8 Preliminaries

In this laboratory, we cover the noise in amplitude modulation. As amplitude modulation, we choose Double Side Band Suppress Carrier (DSB-SC). As we performed in previous laboratories, for DSB-SC modulation, we multiply the message signal with the carrier signal. Thus, the amplitude of the carrier signal changes depending on the amplitude of the message signal. In addition to these works, in this week, we include the noise to our consideration. The term noise is used to represent the unwanted waves that disturb the transmission. While simulating our analog systems, we can generate the noise by using some built-in functions in Matlab. For this laboratory, it is useful to learn about the Matlab functions *im2double(.)*,*reshape(.)*,*awgn(.)*, *imshow(.)* and *numel(.)*.

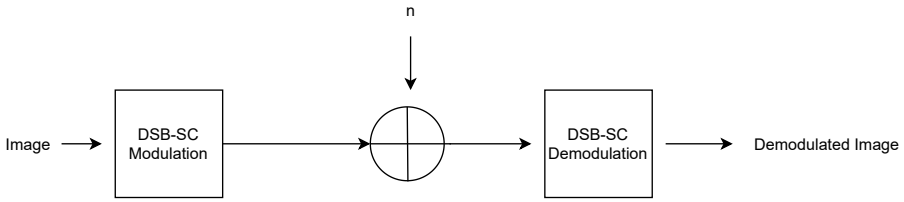

Figure 1: Block Diagram

9 Labwork (AM in noise)

9.1 Construction

a) Read the image file **"cameraman.tif"** that is given in the MATLAB library by using *imread()* and change the class of data by using *im2double()*. In the end, you must have a message signal matrix, **M**.

b) Denote sampling rate F_s of this image as the size of the **M**.

c) Turn your message signal matrix to a message signal vector y by using *reshape()*.
Hint:Use time vector t = 0:(1/Fs):(numel(y) - 1)/Fs.

d) Construct the carrier signal where $c(t) = cos(2\pi f_c t)$, with $f_c = 20kHz$.

9.2 Modulation

a) Obtain DSB-SC AM signal X_{dsbsc}.

b) Add additive white Gaussian noise (AWGN) with signal to noise ratio (SNR) values of 0dB, 5dB, 10dB, 20dB and 30dB using *awgn()* to your modulated X_{dsbsc}.

9.3 Demodulation and Filtering

a) Demodulate modulated X_{dsbsc} signals by multiplying with carrier signal and using a LPF with suitable filter order. **Hint**: Use *butter(.)* and *filter(.)*. Comment on choosing filter parameters.

b) After filtering, you will obtain the demodulated message vectors and you have to convert your demodulated message vectors to demodulated message signal matrices, using *reshape()* again.

c) Comment on the effect of the SNR on demodulated images.

9.4 Plots

a) Plot the original image and the demodulated images on the same figure using *subplot*. Use *imshow()* command to see your figures.

9.5 Mean Square Error (MSE) and comparison

a) Write a MATLAB function which calculates the MSE values between the message signal and demodulated signals with 5 different SNR values by using:

$$\text{MSE} = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[OriginalImageMatrix(i,j) - FilteredImageMatrix(i,j)]^2 \tag{1}$$

where m and n are the number of the rows and columns of the image respectively.

b) Plot the calculated MSE values with respect to SNR=[0,5,10,20,30].

c) Comment on the result.