Lab 01 for MLSP

September 4th, 2018

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Exercise 1: Image Manipulation

Read the 'cameraman.tif' image from a file using the imread function. This function will load the image in a matrix.

```
close all, clear all
Cameraman_image = imread('cameraman.tif');
```

What is the size of the image?

```
size(Cameraman_image)
```

```
ans =

   256   256
```

Assign fade factor, and multiply with the image matrix. Store in Fade_image variable

```
fade_factor = 0.5;
Fade_image = fade_factor .* Cameraman_image;
```

Create First Part and Second Part Images.

```
First_part_image = Cameraman_image(1:100, 1:100);
Second_part_image = Cameraman_image(end-99:end, end-99:end);
```

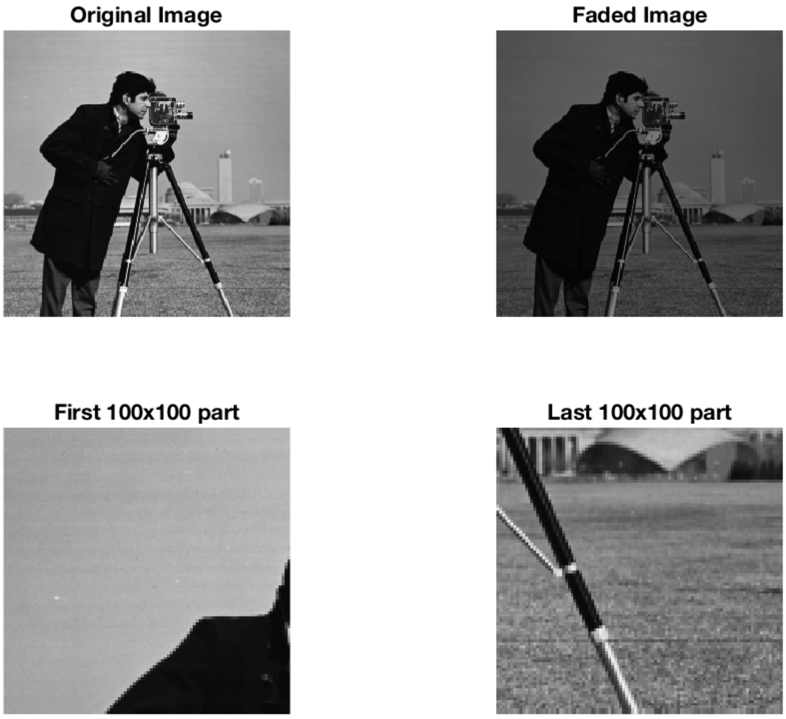
Plot all the images

```
figure(1);
subplot(2,2,1);
imshow(Cameraman_image); title('Original Image');

subplot(2,2,2);
imshow(Fade_image); title('Faded Image');

subplot(2,2,3);
imshow(First_part_image); title('First 100x100 part');

subplot(2,2,4);
imshow(Second_part_image); title('Last 100x100 part');
```



Exercise 2: Quantization

Load this segment of speech into MATLAB workspace

```
p = audioread('filename1.wav');
```

Change resolution from 16 bits/sample to 8 bits/sample, and save the file, and read it in again.

```
audiowrite('filename2.wav', p, 8000, 'BitsPerSample', 8);
p1 = audioread('filename2.wav');
```

Change resolution from 16 bits/sample to 1bit/sample, by simple thresholding. All values in p1 greater than 0 are set to 1, and all values less than zero are set to 0.

```
p2 = [p1 > 0];
```

Finally, play these sounds and note observations

```
sound(p, 8000);
sound(p1, 8000);
sound(double(p2), 8000);
```

Exercise 3: Aliasing Effect

Define the two cosine waves on a sufficiently high sampling frequency Take sampling frequency to be 6000 Hz (can be any high frequency) for a 50ms time interval

```
t = 0.0:1/6000.0:0.05;
```

```
cosx_100 = cos(2*pi*100*t);
cosx_600 = cos(2*pi*600*t);
```

To sample at 500Hz, define a time array sampled at 500Hz

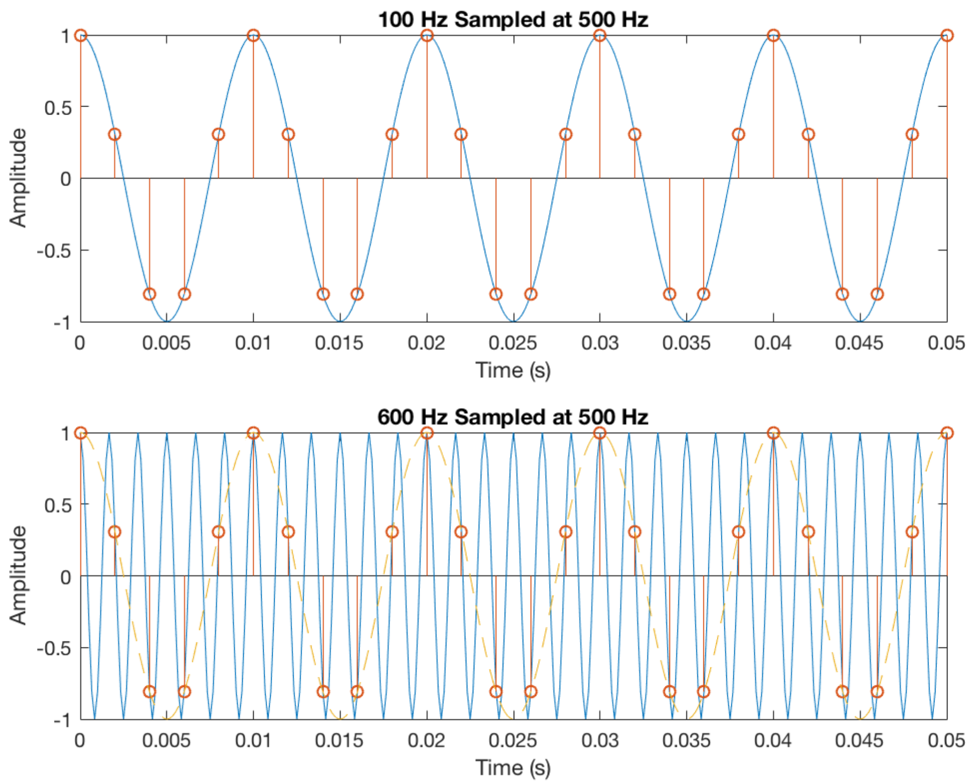
```
t_samp = 0.0:1/500.0:0.05;

cosx_100_500 = cos(2*pi*100*t_samp);
cosx_600_500 = cos(2*pi*600*t_samp);
```

Now, plot the original cosines sampled at 6000Hz, and the corresponding 500Hz sampled waves as stem plots.

```
figure(5);
subplot(2, 1, 1);
plot(t, cosx_100); title('100 Hz Sampled at 500 Hz');
hold on; xlabel('Time (s)'); ylabel('Amplitude');
stem(t_samp, cosx_100_500);

subplot(2, 1, 2);
plot(t, cosx_600); title('600 Hz Sampled at 500 Hz');
hold on; xlabel('Time (s)'); ylabel('Amplitude');
stem(t_samp, cosx_600_500);
plot(t, cosx_100, '--');
```



According to the Nyquist Sampling theorem, we require a sampling frequency of $f_s > 2B$, where B is the highest frequency that exists in the original signal.

- For the 100Hz signal, 500Hz is enough to sample the wave correctly.
- For the 600Hz signal, 500Hz sampling will result in aliasing. In general, when a sinusoid of frequency f is sampled by a frequency f_s, the sampled wave is indistinguishable from those of another sinusoid whose frequency differs from f/f_s by any integer. In other words $2\pi(\frac{600}{500}) = 2\pi + 2\pi(\frac{100}{500})$, and this is why the aliased 600Hz wave looks exactly like a 100Hz wave.