iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VIII **Month of publication:** August 2020

DOI: https://doi.org/10.22214/ijraset.2020.31274

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

Estimation of DOA Algorithm for Linear Arrays

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Abstract: ***This paper presents Estimation of Direction of arrival (DOA) for eight elements linear array antenna. Different algorithms are used to estimate DOA i.e. convectional methods which are, Minimum Variance Distortionless Response (MVDR) and the subspace method i.e Multiple Signal Classification (MUSIC) and the comparison is done between them for SNR, snapshot, and resolution. The DOA algorithm is carried out by using 1×8 linear array antenna. These algorithm are analysed and stimulated for varying inputs parameters like Signal-to-Noise Ratio, and varying the angular separation between the sources for 8 elements linear array elements. The comparative study of different algorithm is carried out such as MVDR and Music.***
Keywords: Angle of arrival, Bartlett, Resolution, (MVDR), Linear Array, MUSIC, Signal to Noise ratio, Linear Array

I. INTRODUCTION

Smart antenna are used for wireless communication using steering beam by computing the angle of arrival of incoming signals viz; desired signal towards user direction, nulls towards interfering signals and multipath signals, which is obtained from very large antenna. Smart antenna process the incoming signal via angle of arrival for the desired signal and used to generate the interference caused by simultaneous users [1]. In uniform linear array (ULA) the array elements are equally spaced along the axis with the spacing element d=0.5 and the DOA is obtained using different algorithm such as Minimum Variance Distortionless Response(MVDR) and subspace method i.e. Multiple Signal Classification (MUSIC) algorithms for various parameters like SNR and angular. separation between the sources[2].The DOA algorithm namely MVDR and MUSIC ,ESPIRT which are explained in Constantine A. Balanis [3], L.C.Godara[4].These authors have described about the use of the antenna array to provide the sufficient efficiency for the wireless communication and to provide feasibility of array antenna for mobile communication .[5] gives the information about the linear array antenna for 8 elements which is been compared between the Linear Predication and MUSIC for different SNR values. The DOA is compared for various parameters like Searching

Algorithm, resolution and Mean square error. This paper gives the information about the DOA algorithm by

Varying SNR, angular separation between the sources and snapshots for 8 elements Linear array antenna. The DOA is estimated using methods such as MVDR and MUSIC for the pseudo spectrum and is simulated in MATLAB for various SNR, resolution and snapshot. The comparison is done between the MVDR and MUSIC to get better resolution.

II. INPUT DATA MODEL

The input data model D signals arriving from D directions. These incoming signals received by an array antenna which consists of M elements with *M* potential weights. Each received signal (*t*) is associated with AWGN. Time is represented by *Kth* time sample. Thus, the output of the array y(t) will be given in the following form:

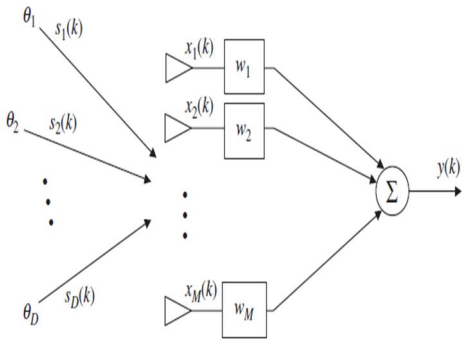

Figure 1: Input Data model for M array element with D sources

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$$y(t) = w^T x_m(t) \quad (1)$$

$$x(t) = \sum_{i=1}^{D} a(\theta_i, \emptyset_D)\, s_i(t) + n(t) \quad (2)$$

Where (t) input signal and $w^{t.}$ is the array weight given by

$$(t) = [(\theta_{i,}) \dots \dots \dots (\theta_D, \phi_D)][s_i(k)] + n(k) \quad (3)$$

$s_i(k)$ = vector of the incident complex monochromatic signals at time K
n(k)= noise vector at each array element m, zero mean, variance σ2
$a(\theta_{i,}\phi_i)$ = M-element array steering vector for the $\theta_{i,}$ direction of arrival.

III. ESTIMATION DIRECTION OF ARRIVAL

The signal is received at the array antenna from the localization of sources is been radiated. Here the angle is obtained from the sensors according to which the array antenna is steered towards the desired users and nulls towards interferer and the objective is to obtain angle of arrival from where the user is transmitting.
The DOA is estimated using following algorithm which is divided into two groups: the conventional algorithm and the subspace algorithm.

A. DOA Estimation for Conventional Methods

1) *MVDR Algorithm:* The MVDR algorithm measures the signal received at an array elements and computes the angle in all desired directions . In this algorithm the constrained is considered that is gain in the desired direction remains unity. The weighting vector we obtain by [5].

$$W=\frac{R^{-1}S_\theta}{S_\theta^H R^{-1} S_\theta} \quad (4)$$

which gives MVDR power spectrum [5]

$$(\theta)=\frac{1}{S_\theta^H R^{-1} S_\theta} \quad (5)$$

B. Subspace Approach for DOA Estimation

The Subspace methods depends on the of the correlation matrix R (R_{xx}). The Subspace method is divided into the signal subspace and the noise subspace and .The array vectors are obtained from the incoming sources which are orthogonal to the noise signal . The signals is used to retrieve harmonics under the mean square constraint. The minimum -norm method introduced by S.S Reddi provides the power basis instead of eigen decomposition. This method is applicable for uniform linear array. The noise signal is associated with the smaller eigenvalues of the correlation matrix, and the larger eigen values is obtained for incoming signal.

1) *Music Algorithm:* The multiple signal classification (MUSIC) method is relatively simple and efficient Eigen structure variant of DOA estimation methods. MUSIC estimates the number of sources, the angles of arrival, and spectral analysis of the waveform . MUSIC makes the assumption that the noise in each channel is uncorrelated and assumes noise correlates along the diagonal matrix .The incident signal will correlates with nondiagonal signal correlation matrix. The high gain and the directivity can be obtained even when the sources are placed closed to each other.

MUSIC algorithm is computed by following equation Inside the algorithm, general array manifold vector is defined to be the set

$$\Lambda = \{(\psi_i): \psi_i \epsilon \Theta\} \quad (6)$$

The subspaces is achieved by Eigen decomposition of the auto covariance matrix of the received data R_{xx}.

$$R_{xx} = \sum_{n=1}^{N} \lambda_n e_n e_n^H = E\Lambda = E_s \Lambda_s E_s^H + E_n \Lambda_n E_n^H \quad (7)$$

$$R_{xx} = E_s \Lambda_s E_s^H + \sigma_n^2 E_n E_n^H \quad (8)$$

The Eigen vectors E=[E_s,E_n] can be assumed to form an orthonormal basis ,where E_s is the signal subspace and $E_n$is the noise subspaces. Once the subspaces are determined the DOA of the desired signals can be estimated by calculating the MUSIC spatial spectrum with (Ψ) is the array steering vector with (Ψ) is the complex conjugate of steering vector.

$$(\Psi)=\frac{v^H(\varphi)V(\varphi)}{V^H(\varphi)E_N E_N^H V(\varphi)} \quad (9)$$

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IV. SIMULATION RESULTS and DISCUSSIONS

The algorithms such as MVDR and MUSIC with their pseudo spectrum equations are analysed and simulated in MATLAB for eight elements linear array by varying input parameters such as SNR and angular separation between the sources. Thus the resolution of MVDR and MUSIC algorithm at a given value of SNR is determined and comparison is done between them.

A. MVDR Method

The simulation of MVDR algorithm for eight elements Linear array is shown in the figure2 and figure3 gives the varying SNR ,resolution and snapshots of MVDR algorithm where the DOA angles considered to be [-30 30] .The SNR values is varied from -60dB to 15dB insteps of 15 dB . It is observed that the algorithm imparts better performance at higher SNR values . The figure 5 gives the resolution profile of MVDR algorithm for a given SNR of 0dB . It is found that the algorithm is able to resolve for 9°.

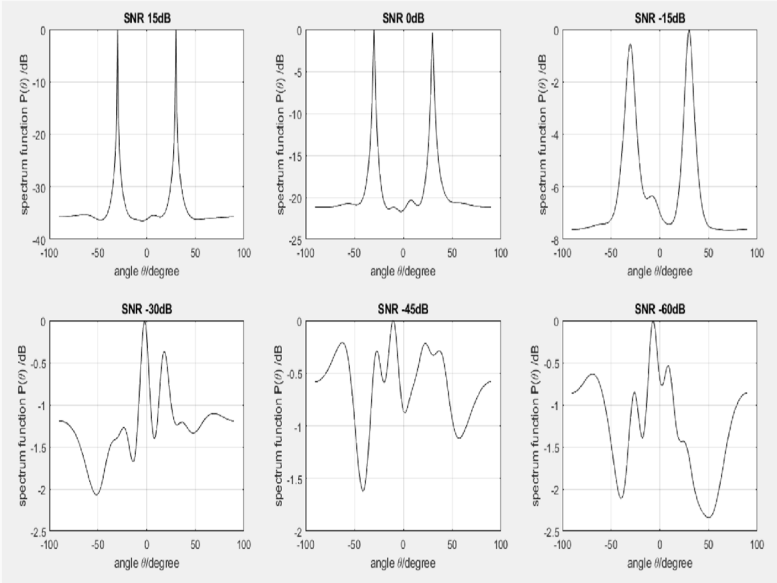

Figure 2: MVDR pseudospectrum with varying SNR value -60 to 15db

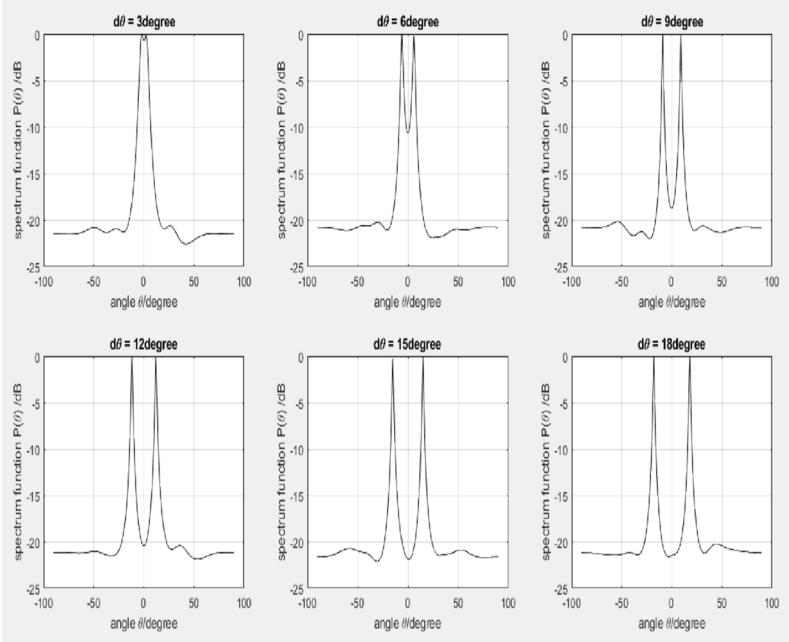

Figure 3: MVDR pseudospectrum with varying resolution

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B. MUSIC Method

The simulation of MUSIC algorithm for 8 element Linear array is shown figure 5 and figure 6. Figure 5 gives the varying SNR profile of MUSIC algorithm where the DOA angles considered to be [-30 30] .The SNR values is varied from -15dB to -30dB insteps of 15dB . It is observed that the algorithm performance at lower SNR values . The figure 6 gives the resolution profile of MUSIC algorithm for a given SNR of 0dB . It is found that the algorithm is able to resolve for 6deg .

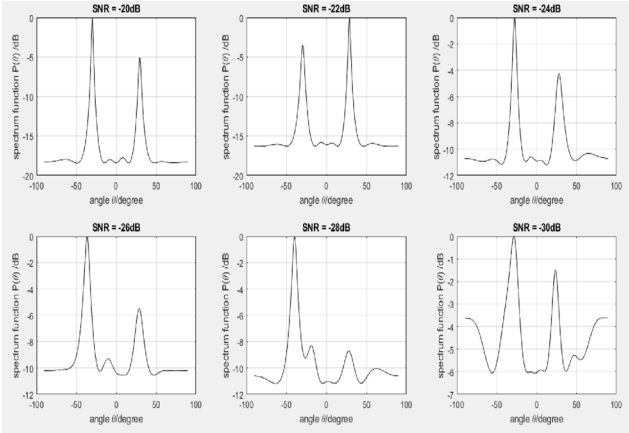

Figure 4: MUSIC pseudospectrum with varying SNR of MUSIC algorithm for 8 element Linear array antenna at SNR value -15 to -30dB.

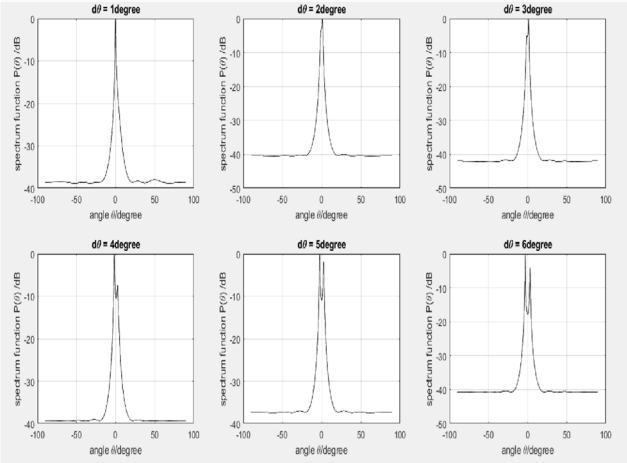

Figure 5: Resolution of MUSIC algorithm is resolved at 6deg.

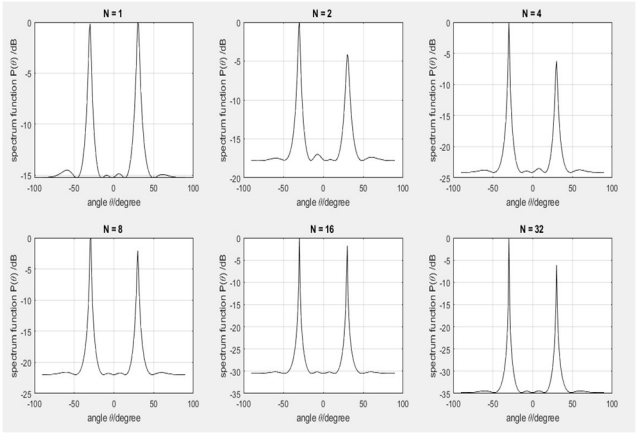

Figure 6: MUSIC pseudospectrum with varying snapshots

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V. CONCLUSION

The main objective of this paper is to analyze the different DOA algorithm using MVDR and MUSIC and to study their performances based on varying Snapshots,SNR and angular resolution for eight element Linear array. The simulation results shows that performances of DOA algorithm improves with increasing the SNR values. As for the conventional DOA methods are considered MVDR algorithm performs better as it exhibits resolution of 9deg at the given SNR -15dB. And the analysis is continued with the subspace method i.e. MUSIC algorithm resolution is achieved by 6deg at the given SNR of -30dB. When two algorithm are compared the Music algorithm performs better with lower SNR values and it is more accurate, gives better resolution than MVDR method .

REFERENCES

[1] Carl B.Dietrich, Jr., Warren L.Stutzman, “Smart Antenna in wireless Communication: 13ase-Station Diversity and Handset Beamforming”, IEEE Antenna and propagation magazine,vol.42,Issue5, 2000,Page(s):142-151.
[2] A.Ibrahim., M.Y.Alias , “Joint adaptive modulation adaptive beamforming for mobile communication”, Proceedings of the 2007 IEEE International Conference on Communications,May2007,Penang,Malaysis ,page(s) 254-259.
[3] Constantine A. Balanis, “Introducing to Smart Antenna theory ”, Wiley publication .first edition ,2007,ISBN:1598291769.
[4] Lal Chand Godara, “ Smart Antenna”, CRC press publication ,2004 .
[5] Frank Gross, “Smart Antennas for Wireless Communications with MATLAB”, McGraw-H publications, 2005, ISBN.

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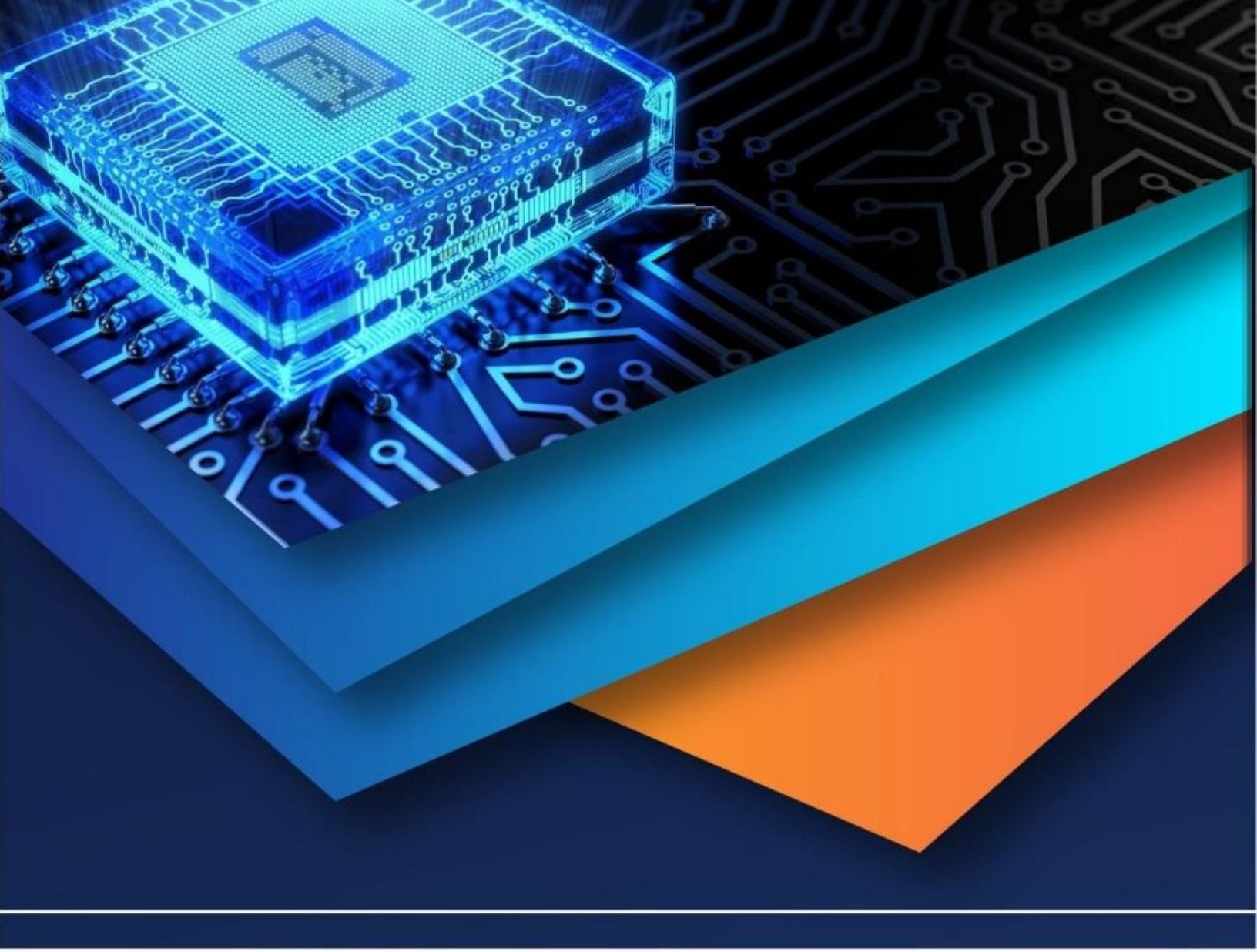

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