Advanced Science and Technology Letters
Vol.98 (CES-CUBE 2015), pp.38-41
http://dx.doi.org/10.14257/astl.2015.98.10

High Resolution Signal Estimation Using MVDR-MUSIC Combination Algorithm

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Abstract. Adaptive array system is to search for desired signal in multipath channels. Adaptive array system is correctly estimation for desired signal to remove noise and interference through optimum weight. Adatpive array system is to signla receive or transmission for specific driection using array antennas. Compared with the proposed method for arrays of element geometry, this proposed method can be easily implemented. It does not increase the computation al complexity of MUSIC algorithm and adaptive beamforming. It allow us to work on a data domain, and thus enables us to incorporate the recently developed weight algorithm to DOA estimation and updating and enables us to implement MVDR beamforming algorithm using array antennas. When there are several targets and the angular separation between two targets less than the beam width, traditional direction estimation algorithms fail to get the target directions correctly. High resolution direction of arrival estimation algorithm such as MUSIC can be used to overcome this problem in narrowband systems.

Keywords: DOA, Array antenna, MUSIC algorithm, MVDR

1 Introduction

In many applications of adaptive array antennas, this field has been researched radar, sonar, communication and biomedical engineering. A highly directive antenna beam can be used to advantage[1]. The direction beam can be realized by forming an array with a number of elements radiators. Much of the work in array processing has focused on methods for high resolution direction of arrival(DOA) estimation and optimum adaptive beamforming. These methods include the well-known MUSIC, ESPRIT, algorithm for DOA estimation and MVDR and LCMV algorithm for beamforming[2]. However, an important drawback of these techniques is the severe degradation of the estimation accuracy in DOA estimation or signal cancellation in adaptive beamforming in the presence of highly correlated or coherent signals[3].

In this paper, we studied about estimation of desired signal and high beamforming high resolution direction of arrival estimation algorithms.

ISSN: 2287-1233 ASTL

2 Estimation method

We consider uniform linear array with M array element sensors space by the distance d and K narrow band sources signal in far field impinge array. The received signal at the $m-th$ array sensor at time is given by[4-5]

$$\mathrm{X} = s(t) + n(t) \tag{1}$$

Where $\mathrm{X} = [x_1(t), x_2(t), \cdots x_M(t)]$ is the signal vector on array antennas. $s(\mathrm{t})$ is signal steering, n(t) is noise signal. The output of a narrowband beamformer is given by

$$\mathrm{Y} = \mathrm{W}^H X(t) \tag{2}$$

Here $\mathrm{W}=[\mathrm{w}_1, \mathrm{w}_2, \cdots, \mathrm{w}_M]^T$ is the complex vector of beamformer weights, and $(\ )^T$ And $(\ )^H$ are the transpose and hermitian transpose, respectively. The signal to noise ratio has the following

$$\mathrm{SNR} = \frac{W^H R_S W}{W^H R_N W} \tag{3}$$

Where $\mathrm{R}_s = E[s(t)s^H(t)\ ]$, $\mathrm{R}_N = E[n(t)n^H(t)\ ]$, R_s is signal covariance matrices and R_N is nose covariance matrices. E[ ] is expected value. To finding the maximum of Eq(4) is equivalent to the following optimization problem as follow

$$\min_W W^H R_N W \qquad \text{subject to} \qquad W^H a = 1 \tag{4}$$

Minimum variance distortionless response beamformer(MVDR) can be written as follow

$$W_{MV} = \frac{R_N^{-1} a}{a^H R_N^{-1} a} \tag{5}$$

MUSIC algorithm is divided into signal subspace(E_s) and noise subspace(E_N) using eigen decomposition and eigen value. MUSIC spectrum is as follow

$$P_{MVMU} = \frac{a(\theta)^H W_{MV} W_{MV}^H a(\theta)}{a(\theta)^H W_{MV} E_N W_{MV}^H E_N^H a(\theta)} \tag{6}$$

3 Simulation

We used array antenna 9 elements separated by half wavelength, signal to noise ratio is 20dB, snapshots is in 100 numbers, zero mean narrowband Gaussian distributed and uncorrelated sources impinge on the array from far field with distinct. DOA. We estimated in the number of source to 4 which locate at [-10^o ,-5^o ,0^o , 5^o]. Fig. 1 is showed about 3 direction of arrival among [-10^o ,-5^o ,0^o , 5^o]. It was estimation for desired signal of 3 numbers in [-10^o ,x ,0^o , 5^o], It was not correctly estimation about the 4 signals. Fig. 2 is showed estimation direction of arrival with proposed algorithm in this paper at [-10^o ,-5^o ,0^o , 5^o]. Fig 2 is correctly estimation direction of arrival of 4 number signals in [-10^o ,-5^o ,0^o , 5^o].

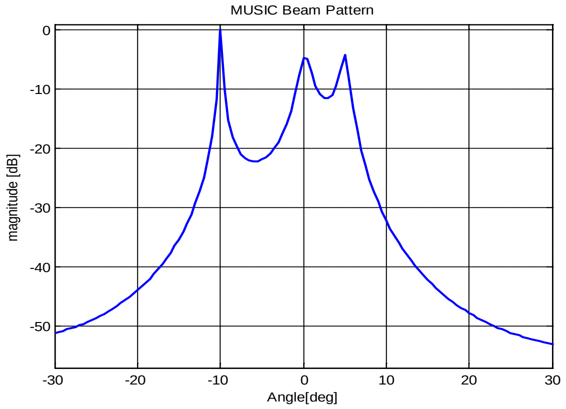

Fig. 1. Direction of arrival estimation of MUSIC Algorithm

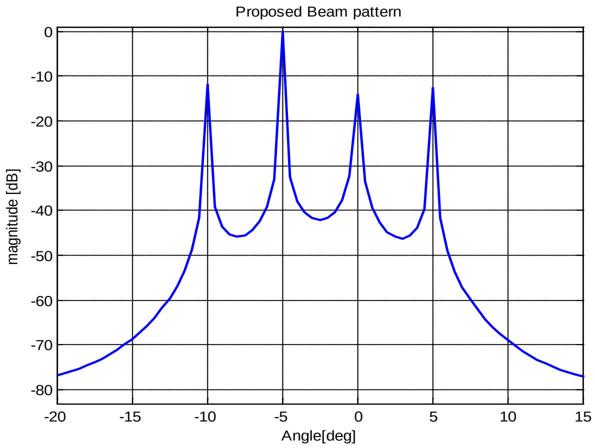

Fig. 2. Direction of arrival estimation of Proposed Algorithm

4 Conclusion

In this paper, we proposed high resolution algorithm in order to estimate desired signals. This algorithm is combination LCMV and MUSIC method. Estimation technique is high resolution processing algorithrm based on constant beamforming and weight vector. The high resolution beamforming method is not only improvement resolution angle of target but also estimation correctly for desired signals. We improved a enhance estimation for direction of arrival using renew weight algorithm. We proposed efficient estimation for desired signals using combination MUSIC algorithm. This paper is showed that proposal algorithm is good performance better than conventional algorithm in of arrival estimation

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