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Comparative study between Direction of arrival for wide band & narrow band Signal using Music Algorithm

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ABSTRACT

Direction of arrival is a key parameter in array signal processing. It is one of the important problems in field such as sonar, radar, and wireless communication. Traditional DOA estimation algorithm consists of large no of snapshot and are not reliable in application such as underwater array processing. There are many sources such as seismic wave, acoustic signals, speech and signal processing which is wide band signal and estimation parameters such as snapshot, side lobes, resolution is an important task. In the recent advancement of technology wide band signal are more favoured over narrow band signals. Wide band signal are able to estimate DoAs efficiently with less side lobes and snapshots. In this paper a comparative analysis of direction of arrival for wide band and narrow band by analysing angular spectrum of MUSIC algorithm. We will estimate the position of spectral with different scanning grid size. We will search the spectral peak position and estimates final DOA Therefore it become important to study and analyzed wide band signal specially application such as 5G m-MIMO systems.

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1. INTRODUCTION

Direction of arrivals (DOAs) is an important problem in different field such as sonar, radar, Bio-medicine signal processing and array signal processing [1-5].The angle of arrival of received signal by an antenna array is estimated by DoAs.There are different sorts of algorithm proposed in last four decades such as beam forming techniques," Delay and Sum method , Barlett method,Capon-Beam former, Linear prediction,Maximum Entropy,Minimum Norm, Propagator method, Partial covariance matrix, Estimation method of signal parameter by rotational invariance method(ESPRIT), Multiple signal classification(MUSIC) algorithm ."[6-7]. Although several algorithms are proposed under some assumption such as number of snapshots, signal to noise ratio is high and signal source is un-corelated. Bartlett, Capon and ESPRIT direction finding algorithms have been compared in worst-case scenarios.

A lot of research has been taken place in last 20-30 years in narrowband signal for estimating Direction of Arrivals, but it requires a large snapshot also resolution requirement is more in ESPRIT and MUSICs algorithm are only apply to narrow band sources. Furthermore, wideband signal which are widely used in information system especially application such as 5G m MIMO systems. Hence among different direction of arrival algorithm proposed earlier MUSIC are widely used as it provides super resolution and better accuracies [8]. Although this algorithm has high complexity in case of narrow band signal. In this paper a comparative study between DOAs estimation algorithm for narrow band and wide band using MUSIC algorithm restricted to one- dimensional stationary case is provided.

The outline of this paper is arranged as follows. In part 2 the signal model is described here the problem is formulated in case of narrow band and wide band source; we review the MUSIC algorithm in part 3. The simulation results and their analysis are presented in part 4. Finally, conclusion is presented in part 5.

2 SIGNAL MODEL

Consider an array of elements receiving N Sources such that every element of the array includes zero suggest Gaussian noise, d is the distance between sensor , θ is the angle elevated

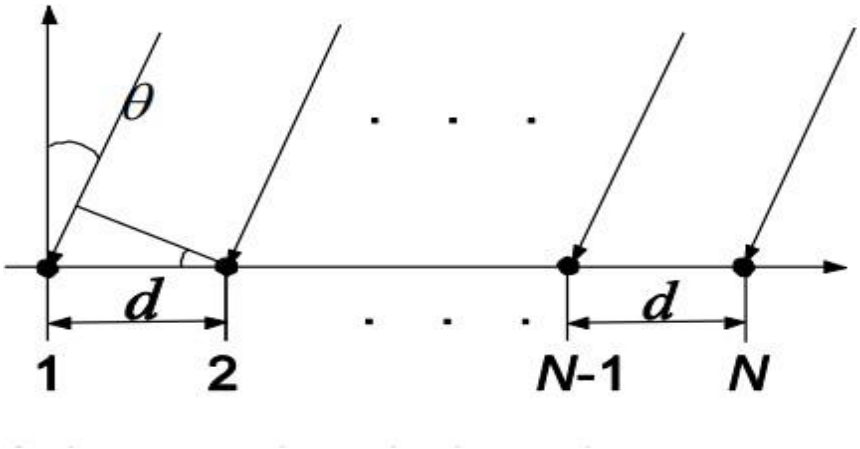

Figure 1. Uniform linear array

The signal is steering in different time and determine by solving below equation

$$S(t)=Re\{S_l(t)\, e^{j2\pi f_c t}\} \quad (1)$$

where S_l is a narrow band signal with Direction of arrival to be estimated i.e Bandwidth << fc. where fc is frequency of carrier

$$\Delta t_k = k d \sin\theta / c \quad (2)$$

Here d is the distance between the antenna elements. For proper estimations distance d should be consider greater than λ/2 metre. The signal receiving by kth antennae element is given as:

$$x_k(t)= Re\{S_l(t-\Delta t_k)\, e^{j2\pi f_c(t-\Delta tk}\} \quad (3)$$

The symbol period of signal received is defined as:

$$x_k(nt)= S_l(nt-\Delta t_k)\, e^{j2\pi f_c \Delta tk} \quad (4)$$

If we consider Bandwidth >> fc then this signal is called wide band signal [16]

3 DOA ALGORITHMS

3.1 MUSIC Algorithm

It has become a Key algorithm for theoretical system of spatial spectrum. For spatial spectrum estimation, Multiple Signal Classification (MUSIC) algorithm has created new era. The idea behind of MUSIC algorithm is to lead characteristic decomposition for the covariance matrix of any array output data, which result in a signal sub-space orthogonal with a noise sub-space alike to the signal component [9-11] To constitute a spectrum function these two orthogonal sub-spaces are used. The multiple signal classification procedure is defined, and it can be executed as an algorithm to give estimates number of signals, DoA, strength & cross-co-relation, strength of noise and interference [12-15].

Let a(θ) be steering vector corresponding to one of the incoming signals, then a(θ) will have no pt. be precisely orthogonal to the noise sub-space because of errors in estimating Q_n.

However, the function

$$P_{Music} = \frac{1}{aH(\theta)\mathbf{Q}n\ \mathbf{Q}nH\ a(\theta)} \quad (5)$$

Equation (5) implies a very large value when θ is equal to the DoA related to one of the signals. The PMusic function is known as a pseudo "spectrum" provide the DoA estimates [16- 18].

Procedure for MUSIC algorithm

1. Finding R autocorrelation matrix.
2. Eigen-decomposition.
3. Calculation of Eign vector.
4. Scan Angle at different value angle of arrival.
5. Find final DOAs peaks.

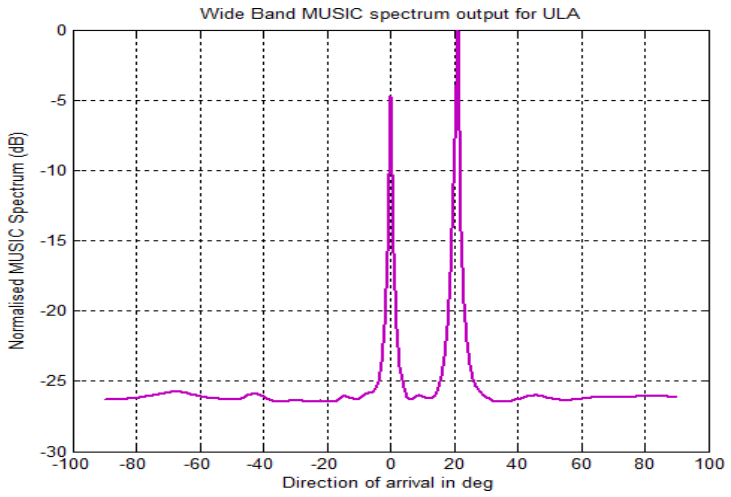

Figure 2: Angular spectrum in case of narrowband signal

4 SIMULATION RESULTS

The performance of MUSIC algorithm can be seen with the help of angular spectrum at different angular grid. In this section simulation result of narrow band and wide band signal shown in fig 2 and fig 3 respectively with the help of MATLAB. We investigate performance of MUSICs algorithm by placing two targets at 0° and 20°. Here we assume noise is Gaussian having mean zero and SNR is 12 db.

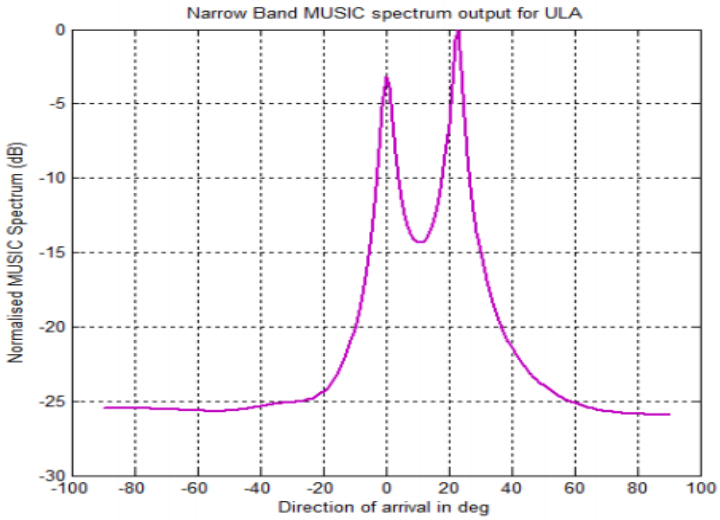

Figure 3: Angular spectrum in case of wide band signal

5. CONCLUSION

Compared to previous traditional algorithm such as ESPRIT, Pisarenko harmonic decomposition, delay and sum method, capon beam former angular spectrum of MUSIC spectrum have less side lobe. We also observed that in uniform linear array of antenna when SNR=12 db in case of narrow band resolution of signal is low with respect to wideband signal. Wide band signals perform superior resolution and having less side lobe and better accuracy.

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