浙江工业大学
ZHEJIANG UNIVERSITY OF TECHNOLOGY

ExperimentReport Ⅴ

about Communication System Simulation with Matlab

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TASK Ⅰ

一、The code with comments or note

1）task5_1.m

```
function [pOfee]=task5_1(snr)
SNR=exp(snr*log(10)/10);    % signal to noise ratio per bit
sgma=sqrt((5.25)/(6*SNR));   %  standard deviation of noise
N=10000;         % number of symbols being simulated
dsource=zeros(1,20000);
% generation
for i=1:N
  temp=rand;        % a uniform random variable over (0,1)
  if (temp<0.125)
    dsource(i)=0;
  % with probability 1/8, source output is "000"
  elseif (temp<0.25)
    dsource(i)=1;                           % "001"
  elseif (temp<0.375)
    dsource(i)=2;                           % "010"
  elseif (temp<0.5)
    dsource(i)=3;                           % "011"
   elseif (temp<0.625)
    dsource(i)=4;                           % "100"
  elseif (temp<0.75)
    dsource(i)=5;                           % "101"
  elseif (temp<0.875)
    dsource(i)=6;                           % "110"
  else
    dsource(i)=7;                           % "111"
  end
```

```
end;
% detection, and probability of error calculation
numoferr=0;
for i=1:N
  % The matched filter outputs
  if (dsource(i)==0)
    r=-3.5+gngauss(sgma);% if the source output is "000"
  elseif (dsource(i)==1)
    r=-2.5+gngauss(sgma);                    % "001"
  elseif (dsource(i)==2)
    r=-1.5+gngauss(sgma);                    % "010"
  elseif (dsource(i)==3)
    r=-0.5+gngauss(sgma);                    % "011"
  elseif (dsource(i)==4)
    r=0.5+gngauss(sgma);                     % "100"
  elseif (dsource(i)==5)
    r=1.5+gngauss(sgma);                     % "101"
  elseif (dsource(i)==6)
    r=2.5+gngauss(sgma);                     % "110"
  else
    r=3.5+gngauss(sgma);                     % "111"
  end;
  % detector follows
  if (r<-3)
    decis=0;       % decision is "000"
  elseif (r<-2)
    decis=1;                 % "001"
  elseif (r<-1)
    decis=2;                 % "010"
  elseif (r<0)
```

```
    decis=3;                    % "011"
  elseif (r<1)
    decis=4;                    % "100"
  elseif (r<2)
    decis=5;                    % "101"
  elseif (r<3)
    decis=6;                    % "110"
  else
    decis=7;                    % "111"
  end;
  % if it is an error, increase the error counter
  if (decis~=dsource(i))
    numoferr=numoferr+1;
  end;
end;

pOfee=numoferr/N  % probability of error estimate
pObe=4/7*pOfee  %probability of bit error
```

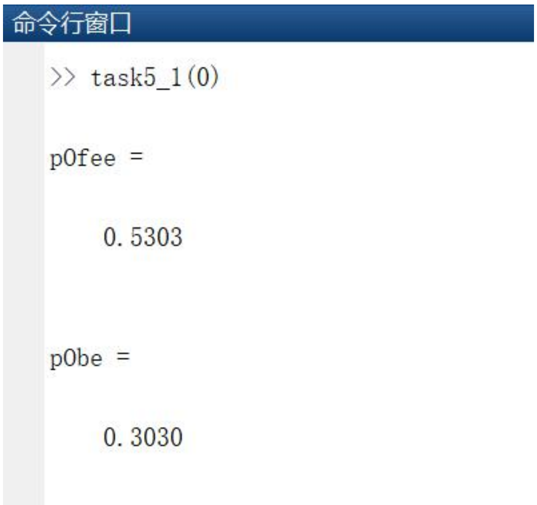
2) gngauss.m

```
function [gsrv1,gsrv2]=gngauss(m,sgma)
if nargin == 0,
  m=0; sgma=1;
elseif nargin == 1,
  sgma=m; m=0;
end;

u=rand;                  % a uniform random variable in (0,1)
z=sgma*(sqrt(2*log(1/(1-u))));  % a Rayleigh distributed
```

```
random variable
u=rand;             % another uniform random variable in (0,1)
gsrv1=m+z*cos(2*pi*u);
gsrv2=m+z*sin(2*pi*u);
```

二、The resulted figure


命令行窗口

```
>> task5_1(0)

p0fee =

    0.5303


p0be =

    0.3030
```

Fig.1 probability of error estimate and bit error

三、The discussion on the result

When the SNR per bit is 0dB, the symbol error rate and bit error rate of 8-PAM are 0.5303 and 0.3030 Obviously according to the answer from the command windows.As for the way to get answers is to the following principle.

Noise variance: N0/2

SNR: EB/N0

Pb=P*(2k-1)/(2k-1)

TASK Ⅱ

二、The code with comments or note

1）task5_2.m

```
N =10000;
Ns=1000;    % Sampling points per symbol
Ts=1;
M=8;        % 8_PAM
Fs=Ns;      % sampling rate is 1000HZ
dt=Ts/Ns;
t=0:dt:(N*Ns-1)*dt;
gt = ones(1,Ns);
d = randi(M,1,N);     % Generate a 1-by-N matrix of random
integers between 1 and M.
dd=2*d-1-M;           % dd is 1-M to M-1
a = sigexpand(dd,Ns);
st = conv(a,gt);      % Digital baseband signal st
[f_st,sf_st]=T2F(t,st);

figure(1)
subplot(1,2,1)
plot( t,st(1:length(t)) );
axis([0 10 -10 10]);
xlabel('t');ylabel('s(t)');
title('Waveform In Time Domain');
subplot(1,2,2)
plot(f_st,sf_st);
xlabel('f');ylabel('S(f)');
title('Waveform In Frequency Domain');
```

```
%% Filter transfer function
H=zeros(1,length(sf_st));
%generate the lowpass filter
for i=1:length(sf_st)
   if abs(f_st(i))<3
      H(i)=1;
   end
end
Y=sf_st.*H;  % output spectrum
% output of the filter as if the signal starts 0s
Y=Y.*exp(1i*2*pi*f_st*t(1));
[t1,y]=F2T(f_st,Y);

figure(2)
subplot(1,2,1)
plot(t,y(1:length(t)));
axis([0 10 -10 10]);
xlabel('t');ylabel('s(t)');
title('After H, Waveform In Time Domain');
subplot(1,2,2)
plot(f_st,sf_st);
xlabel('f');ylabel('S(f)');
title('After H, Waveform In Time Domain');
```

2) sigexpand.m

```
function [out]=sigexpand(d,M)
%The input sequence is expanded to a sequence with an interval
of N-1 Zeros
N = length(d);
```

```
out = zeros(M,N);
out(1,:) = d;
out = reshape(out,1,M*N);
```

3）T2F.m

```
function [f,sf]=T2F(t,st)
%input is time and the signal vectors
%output is frequency and signal spectrum

dt=t(2)-t(1);
T=t(end)-t(1)+dt;
df=1/T; %smapling rate
N=length(st);

f=-N/2*df:df:(N/2-1)*df; %频域抽样点
sf=fft(st);
sf=T/N*fftshift(sf).*exp(-j*2*pi*f*t(1));   %补偿时间移位
```

4）F2T.m

```
function [t,st]=F2T(f,sf)
%output is time and the signal vectors
%input id frequency and signal spectrum

df=f(2)-f(1);
Fmx=f(end)-f(1)+df;
dt=1/Fmx; %smapling rate
N=length(sf);
T=N*dt;
```

```
t=0:dt:T-dt; %时域抽样点
sff=ifftshift(sf);
st=Fmx*ifft(sff);
```

二、The resulted figure

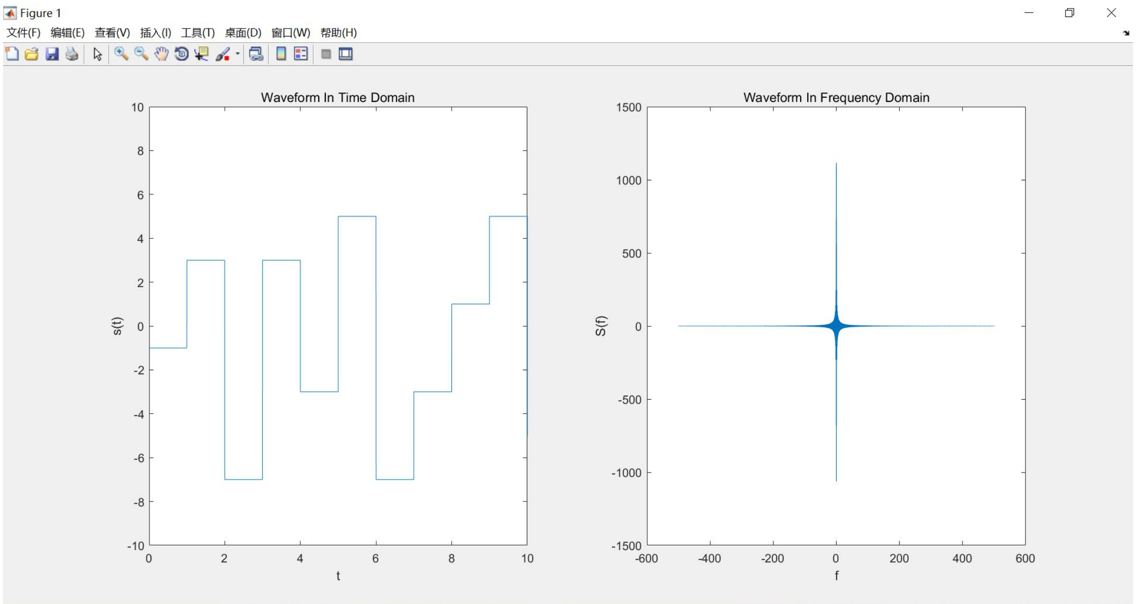


Fig.2 The Original Waveform (t&f)

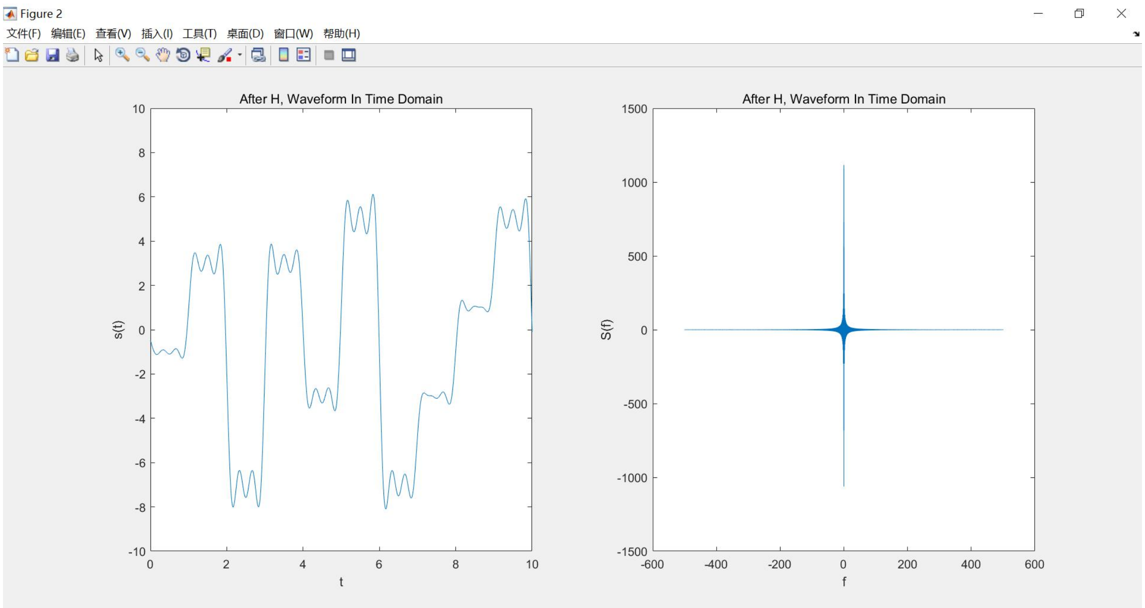


Fig.3 The Waveform After H (t&f)

三、The discussion on the result

Actually,this task is a little difficult for me to do that so i asked my classmates for help and get their way to solve this question. And I get the signal orignal waveform and others after the lowpass filter and they are the same figure.

TASK Ⅲ

三、The code with comments or note

1）task5_3.m

```
Ts=1 ;
N_sample=17;
dt=Ts/N_sample;
df=1.0/(20.0*Ts);
t=-1000*Ts:dt:1000*Ts;
f=-200/Ts:df:200/Ts;
alpha=[0,0.5,1] ;
Xf=zeros(1,2000);
X=zeros(1,2000);
% The roll-off Coefficient = 0,0.5,1

 % The waveform is expressed(the definition of raised cosine)
 for n=1:length(alpha)
    for k=1:length(f)
        if abs(f(k))>0.5*(1+alpha(n))/Ts
            X(n,k)=0;
        elseif abs(f(k))<0.5*(1-alpha(n))/Ts
            X(n,k)=Ts;
          else
            X(n,k)=0.5 *Ts *(1+cos(pi*Ts/(alpha(n)+eps)...
                *(abs(f(k))-0.5*(1-alpha(n))/Ts)));
        end
    end
end
```

```
figure(1)
plot(f,X);
axis([-1 1 0 1.2]);
xlabel('f/Ts');
ylabel('Spectrum Of RC');
legend('\alpha=0','\alpha=0.5','\alpha=1');

%% Take alpha=0.5 for example
for m=1:length(f)
    X(m)=X(2,m);
end
ff=zeros(1,2000);
add=zeros(1,2000);
for f1=1:round(length(f)/20)
    ff(f1)=f1-1-round(length(f)/20)/2;
    sum=0;
    for ff1=1:round(length(f)/20)
        if (f1+ff1-1)<=round(length(f)/20)
            sum=sum+X((ff1)*20);
        else
            sum=sum+X(length(f)-round((ff1)*20));
        end
    end
    add(f1)=sum;
end

figure(2)
plot(ff,add);
xlabel('f');
ylabel('Spectrum Of RC After Translation&Addition');
```

二、The resulted figure

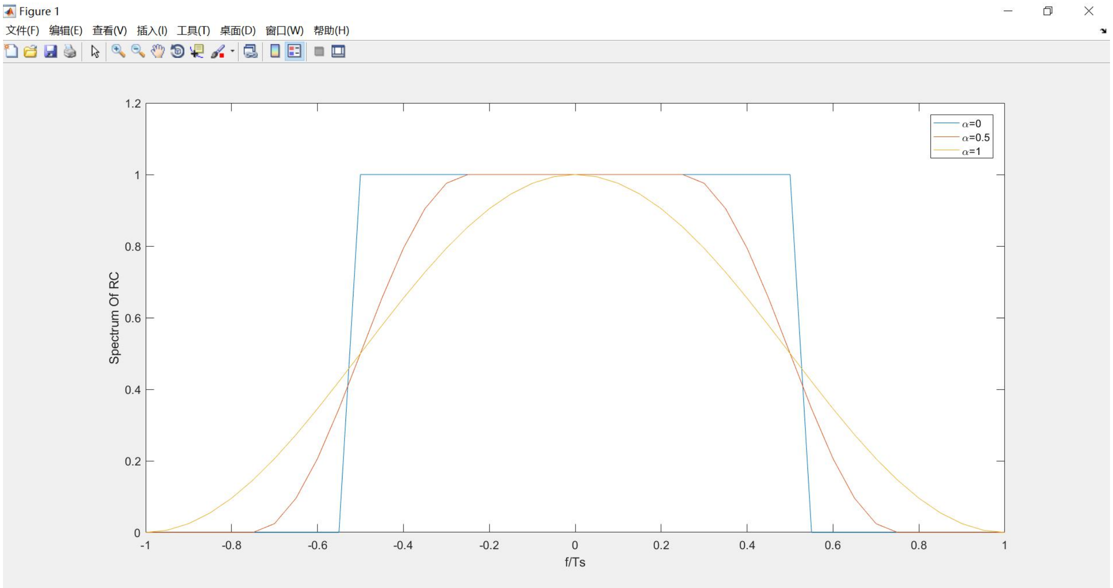


Fig.4 The Spectrum Of RC

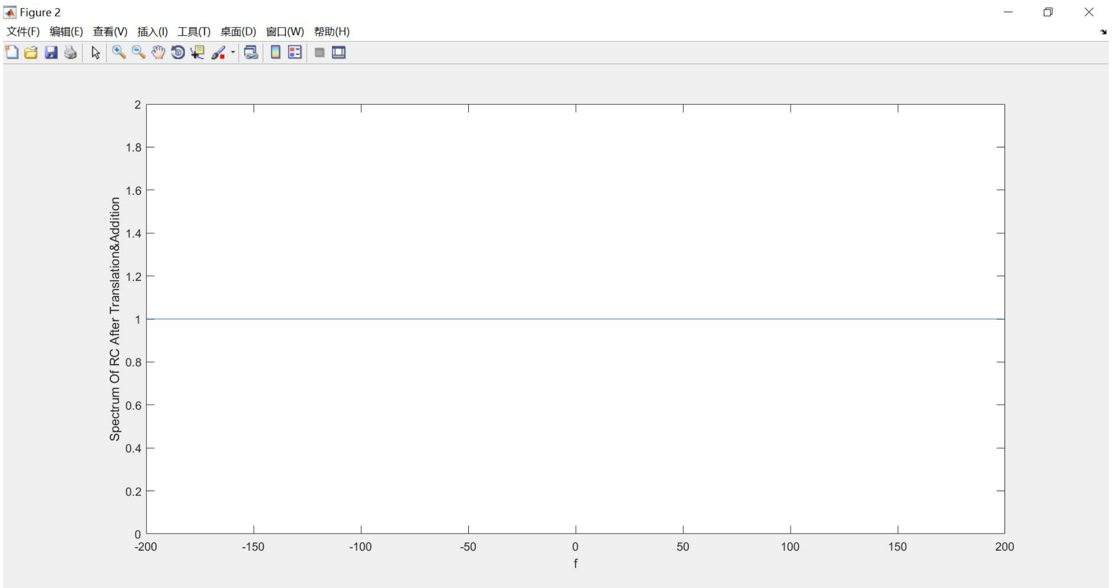


Fig.5 The Spectrum Of RC After Translation&Addition

三、The discussion on the result

From the task, the raised cosine waveform satisfication should conform ti the following equality so the answer is T absolutly when the period id 1/T. And the solution I got is based on the clss and the web query.

$$\sum_{m=-\infty}^{\infty} X\left(f+\frac{m}{T}\right)=T$$