Image Compression

Objective: To apply 2-D DCT for compressing images.

Procedure:

a) Download the following test images from the course website camera256.mat, boat512.mat, goldhill512.mat, and peppers512.mat

b) Perform DCT compression as follows:

1) First generate an all zero matrix with size same as the test image. This will store the final compressed image. Let this be I_comp.

2) Generate a variable to store the quantization matrix Q50 (see lab manual) .Use a variable eg. Level to store the desired quality level for the compressed image (10,40 or 50)

3) Compute the scaling factor for quantization

$$\tau = \begin{cases} \frac{100 - level}{50} & if\ level > 50 \\ \frac{50}{level} & if\ level < 50 \end{cases}$$

Then use this scaling factor to get the quantization matrix for the desired quality level Q = τ Q50

4) Perform block processing as follows

i) Split the test image I into 8 x 8 block matrices (Hint: Use for loop) .Let each block be B.

ii) Perform level off on B by subtracting 128 from each of its entries. Let this levelled off block be Bt .

iii) Apply 2D-DCT to Bt to obtain C.

iv) Perform Quantization by pointwise dividing C by the quantization matrix Q obtained in step 3) and rounding off the resulting matrix. Let this matrix be S.

v) Perform de Quantization by pointwise multiplying S by the quantization matrix Q. Let this matrix be Ct.

vi) Apply inverse 2D-DCT to Ct to obtain Bt.

vii) Add 128 to Bt to obtain B.

viii) Place each processed block in its correct location.

c) Perform quality evaluation of each of reconstructed image by comparing it with the original image as follows.

i) Subjective evaluation: Visually inspect images and rank the results obtained for each of the test images in each of the analysed quality levels using quality descriptors: low, medium or high.

ii) Objective evaluation: For objective evaluation you will use percentage of zeros and PSNR.

1) Percentage of zeros: After getting the compressed image calculate number of zeros and percentage of zeros ‘pzeros’ for each image. (Useful matlab functions : nnz , numel. Note : nnz(A) will give you non zero elements in A but nnz(~A) will give you number of zeros in A)

2) Peak Signal to Noise Ratio : The formula for PSNR is

$$PSNR = 10log_{10}\left(\frac{255^2}{{\sigma_e}^2}\right)$$

Where ${\sigma_e}^2$ is the mean squared error and can be evaluated using MATLAB as

$${\sigma_e}^2 = mean(mean(I_{rec} - I_{orig}).\hat{}2)$$

Hint : You can use the PSNR function in matlab

peaksnr = psnr(A,ref,peakval)

d) For some images explain why visual quality cannot be maintained easily as compared to other images for a given compression ratio? (Hint: Frequency content, correlation)

Hint: You can create a function for the whole thing.

[peaksnr, pzeros, I_comp] = dct_compression(I, Q50,level)

Bonus Question: How does percentage of zeros effect the quality of images, storage and compression? Comment on advantages and disadvantage of DCT block by block processing you notice in the images (any visual artefacts, computation speed)?

Please Include following in your lab report:

a) Images for different quality levels

b) Table of observation for each analysed image

Quality Level	Percentage of zeros in S	PSNR	Visual Quality (Low, Medium , High)

c) Comments on results