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Pulse Code Modulation (PCM) Date- 14/03.

Aim- To develop a MATLAB program for PCM of input msg signal and demodulation of encoded signal to obtain the output.

Software Used- MATLAB 2024b.

Theory- Modulation is the process of varying one or more parameters of a carrier signal in accordance with the instantaneous values of the message signal. There are various techniques to do modulation, PCM is one of them.

* PCM is a method that is used to convert an analog signal into a digital signal so that a modified analog signal can be transmitted through the digital communication network.

PCM is in binary form, so that there will be only two possible states (0's and 1's.).

In pulse code modulation, we have 3 major steps.

1. Sampling
2. Quantizing
3. Encoding

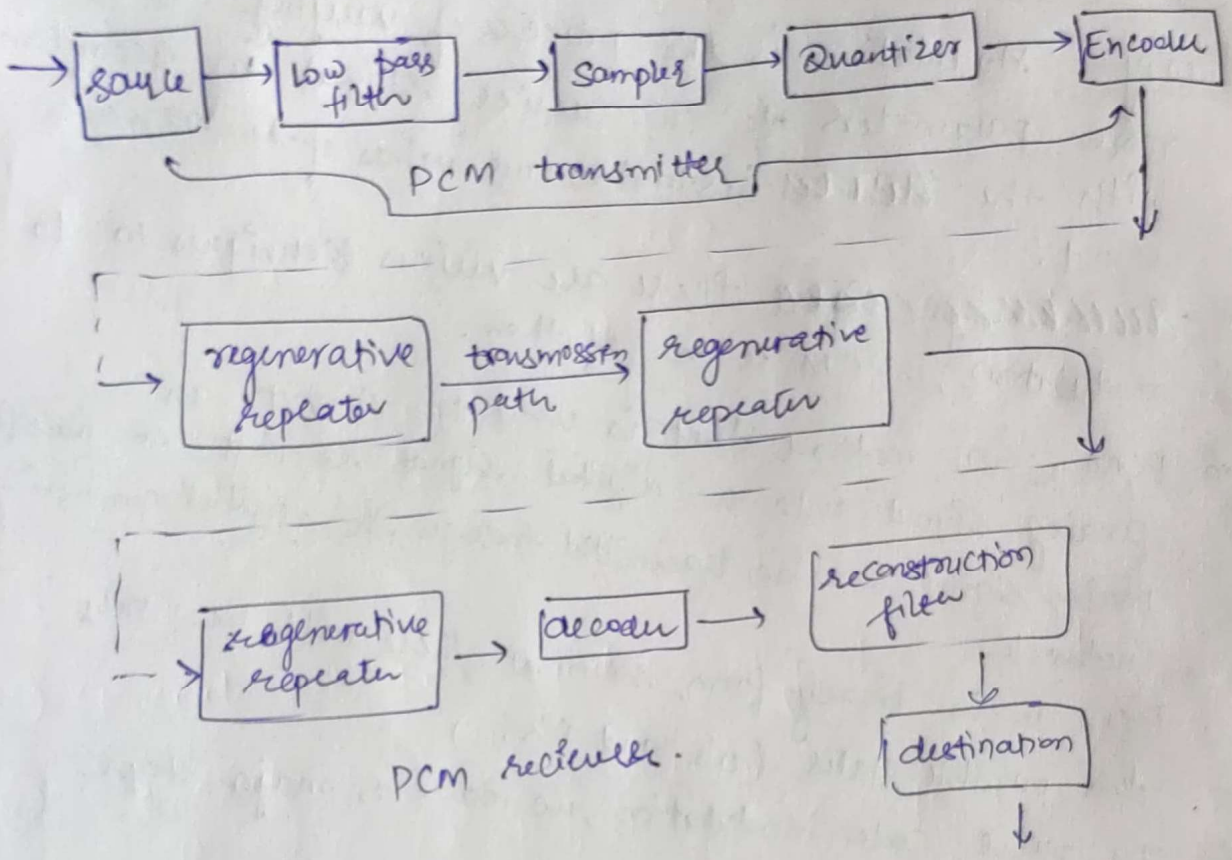
Here, the analog message is first sampled and then the amplitude of sample is approximated to nearest set of quantisation level. This allows the representation of time and amplitude in a discrete manner. Thereby generating a discrete signal.

This discrete signal is then converted into its binary form for this transmission of signal.

In PCM, the signal gets transmitted in the coded format and must be decoded at the receiver in order to have the original message signal.

Block Diagram -

it is composed of transmitter, transmission path and a reciever



Procedure

① Here we took two input variable, one for the value of n- bit PCM system and another for no. of sample in one period of input signal

② A sinusoidal input was taken for time of 4π rad. and 100 samples.

③ The amplitude of the input signal is taken is 10V and plotted using the subplot func. in first part of first fig

④ The signal is then sampled at the rate of n1 samples in 2π time and plotted.

⑤ Next, we quantize the signal using the algorithm shown in MATLAB code of the next section.

⑥ After quantizing the signal is then encoded by converting the Index vector from decimal to binary and then to a coded row vector.

⑦ The modulated signal is then demodulated using a reshape command in which we pass the encoded signal, value of n-bit system and length of coded vector. The demodulated vector is then plotted and observed in output.

⑧. We observed the signal waveform at different values of n-bits system and no. of sample per period.

Observation –

from 1 and 2, It can be observed that on increasing the bit value of the PCM system and samples per period, the received (demodulated) signal becomes identical to the transmitted signal.

Result –

The MATLAB program for PCM of a signal was developed and plots for sampling, Encoding and DeModulation were obtained.

```
clc;
close all;
n=input('Enter n value for n-bit PCM system : ');
n1=input('Enter number of samples in a period : ');
L=2^n;

% % Signal Generation
x=0:1/100:4*pi;
y=10*sin(x); % Amplitude Of signal is 10v
subplot(2,2,1);
plot(x,y);grid on;

% Sampling Operation
x=0:2*pi/n1:4*pi; % n1 number of samples have to be selected
s=8*sin(x);
subplot(3,1,1);
plot(s);
title('Analog Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
subplot(3,1,2);
stem(s);grid on; title('Sampled Signal');
ylabel('Amplitude--->'); xlabel('Time--->');

% Quantization Process
vmax=8;
vmin=-vmax;
del=(vmax-vmin)/L;
part=vmin:del:vmax; % levels are between vmin and vmax with difference of del
code=vmin-(del/2):del:vmax+(del/2); % Contain Quantized values
[ind,q]=quantiz(s,part,code);% Quantization process

% ind contain index number and q contain quantized values
l1=length(ind);
l2=length(q);

for i=1:l1
    if(ind(i)~=0)
% To make index as binary decimal so started from 0 to N
        ind(i)=ind(i)-1;
    end
    i=i+1;
end

for i=1:l2
    if(q(i)==vmin-(del/2))
% To make quantize value in between the levels
        q(i)=vmin+(del/2);
    end
end
subplot(3,1,3);

stem(q);grid on; % Display the Quantize values
title('Quantized Signal');
```

```
ylabel('Amplitude--->');
xlabel('Time--->');

% Encoding Process
figure
code=de2bi(ind,'left-msb');% Convert the decimal to binary
k=1;
for i=1:l1
    for j=1:n
        coded(k)=code(i,j); % convert code matrix to a coded row vector
        j=j+1;
        k=k+1;
    end
    i=i+1;
end

subplot(2,1,1); grid on;
stairs(coded); % Display the encoded signal
axis([0 100 -2 3]); title('Encoded Signal');
ylabel('Amplitude--->');
xlabel('Time--->');

% Demodulation Of PCM signal
qunt=reshape(coded,n,length(coded)/n);
index=bi2de(qunt','left-msb');% Get back index in decimal form
q=del*index+vmin+(del/2); % Get back Quantized values
subplot(2,1,2); grid on;
plot(q);

% Plot Demodulated signal
title('Demodulated Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
```

Figure 1

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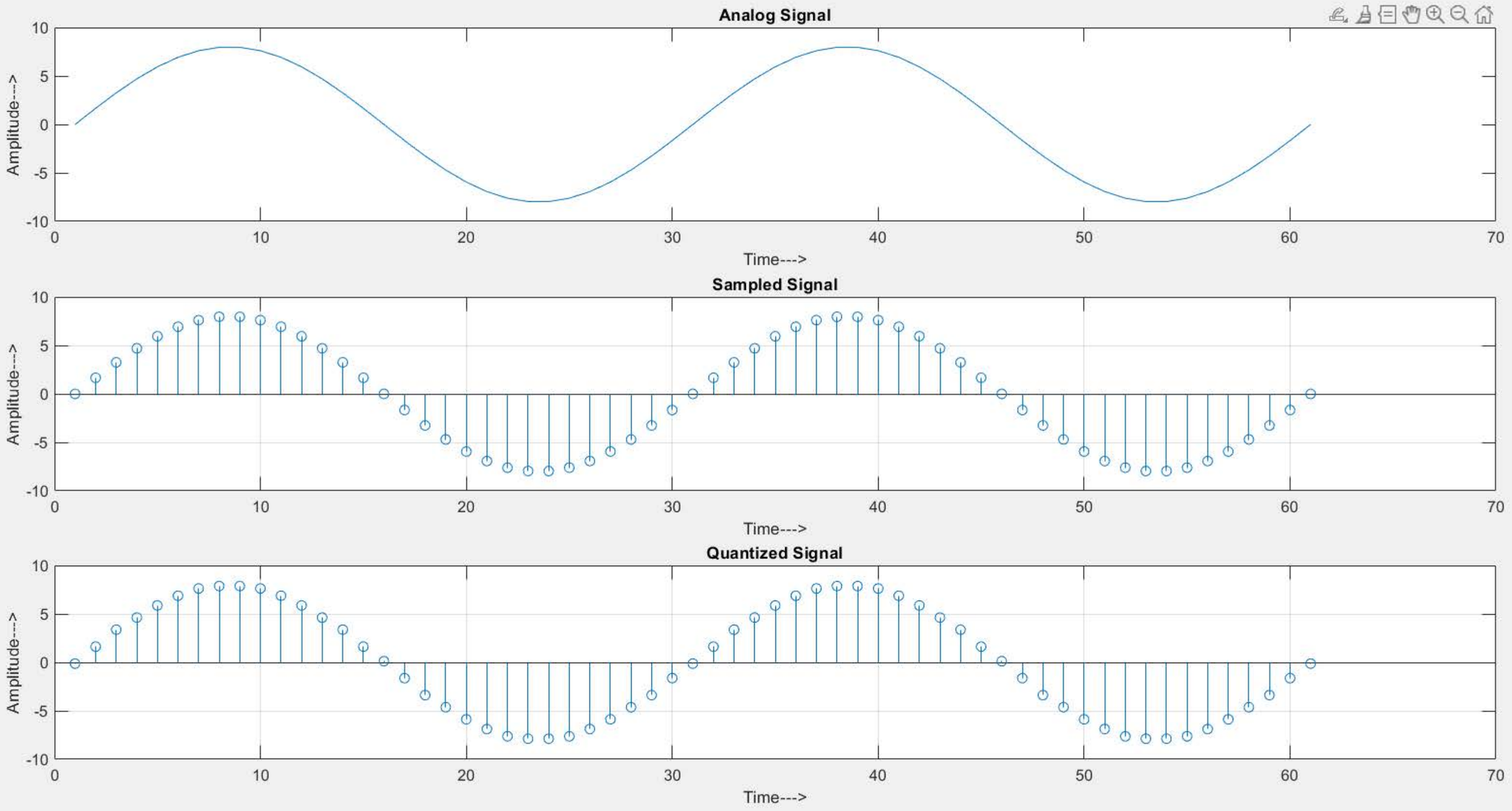

Figure 2

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