112-2 CWN Lab2 Report

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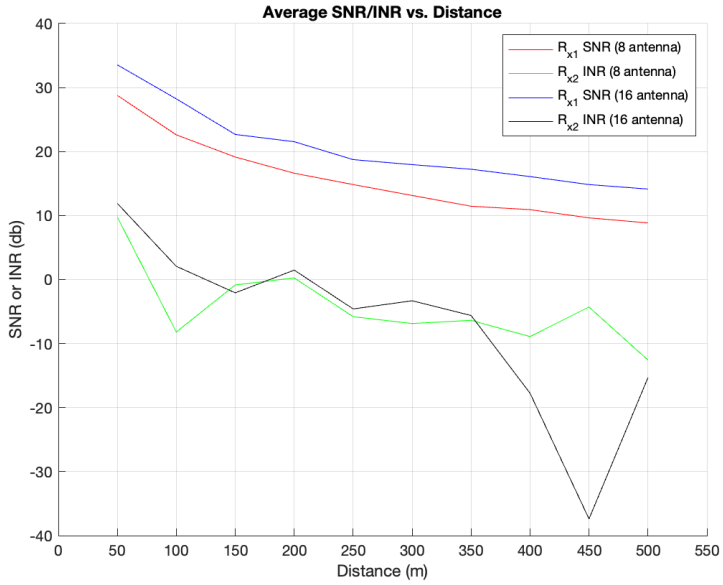
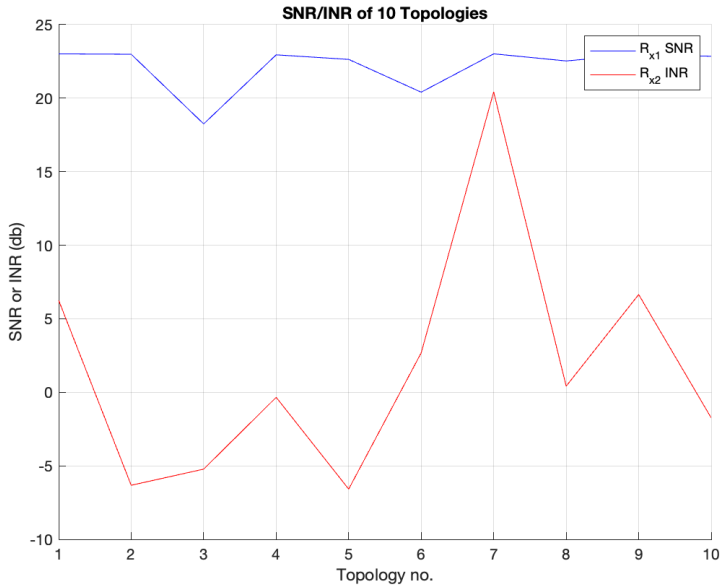
Task 1

- d = [50:50:500]m, antenna number = 8 and 16



  - Observation
    Receiver 1 with 16 antenna has higher SNR, showing that more antenna enhances accuracy. The INR of receiver 2 shows less correlation with the number of antenna.

- 10 topologies when d = 200m, antenna number = 16

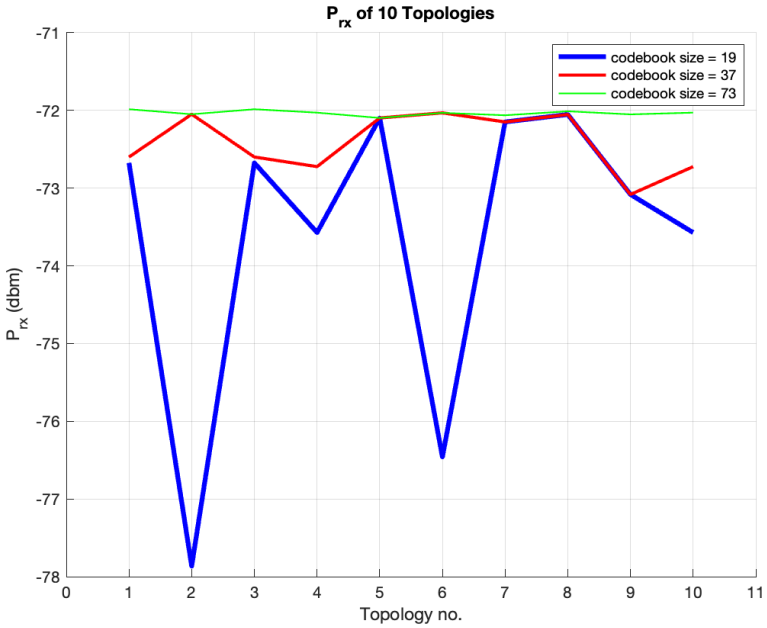


  - Observation (about the side lobe interference)
    When the angle of departure of the two receivers are too close, the side lobe of receiver 1 on the direction of receiver 2 will be strong. In this case, the INR will be very

high, showing a strong side lobe interference. For example, topology No.7 in the graph have receivers with similar angles, while topology No.5 does not.

The SNR of receiver 1 is stable around 22db since we are always choosing the best beam for receiver 1. The INR is not stable because it depends on the difference of angle between the receivers, and the location of receiver is chosen randomly.

- 10 topologies for codebook with different sizes, d = 200m, antenna number = 16



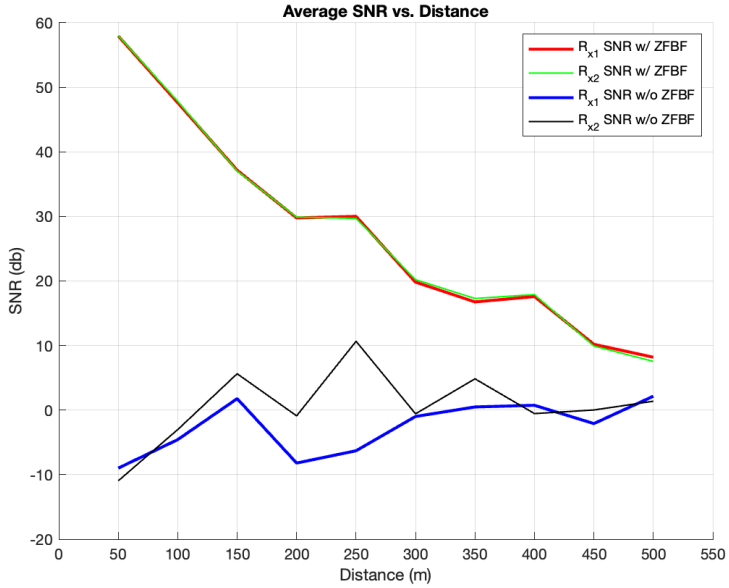
- Observation (about the impact of codebook sizes)

The size of codebook decides the number of possible beam directions. The larger the codebook is, the more possible directions. Since the angle gap between the beams are smaller in larger codebook, it can be easier to find the beam that exactly aims at the desired direction. Therefore, the larger the codebook is, the more stable receive power is.

As shown in the graph, the codebook with size=73 always has P_rx around -72 dbm. On the other hand, the codebook with size=19 can sometimes have P_rx around -72 dbm, but sometimes around -78 dbm, showing some unstableness.

Task 2

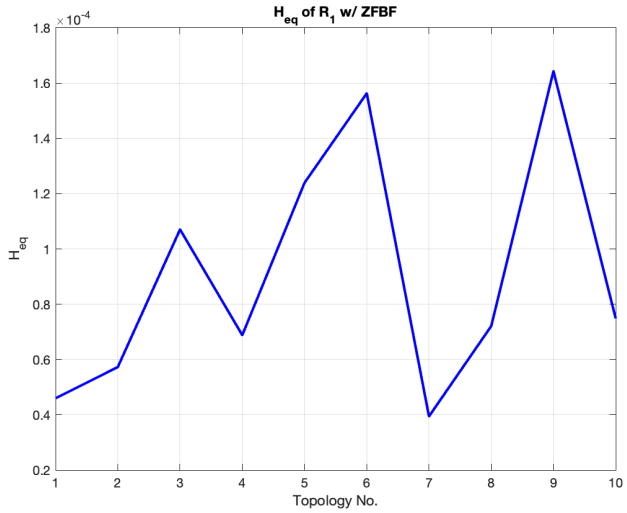
- d = [50:50:500]m, average SNR of 2 users w/ or w/o ZFBF

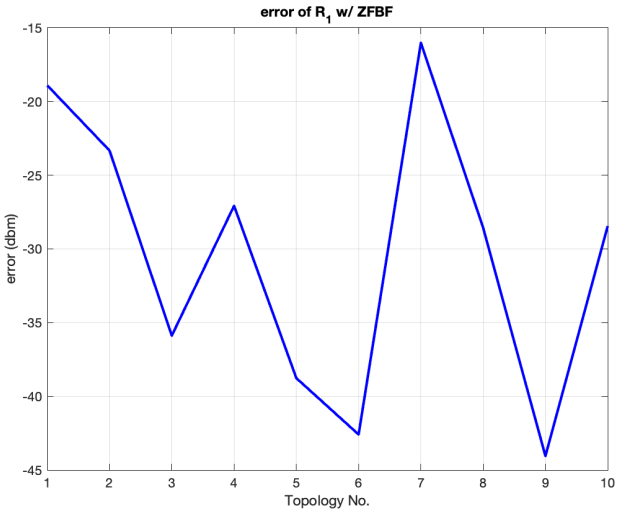


  - Observation

    The SNR is much better with ZFBF.

- H_eq and error of Rx1 w/ ZFBF





  - Observation
    - why error varies across different rounds of experiment

      The orthogonality of channel affects the error of the system. Since the channel of the system is generated randomly, there is no guarantee of the orthogonality of the channels. Therefore, the error varies across different rounds of experiment.

    - why H_eq would be different across different rounds of experiment

      The H_eq with ZFBF is calculated by first finding the inverse matrix of H, then scale the inverse of H to power=1, which is the matrix W. After scaling,

H*W=I*c, where c is a constant. H_eq is assigned c. Since the constant is determined by the magnitude of scaling, and the scaling is determined by the orthogonality of channel, the value of H_eq is affected by the orthogonality of channel. Larger H_eq represents more orthogonal channel. Because the channel is generated randomly, H_eq is different across different rounds of experiment.

- correlation between H_eq and error

  The H_eq and error is negatively correlated. If H_eq is larger, the channel is more orthogonal and has better quality. This indicates lower error. On the contrary, is H_eq is smaller, the error is higher.

Questions

- What have you learned from this lab?

I have a better understanding on the process of analog and digital beamforming. I learned how the devices (eg. antenna number) and ZFBF affect the SNR. Also, I see the impact of side lobe in the process of analog beamforming. Moreover, I understand how analog and digital beamforming works differently and helps the transmission of signal.

- What difficulty have you met in this lab?

I have difficulty understanding the concept of decoding with and without ZFBF. Luckily, by following the instructions TAs provide, I can complete the task successfully and get to know the process of decoding.