

Performance Enhancement of Aperture Antennas Used for Estimation of Direction of Arrival (DOA)

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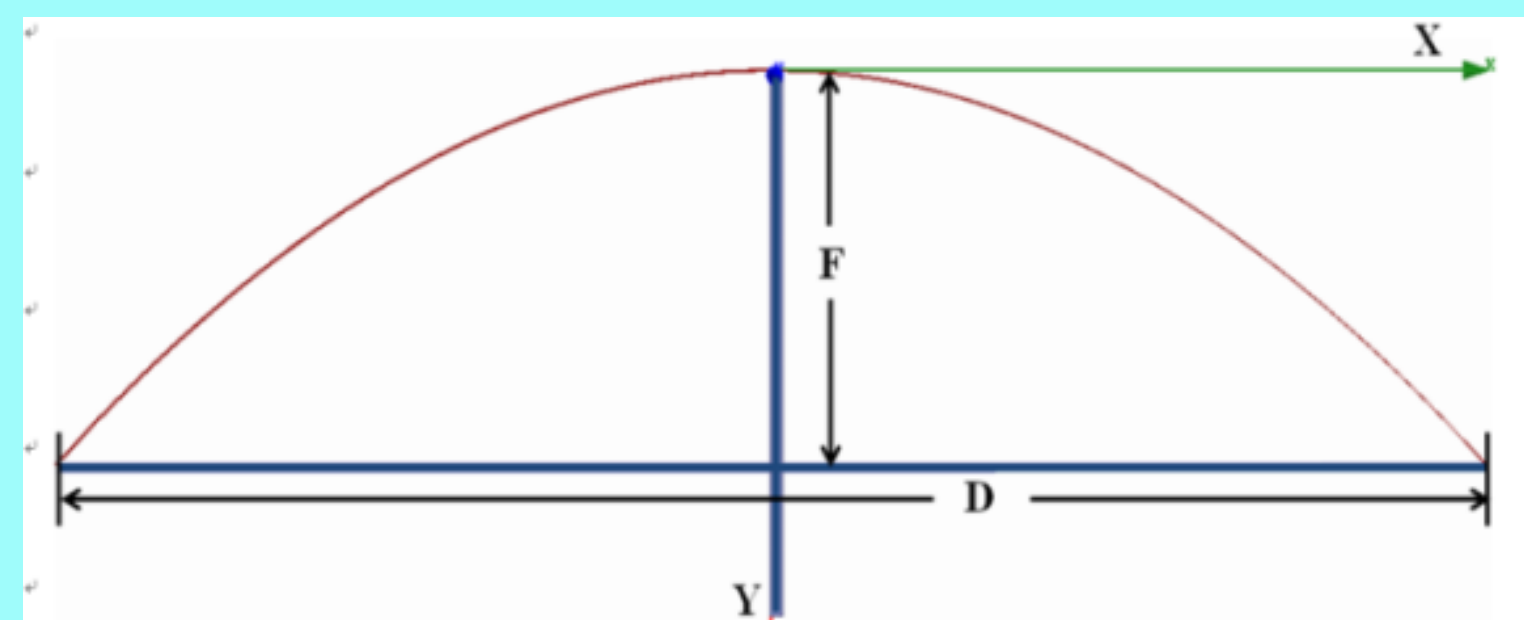
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Problem



Geometry of the parabolic reflector with sensors located in its focal plane.

We assume that the sensors receiving the signals are distributed in the focal plane of the reflector along the y axis. Our task is to estimate the azimuthal angle of arrival by using the proposed method.

$$\mathbf{x}(t) = \mathbf{A}\mathbf{s}(t) + \mathbf{n}(t)$$

$$\mathbf{x}(t) = [x_1(t), \dots, x_N(t)]^T$$

$$\mathbf{A} = [a(\theta_1), \dots, a(\theta_I)]$$

$$\mathbf{s}(t) = [s_1(t), \dots, s_I(t)]^T$$

$$\mathbf{n}(t) = [n_1(t), \dots, n_N(t)]^T$$

Method

The proposed DOA estimation technique involve the following two steps:

Step 1: Use correlation method to obtain an initial and crude estimate of the DOA.

$$\rho_{ik} = \frac{E[s_i(t)s_k^*(t)]}{\sqrt{E[|s_i(t)|^2]E[|s_k(t)|^2]}}$$

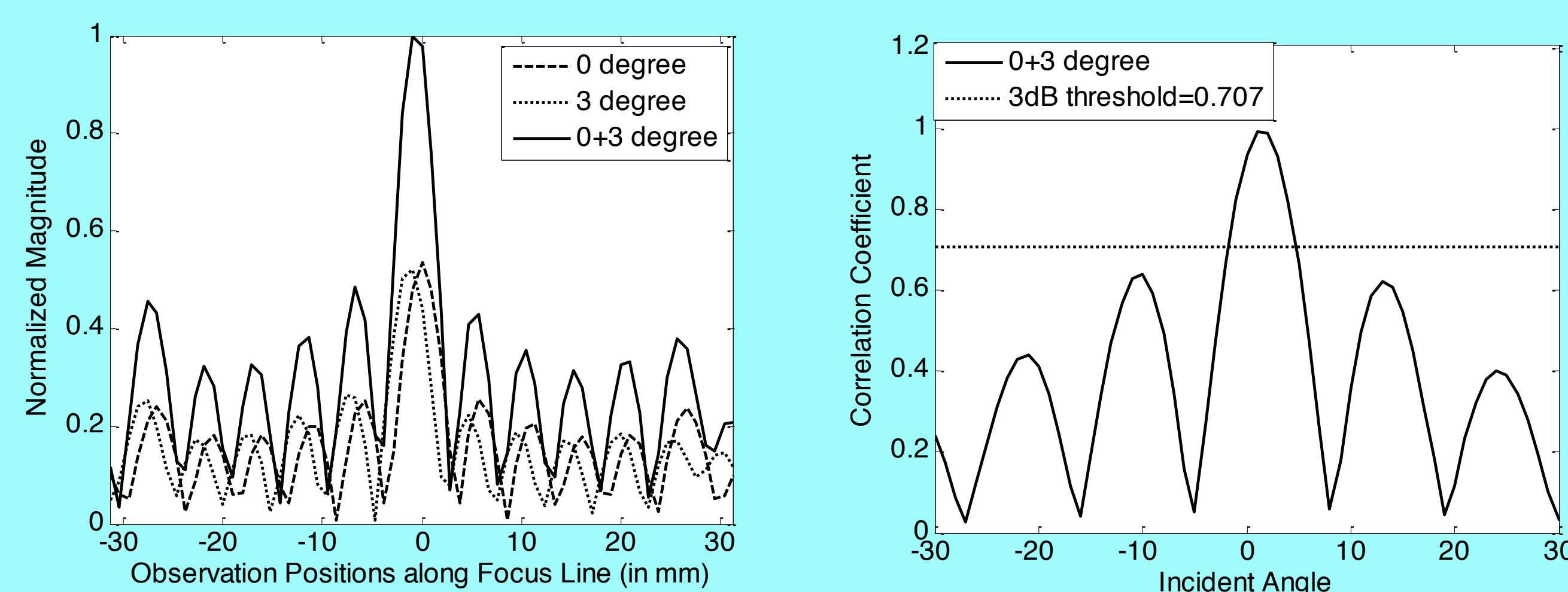
Step 2: Utilize Inverse Matrix method or the SVD method, depending on the SNR level to narrow the search range and improve the resolution.

$$R_{I \times I} = B_{I \times N}^{-1} S_{N \times I} \quad R_{I \times I} = C_{I \times M}^{-1} K_{M \times I}$$

Conclusions

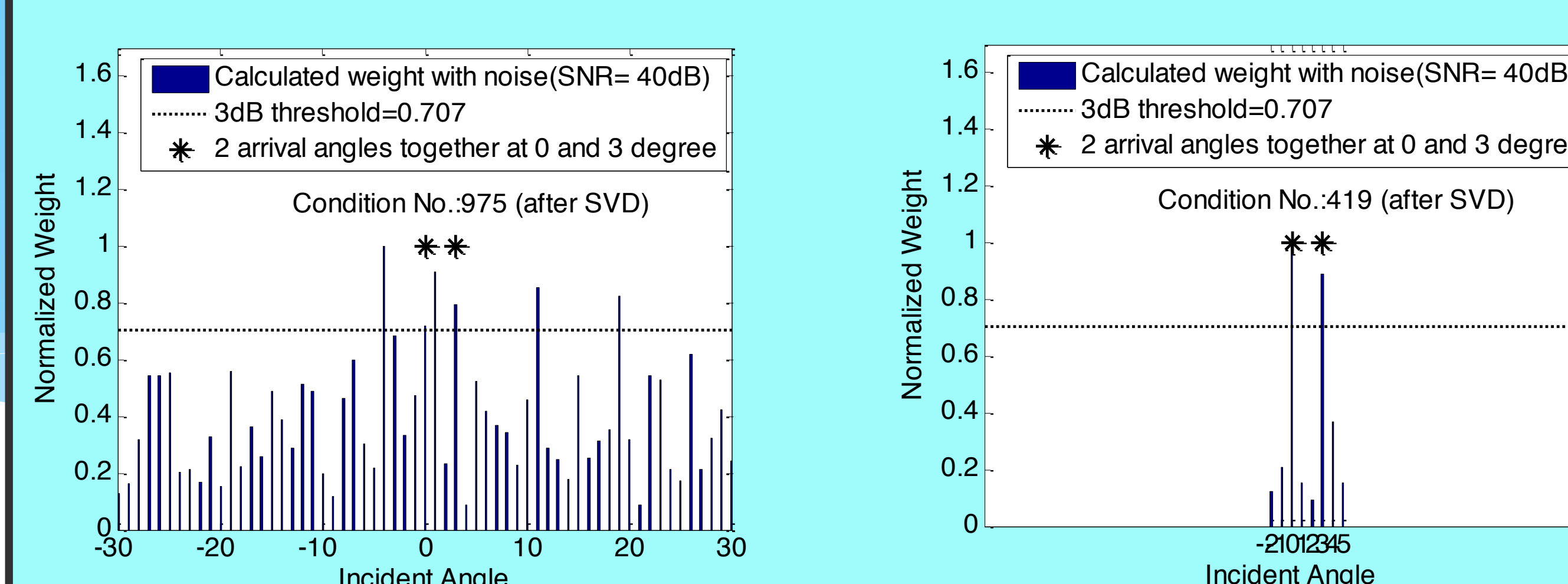
- Crude estimate of the DOA can be obtained by using correlation method.
- For the noise-free case, or if the SNR is low, we can use the Inverse Matrix method to find the incident angle of incoming signal.
- The SVD method is useful for dealing with ill-conditional matrices in practical situations.
- Improvement in that angle resolution obtained by using the proposed approach is far superior to those realized when using the correlation or other traditional schemes

Simulations (1)



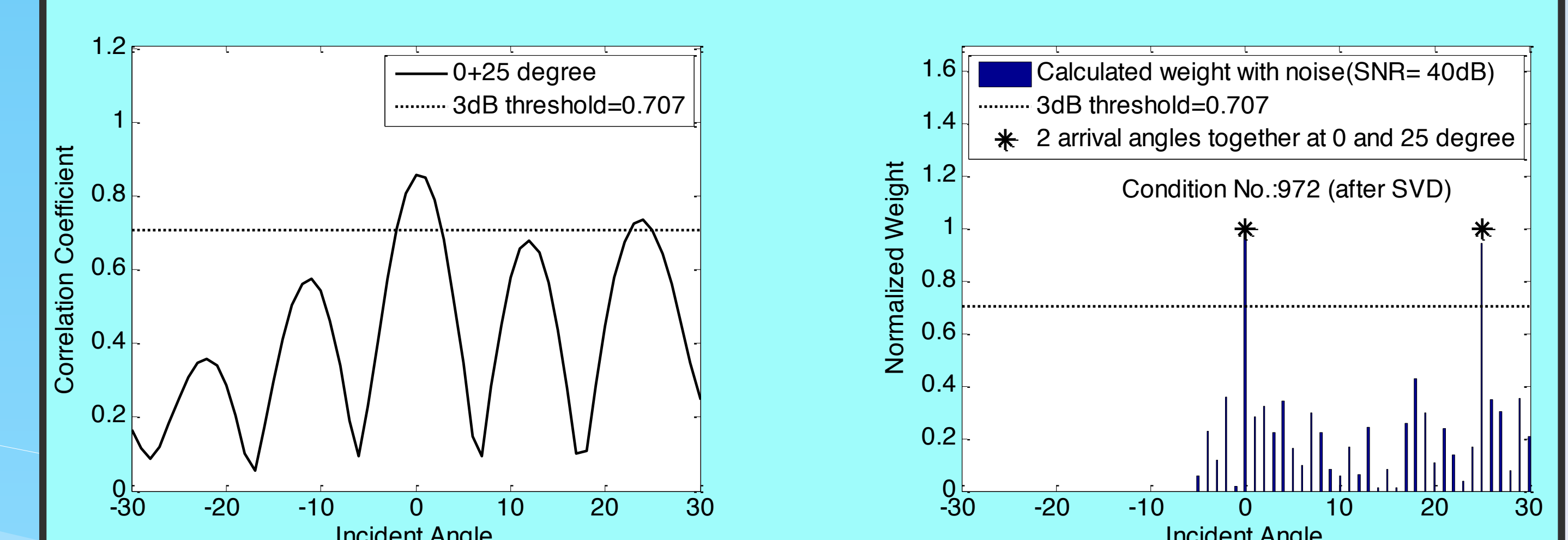
For the case of simultaneous incidence of two waves coming from 0° and 3° (a) normalized magnitude; and (b) correlation coefficient.

Simulations (2)



For the case of simultaneous incidence of two waves coming from 0° and 3° (a) DOA results obtained by using the entire range; and (b) fine search DOA results (normalized) using the proposed algorithm.

Simulations (3)



For the case of simultaneous incidence of two waves coming from 0° and 25° (a) correlation coefficient; and (b) fine search DOA results (normalized) using the proposed algorithm.