Matlab Assignment 2 **COMP 576, spring 2018** **1 Feb. 2018**
DFT magnitude and phases vs. translation **Due Thursday, 15 Feb. 2018 at classtime**

The DFT of a 2D image can be written in terms of magnitudes and phases at each frequency, as given in the course notes. This assignment relates to the relation of these quantities with image contents and position.

Choose two 2D images both of which contain noticeable objects but which are of strongly different subjects. For example, you might choose a picture of a person and that of a street scene showing buildings. To make the computations manageable and to allow you to use the DFT program we give you, sample both images to 128×128 by choosing every n^{th} pixel in each dimension, for an appropriate n. Call these images A and B.

1) The AmpPhaseDFT MATLAB function provided on SAKAI with this assignment computes the DFT of your image (as a 128×128 array of double precision reals) and generates two images of 128×65 pixels. The first image gives amplitudes (or, at the frequencies 0 and 0.5 in each direction signed coefficients), and the second image gives phases (each an angle in $[-\pi,\pi)$) at respective frequencies, with the angle at frequencies 0 and 0.5 in each direction being 0. The $j+1,k+1^{th}$ pixel of the first image gives the amplitude component (a non-negative number) of the input image's DFT at frequency $\nu_y = j/128$, $\nu_x = k/128$, with j and k running between 0 and 128. The $j+1,k+1^{th}$ pixel of each image gives that (amplitude or phase) component of the input image's DFT at frequency $\nu_y = j/128$, $\nu_x = k/128$, with j running between 0 and 127 and k running between 0 and 64. You call this function as follows:
[mag, phase]= AmpPhaseDFT(inputimage).

   The ReconfromAmpPhase MATLAB function provided on SAKAI with this assignment reconstructs an output image by taking as input the mag and phase arrays of the form just described and both displays the image and returns the corresponding image array (again as a 128 ×128 array of double precision reals) . You call this function as follows:
   [outputimage]= ReconfromAmpPhase(mag,phase).

   For both image A and image B, apply AmpPhaseDFT and then ReconfromAmpPhase on the result. Display and pass in to the matlab grader the two input images and the two output images as well as the difference of each input,output pair. You should confirm to yourself by that the difference images are zero, up to some computational error. These 6 arrays, in the order input A, output A, difference A, input B, output B, difference B will be the first six results that your program will produce for the Matlab grading program.

2) Now create the computed DFT image pair AmpAPhaseB from the amplitudes of image A and the phases of image B. Also, create the computed DFT image pair AmpBPhaseA from the amplitudes of image B and the phases of image A. Using the program ReconfromAmpPhase, compute the inverse DFT's of AmpAPhaseB and AmpBPhaseA. This will yield two ordinary images, which will be the second two images you should display for yourself. Also, those two images should be turned into the Matlab grader. Compare each of these two images to A and B. Noting which one of these each resembles more, conclude whether amplitude or phase is the

stronger feature in images of objects. Your answer should be submitted to the Matlab grader and should be in the form “Amplitude” or “Phase”.

3) Given your input image A, write code to compute a new image A_shifted which is A translated with wraparound by some Δx, Δy, each of integer value, added to the respective pixel indices. The wraparound should make pixel locations with new indices >128 or <1 be replaced with their (values-1) modulo 128 +1. For each A_shifted, as described below, you should apply the function AmpPhaseDFT, and look at your DFT magnitude and DFT phase arrays (display them as images). You should then compute the difference of the magnitude coefficient array for A_shifted minus the magnitude coefficient array for the translated image A minus magnitude image for the untranslated image A, and do likewise for the two phase arrays: translated phase array for A_shifted minus phase array for the untranslated image A. Do this for an x translation (by Δx) alone ($\Delta y=0$) and then for a translation in which Δx is the same but $\Delta y \neq 0$

   What you will turn in to the matlab grader are the two integers Δx and Δy followed by A_shifted, then the magnitude difference array for an x translation alone ($\Delta y=0$), then the phase difference array for the same x translation alone, then the phase difference array for an x and y translations, then the phase difference array for the same x and y translations. You should follow this with four answers in words, first a pair of words for the x translation alone and then for the x and y translation together. Those answers should be the words “Same magnitude” or “Different magnitude”, followed by “Same phase” or “Different phase”, where in each case you are comparing the arrays for A_shifted with that for A.