HW#3

SIMULATIONS

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Question 2:

The answer for W_{opt} if we just want to receive in a special angle θ will be :

$$W_{opt} = \frac{R_u^{-1} c(\theta)}{c(\theta)^H R_u^{-1} c(\theta)}$$

In this equation c(θ) is a matrix containing delays in each antenna. Using this equation and information of the given sent signals, W_{opt} are found.

By changing the M value in code W_{opt} for M = 11 can be found too.

Question 3:

In this question, two complex normal signals are simulated. These signals model the sent signal from sources. They are independent and have the same power equal to 10. This state means their expected value is zero and their variance is 10.

Using “normrand” command in matlab, s1 and s2 signal which are the sent signals are created. Signal size is set as 1000 in this question.

For simulating noise the same story holds. “Normrand” command is used. But for noise variance is 1.

Because of the distance between antennas which is $\frac{\lambda}{۲}$, there’ll be a delay between received signals in different antennas. If we assume the first antenna from left receives the signal with no delay, the second antenna will receive signal with a delay equal to $\exp(j2\pi cos\theta)$ and the M^{th} one’s delay will be $\exp(j2(M-۱)\pi cos\theta)$. (θ is the angle between the earth and signal beam.)

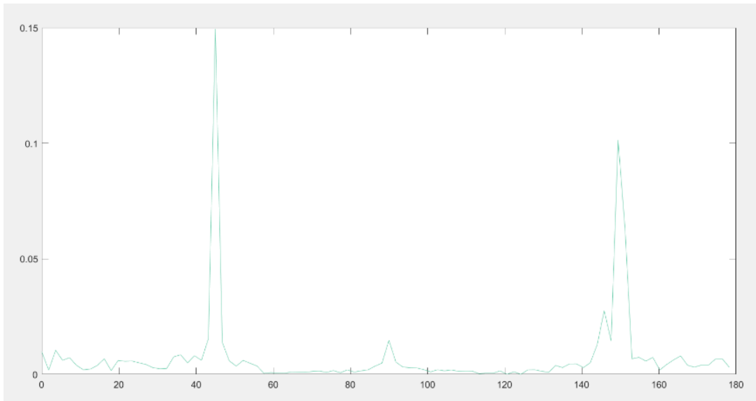
Based on this approach a matrix is needed to be defined containing these delay parameters. In this question two different values for θ is given. So 2 different matrix are defined. One for angle equal to 45 degrees and the other one 150 degrees.

The received signal will receive s1 and s2 and noise. But s1 and s2 will have a coefficient explained above, the delays. All the received signals are collected in a vector called u. Its components are the received signal of each antenna. Since here M is 5 and signal size is assumed as 1000, u ‘ll be a matrix of size 100*5.

With the summation given, R_u is then calculated. It’ll be a 5*5 matrix.

Then θ is defined to be between 0 and 180. Using θ now c(θ) is found the same way as a(θ) for 45 and 150 degrees.

With $c(\theta)$ and the approximation of R_u, J_{min} is calculated. Now we need to plot the result. It'll be like this :



So this plot shows clearly, there are 2 peaks in 45 and 150. This shows that we can identify the angle of the beams. Since the angles are different, peaks are clear and can surly state that these 2 are the angle of beams.

If we simulate for N = 1000 the result would be the same as well :