Signals and Systems MATLAB HW1
Deadline: 2019/03/29 before 23:59

The Convolution Sum

In this section, you will learn how to compute the convolution sum of two signals using MATLAB.

1.Background

Suppose there are two finite-duration signals $x_1[n]$ and $x_2[n]$; now, there are two integers N_1 and N_2 so that $x_1[n]$=0 outside the interval $1 \le n \le N_1$, and $x_2[n]$=0 outside the interval $1 \le n \le N_2$.

The convolution sum of the two signals, denoted by $y[n]$, is written as

$$y[n] = \sum_{k=-\infty}^{\infty} x_1[k]x_2[n-k]. \tag{1}$$

To obtain the value using MATLAB, you may directly type the function just like

$$y = \boldsymbol{conv}(x_1, x_2) \tag{2}$$

where $x_1 = [x_1[1], x_1[2], \dots, x_1[N_1]]^T$, $x_2 = [x_2[1], x_2[2], \dots, x_2[N_2]]^T$ and the superscript *T* denotes the transpose operation.

Expecting for the direct computation of (1), there are some other methods to compute the convolution sum. For instance, it can be computed by following matrix form as

$$\begin{bmatrix} y[2] \\ \vdots \\ y[N_1+N_2] \end{bmatrix} = \begin{bmatrix} x_1[1] & 0 & \dots & 0 \\ x_1[2] & x_1[1] & \ddots & \vdots \\ \vdots & x_1[2] & \ddots & 0 \\ x_1[N_1] & \vdots & \ddots & x_1[1] \\ 0 & x_1[N_1] & \ddots & x_1[2] \\ \vdots & 0 & \ddots & \vdots \\ 0 & \dots & 0 & x_1[N_1] \end{bmatrix} \begin{bmatrix} x_2[1] \\ x_2[2] \\ \vdots \\ x_2[N_2] \end{bmatrix}. \tag{3}$$

Note: please notice the dimension of each matrix.

2.Questions:

Given two signals are

$$x_1[n]=\begin{cases} n, & 1\le n\le 150 \\ 300-n, & 151\le n\le 299 \\ 0, & \text{elsewhere} \end{cases}$$

and

$$x_2[n]=\begin{cases} 1, & 1\le n\le 300 \\ 0, & \text{elsewhere} \end{cases}$$

Program a MATLAB script (save as **myconv.m** file) to achieve the question a to d.

a. (25%)Use the MATLAB function **stem** to plot $x_1[n]$ vs n and $x_2[n]$ vs n.

b. (25%)Use the MATLAB function **conv** to compute equation (1) and use **stem** to plot the output $y[n]$ vs n.

c. (25%) Program the MATLAB script by yourself to compute equation (1) by using equation (3) matrix form and use **stem** to plot the output $y[n]$ vs n. (You could verify whether the answer is the same as question b.)

d. (25%) Repeat question c but $x_1[n]$ and $x_2[n]$ are changed to the following

$$x_1[n]=x_2[n]=\begin{cases} 1, & 1\le n\le 300 \\ 0, & \text{elsewhere} \end{cases}.$$

Note: We expect that if executing your **myconv.m** file, there will be total five figures come out in order. (Question a has two figures; question b~d has one figure respectively).

3.CEIBA Submission

- Please upload a compressed file (.zip, .rar or .tar), which includes your **m-file (**save as **myconv.m** file**)** and a **word file (**save as **report.doc** file**)**. Please show the plots mentioned above in the word file (report.doc) and some explanation.
- The compressed file name should be **ID_MATLAB1**.
  (ex: B07901xxx_MATLAB1)