School of Engineering and Applied Science (SEAS)
Ahmedabad University

BTech(ICT) Semester V: Wireless Communication (ECE311)

Laboratory Assignment-6

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1. Solution Problem-1

   (a) Matlab Script:

```
close all;
clear all;
clc;
%bpsk
%step1: Analytical plot
%define SNR
Eb_No_db= [0:12] ;

%convert into linear
Eb_No_Lin=10.^ (Eb_No_db/10);

%simulation
N=1000000;
ip = rand(1,N)>0.5; % generating 0,1 with equal probability
s = 2*ip-1; % BPSK modulation 0 -> -1; 1 -> 1
index=1;

for ii = 1:length(Eb_No_db)

   p=sqrt(1/Eb_No_Lin(ii))
   n1= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; % white gaussian noise, 0dB variance
   h1=1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; %rayleigth channel
   % Noise addition
   y1 = h1.* s + p*n1 ; % additive white gaussian noise

   n2= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; % white gaussian noise, 0dB variance
   h2=1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; %rayleigth channel
   % Noise addition
   y2 = h2.* s + p*n2 ; % additive white gaussian noise

   n3= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; % white gaussian noise, 0dB variance
   h3=1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; %rayleigth channel
   % Noise addition
   y3 = h3.* s + p*n3 ; % additive white gaussian noise

   n4= 1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; % white gaussian noise, 0dB variance
   h4=1/sqrt(2)*[randn(1,N) + j*randn(1,N)]; %rayleigth channel
   % Noise addition
   y4 = h4.* s + p*n4 ; % additive white gaussian noise

   %mrc_1x3
   for kk=1:N
   d(kk)=conj(h1(kk)) * y1(kk) + conj (h2 (kk)) * y2(kk)+ conj (h3 (kk)) * y3(kk);
     if (real(d(kk))>0)
       dataDetect(kk)=1;
     else
       dataDetect(kk)=0;
     end
   end

```

```
%error detection
error=xor(ip,dataDetect);
bers(index)=sum(error)/N;
snr(index)=ii;
[snr(index) bers(index)]

%mrc_1x4
for kk=1:N
d2(kk)=conj(h1(kk)) * y1(kk) + conj (h2 (kk)) * y2(kk)+ conj (h3 (kk)) * y3(kk) + conj (h4 (kk)) * y4(kk);
  if (real(d2(kk))>0)
    dataDetect2(kk)=1;
  else
    dataDetect2(kk)=0;
  end
end

%error detection
error2=xor(ip,dataDetect2);
bers2(index)=sum(error2)/N;
snr(index)=ii;
[snr(index) bers2(index)]

%normalization
H1=h1.*conj(h1);
H2=h2.*conj(h2);
H3=h3.*conj(h3);
H4=h4.*conj(h4);

%antenna selection conditions
%sc_1x3
for mm=1:N
      if (H1(mm)>H2(mm) && H1(mm)>H3(mm))
         h(mm) = h1(mm);
         y(mm) = y1(mm);
     elseif (H2(mm)>H1(mm) && H2(mm)>H3(mm))
         h(mm) = h2(mm);
         y(mm) = y2(mm);
     else
         h(mm) = h3(mm);
         y(mm) = y3(mm);
     end
     %error detection
     d(mm) = conj(h(mm))*y(mm);
     if(real(d(mm))>=0)
         det(mm) = 1;
     else
         det(mm) = 0;
     end
end
b1 = xor(ip, det);
sc_1x3(index) = sum(b1)/N;
snr(index)=ii;
[snr(index) sc_1x3(index)]

%antenna selection conditions
%sc_1x4
for mm=1:N
      if (H1(mm)>H2(mm) && H1(mm)>H3(mm) && H1(mm)>H4(mm) )
         h(mm) = h1(mm);
         y(mm) = y1(mm);
     elseif (H2(mm)>H1(mm) && H2(mm)>H3(mm) && H2(mm)>H4(mm))
         h(mm) = h2(mm);
         y(mm) = y2(mm);
     elseif (H3(mm)>H1(mm) && H3(mm)>H2(mm) && H3(mm)>H4(mm))
         h(mm) = h3(mm);
         y(mm) = y3(mm);
     else
         h(mm) = h4(mm);
         y(mm) = y4(mm);
```

```
        end
        %error detection
        d4(mm) = conj(h(mm))*y(mm);
        if(real(d4(mm))>=0)
            det(mm) = 1;
        else
            det(mm) = 0;
        end
    end
    b1_4 = xor(ip, det);
    sc_1x4(index) = sum(b1_4)/N;
    snr(index)=ii;
    [snr(index) sc_1x4(index)]
    index=index+1;
end

semilogy(Eb_No_db,bers,'d-','LineWidth',3);
hold on
semilogy(Eb_No_db,bers2,'d-','LineWidth',3);
hold on
semilogy(Eb_No_db,sc_1x3,'<-','LineWidth',3);
hold on
semilogy(Eb_No_db,sc_1x4,'<-','LineWidth',3);
grid on
legend('simulation MRC (1x3)','simulation MRC (1x4)','simulation SC (1x3)','
    simulation SC (1x4)');
xlabel('Eb/No, dB');
ylabel('Bit Error Rate');
```

(b) Simulation Output:

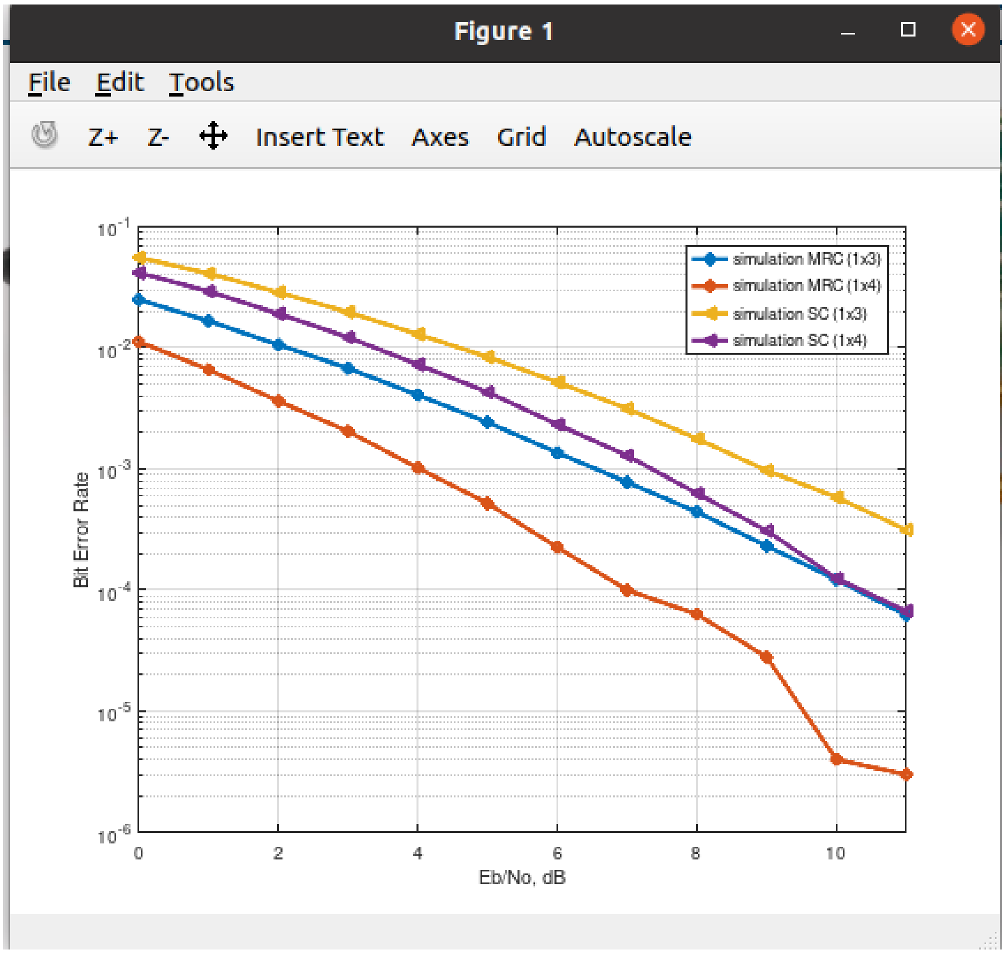

Fig 1:Plot of BER v/s SNR comparison with MRC and SC

(c) Inference:

⋆ **MRC BER performs better than SC BER.As increasing no of antennas BER performs better with same SNR Value.**
⋆ **BER :: MRC(1X4)> MRC(1X3)> SC(1X4)> SC(1X3)**
⋆ **Reason is, MRC uses perfect knowledge of CSI , Selection Combining (SC) combines antennas at Rx as one switch**