American International University- Bangladesh

Course Name: Communication Laboratory

Experiment No: 04

Experiment title: Study of Analog to Digital Conversion using MATLAB

Section: D

Semester: Summer 23-24

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ID:23-51364-1

Title: Study of Analog to Digital Conversion using MATLAB

Abstract:

This experiment is designed to-

1.To understand the use of MATLAB for solving communication engineering problems.
2.To develop understanding of Digital to Analog conversion using MATLAB.

Introduction:

Analog signals are continuous and can take any value within a certain range, but digital signals are discrete and only accept specific values. Converting analog signals to digital data is critical for many modern applications due to the numerous benefits that digital signals provide over analog signals, such as noise resistance, simplicity of storage and transmission, and interoperability with digital systems.

Performance Task for Lab Report: (my ID = 23-51364-1)

Convert the following analog signal into digital data:

sig = a1*sin(2*pi*f1*t) + a2*cos(2*pi*f2*t) + a3*sin(2*pi*f3*t) + a4*sin(2*pi*f4*t);

[a1 = F + 1, a2 = F + 3, a3 = F + 2, a4 = F + 4, f1 = G + 5, f2 = G + 7, f3 = G + 1, f4 = G + 2]

a) Show analog signal, sampled signal, and quantized signal.

b) Show the digital data from the analog signal.

c) What are the appropriate values of sampling frequency and number of levels of quantization if minimum required SNR and bandwidth of the channel are 25 dB and 150 Hz respectively.

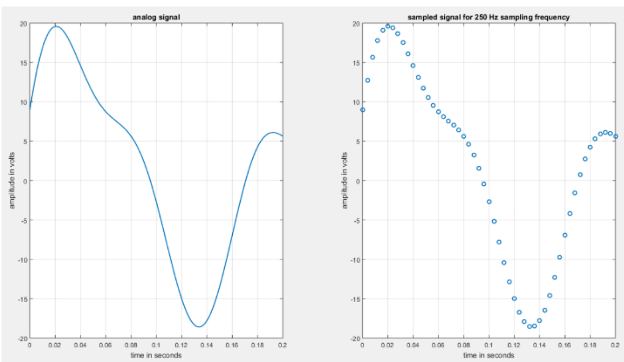
Code:

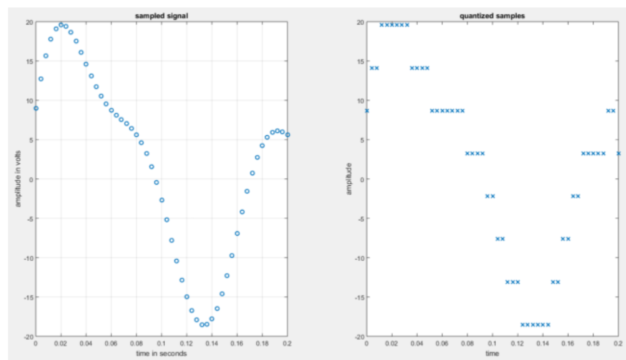
```
A=2;
B=3;
C=5;
D=1;
E=3;
F=6;
G=4;
H=1;
a1 = F + 1;
a2 = F + 3;
a3 = F + 2;
a4 = F + 4;
f1 = G + 5;
f2 = G + 7;
f3 = G + 1;
f4 = G + 2;
```

```
time_duration = 0.2;


a = [0.4 0.6 0.8];
f = [5 12 20];
analog_t = 0:0.0001:time_duration;
analog_sig = a1*sin(2*pi*f1*analog_t) + a2*cos(2*pi*f2*analog_t) +
a3*sin(2*pi*f3*analog_t) + a4*sin(2*pi*f4*analog_t);
figure
subplot(1,2,1)
plot(analog_t, analog_sig,'linewidth',1.5)
grid on
xlabel('time in seconds')
ylabel('amplitude in volts')
title('analog signal')

fs = 250;
ts = 1/fs;

samp_t = 0:1/fs:time_duration;
samp_sig = a1*sin(2*pi*f1*samp_t) + a2*cos(2*pi*f2*samp_t) +
a3*sin(2*pi*f3*samp_t) + a4*sin(2*pi*f4*samp_t);
subplot(1,2,2)
plot(samp_t, samp_sig,'o','linewidth',1.5)
grid on
xlabel('time in seconds')
ylabel('amplitude in volts')
title(['sampled signal for ',num2str(fs),' Hz sampling frequency'])

L = 8;

delta = (max(samp_sig) - min(samp_sig))/(L-1); % step size
quant_sig = min(samp_sig) + round((samp_sig-min(samp_sig))/delta)*delta; %
quantized signal
figure
subplot(1,2,1)
plot(samp_t, samp_sig,'o','linewidth',1.5)
grid on
xlabel('time in seconds')
ylabel('amplitude in volts')
title('sampled signal')
subplot(1,2,2)
plot(samp_t, quant_sig,'x','linewidth',1.5);
xlabel('time')
ylabel('amplitude')
title('quantized samples')

nb = log2(L);

i = round((samp_sig-min(samp_sig))/delta);
dig_data_matrix = de2bi(i,nb);
dig_data = reshape(dig_data_matrix',1,[]);
disp(['The index values for encoding from quantization of the sampled signal
are: ',num2str(i)])
```

```
disp(['The converted bits from the input analog signal are:
',num2str(dig_data)])

f=150;
fs=2*f

SNR=25;
%SNR=6.02*nb+1.76;
nb=round((SNR-1.76)/6.02)
L=2^nb
```

<u>Output:</u>





The index values for encoding from quantization of the sampled signal are:

5 6 6 7 7 7 7 7 7 6 6 6 6 5 5 5 5 5 5 5 4 4 4 4 3 3 2 2 1 1 1 0 0 0 0 0 0 1 1 2 2 3 3
4 4 4 4 4 5 5 4

The converted bits from the input analog signal are:

1 0 1 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 0 1 1 0 1 1 0 1 1 1 0 1 1
0 1 1 0 1 1 0 1 1 0 1 1 0 1 1 0 1 0 0 1 0 0 1 0 0 1 0 0 1 1 1 0 1 1 0 0 1 0 0 1 0 1 0
0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 1 1 0 1 1 0
0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 1 0 1 1 0 1 0 0 1

```
fs =

   300

nb =

     4

L =

    16
```


References:
1. MATLAB user guide.
2. Prof. Dr.-Ing. Andreas Czylwik, “MATLAB for Communications”