Advanced Communication Theory Coursework

Part A

Original Photos

Task 1

After pathing through the channel, the delay is estimated based on the value of correlation between the received signal and its shift version. The maximum value of the correlation indicates the delay. As shown in the following data, the delay is estimated accurately, while the BER is quite high. This shows that the performance of single receiver array is bad.
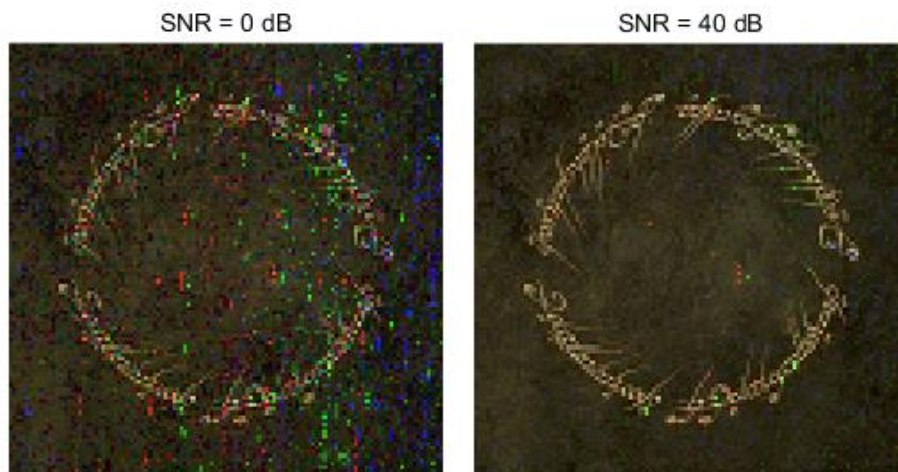
```
----------------------------------------------------------------------------
                                SNR = 0 dB
                             Actual delay = 5
                            Estimated delay = 5
                         Bit Error Rate = 12.2788%
----------------------------------------------------------------------------
                               SNR = 40 dB
                             Actual delay = 5
                            Estimated delay = 5
                         Bit Error Rate = 2.4886%
----------------------------------------------------------------------------
```

SNR = 0 dB   SNR = 40 dB

Task 2

After pathing through the channel, the delay is estimated based on the value of correlation between the received signal and its shift version. The difference between task 2 and 1 is the multipath effect. The desired source 1 has 3 paths, hence the first three maximum values of the correlation indicate the delays in three paths. As shown in the following data, the delay is not precisely accurate, but the BER is much lower than that of task 1. This shows that the multipath effect increases the performance.

SNR = 0 dB

Actual delay for each path = [3   5   12]

Estimated delay for each path = [3   6   12]

Bit Error Rate = 4.6287%

SNR = 40 dB

Actual delay for each path = [3   5   12]

Estimated delay for each path = [3   10   12]

Bit Error Rate = 0.14183%

SNR = 0 dB   SNR = 40 dB
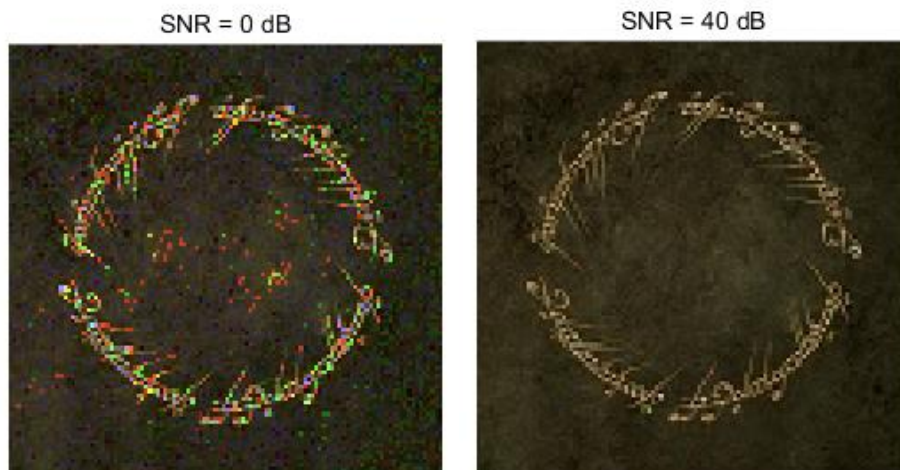
Task 3

In task 3, a UAR of 5 antennas is employed at the receiver. A super-resolution beamformer and STAR manifold receiver are used to analyse the received signal. The super-resolution beamformer provides the weight to maximise the signal to interference ratio, because interference contributes to BER more than noises. As shown in the following data, the delay and DOA[azimuth elevation] are estimated correctly for the desired source, and the BER is much lower than that of task 1 and 2.

```
--------------------------------------------------------------------------------
                              SNR = 0 dB
                           Actual delay = 5
                          Estimated delay = 5
                         Actual DOA = [30   0]
                        Estimated DOA = [30   0]
                       Bit Error Rate = 0.10496%
--------------------------------------------------------------------------------
                              SNR = 40 dB
                           Actual delay = 5
                          Estimated delay = 5
                         Actual DOA = [30   0]
                        Estimated DOA = [30   0]
                        Bit Error Rate = 0%
--------------------------------------------------------------------------------
```

Task 4

In task 4, the spatiotemporal beamformer and STAR manifold receiver are used to analyse the received signal. The estimated delay for each path and DOA[azimuth1 elevation1 azimuth2 elevation2 azimuth3 elevation3] are shown in the following data. The recovered text is not perfect, the letter "l" in "accompdished" becomes "d", but it does not influence the delivery of the text.

Recovered text = "   mission accompdished! You are awesome!!!!!!!!!!!!!!"
Estimated delay = [6 11 21]
Estimated DOA = [115   0   51   0   51   0]