ELEC421 Matlab Project

Content focus: Linear prediction, image basics and image processing (color systems, quantization, digital halftoning, image filtering, image compression).
Grade Percentage: 10%
Due day: Dec. 08, 2021

Policies:

- Academic Honesty: You are responsible for all academic honesty policies, including adhering to prescribed resources during in-class evaluations and take-home evaluations. Violations will be referred for disciplinary action. Pleas of ignorance will not be considered.
- Organize your results in an easy-to-follow format and always provide your comments on the results.

Matlab assignments:

1: Linear prediction analysis of speech signal
A brief report is required, with free form. Contents to be included in the report: brief method description, results (e.g. figures) and discussions of the results, and also the code in Appendix.
The objective of this problem is to demonstrate some basic ideas of speech signal analysis.

- Download the "dft.wav" file from the course website, and figure out some information of the .wav file by using 'wavread' command in Matlab.
  E.g. find out the sampling rate and the length of the recording (in second); hear the speech by using either 'sound' or 'wavplay' command in Matlab.
  Download the data file 'wordSample.mat', which is part of the above speech data with the same sampling rate.
- Linear predictive coding (LPC) speech coding, using the data in 'wordSample.mat'.
  Implement the linear predictive coding (LPC) similar to LPC-10 (find AR Model from speech signal using the Levinson-Durbin algorithm) or you can use 'lpc' command in Matlab directly.
  Use LPC to analyze the real speech signals: divide the data into segments first, then apply the LPC to see the results, discuss the effects of the order in the AR models (e.g. order=12, 16, 20).
- Linear predictive coding (LPC) speech synthesis: compare actual and predicted signals, study prediction errors. Plot both the actual and predicted signals, also plot the error signal. Hear the predicted signal yourself, and make your comments.

2. Be familiar with basic image analysis functions in Matlab Image Processing Toolbox (you can use "help images" in Matlab). Examples:

- Read and display an image: imread(.); imshow(.)
- Image types and type conversions: e.g., rgb2gray(.)
- Color space conversions: e.g., rgb2ycbcr(.), rgb2ntsc(.)
- Image spatial transformations: e.g., imresize(.), imrotate(.), imcrop(.)
- Image transforms: DCT, Basic DWT (discrete Wavelet transform)

3. (**Color systems**) Download the color image 'children.JPG' from the course website. For the color image 'children.JPG', you need to try basic image analysis functions in Matlab Image Processing Toolbox (you can use *help images*), e.g.
   - read and display the color image;
   - plot the R,G,B sub-images;
   - convert the RGB color values to YCbCr color space and display them;
   - convert the image into gray image and display it;
   - resize the gray image to the standard size 512-by-512, and plot the resized image.

Note: For this assignment, you are allowed to use the existing Matlab functions in Image Processing Toolbox.

4. (**Digital halftoning**) Go to the course website and download a 512x512 grayscale image 'lena.bmp'. Read the image into MATLAB. Write a Matlab function to generate a "continuous-tone gray-scale" binary image by selecting one error-diffusion halftoning method and appropriate parameters. Please note that you are allowed only **one bit** for each pixel. Save the binary image, and discuss your result.

Note: You are required to *write YOUR OWN codes.* Do not call Matlab's built-in *dither* functions, though you might use those as benchmarks to test and compare the results of your own codes. Simply copying or modifying codes found on the Internet is also not allowed.

5. (**Image Denoising**) Go to the course website and download a 512x512 grayscale image 'boat1.tiff', which is corrupted by a Gaussian noise of zero mean and variance 1000. Read the image into MATLAB. Write a Matlab function to remove the noise as much as you can.

Note: The original clean image "boat.tiff" is also provided for you to compare your results with the clean image.

6. (**Basic DCT/JPEG Analysis**) For the gray image 'lenna.bmp',
   (a) Based on the original pixel domain image, display a histogram for the image.
   (b) Divide the image into 8-by-8 blocks, for each block, compute the 2D DCT. Study the histograms of the corresponding DCT coefficients, and comment on your results.
   (c) Reconstruct the image from using only 2, 4 and 8 largest (in terms of magnitude) DCT coefficients in each block (the rest is simply set to zero). Display and compare the reconstructed image, and compare the image quality by calculating the peak signal-to-noise ratio (PSNR) with respect to the original image.