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MUSIC For OFDM By Using An Uniform Antenna Array With Two Elements

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Multicarrier communication (MC) has capability of high speed transmission, fading combating, simplixity of equalization leading to its widely application. Among many MC application, OFDM(Othorgonal Frequency Division Multiplex) is a very promising candidate. In addition, problem of DOA(Direction of Arrival) estimation using MUSIC algorithm is solved for point source and futher for sources with pertubation.This paper presents the application of MUSIC algorithm for DOA estimation for OFDM communication. The simulation results in AWGN channel are shown.

I. INTRODUCTION

MUSIC is short of Multiple Signal Classification proposed in [1].This is one of famous subspace based array processing to DOA estimation (Direction of Arrival) and even strength, polarization characteristic of the incoming signal. In MUSIC, for point source the autocovariance matrix of incoming signals on antenna array is considered. The rank of that matrix depends on number of array elements corresponding to number of independent uncorrelated inputs. In previous research of DOA determination, it is proved that MUSIC is the most efficiently compared to Maximum Likelihood Estimation [2], ESPRIT [3], and others having the ideas based on them. For OFDM signal, it consists of components having its amplitude independently and its frequency orthorgonality [4],[5],[6]. Especially, in OFDM all subcarriers are transmitted simultaneously in the channel so transmission speed is increased and there is a capability of application variety modulation scheme for individual subcarriers. In this paper, the problem of DOA estimation for OFDM using an uniform antenna array with two elements will be presented.

II. MUSIC ALGORITHM

MUSIC is short of multiple signal classification proposed in[1]. In this paper, the correlation matrix of output signal is given by

$$R_{xx} = E\left\{x\ x^H\right\} \qquad (1)$$

Therefore, the relation between incoming signal and output signal can be expressed as

$$R_{xx} = A\, R_{ss}\, A + \delta^2 I \qquad (2)$$

Consider the case when λ is eigen vector of Rxx then we define

$$\lambda = \{\lambda_0, \lambda_1, ... \lambda_{N-1}\} \qquad (3)$$

That eigen vector will be satisfied the determinant as follows

$$|R_{xx} - \lambda_i I| = 0 \qquad (4)$$

Substitute (6) into (8), it can be easy to see that the eigenvalue of $ARssA^H$ is

$$\nu = \{\nu_i | \nu_i = \lambda_i - \delta^2\} ....i = 0,1,....N-1 \qquad (5)$$

Because D is less than N then $ARssA^H$ will be positive semidefine with rank D. Thus N-D eigenvalue will be equal zero or N-D eigenvalue of Rss will be equal σ^2. So, minimum eigenvalue will be determined. Eigenvector associated with that eigenvalue names, q_i , will be solution of

$$(R_{xx} - \lambda_i I) q_i = 0..........i = 0,....N-1 \qquad (6)$$

We set

$$A = \{a(\theta_0), a(\theta_1), ...a(\theta_{D-1})\} \qquad (7)$$

$$V_n = \{q_i, i = D.....N-1\} \qquad (8)$$

$$A^H q_i = 0.........i = D,.........N-1 \qquad (9)$$

Then

The DOA, θ, is the extremes of power spectrum function

$$P(\theta) = \frac{1}{a^H(\theta) V_n V_n^H a(\theta)} \qquad (10)$$

III. MUSIC FOR OFDM

In general, MUSIC is an subspace based method they used geometric of vector space to separate signal space and noise space. The incoming signals in signal space projection on to the noise space corresponding to angle of arrivals from true sources. In proposed system consists of an uniform antenna array with two elements. The problem in case of OFDM communication is that calculation of the power spectrum in formula (10) with modified autocorrelation matrix of the incoming OFDM signal compared to conventional sinusoid point source.

IV. SIMULATION RESULTS

In our simulation, OFDM signal consists of 8 carriers with its subcarrier amplitudes and its subcarriers frequencies are given in the **Table 1**. To comparing we consider the point source is sinusoid with frequency of 900MHz and amplitude of 5mV and assume both signal with the same transmitted power, the SNR in both case also be equal to 20dB. The OFDM symbol duration is 8 μs so the required banwidth for OFDM signal is 1MHz that is enough compared to the carrier frequency. The MUSIC power spectrums for point source are nearly the same as that calculated for OFDM signal (**Figure 1** and **Figure 2**).

Qua	Carrier1	Carrier2	Carrier3	Carrier4	Carrier5	Carrier6	Carrier7	Carrier8
Amp	1mV	1mV	1mV	1mV	2mV	2mV	0.5mV	0.5mV
Freq	125kHz	250kHz	375kHz	500kHz	625kHz	750kHz	850kHz	1MHz

Table 1.

V. CONCLUTIONS

In this paper the MUSIC algorithm is verified for OFDM signal. The good thing of MUSIC is that it works well in OFDM transmission.

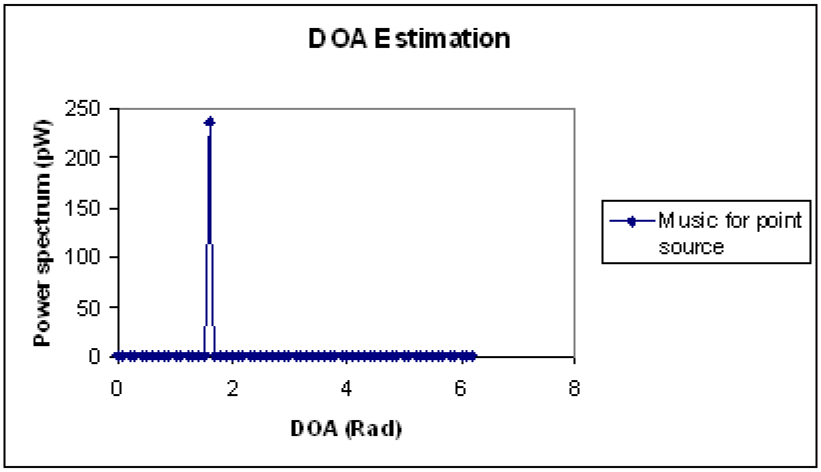

Figure 1: Power spectrum for point source at DOA of 1.6 rad

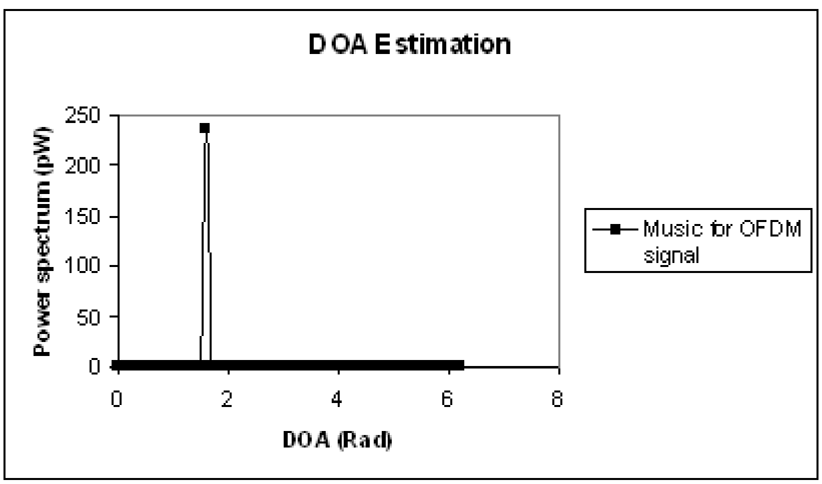

Figure 2: Power spectrum for OFDM signal at DOA of 1.6 rad

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