Batch: B1 Roll No.: 1813071
Experiment / assignment / tutorial No.___2___
Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Title : Filtering of noise corrupted signal using of moving average filter and its realization.

AIM : To attenuate noise signal superimposed on desired signal and realize the filter.

OUTCOME: Students will be able to Analyze and Realization of the LTI Discrete time systems using Z transform, Design of Digital Filters and Use software tools for processing and analysis of discrete time signals.

Theoretical Background: Following points should be included :

Impulse response h(n) of Moving average filter in time domain.(say length L and origin at center and symmetric coefficients)

- Find Fourier Transform of h(n) .
- Plot magnitude and phase response.
- Show cut off frequency on magnitude response.
- Realize the filter (Direct form I)

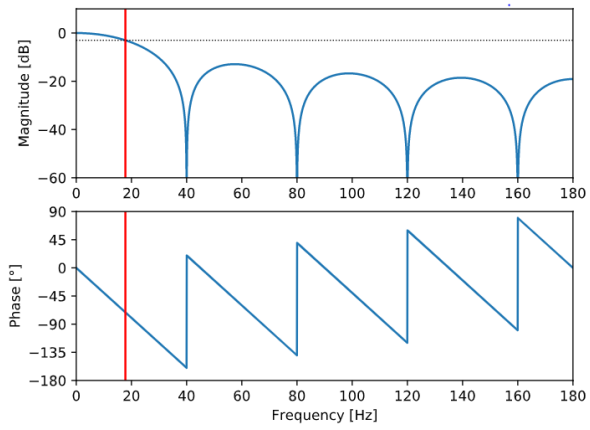
1) The moving average filter is a convolution using a very simple filter kernel. For example, a 5 point filter has the filter kernel: 1/5, 1/5, 1/5, 1/5, 1/5, . That is, the moving average filter is a convolution of the input signal with a rectangular pulse having an area of one.

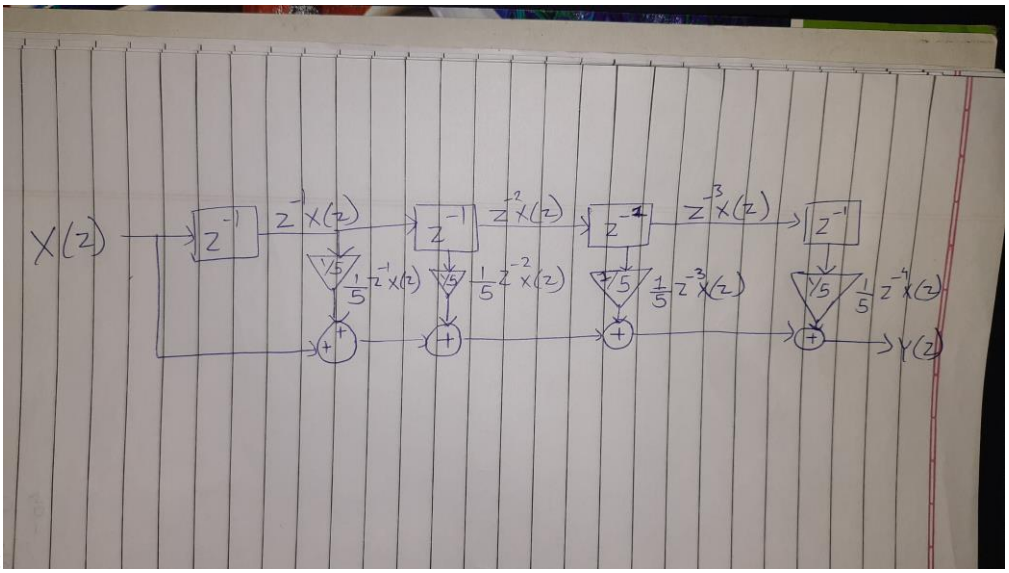
2)The impulse response of an L-sample moving average is

$$h(n) = 1/L, \text{ for } n = 0, 1, ..., L - 1$$

$$h(n) = 0, \text{ otherwise}$$

2) Magnitude and phase response:



Df form: 

Moving average filter : The moving average filter is a simple Low Pass FIR (Finite Impulse Response) filter commonly used for regulating an array of sampled data/signal. It takes M samples of input at a time and takes the average of those to produce a single output point. As the length of the filter increases, the smoothness of the output increases, whereas the sharp modulations in the data are made increasingly blunt.

The cutoff frequency for the output signal is 90kHz. This has been obtained from the plot of magnitude and phase response for the equation of the Moving average filter.

Write MATLAB program in following steps.

1. Generate noise sequence
   with length R =64. D=
   rand (R,1)-0.5
2. Generate uncorrupted sequence and add noise for m = 1:1:R
   S(m)= 2*(m-1) *0.9^(m-1) 1≤m≤R
   X(m)= s(m) + d(m)
3. Read length of MA filter. M= input('Length')
4. Generate MA
   filter
   coefficients H=
   ones(1,M)/M
5. Find output
   Y=conv(h,x)
6. Plot the result
   K=0:1:R-1
   Plot (K,S,K,Y)

7. Using Simulink realize the filter and observe the output on the scope.

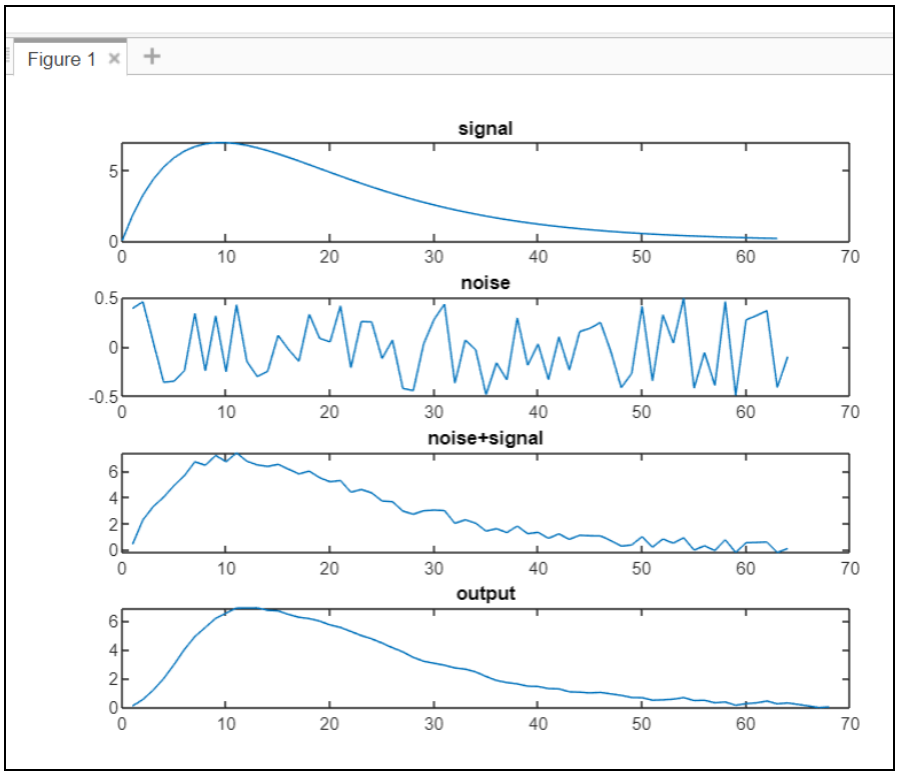
Observations:

1. Plots of corrupted signal X and output signal Y
   Compare uncorrupted signal S and output signal Y

MATLAB Drive

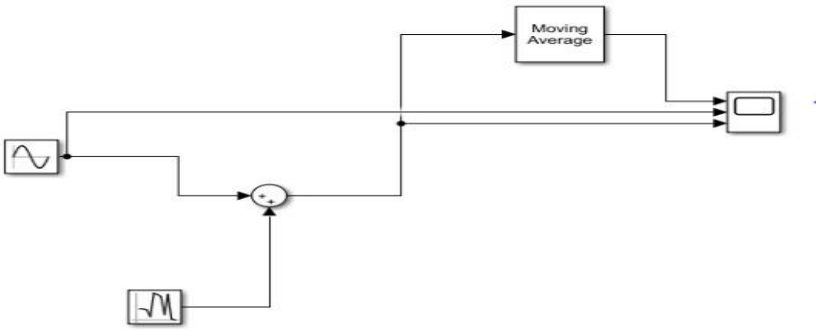
noise_removal.m

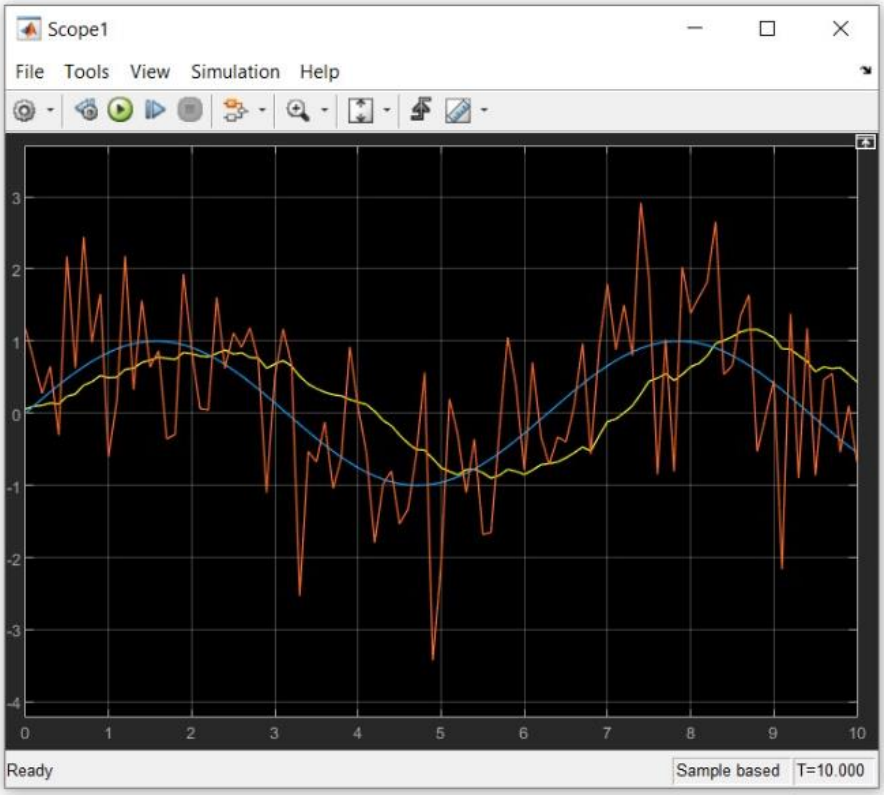
```
close all
r=64;
d=rand(1,r)-0.5;
m=1:1:r;
s=2*(m-1).*(0.9.^(m-1));
x=s+d;
M=input('Length')
h=ones(1,M)/M;
Y=conv(h,x);
%out = filter(h,1,x);
K=0:1:r-1;
subplot(4,1,1);
plot(K,s);
title("signal")
subplot(4,1,2);
plot(d);
title("noise");
subplot(4,1,3);
plot(x);
title("noise+signal");
subplot(4,1,4);
plot(Y);
title("output")
```



Attach printout of code & output

Simulink model and scope output





Important MATLAB functions Used with brief description:

w = conv(u, v) returns the convolution of vectors u and v. If u and v are vectors of polynomial coefficients, convolving them is equivalent to multiplying the two polynomials.

The **rand** function generates arrays of random numbers whose elements are uniformly distributed in the interval (0,1).
Y = rand(n) returns an n-by-n matrix of random entries. An error message appears if n is not a scalar.

Y = ones(m,n) or Y = ones([m n]) returns an m-by-n matrix of ones.

Conclusion:

Transfer function of moving average filter was studied, generated an input signal, a random noise as per the steps given. Convolution was applied to these two generated signals and the resultant signal was passed to a Moving average filter. The resulting output was similar to the input signal. Thus, the working of filter was proved and verified.

Signature of faculty in-charge