EFFECT OF SPATIAL CORRELATION ON MIMO CHANNEL CAPACITY

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Abstract

This project's goal is to examine how antenna correlations affect the MIMO channel capacity. When there are no detectable spatial correlations between the broadcast and receive antennas, like when they are sufficiently far apart, for instance, the MIMO channel capacity (without knowing the channel state information) is given by

$$C = log2\ det\ (\ INr\ +\ \gamma\ Nt\ HH^{H}\ )$$

Nt = Number of Transmitting Antennas

Nr= Number of Receiving Antennas

H= Nr x Nt (MIMO Channel Matrix)

Pt is Transmition power.

Delta^2n is receiver noise power

gamma is the ratio between transmitter power to receiver noise power.

gamma = -12dB to 32dB in steps of 4dB increment

MIMO Channel capacity is:

$$C = log\ det(INR\ +\ (\gamma/Nt)\ *\ H\ *\ H(Hermitian));$$

Average Channel Capacity is:

$$Cav = 1/P\ *\ \Sigma(C),$$

Σ = 10^5

Keywords: *MIMO, Spatial channel, Channel Capacity, Average Channel Capacity, Transmitting and receiving antenna, Outage probability, Signal to Noise Ratio, Channel Realization.*

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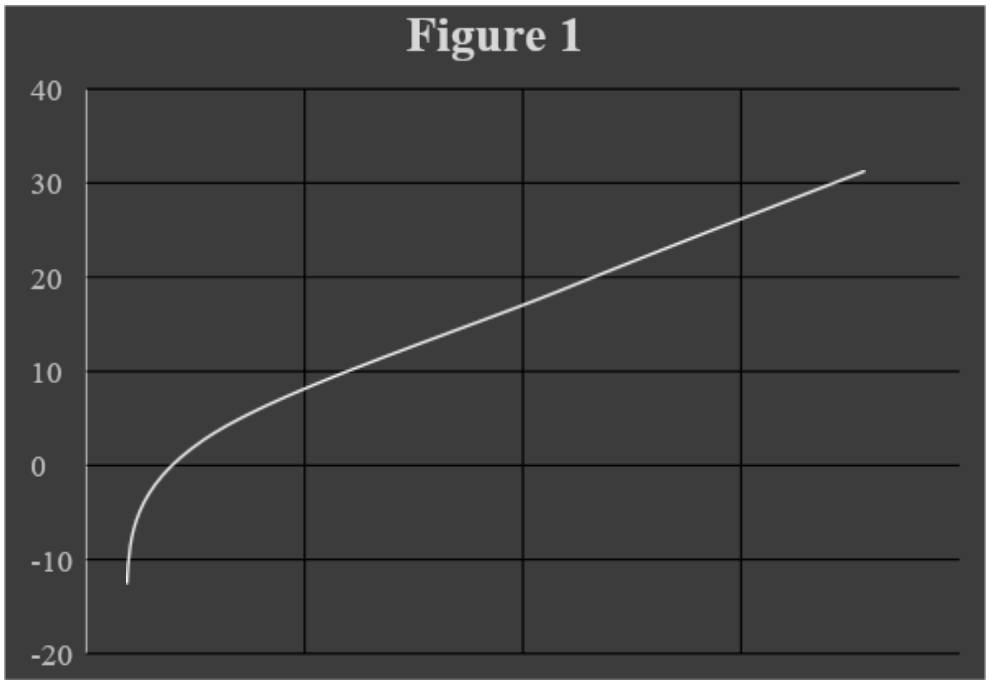
- Plot average channel capacity, Cav, for uncorrelated channel, H, taking γ in dB from −12 dB to 32 dB, in steps of 4 dB increments, and Nr = Nt = 3.

```
% number of channel realisation
% q=1./p;
% SNR = 10.^(gammaBar/10);
% H = sqrt(1/2) * (randn(1))*randn);
% H=(1/2)*(randn(Nr,Nt)+1i*randn(Nr,Nt));
for
    c=zeros(1,p);
    for idx = 1:p

H=sqrt(1/2)*(randn(Nr,MC)+1i*randn(Nr,MC));
        c(idx)=
log2(det(eye(Nr)+(gammaBarL(i)/Nt)*abs(H*H'
));
    end
     Cavg(i)= mean(c,"all");

end
figure(3);
plot(CavgL,gammaBar,"black')
xlabel('SNR in dB');
ylabel('Ergodic Channel Capacity')
title ("Figure 1.Cavg");
grid on;
hold on;
```

Output:

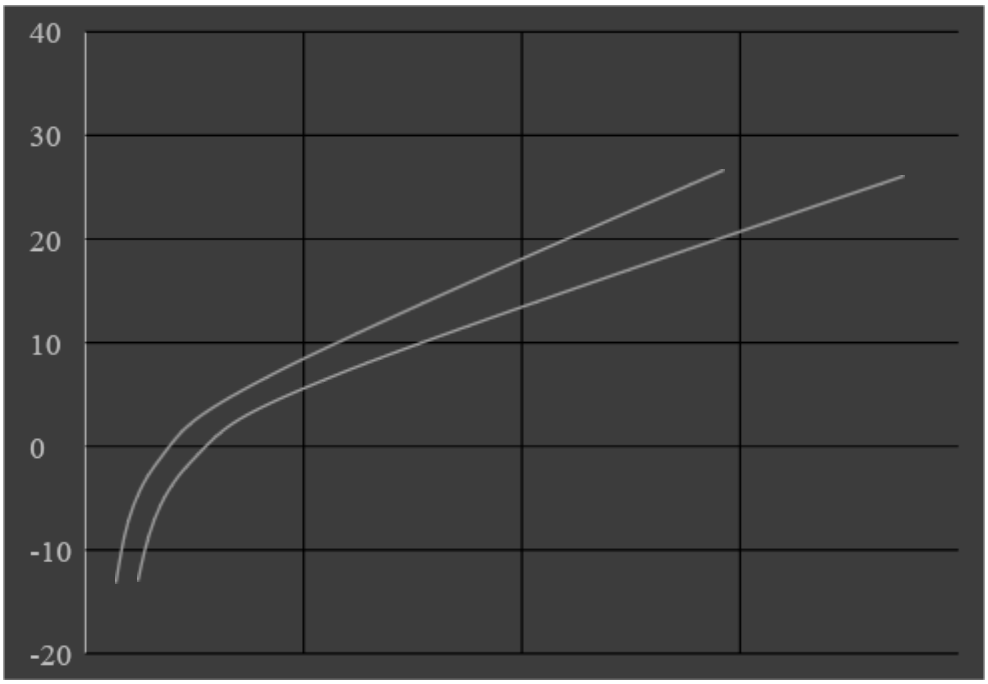


Question 2

- Repeat (1) for the correlated MIMO channel, Hc, by taking ρr = ρt = [0.06, 0.65, 0.92]. Plot the curves of (1) and this step in a single figure (1st Figure).

```
%
for
    for


    end
end

% Hc=sqrt(1/2)*(randn(Nr,Nt)+1i*randn(Nr,Nt));
for


end
```

Output:



Question 3

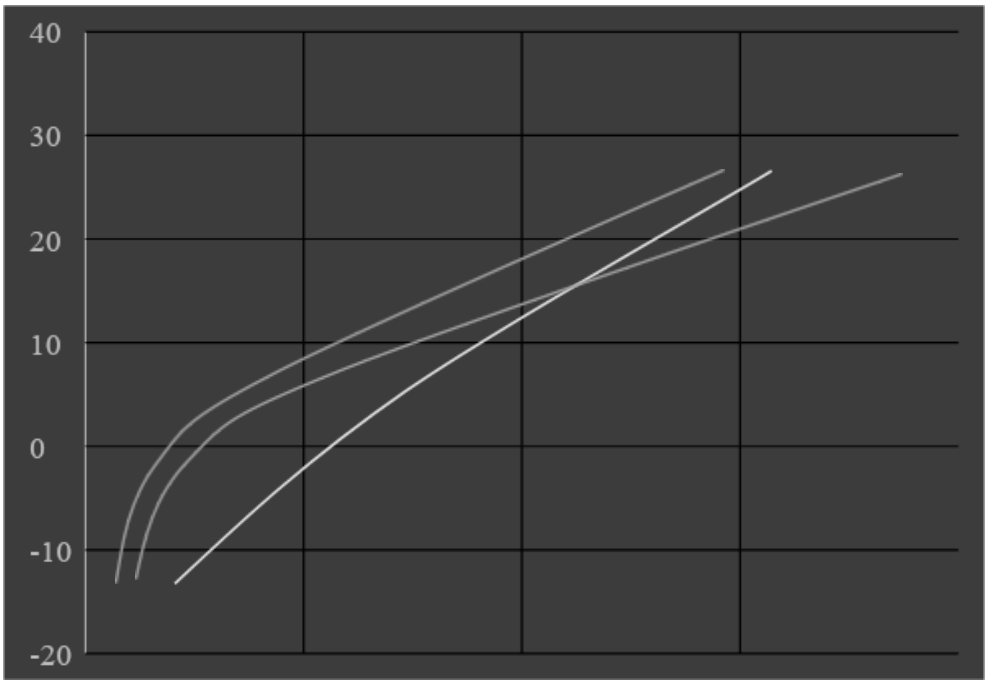
Repeat (1) and (2) for Nr = Nt = 6 (plot curves in 2nd figure), and Nr = Nt = 9 (plot curves in 3rd

```
                % number of channel realization


for

    for
%

    end

End
```

figure)

Question 4

Output:



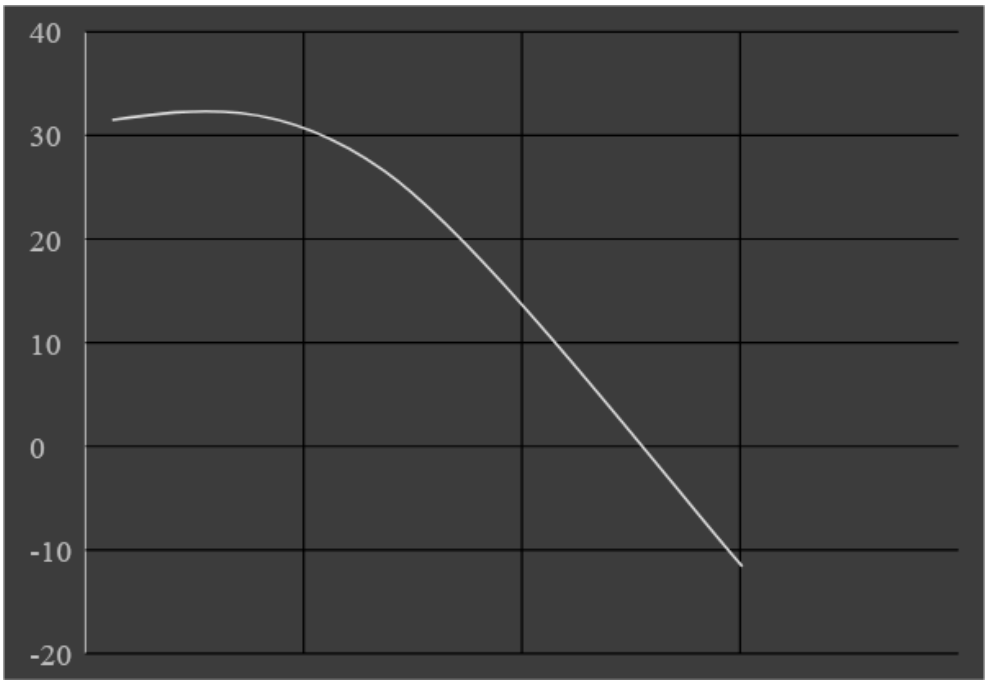
Question 5

Now take γ = 8 dB case. Consider the following outage probability Pout = Pr{C ≤ r} (16)

Change r from 1 to 100 in steps of 0.1. • 5) Plot Pout versus r for uncorrelated channel, H, with Nr = Nt = 3.

MIMO8

Output:



Question 6

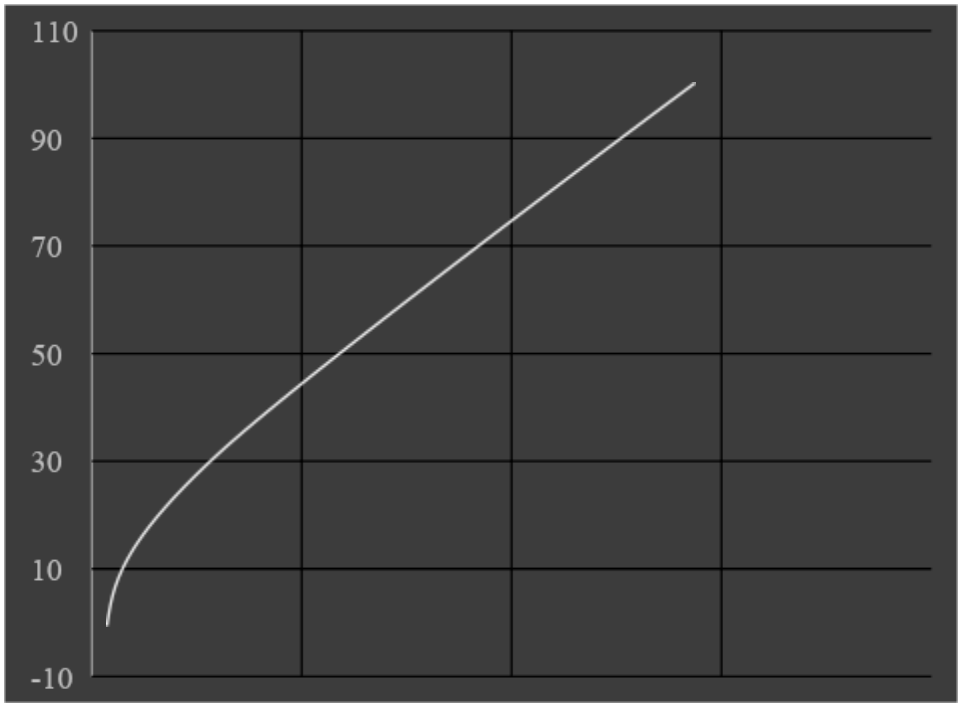
- Plot Pout versus r for correlated channel, Hc, with ρr = ρt = [0.06, 0.65, 0.92] for Nr = Nt =

```
for

end

     on

%Calculate Theoretical outage probability
%Plot theoretical outage probability
     on
```

3. Plot the curves of (5) and this step in a single figure (4th figure)

MIMO10

Output:



Question 7

- Repeat (5) and (6) for Nr = Nt = 6 (plot curves in 5th figure), and Nr = Nt = 9 (plot curves in

```
for

end

     on

%Calculate Theoretical outage probability
%Plot theoretical outage probability
     on
```

6th figure)

```
for

end

     on


%Calculate Theoretical outage probability

%Plot theoretical outage probability

     on
```

Conclusions

In this project, "Study of Effects of Spatial Correlation on MIMO Channel Capacity," I learned a lot about Multiple Input Multiple Output (MIMO) systems, including SISO, MIMO, MISO, and many other systems' concepts, Multiplexer and Demultiplexer. However, I still need to better understand MATLAB in order to attempt more problems of this nature, as the codes above might not be exactly as needed, apology for that, and need more guidance.

References for MIMO concept

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