TASK 1

Personal data:
X=7, Y=25
The angle for modulation $\varphi = X + 2Y = 57°$

The three transmitted images with the same size 112×160:

s1(photo-1)   s2(photo-2)   s3(photo-3)

When SNR=0dB, the received image "photo-1":

the received image

When SNR=40dB, the received image "photo-1":

the received image

Comments: the received image has more noise with lower SNR ratio of the transmit channel.

TASK 2

Personal data:

X=7, Y=25

Signals arriving at the Receiver	Relative delay in Tc
1st path of s1(t)	(X+Y) mod 4 = 0
2nd path of s1(t)	(X+Y) mod 4 = 6
3rd path of s1(t)	(X+Y) mod 4 = 11
s2(t)	8
s3(t)	13

The transmitted images are the same as TASK1.

Results:

When SNR=0dB, the received image "photo-1":

the received image
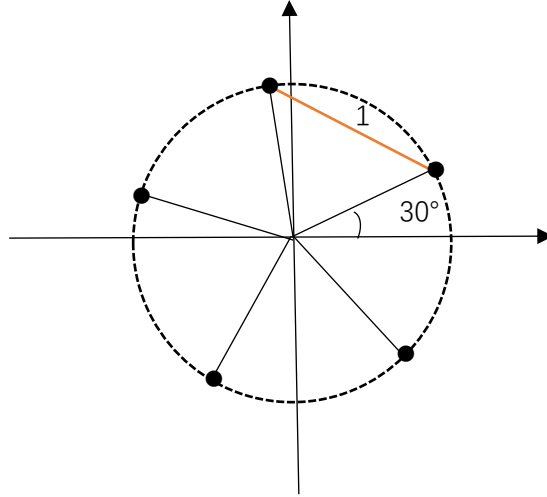

When SNR=40dB, the received image "photo-2":

the received image

Comments: the results are better than that of TASK 1, as in TASK 2, the receiver combine the received signals of all the three paths of user 1.
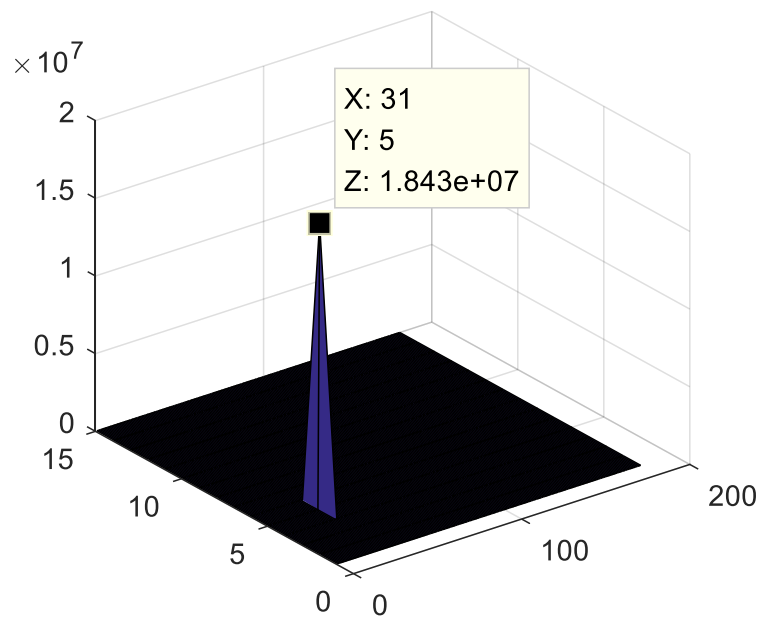
TASK 3

Uniform circular array with 5 isotropic elements with half-wavelength inter-antenna spacing (1ˢᵗ element: 30° anticlockwise with respect to the x-axis):

The transmitted images are the same as TASK1 and TASK2.

The used channel estimation method: STAR algorithm

The surface of STAR subspace cost function:

Comments: the only one peak in the surface indicates the estimated time delay and DOA. The time delay of the received signal is 5 and the DOA is 31-1=30° (as the index of MATLAB starts from 1 rather than 0).

As there is only one path for the desired user, the WIENER-HOPF beamformer is used.

Results:

When SNR=0dB, the received image "photo-1":

the received image

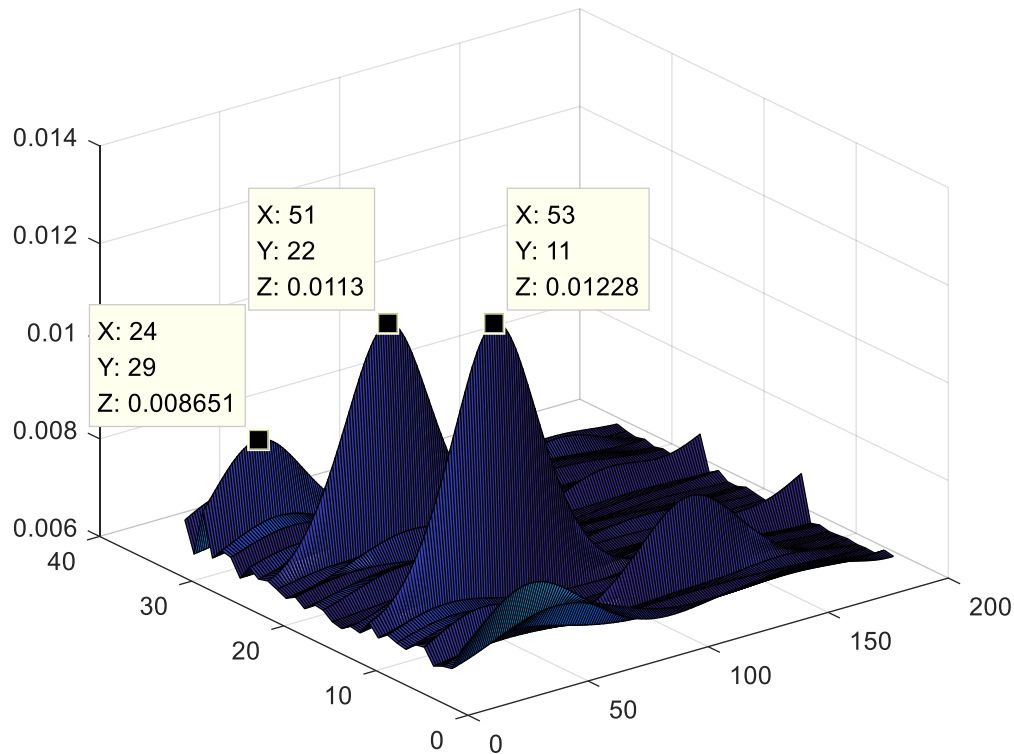When SNR=40dB, the received image "photo-1":

the received image

TASK 4

Personal data: phase shift of M-sequence = 10

the angle for modulation $\varphi = 10°$

The used channel estimation method: STAR algorithm

The surface of STAR subspace cost function:

Comments: there are 3 peaks in the subspace surface, and the estimated time delays of the received signal are 11, 22 and 29, with the corresponding estimated DOA 52, 50 and 23. (The value of DOA = X – 1, because the index of MATLAB starts from 1 rather than 0, the range of X axis is [1, 181] rather than [0, 180]).

As there are 3 paths of 1 user (i.e. a multi-path problem), the spatiotemporal-RAKE receiver is used in this task.

Results:

The received message:

Yunyi, excellent!!! You have completed the mission!!!!!!!!!!