

School of Engineering and Applied Science (SEAS)
Ahmedabad University

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

Laboratory Assignment-3

Enrollment No: AU1841029

Name: Kalki Bhavsar

1. Task: Simulated and Analytical plot of (1×2) and (1×4) SIMO wireless system.

(a) Matlab Script:

```
1 clear all;
2 close all;
3 clc;
4
5 *** Initialization *****%
6 SNRdB = 1:1:35;
7 N = 1000000;
8 x= rand(1,N)>0.5;
9 s=2*x-1;
10 SNR_linear = 10.^(SNRdB./10);
11 BER_1x1_theory = (1/2).*(1-(sqrt(SNR_linear./(SNR_linear+1))));
12
13
14 % *****%
15 % **** 1*1 Simulation ****%
16 % *****%
17
18 % *** Transmitter *****%
19
20 for i = 1:length(SNRdB)
21     SNR_linear = 10.^(SNRdB(i)/10);
22     total_error_bits=0;
23
24 % *** BPSK signal generation ***%
25     h = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
26     n = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
27
28 % *** Reciever *****%
29     y = (h.*s) + n;
30
31     for k = 1:N
32         d(k) = (conj(h(k))*y(k));
33         if real(d(k))>=0
34             data(k)=1;
35         else
36             data(k)=0;
37         end
38     end
39
40 % *** Bit error Rate (BER) calulation **%
41     for k = 1:N
42         error_bits=xor(x(k),data(k));
43         total_error_bits = total_error_bits + error_bits;
44     end
45     BER_1x1_simulation(i) = total_error_bits/N;
46 end
47
48
49
50
```

```

51
52 % *****%
53 % **** 1*2 Theory ****%
54 % *****%
55 SNR_linear = 10.^(SNRdB/10);
56 u = sqrt(SNR_linear./(SNR_linear+1));
57 BER_1x2_theory = (1/4)*(2-(3*u)+(u.^3));
58
59 % *****%
60 % **** 1*2 Simulation ****%
61 % *****%
62
63 for i = 1:length(SNRdB)
64     SNR_linear = 10.^(SNRdB(i)/10);
65     total_error_bits=0;
66     h1 = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
67     h2 = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
68     n1 = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
69     n2 = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
70
71     y1 = (h1.*s) + n1;
72     y2 = (h2.*s) + n2;
73
74     for k = 1:N
75
76         d(k) = (conj(h1(k))*y1(k))+(conj(h2(k))*y2(k));
77         if real(d(k))>=0
78             data(k)=1;
79         else
80             data(k)=0;
81         end
82     end
83
84     for k = 1:N
85         error_bits = xor(x(k),data(k));
86         total_error_bits = total_error_bits + error_bits;
87     end
88     BER_1x2_simulation(i) = total_error_bits/N;
89
90 end
91
92 % *****%
93 % **** 1*4 Simulation ****%
94 % *****%
95
96 for i = 1:length(SNRdB)
97     SNR_linear = 10.^(SNRdB(i)/10);
98     total_error_bits=0;
99     h1 = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
100    h2 = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
101    n1 = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
102    n2 = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
103    h3 = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
104    h4 = (1/sqrt(2)).*(randn(1,N)+ 1i*randn(1,N));
105    n3 = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
106    n4 = (1/sqrt(2*SNR_linear)).*(randn(1,N)+ 1i.*randn(1,N));
107    y1 = (h1.*s) + n1;
108    y2 = (h2.*s) + n2;
109    y3 = (h3.*s) + n3;
110    y4 = (h4.*s) + n4;
111
112    for k = 1:N
113
114        d(k) = (conj(h1(k))*y1(k))+(conj(h2(k))*y2(k)) + (conj(h3(k))*y3(k))+(conj
(h4(k))*y4(k));
115        if real(d(k))>=0
116            data(k)=1;
117        else
118            data(k)=0;
119        end

```

```

120     end
121
122     for k = 1:N
123         error_bits = xor(x(k),data(k));
124         total_error_bits = total_error_bits + error_bits;
125     end
126
127     BER_1x4_simulation(i) = total_error_bits/N;
128 end
129
130
131 % *** Plot the simulation result ***%
132 figure
133
134 semilogy(SNRdB, BER_1x1_simulation, 'g-o', 'linewidth', 2);
135 hold on;
136 semilogy(SNRdB, BER_1x1_theory, 'y-o', 'linewidth', 2);
137 hold on;
138 semilogy(SNRdB, BER_1x2_theory, 'r-o', 'linewidth', 2);
139 hold on;
140 semilogy(SNRdB, BER_1x2_simulation, 'c-o', 'linewidth', 2);
141 hold on;
142 semilogy(SNRdB, BER_1x4_simulation, 'b-o', 'linewidth', 2);
143
144 title('Simulated and Analytical BER plot of (1*2) and (1*4) SIMO wireless system.'
145 );
146 legend ("nRx=1 Analytical","nRx=1 Simulation","nRx=2 Analytical","nRx=2 Simulation
147 ", "nRx=4 Simulation");
148 xlabel("Signal To Noise Ratio (SNRdB)");
149 ylabel("Bit Error Rate (BER)");
150 axis([1 30 10^-5 10^0]);
151 hold off
152 grid on
153
154 % *****%

```

(b) Simulation Output:

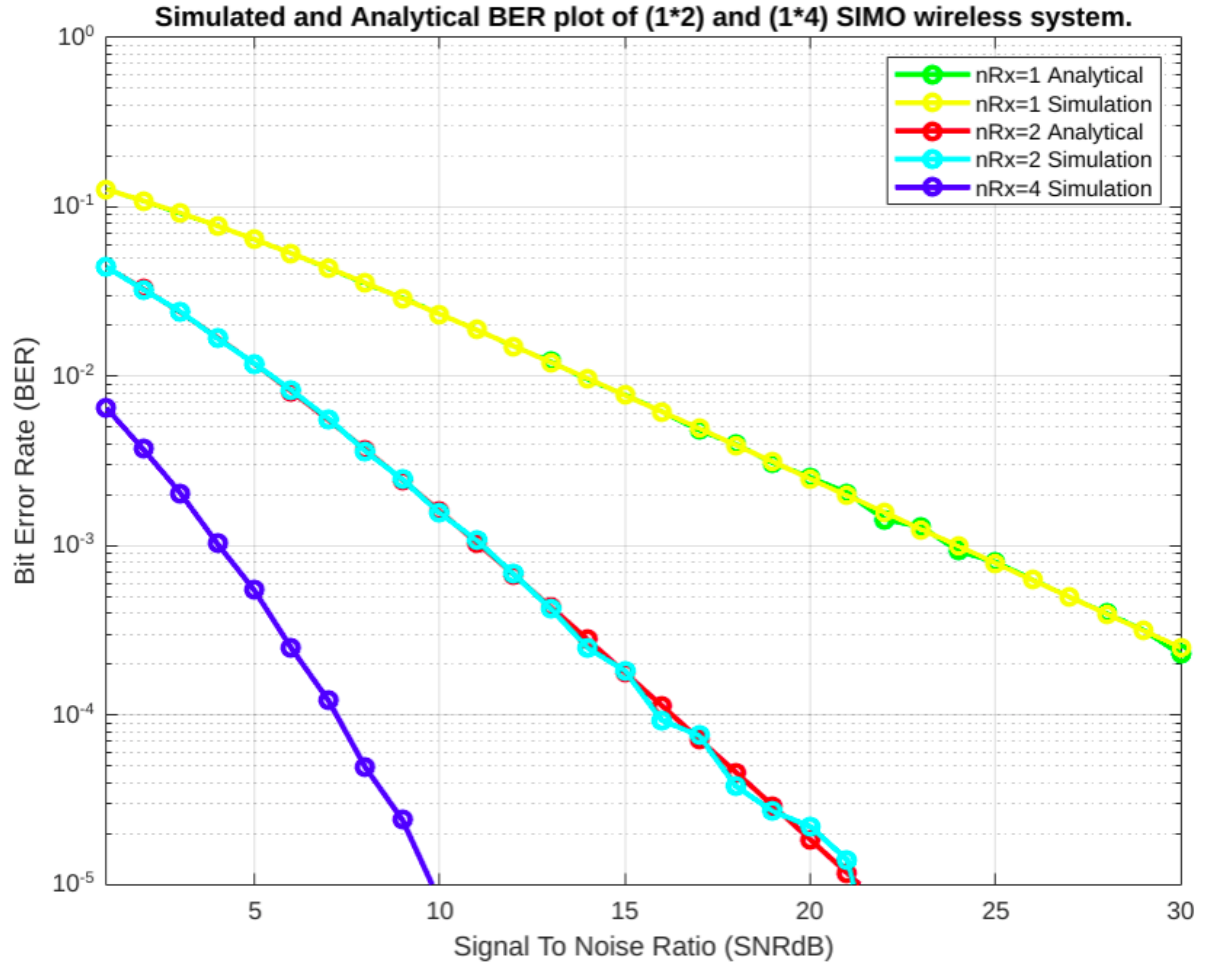


Figure 1: Simulated and Analytical BER plot of (1*2) and (1*4) SIMO wireless system.

- (c) **Inference 1:** Rayleigh fading channel which is a more realistic representation of a wireless communication channel. In fact, for rayleigh fading, the plot has a steady slope in BER curve for SISO(1*1) channel model. With increasing the signal power, the bit error in received signal reduces steadily.
- (d) **Inference 2:** In SIMO, the multiple receivers are receiving data with high data rate. That implies reduction of errors which delimits the BER value to give the best performance of the system with less noise. Therefore, it is necessary to choose better channel that has better BER performance when building the transceiver in order to produce less noise and high performance. In SIMO (1*2), if at one Rx, signal is in deep fading then the second Rx can receive the signal. This way, we can improve performance the over SISO(1, 1).
- (e) **Inference 3:** For SIMO (1*4) BER is small as compared to SIMO(1*2) and SISO(1*1). In SIMO(1*2), if at one Rx, signal is in deep fading then the second Rx can receive the signal and we can improve performance over SISO(1*1). But if the more than one Rx, signal is in deep fading then third or fourth Rx can receive the signal and we can improve performance over SIMO(1, 2). Hence the SIMO (1, 4) is more efficient for fading channels.
- (f) **Inference 4:**
 The SNR for nRx=4 simulation is less than the SNR of nRx=2 simulation.
 The SNR for nRx=4 in BER v/s SNRdB is around 4.7dB for 3G and around 7.2dB for 4G.
 The SNR for nRx=2 in BER v/s SNRdB is around 11dB for 3G and around 16.5dB for 4G.