Image Coding

Multimedia Signal Processing

Politecnico di Milano – Polo regionale di Como

Summary

- Ex1: Jpeg (baseline profile) encoder
- Ex2: Inter (temporal) predictive encoder (open and closed loop)
- Ex3: KLT and DCT transform: calculation and comparison
- Ex4: Intra (spatial) predictive encoder

Exercise 1

1. **Load the image *lena512color.tiff* and transform it from RGB color space into YCbCr one, according with the following:**

$$\begin{pmatrix} y \\ c_b \\ c_r \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & 0.331 & 0.5 \\ 0.5 & -0.419 & -0.0813 \end{pmatrix} \cdot \begin{pmatrix} r \\ g \\ b \end{pmatrix}$$

2. **Consider only the luminance component (y) and compute the DCT transform of the whole image and show the result.**

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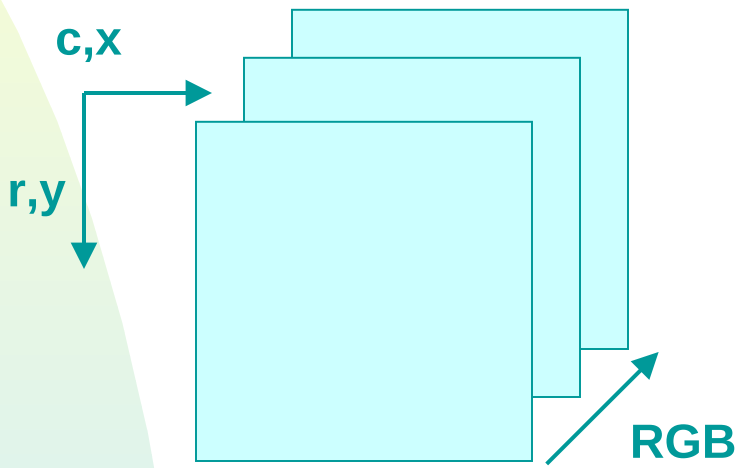
Exercise 1

- **Hint 1: to read the image use the command: "imread", which returns a three dimensional array:**



Exercise 1

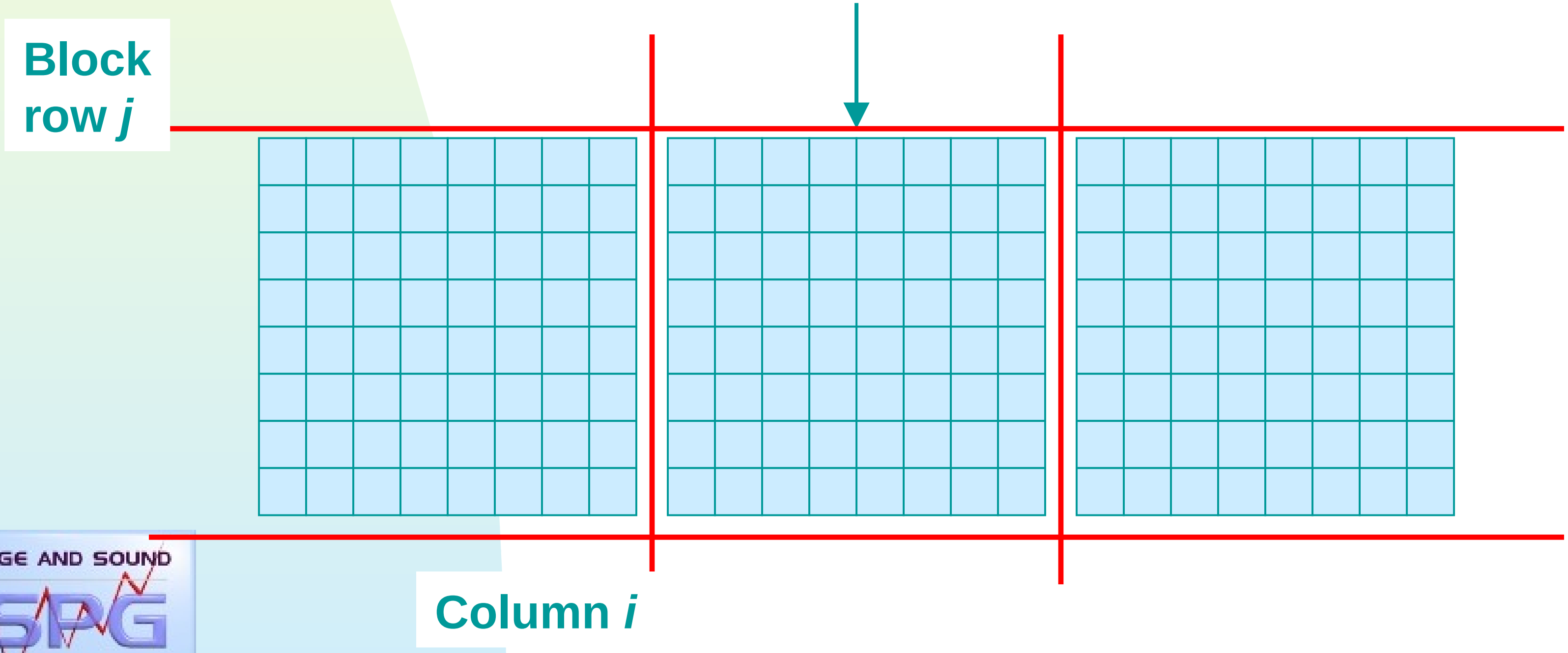
- Hint 2: the DCT transform is separable hence it can be compute first column wise and then row wise:
- YDCT = T*(Ximage)*Tt
- The DCT matrix is as follows:

$$t_{ij} = \begin{cases} \sqrt{\dfrac{1}{N}} & i = 0,\ j = 0 \ldots N-1 \\ \sqrt{\dfrac{2}{N}} \cos\left(\dfrac{(2j+1)i\pi}{2N}\right) & i = 1 \ldots N-1,\ j = 0 \ldots N-1 \end{cases}$$

Exercise 1

1. Simulate the JPEG baseline profile:
   - Divide the image into blocks having size 8x8
   - For each block compute the DCT
   - Show the transformed image
   - Hint:

Y((j-1)*8 + 1:j*8, (i-1)*8 + 1:j*8)



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Exercise 1

4. Use a threshold quantization scheme to quantize the DCT coefficient inside each block: the quantization matrix is stored into Qjpeg.mat file. Let Q be a scaling factor to tune quantization between fine and coarse, then the quantization matrix will be:

$$Qmatrix = Qjpeg*Q$$

5. Reconstruct the image from quantized coefficients, show it and find the PSNR.

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Exercise 2

1. Load the sequence table_tennis.mat provided. Compute the entropy of overall sequence under the assumption of discrete memory-less source.
2. Design a simple open loop prediction scheme, in order to tackle temporal redundancy. The first frame is encoded as INTRA (I frame) while the others as INTER (P frames)
3. Compute the entropy of the prediction error (lossless case) (P frames only) and compare the result with the memory less one.
4. Design a simple open loop predictive codec (lossy), quantizing the prediction error using 16 levels. Reconstruct the sequence and verify experimentally the problems caused by drift

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Exercise 2

6. **Design a simple closed loop predictive codec (DPCM) in order to avoid the issue of drift**

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Exercise 3

1. Load the image lena512color.tiff and extract the luminance component.
2. Consider a block image of dimensions K x K. find the Karhunen-Love transform (KLT) of the random process: **image block**:
   - Set K = 8 and estimate the autocovariance matrix looping through all image blocks (*)
   - Find the KLT transform matrix and apply it over each image block (*,**)

1. Quantize the KLT coefficients with the same zonal mask as in the exercise 1.
2. Reconstruct the image from the quantized coefficients, display it, find the PSNR and compare it with the Jpeg one.