# Performance Evaluation of Single Snap Shot DoA Method

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The direction of arrival is the essential issue in many applications like radar, sonar, and seismology, etc.[1]. The super resolution algorithms have been proposed as an alternative for conventional algorithms to overcome the limits on resolution[2]. One of these method is the multiple signal classification which abbreviated by (MUSIC). The idea behind the MUSIC algorithm is the decomposition of the correlation matrix using Eigen-decomposition technique to extract signal and noise space[3]. The noise subspace is orthogonal to the steering vectors[4]. However, it needs many symbols to achieve the results that in return need more processing time.Therefore, a fast algorithm is desired especially with applications that need real time processing. The first sighted method to perform single snap shot is done by Zhang et al in 1991[1]. Then followed by Ren in 1997[2], and other more can be found in [5-7]. In this paper, a modified algorithm for coarse beamforming method mentioned in Kim work [4] was proposed and exploited. The coarse method characterized by its simplicity and ease of implementation in software as in following. Consider L coherent sources impinging a uniform linear array with N identical sensorsspaced by λ/2.At certain time *t* (a snap shot) the array output is represented as:

$$\boldsymbol{x}(t) = \boldsymbol{A}(\theta)\boldsymbol{s}(t) + \boldsymbol{n}(t) = [x_1(t), x_2(t), \dots \dots, x_N(t)]^T$$

Where $\boldsymbol{A}(\theta)$ is the steering vectors matrix, $\boldsymbol{s}(t)$ is the signal vector and $\boldsymbol{n}(t)$ is the noise vector associated with each element.The idea in this method is to generate a pseudo-covariance matrix $\boldsymbol{X}(t)$given by:

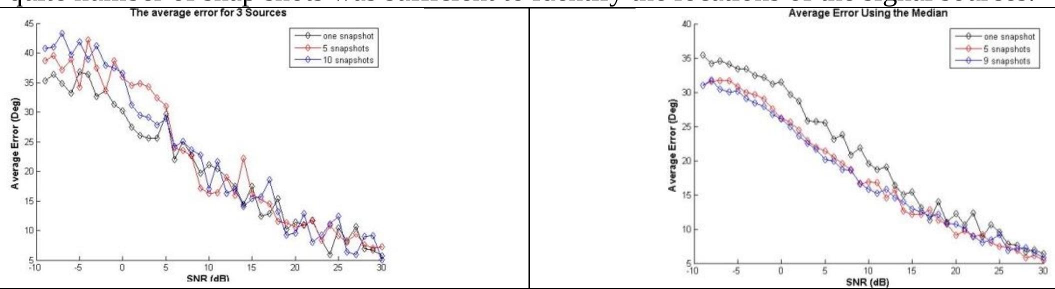
$$\boldsymbol{X}(t) = \begin{bmatrix} x_1(t) & x_2(t) & \cdots & x_M(t) \\ x_2(t) & x_3(t) & \cdots & x_{M+1}(t) \\ \vdots & \vdots & \ddots & \vdots \\ x_M(t) & x_{M+1}(t) & \cdots & x_N(t) \end{bmatrix}$$ where M=(N+1)/2.

Then, for a certain desired direction ($\theta_s$)the steering vector a($\theta_s$) transposed into:

$$\boldsymbol{S}(t) = \begin{bmatrix} a_1(t) & a_2(t) & \cdots & a_M(t) \\ a_2(t) & a_3(t) & \cdots & a_{M+1}(t) \\ \vdots & \vdots & \ddots & \vdots \\ a_M(t) & a_{M+1}(t) & \cdots & a_N(t) \end{bmatrix}$$

Including the desired signal the received signal *X(k)*will also include several interferences signals, in addition to the receiver noise. Therefore, the difference between the desired signal based on its direction and the received one results only thermal noise, this can be expressed by:$[X(k) - \alpha S(\theta_s)][v] = [0]$, and then reduced to $X(k)v = \alpha S(\theta_s)v$.

This could be considered as an eigen value problem for which the decomposition of *X(k)*can compute eigen vector v. The performance of the proposed method was illustrated into Figure 1, in which one snap shot is considered to compute the AoA, then either average or median are used. It can be concluded that the average error over quite number of snap shots was sufficient to identify the locations of the signal sources.




(a) (b)

Figure 1: Performnace of the propoesd method average errors versus SNR; (a) Using average , (b) Using Median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