Lab 1 – MATLAB, usb_cam, Convolution

Idea
During this lab you will become familiar with MATLAB and how to use its help function. You will also get to test out the TekBots™ usb_cam using MATLAB. Lastly you will also revisit the concept of convolution and write a user defined function in MATLAB involving convolution.

Objectives
- Review MATLAB concepts.
- Test the TekBots™ usb_cam device.
- Write custom convolution function for MATLAB.

Procedure
MATLAB concepts
In order to use MATLAB efficiently there are two important functions that you need to know about. The first one is “help”. By typing “help” at the command prompt in MATLAB, you will see a list of functions that is categorized by topic. Typing “help <topic>” will list functions within the specified topic. Typing, “help <function>” will display information on the functions themselves. Try typing, “help help”. The second important function is “lookfor”. This function will go through all the description text of all the different functions in MATLAB and list the functions that contain a word that you specify. For example, “lookfor multiply” will display a list of all the function that has something to do with the multiplication of two variables.

- Spend some time looking at the help info for the following functions: pi, plot, stem, cos, axis
- Look for functions that would allow you to do: $e^{(x)}$, $x^2$ or $\sqrt{2}$

1) Create a 2.5Sec plot of a sine wave with amplitude of 5 and frequency of 2Hz, Figure1.A. Remember that this is a discrete representation of a sine wave. Look at the difference between plotting the sine wave with 200, 25, 10 and 5 data points in one period.
2) Use the stem function to graph one period of the same sine wave with 25 data points per period, Figure1.B. How can the plot function be used to see the discrete data points as the stem function shows them?

3) Modify your equations from 1) in order to have the sine wave’s amplitude decay from 5V at 0Sec to roughly 1V at 2.5Sec. Also show the discrete plot, Figure1.C.

![Figure1.C](image1.png)

**TekBots™ usb_cam**

There are several different MATLAB functions that have been developed for the TekBots usb_cam. “getpic” is the function that will be used during this lab. Refer to Sections 4.1 and 4.2 of the usb_cam User Guide for instructions on how to use the usb_cam with MATLAB.

- Review the cam datasheet: usb_cam.pdf.
- Look for functions that would allow you to display and save a RGB image. Also, use “help” or “lookfor” to find information on how to write your own MATLAB functions.

![Figure2](image2.png)

4) Use the TekBots usb_cam to read a picture into MATLAB. An image consists of a 2x2 matrix of pixels. Each pixel has three bytes of information (Red, Green, Blue). From the picture that you took, build another bigger image that consists of 4 sub images. The first image should be a gray scale of the original, while the other three
are the Red, Green and Blue separated out into individual images, Figure2. Write a function called separateRGB() that will build this new image and return it as a variable. Below is how your function could be used.

Example: In MATLAB

- RGB = getpic;  // usb_cam function
- BigIM = separate(RGB);  // your custom function
- Image(BigIM);  // MATLAB function

**Convolution**

Recall that the convolution sum expresses the output of a discrete-time system in terms of the input and the impulse response of the system.

- Look for functions that would allow you to do convolutions.

5) Write a MATLAB function called show_convolution(signal1, signal2). The function should take as input; two discrete time waveforms of any size, compute the convolution and plot both the input waveforms and the resulting convolution. The three plots should be displayed on the same window, one above the other, and have the same axis scale as shown in Figure3 below.

![Figure3](image)

**Post Lab**

Write a paragraph summarizing what you have learned in this Lab. Also include a copy of all MATLAB code written and a copy of all the plots and images created. Turn in you lab results to your Lab TA at the beginning of the next Lab session.