EC516 Lab 2 (Fall 2016)

Due Thursday Oct 6th, 2016

Lab 2

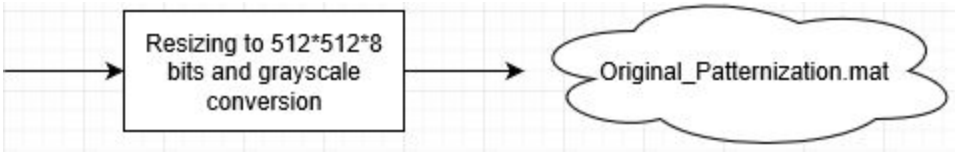
This lab is the second in a series of MATLAB assignments designed to explore Digital Signal Processing from an **alternative patternization** perspective and its importance in computational tasks such as **Learning, Enhancement, Authentication, Detection, Encoding, Recognition or Separation (LEADERS).** In this particular lab you will get a sense of how some patternizations are better than other patternizations for the purpose of compressing image data.

A grayscale image is effectively a 2-Dimensional signal. It is defined in the spatial coordinate system by a mathematical function x[n1,n2] where n1 and n2 are the 2 coordinates horizontally and vertically. The value of x[n1,n2] indicates the 'pixel intensity'(on a gray level scale) at point (n1,n2) on the image and is typically represented by 8 bits. For example, an image with 512 rows and 512 columns will require a total of 512 x 512 x 8 bits of information to represent it. The idea of encoding is to find ways of representing the image with much fewer bits, without significant quality reduction, in order to aid storage and transmission of the image data.

The lab is divided into 7 sections:

a) **<u>Uploading an Image and Converting to Original Patternization:</u>**

Uploaded Image

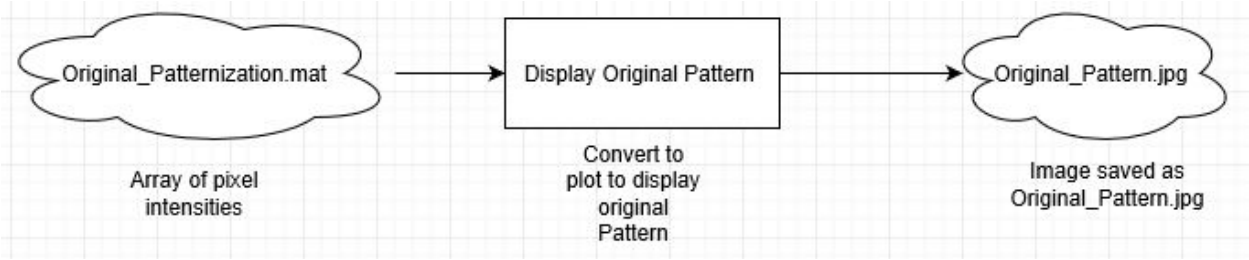


The first step is to upload an image into MATLAB from your laptop. The uploaded image is resized to 512*512*8 bits and stores as Original_Patternization.mat, which is an array of 2-Dimensional real values that form a pattern as a function of space.

GUI Usage:

- Download and unzip EC516_Lab2.zip provided to you into your current directory in MATLAB.
- Open and run EC516_Lab2gui.m provided to you. This will open a GUI named 'EC516Lab2gui'.
- Click on "Upload and Convert to Original Patternization" button and choose the image you want to upload. Please make sure you upload an image that has a resolution greater than or equal to 512*512 pixels. Also the image must be a .jpg image.
- Once the image is uploaded, it will be converted to a 512*512*8 bits grayscale image and saved as Original_Patternization.mat.

b) <u>Displaying the Original Patternization:</u>

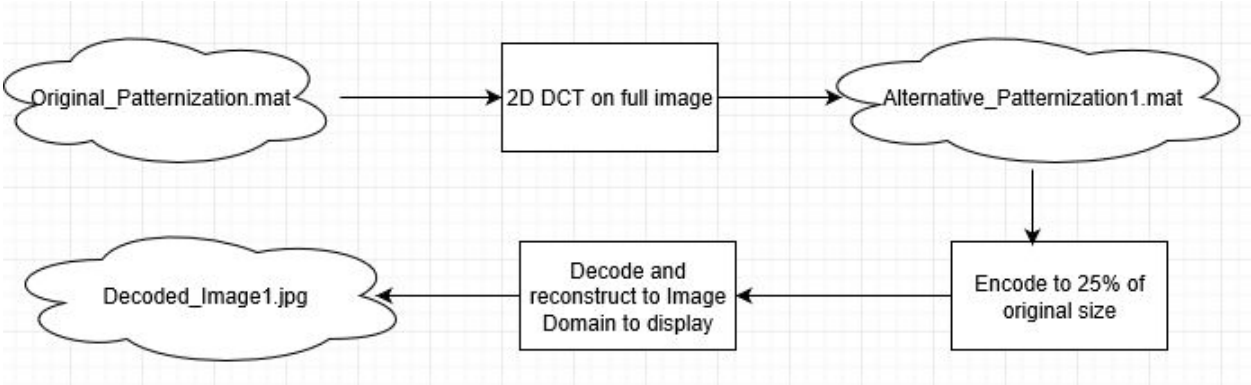


Now that we have stored the original pattern, we would like to Display the Original Patternization. An example of Original_Pattern.jpg is shown below:

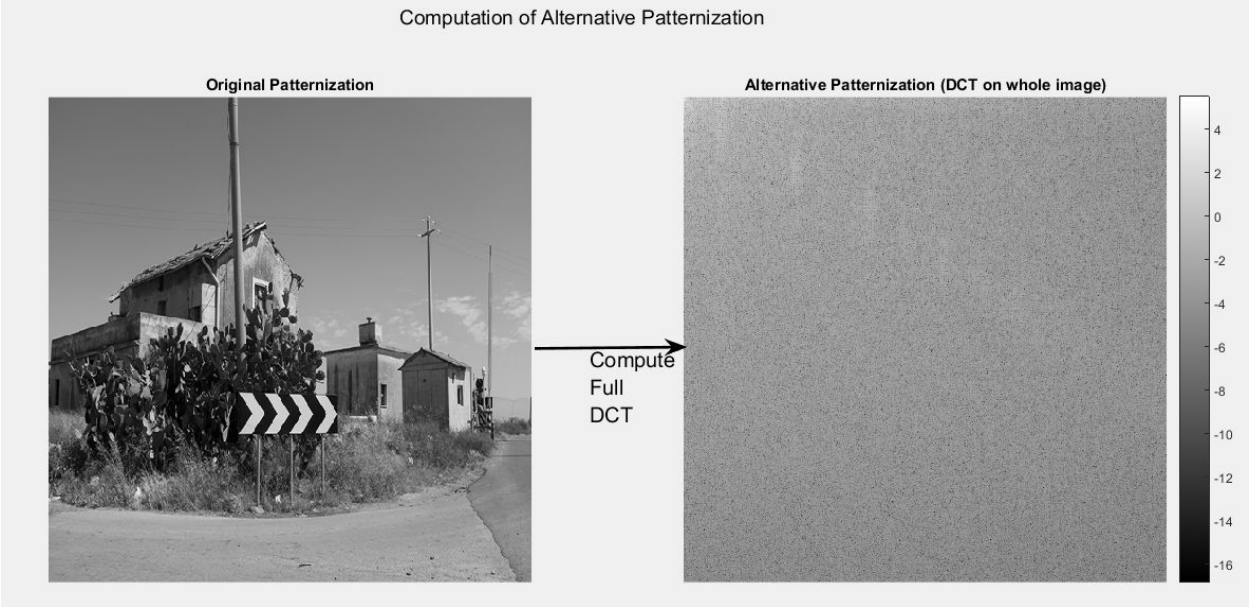
GUI Usage:

- Click on the 'Display' button in the 'Display Original Patternization section of the GUI'. An image of the original patternization pops up and and this image is saved as Original_Patternization.jpg.

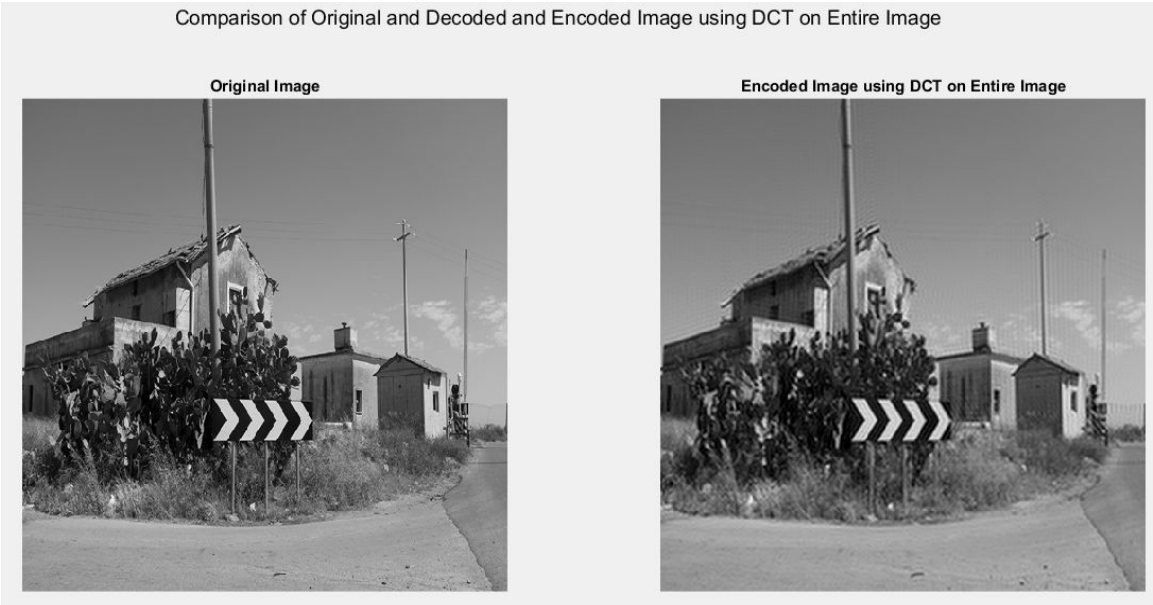
c) Alternative Patternization 1 (DCT on whole image)



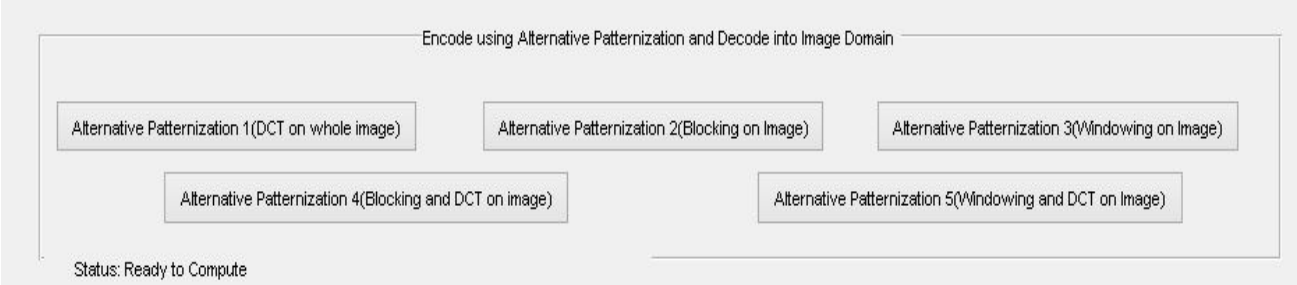
In this step, we take the entire image and compute the 2D Discrete Cosine Transform (DCT) of the image. This is our first Alternative Patternization (Alternative Patternization 1). An example of Alternative Patternization 1 is shown below :



Next we encode this Alternative Patternization 1(AP1) to 25% of its original size by discarding some of its high frequency values. At this stage, the original image is compressed by 75% and the compressed image could be used for purposes such as storage or transmission. In order to display this encoded Alternative Patternization, we decode it (take inverse DCT) and display it back in the image domain (Decoded Image 1). An example of the Decoded Image 1 is shown below :

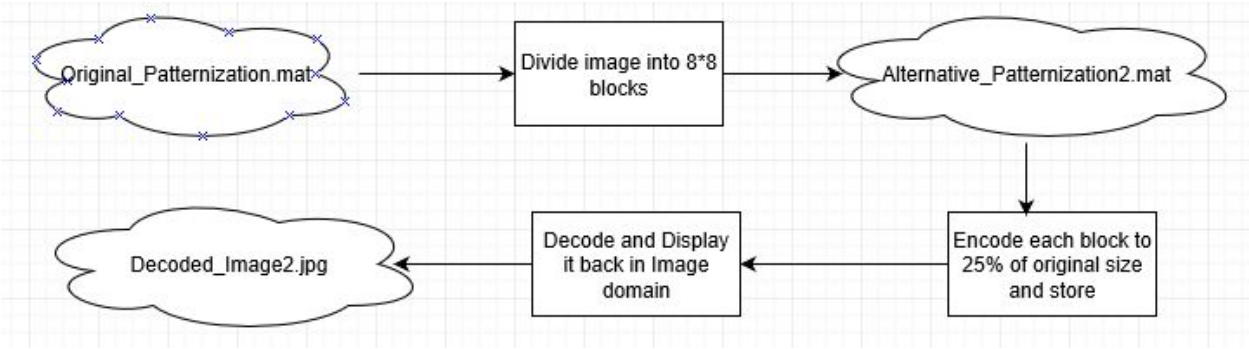


GUI Usage:



- Click 'Alternative Patternization 1 (DCT on whole image)'. The files Decoded_image1.jpg will be saved in your current directory and also pops up in a new window.

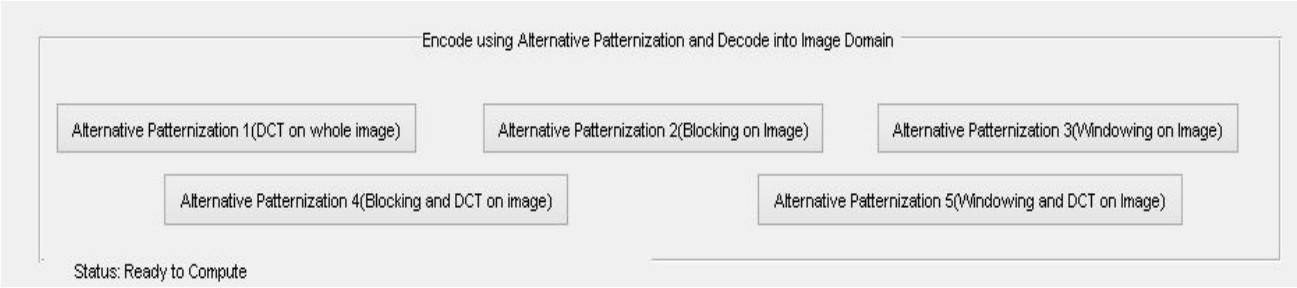
d) <u>Alternative Patternization 2 (Blocking of Image):</u>



In this step, we take the entire image and divide it into 8*8 blocks. This is our second Alternative Patternization (Alternative Patternization 2).

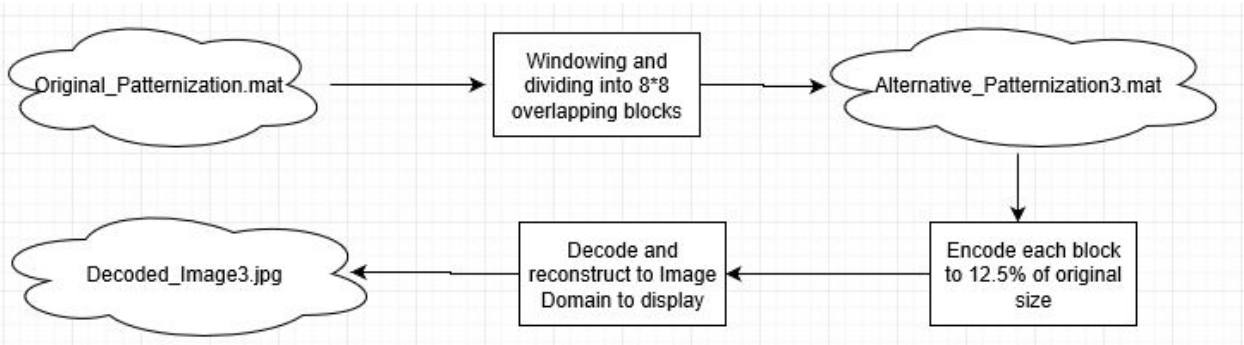
Next we encode this Alternative Patternization 2(AP2) to 25% of its original size by discarding one out of every 4 values in each block and storing it. In order to display this encoded Alternative Patternization, we decode each block (interpolate) and display it back in the image domain(Decoded Image 2). An example of the Decoded Image 2 is shown below :

GUI Usage:



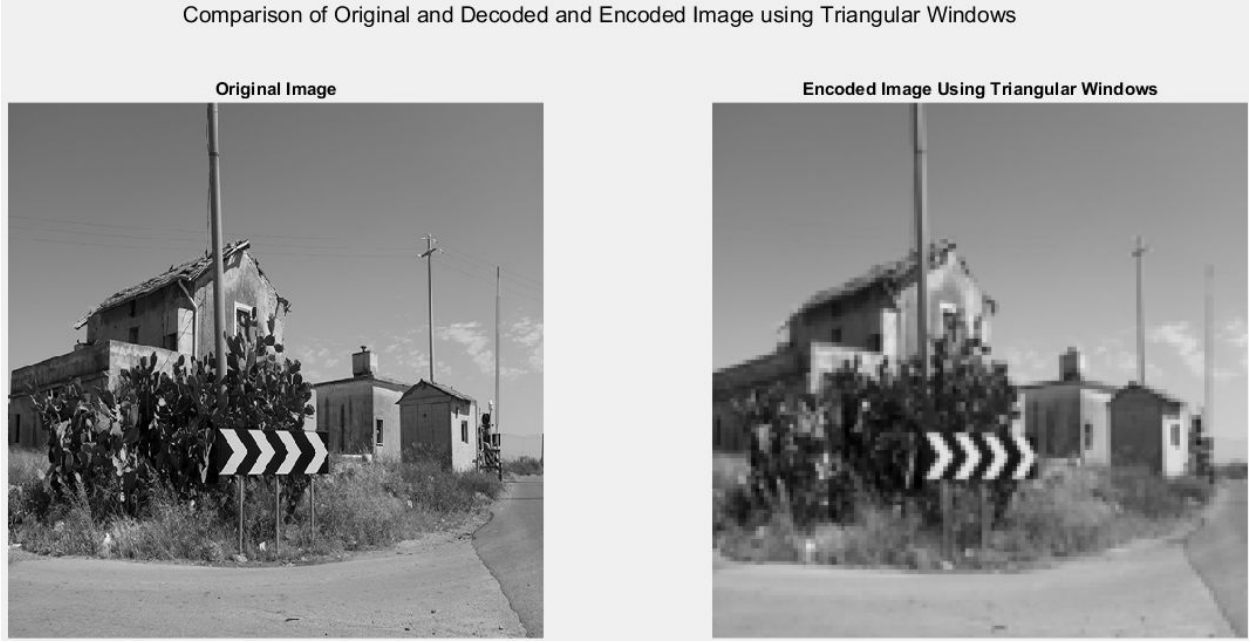
- Click 'Alternative Patternization 2 (Blocking on image)'. The file Decoded_image2.jpg will be saved in your current directory and also pops up in a new window.

e) <u>Alternative Patternization 3 (Windowing of Image):</u>

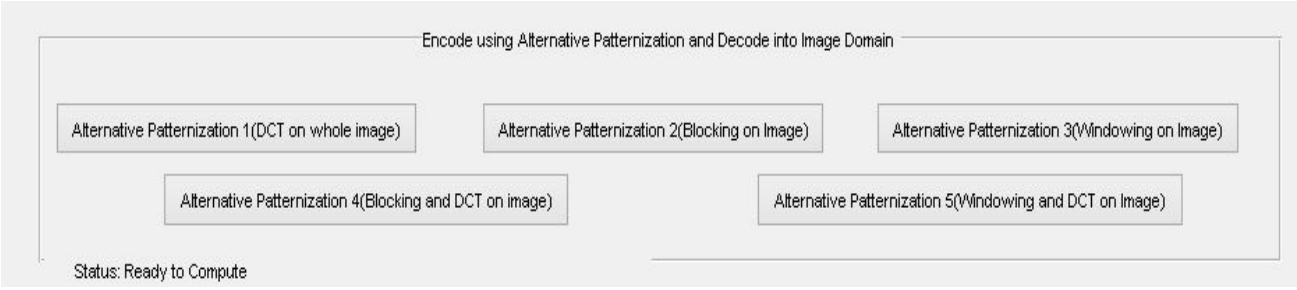


In this step, we take the entire image and divide it into 8*8 overlapping blocks and then window it with a triangular window. This is our third Alternative Patternization (Alternative Patternization 3).

Next we encode this Alternative Patternization 3 (AP3) to 12.5% of its original size by discarding some of the values in each overlapping windowed block. In order to display this encoded Alternative Patternization, we decode (interpolate) each block and display it back in the image domain (Decoded Image 3). An example of the Decoded Image 3 is shown below :

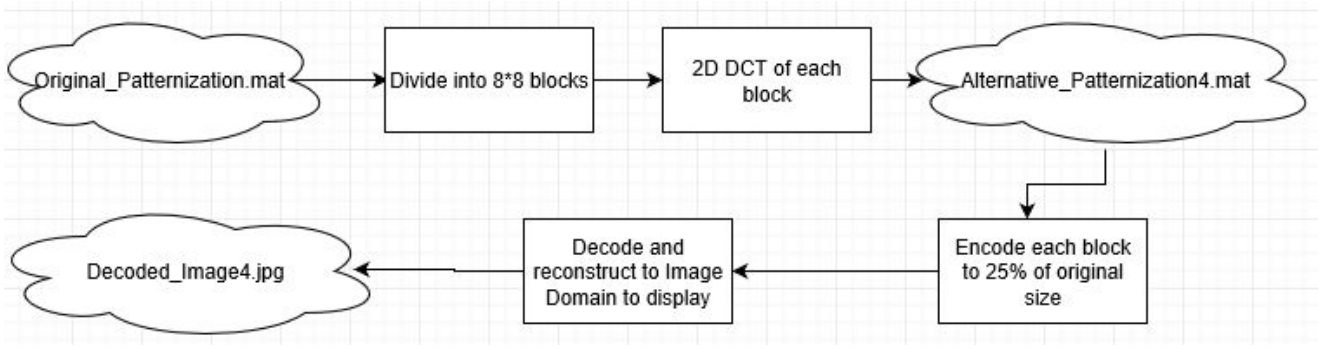


GUI Usage:



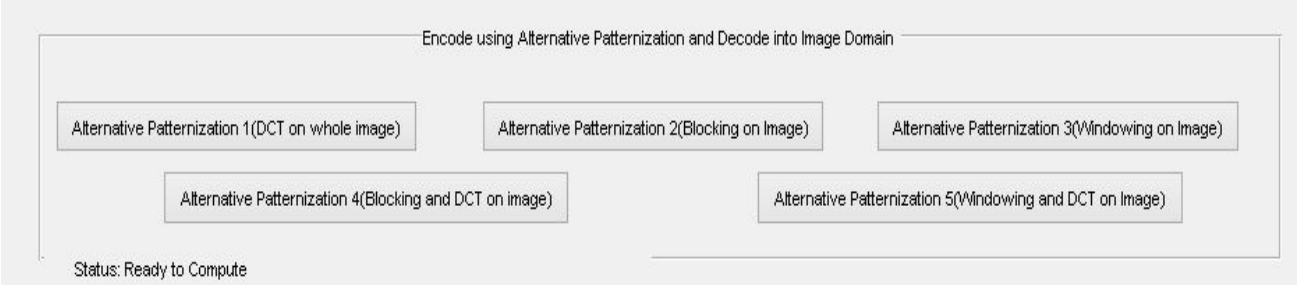
- Click ‘Alternative Patternization 3 (Windowing on image)’. The file Decoded_image3.jpg will be saved in your current directory and also pops up in a new figure window.

e) <u>Alternative Patternization 4 (Blocking and DCT of Image):</u>



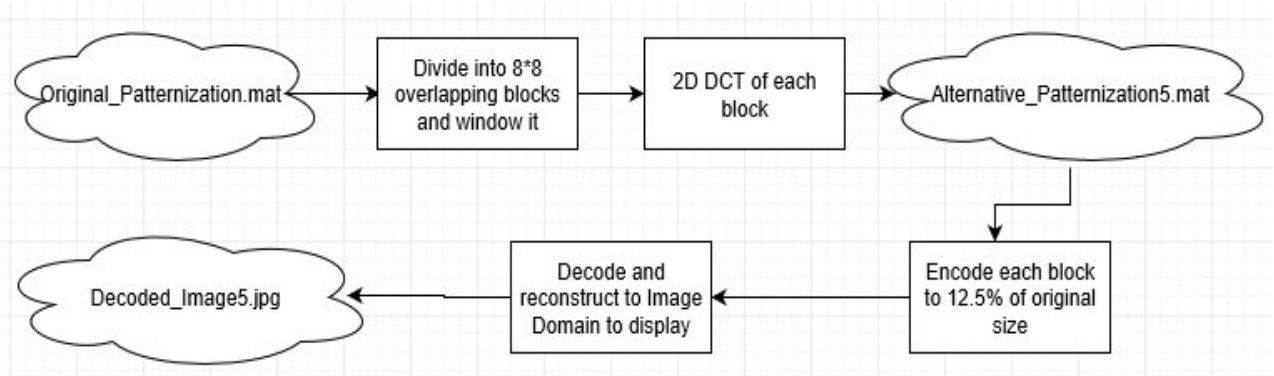
In this step, we take the entire image, divide it into 8*8 blocks and compute the 2D DCT of each block. This is our Alternative Patternization 4 (AP4). Next we encode this Alternative Patternization 4(AP5) to 25% of its original size by setting some of the high frequency values to 0. In order to display this encoded Alternative Patternization, we decode each block and display it back in the image domain (Decoded Image 4). An example of the Decoded Image 4 is shown below :

GUI Usage:



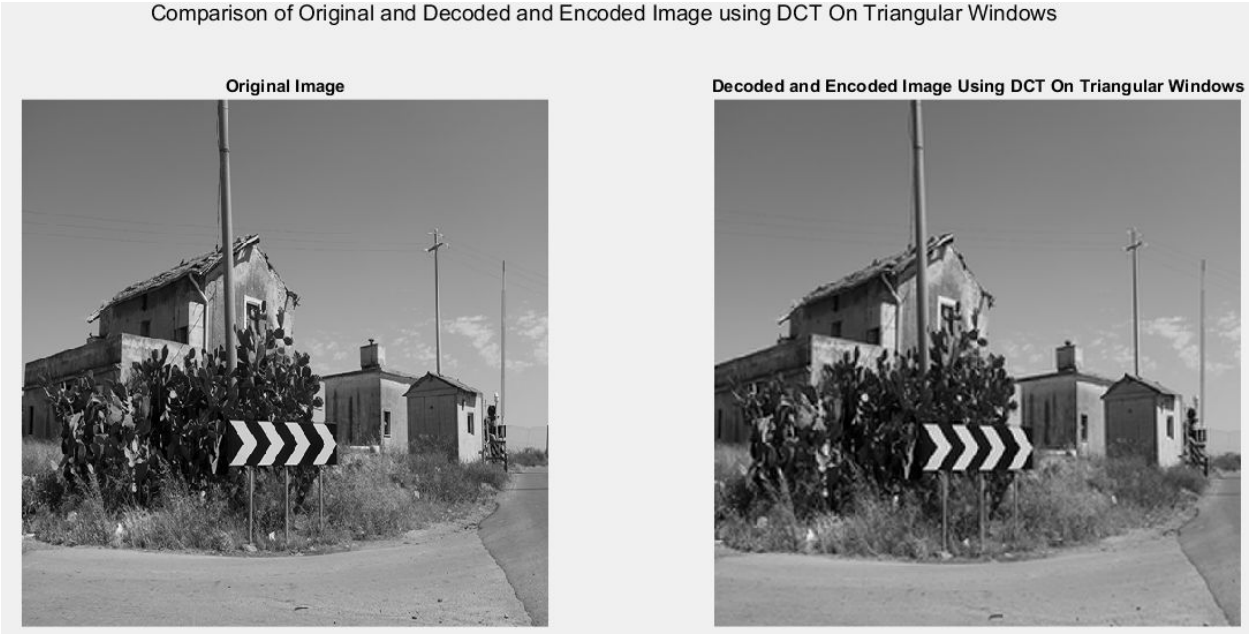
- Click 'Alternative Patternization 4 (Blocking and DCT on image)'. The file Decoded_image4.jpg will be saved in your current directory and also pops up in a new window.

f) <u>Alternative Patternization 5 (Windowing and DCT of Image):</u>

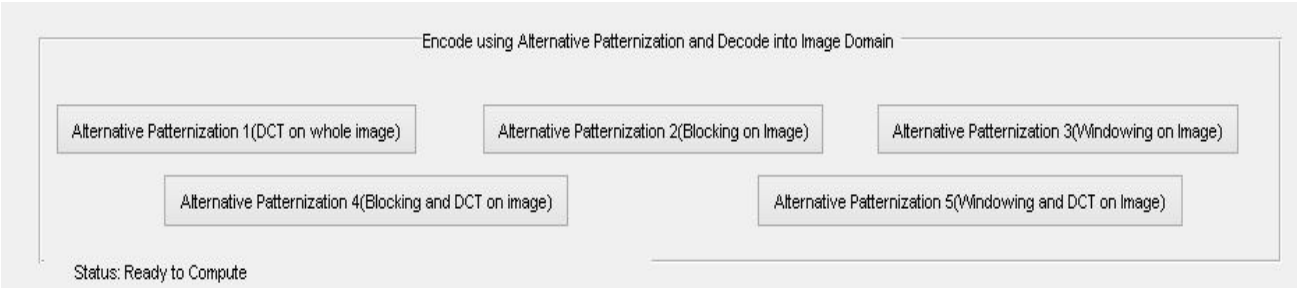


In this step, we take the entire image, divide it into 8*8 overlapping blocks and window it. Next compute the 2D DCT of each block. This is our Alternative Patternization 5 (AP5).

Next we encode this Alternative Patternization 5 (AP5) to 12.5% of its original size by setting some of the high frequency values to 0. In order to display this encoded Alternative Patternization, we decode (take inverse DCT of) each block and display it back in the image domain (Decoded Image 5). An example of the Decoded Image 5 is shown below :



GUI Usage:

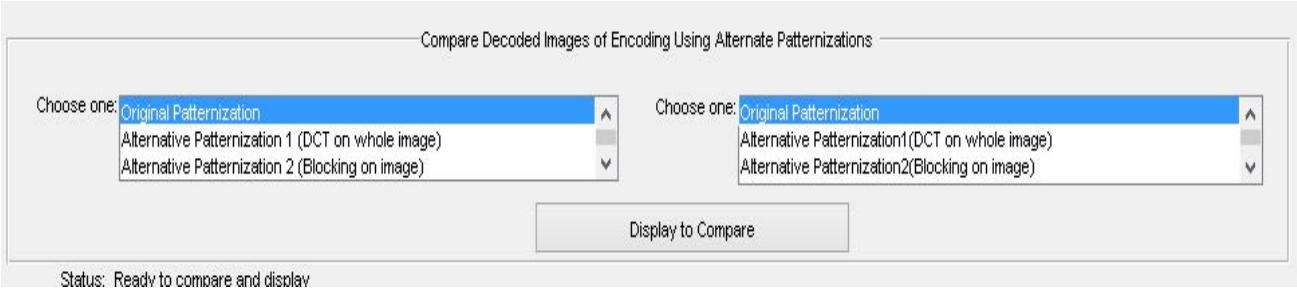


- Click 'Alternative Patternization 5 (Windowing and DCT on image)'. The file Decoded_image5.jpg will be saved in your current directory and also pops up in a new window.

g) <u>Comparing Decoded images using Various Alternative Patternizations</u>

- Please use this segment to compare the decoded images using AP1,AP2,AP3,AP4,AP5. You must complete the the steps from c) to f) before using this section to compare the decoded images.

GUI Usage:



- You must complete the the steps from c) to f) before the 'Display to Compare' button is enabled.
- Select any 2 alternative patternization used for decoding the images and click on 'Display to Compare'.
- The 2 images you want to compare pop up in a new window.

Submission:

1. Print out the original patternization and the decoded images using the five alternative patternizations for one of the images provided to you. (castle.jpg or building.jpg).

2. Describe in a sentence or two what differences you observe between the original patternization and each of the images decoded using the five alternative patternizations.

3. Describe in a sentence or two what differences you observe between images decoded using AP3 (Windowing of Image) and AP5 (Windowing and DCT of Image).

4. Describe in a sentence or two what differences you observe between images decoded using AP4 (Blocking and DCT of Image) and AP5 (Windowing and DCT of Image).

5. Repeat steps 1 to 4 with a new JPEG image of your choice. Please do not share images amongst yourselves to avoid losing marks. Each student must do this exercise with a unique image.