Advanced Topics In Telecommunication Systems

Homework 3 Report

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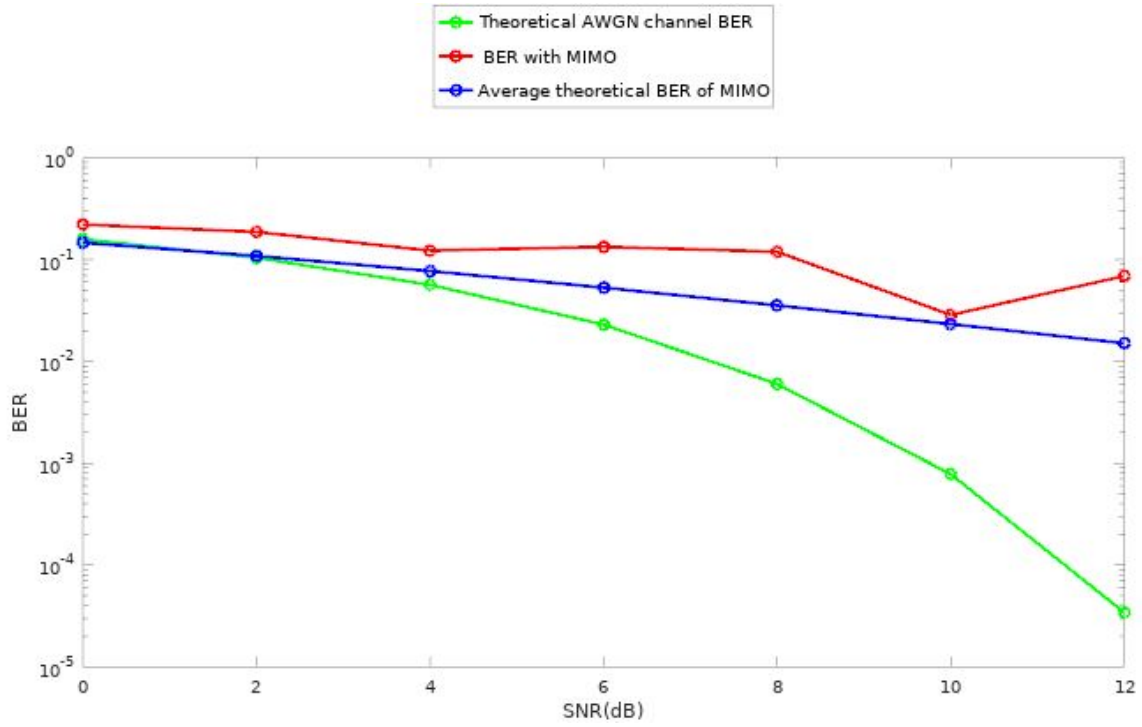
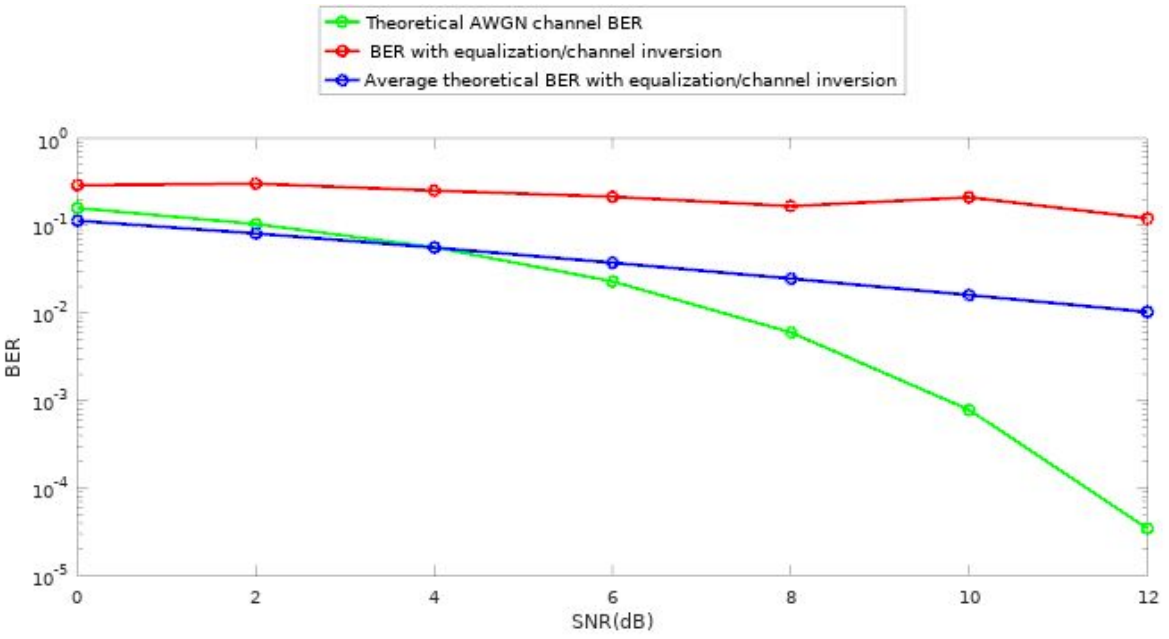
A) Assume that we have a fading channel of the following form: $\vec{y} = \vec{H}x + w$. The channel remains constant for T seconds. We use spatial multiplexing and Least Squares channel inversion (2x2 MIMO) on the receiver's side. The following BER plot shows the bit error rate for different SNR values in our 2x2 MIMO system. For the simulation we use the following values for the constants: Rb =1000 bps, Number of bits = 10000, os = 1, QPSK(m=4) and Tchannel = 1 sec.

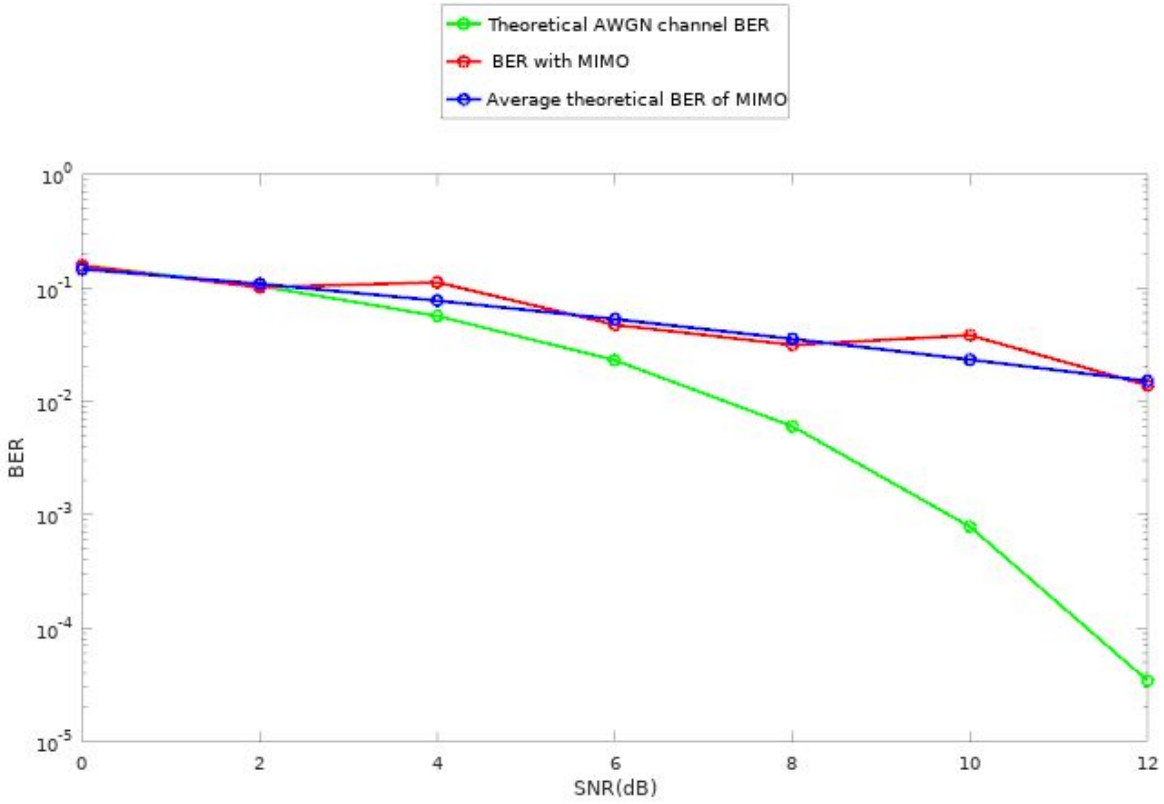


B) We implement 16-QAM modulation and demodulation in our system by changing the symbol encoding technique of the transmitter and the decision algorithm of the receiver. The following BER plots show the bit error rate for different SNR values in our system using by using one antenna or by using MIMO.

i) For the simulation with one antenna on each side, we use the following values for the constants: Rb =1000 bps, No. of bits = 10000, os = 1 and Tchannel = 1 sec.



ii) For the 2x2 MIMO simulation, we use the following values for the constants: Rb =1000 bps, Number of bits = 10000, os = 1 and Tchannel = 1 sec.



C) Using an access point of two antennas that act as a receiver, we have implemented the two techniques of both MRC and spatial multiplexing. We transmit packets with a duration of T seconds from a transmitter that consists of 2 antennas. We assume that a packet has been received correctly if all of its bits have been received correctly. The following table depicts the difference between the two techniques(with BPSK).

SNR(dB)	0	2	4	6	8	10	12	14	16	18	20
MRC(L=2) goodput	0	0	0.1	0.4	0.8	0.9	1	1	1	1	1
MIMO(2x2) goodput	0	0	0	0.2	0.2	0.6	0.8	1.2	1.6	2	2

We can see that the MRC technique achieves the maximum goodput(=1) sooner than the MIMO technique because of the optimization it uses in order to acquire a better signal. On the other hand, with the MIMO technique, we achieve a bigger maximum goodput(=2) because of the fact that we have twice as much throughput.

Bonus question:
We use many combinations in order to achieve the best goodput for a specific SNR. In the following table are shown some of the better combinations.

SNR(dB)	0	2	4	6	8	10	12	14	16	18	20
MRC BPSK	0	0	0.1	0.4	0.8	0.9	1	1	1	1	1
MRC QPSK	0	0	0.1	0.4	0.4	0.8	0.9	0.9	1	1	1
MIMO BPSK	0	0	0	0.2	0.2	0.6	0.8	1.2	1.6	2	2
MIMO QPSK	0	0	0	0	0.4	0.4	0.8	1.4	1.2	1.6	1.4

The best combination that we get from various simulations, before SNR = 12, is the MRC BPSK. The best combination after SNR= 12 is the MIMO BPSK.