SIGNALS AND SYSTEMS LABORATORY 3:
Digital Filtering

INTRODUCTION

In this lab, you will learn the basic and intermediate functions of MATLAB and apply them to the theory of digital filtering. Our objectives in this lab are to

1. Understand MATLAB
    a. Symbolic in Matlab
    b. Z-transform
    c. Determine Zero and Pole and zplane plotting
    d. FIR filter design using window method
    e. Using FDATOOL

2. Practical Applications:
    a. Finger Print Identification

<u>SIGNALS AND SYSTEMS LABORATORY 3:</u>
Digital Filtering

Assignments will be collected in Lab #3. Work in group is allowed.

Experiment #1: Z-transform using symbolic in Matlab

The Symbolic Math Toolboxes incorporate symbolic computation into the numeric environment of MATLAB.

1. Create a variable n*u(n) and calculate its z-transform in
    a. f = sym('n')
    b. z=ztrans(f)
2. Compare the matlab results with the 2 functions from table of common z-transforms

Experiment #2: Plotting zeros and poles on Z-plane

The ROOTS(C) command in Matlab computes the roots of the polynomial whose coefficients are the elements of the vector C. If C has N+1 components, the polynomial is C(1)*X^N + ... + C(N)*X + C(N+1).

1. Determine the zeros and poles for the following functions using the ROOTS command:
    a. z/(z^2 +1/4z+3/8)
    b. (z+1)/(z^2 +1/4z+3/8)

The ZPLANE(Z,P) command plots the zeros Z and poles P (in column vectors) with the unit circle for reference. Each zero is represented with a 'o' and each pole with a 'x' on the plot.

2. Using the command ZPLANE to plot the zeros and poles found above
3. Exercise example 3.6 in the lecture note: Complex Zero/Pole Plot. How does your plot compare to figure 3.8 in the lecture note?

Experiment #3: FIR Filter Design Matlab Exercise

1. Design by Windowing, exercise 3.11

    a. The fir1(n,Wn) command returns row vector b containing the n+1 coefficients of an order n lowpass FIR filter. This is a Hamming-window based, linear-phase filter with normalized cutoff frequency Wn. The output filter coefficients, b, are ordered in descending powers of z. Wn is a number between 0 and 1, where 1 corresponds to the Nyquist frequency.

b. Plot the frequency response of the filter
c. For the same parameter, design a high pass filter using Chebyshev Window
d. Plot the frequency response

2. Design FIR filter using FDATOOL

FDATool is a Graphical User Interface (GUI) that allows you to design or import, and analyze digital FIR and IIR filters.

a. How do your previous plots compares with FDATOOL results?

Experiment #1: Practical Applications: Finger Print Identification

Finger print identification is a common method used by law enforcement to identify criminal. Figure 1 shows the steps of identifying the finger print.

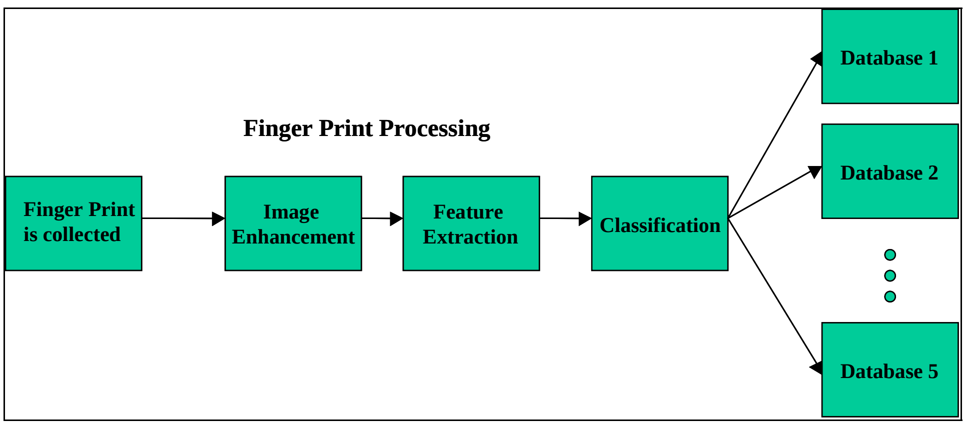

Figure 1 – Finger Print Processing

In this experiment, you are given a finger print. However, the finger print is not clear. It is blurred due to the hand motion, see figure 2.

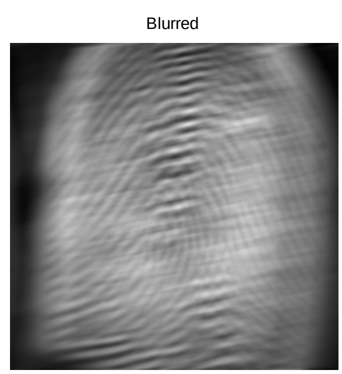

Figure 2 – Blurred by Motion

You are required to design a filter to enhance the image. The point-spread function, PSF, corresponding to the linear motion (LEN) at a certain angle (THETA) are both unknown. You are to identify the PSF and apply it to the image. To deblur the image, you will need to do the following:

1. Guess LEN (1 to 100 pixels) and THETA (0 to 180 degree)
2. Use FSPECIAL command, with 'motion' as the type of blur to estimate the PSF
3. Use deconvwnr command to restore the image
4. Compare it to the original, see figure 3

Figure 3 – Original