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DOA Estimation in Dynamic Environment using DMUSIC and DPM Algorithms

[1*]D. D. Khumane, [2]S.M. Jagade

[1]National Institute of Electronics & Information Technology, Aurangabad, India
[2]Dept. of Electronics and Telecommunication Engineering, S.T.B. College of Engineering, Tuljapur, India

[*]*Corresponding Author: dkhumane@gmail.com, smjagade@gmail.com*

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***Abstract*:** Smart antenna can be reducing multipath and co-channel interference. These benefits include the enhancement of coverage and the channel capacity, lower transmitted power, better signal quality, higher data rate and providing value-added services such as users position location (PL) for dynamic condition. This paper deals with the performance evaluation of Dynamic-MUSIC & Dynamic-PM algorithm for Direction of Arrival (DOA) estimation for smart antenna system using eigenvalue decomposition and without eigen decomposition based algorithms respectively. We focus on the dynamic environment of user i.e. user moves from his initial position to particular location. And by using DMUSIC & DPM estimate their correct position location (PL) to provide the services to the desired user using extended version of MUSIC & PM.

***Index Terms* –** direction-of-arrival (DOA), *Dynamic MUltiple SIgnal Classification (DMUSIC), Dynamic Propagator Method (DPM)*, Position Location (PL), Smart Antenna, Array Antenna.

I. INTRODUCTION

Wireless communication systems are limited in performance and capacity by three major impairments. Basically these impairments are Rayleigh fading, delay spread and co-channel interference. Rayleigh fading causes due to multipath reception. The mobile antenna receives large number reflected and scattered waves. Because of wave cancellation effects, the instantaneous received power seen by a moving antenna becomes a random variable, dependent on the location of the antenna. If the antenna position varies with constant speed, the received signals are with different phase, amplitude, direction and polarization as well as with time. Delay spread is the second impairment, is a measure of the multipath richness of a communication channels. It can be interpreted as the difference between the time of arrival of the earliest significant multipath component and the time arrival of the latest multipath components. The delay spread is mostly used in the characterization of wireless channels, but it also applies in optical fibers. When the delay spread exceeds about 10 percent of the symbol duration, significant inter symbol interference occur, which limits the maximum data rate [1]. Frequency spectrum is very limited resource, by using reuse concept we can extend its limit. But in cellular mobile communication there are many more challenging issues to face the same. By considering recapitulation, traffic theory, channel assignment strategies i.e. fixed and dynamic channel assignment we can somewhat minimize the co-channel interference, fig. 1

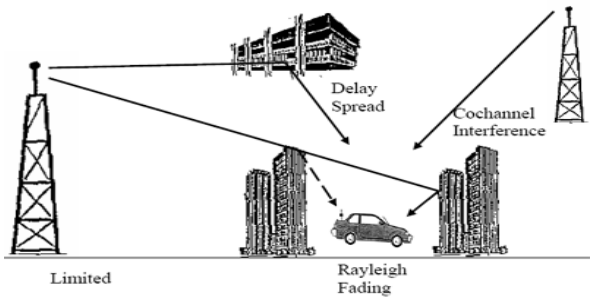

Fig. 1 Wireless system impairments

Apart from that impairments, position location (PL) finding of the desired used is major aspect. If the antenna elements are fixed and users are static in nature, accurate estimation of a Direction of Arrival of incoming signal is somewhat possible. In many commercial and different applications, it is important to find the position location of the desired user or to find the accurate possible direction of threat. Also it is helpful to dispatch the rescue team to the proper location. Instead of single antenna multiple antenna array can be helpful for finding the accurate location of desired user.

Basically many algorithms work on to find accurate position location (PL) of desired user i.e. MUSIC, ESPRIT & Propagator Method (PM) which includes spectral estimation, and eigen analysis. [2]–[3]. When the number of

incoming signal and received antenna arrays are more than computational complexity is more. The computational complexity of ESPRIT can be order of $O(M^2 + 2M^2N)$ multiplication in calculating the eigen decomposition for a covariance matrix with M-element array and N number of snapshots and the computational load of the PM is in O(2MNL), where L is the number of incident signals [3].

If the users are static in nature then PM algorithm is better than the MUSIC for multiple incoming signals' DOA analysis. As MUSIC algorithm estimate all DOA of incoming signal with deviation in its angle, magnitude of power spectrum of PM is better than MUSIC. [4]

In this paper, concentrate the study on the finding the position location of the desired user and extend the discussion, when the users are dynamic in nature. Extension of MUSIC i.e. Dynamic MUltiple SIgnal Classification (DMUSIC) & Dynamic Propagator Method (DPM), and analyze detailed MATLAB simulation results for these algorithms [7], [8], [9].

II. BASICS OF SMART ANTENNA SYSTEM FOR DOA ESTIMATION

Since most DOA estimation algorithm have reached a mature state, accurate estimation of the angle of arrival of signals impinging an array of antenna becomes the most important parameters regarding the performance of an adaptive array. Conventional methods, linear prediction methods, eigen structure methods and estimation of signal parameters via rotational invariance techniques etc. are the most powerful tool for DOA estimation. [5] All these methods are based on the digital beamforming antenna array. Incoming signals are received by the antenna elements and down converted to base band signal and fed into a digital signal processor chip where the algorithm can execute and processed on the incoming data, DOA is to be estimated. Till all this theories are analyzed for the static users i.e. users are fixed at their initial position (angle) and radiate the radiation pattern towards the antenna element. In this paper we focus on, if the users are moved from one position to another and find out the correct position location (PL) of the desired user. And for the same implement the extended version i.e. DMUSIC & DPM algorithm for correct DOA estimation in the dynamic environment.

Fig. 2 shows, the basic schematic for DOA estimation here we use 5 antenna array elements (M) and 5 incoming signals (L) and the antenna elements are arranged with 0.5 spacing for better result.

It also consists of radio unit for converting the signal in to base band signal. Then they are digitized and fed into a digital signal processor (DSP) chip. At that point the DOA estimation algorithms i.e. DMUSIC & DPM are executed.

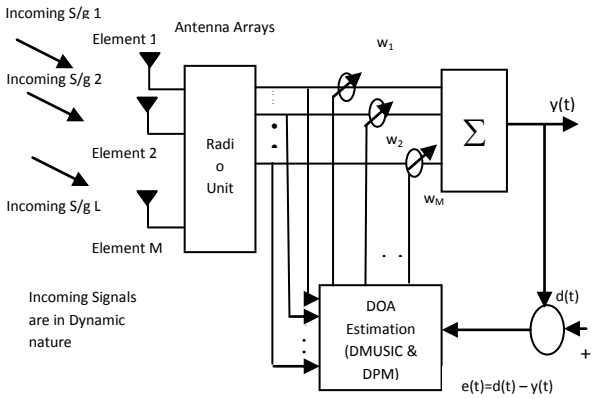

Fig. 2 Model for DOA Estimation

In this paper we compare performance analysis of DMUSIC & DPM algorithms. Here basically DMUSIC algorithm is based on eigen value decomposition and DPM is without any eigen decomposition, for DOA estimation. Here uniform linear array (ULA) pattern is utilized for DMUSIC and for DPM uses one L-shape array configuration which uses the x-z plane. [3]-[6]

As per reciprocity theory for radiation patterns, the received signals can be models as with reference to the data model equation, the DPM the signal vector are received at the X and Z subarray and the received vectors are. [3]

$$X(t) = A_x(\theta)s_x(t) + n_x(t) \quad (1)$$

$$Z(t) = A_Z(\theta)s_Z(t) + n_Z(t) \quad (2)$$

As per reciprocity theory for radiation patterns, received signals can be models as with reference to the data model equation,

$$x(t) = A(\theta)s(t) + n(t) \quad (3)$$

$A(\theta)$, $s(t)$ and $n(t)$ are steering vector, incident waves in azimuth plane and additive white Gaussian noise respectively.

$$x(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \\ . \\ . \\ x_k(t) \\ . \\ . \\ x_M(t) \end{bmatrix} = \begin{bmatrix} 1 \\ . \\ . \\ e^{-j2\pi/\lambda(k-1)d\sin\theta} \\ . \\ . \\ e^{-j2\pi/\lambda(M-1)d\sin\theta} \end{bmatrix} * \begin{bmatrix} s_1(t) \\ . \\ . \\ s_k(t) \\ . \\ . \\ s_M(t) \end{bmatrix} + \begin{bmatrix} n_1(t) \\ . \\ . \\ n_k(t) \\ . \\ . \\ n_M(t) \end{bmatrix} \quad (4)$$

Then the signal correlation matrix at the antenna output is R_{xx}

$$R_{XX} = XX^H \quad (5)$$

Where 'X' is the data matrix, H denotes Hermitian Transpose.

The eigen structure method DMUSIC and without eigen decomposition DPM algorithm is implement for finding desired user location i.e. PL for dynamic environment.

III. SIMULATION RESULTS

Computer Simulation have been conducted to evaluate the DOA estimation for the dynamic environment using the DMUSIC and DPM. Number of antenna array element and the incoming signals are 5, the array spacing 'd' is taken half of the wavelength i.e. 0.5. The number of snapshots N=100, and the wave number 'k' is 180. We can evaluate the performance of DMUSIC & DPM algorithm to estimate the DOA of incoming signals.

For algorithms, the basic assumptions/constant and conditions are the same. The real directions for the incoming signal are 25, 80, 130 and 155 degrees and one user is in dynamic condition, whose movement is starts at an angle of 60^0 and end at 89.99^0 with the interval 0.30, and the real directions are estimated up to 100 samples, for 5 users this is shows in Fig. 3.

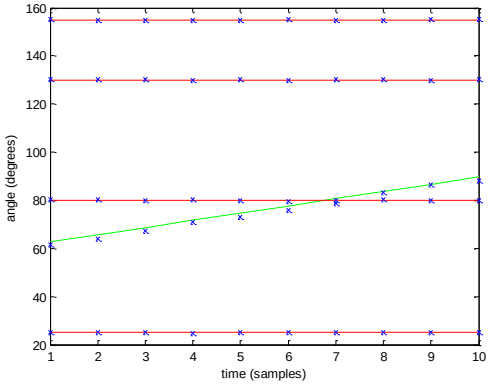

Fig. 3 Estimated Directions for Users

Fig. 4, shows the results of power spectrum versus the azimuth angle for the five coherent sources with estimated DOA at five different degrees.

In these result, incoming signals DOA estimation is not much more accurate. But the user who moves from their initial position and rest at the end, at an angle of 89^0 with DMUSIC and 94^0 with DPM analysis. Also shows the magnitude of power spectrum is 26.46 for DMUSIC and 2.86 for DPM.

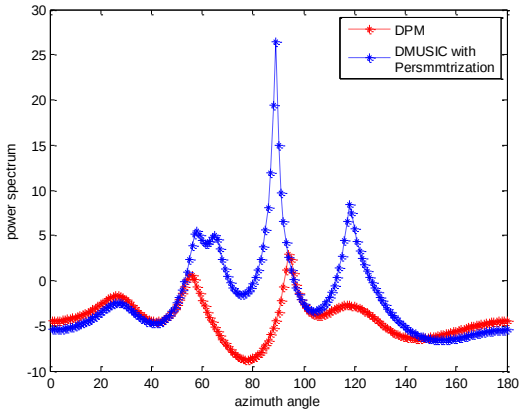

Fig. 4 Power Spectrum for DMUSIC & DPM

IV. CONCLUSION

We have evaluated Dynamic-MUSIC and Dynamic-PM algorithm based on the eigenvector decomposition and non eigenvector decomposition to estimate angle of incoming signals. By studying this we come to conclusion that, even with equal number of elements (L=M) can estimate the DOA with small deviation. The magnitude of power spectrum is better for Dynamic-MUSIC, also gives more accurate DOA than Dynamic-PM algorithm.

REFERENCES

[1]. P.A. Bello and B.D. Nelin, "The Effect of Frequency Selective Fading on the Binary Error Probabilities of Incoherent and Diffrentially Coherent Matched Filter Receivers," *IEEE Trans. Commun. Sys., Vol CS – II June 1963, pp. 170-86.*

[2]. Chen Sun and Nemai Chandra Karmakar, " Direction of Arrival Estimation Based on a Single Port Smart Antenna Using MUSIC Algorithm with Periodic Signals", *International Journal of Signal Processing, summer 2005.*

[3]. Nizar Tayem and Hyuck M. Kwon , "L-Shape 2-Dimensional Arrival Angle Estimation With Propagator Method" *IEEE Trans. On Antennas and Propagation., Vol. 53, No. 5, May 2005*

[4]. Dr. A.N. Jadhav et.al. "Evaluation of PM and MUSIC: Direction of Arrival Estimation for Smart Antenna System", *International Journal of Engineering, Economics and Management" Vo. I, Iss. I, Sept 2012.*

[5]. Godara, L.C., "Application of Antenna Arrays to Mobile Communications, Part II: Beamforming and Direction-of Arrival Considerations," *Proceedings of the IEEE, Vol. 85, No. 8 pp 1195- 1245, August 1997.*

[6]. H.K. Hwang et.al. "Direction of Arrival Estimation using a Root-MUSIC Algorithm", *Proceedings of the International Multiconference of Engineers and Computer Scientists 2008 Vol II, IMECS 2008. 19-21 March, 2008, Hong Kong.*

[7]. Rudra Pratap, "Getting Started with MATLAB 7", *OXFORD University Press,New Delhi,2006.*

[8]. Brian R. Hunt Ronald L. Lipsman, " A Guide to MATLAB –for Beginners and Experienced Users" *Cambridge University Press,2001*

[9]. Timothy A. Davis and Kermit Sigmon," MATLAB Primer" , *A CRC Press Company,7th Edition 2005*

Authors Profile

D.D. Khumane pursed Bachelor of Engineering from S.T.B. College of Engg. Tuljapur in 2002 and Master of Engineering from D.Y. Patil College of Engineering, Kolhapur in 2011. He is currently pursuing Ph.D. from Dr. B.A.M.U. Aurangabad. He is currently working as Assistant Professor in Electronics and Telecommunication Engineering Department, S.T.B. College of Engineering Tuljapur. He has published/presented more than 10 research papers in national/international conferences/journals. He has 15 years of teaching experience and 04 years of research experience.

S.M. Jagade received Ph.D. in Electronics and Telecommunication from SGGSIE & T research center nanded, in Aug. 2008. He is receipt of third best paper award in "Equinox, National IT conference' conducted by Computer Society of India held at Mumbai, in 2000. He is currently working as a Principal in S.T.B. College of Engineering, Tuljapur. He has successfully completed research project sponsored by Terna Electro Tech Cooperative Society's Energy Meter Production Plant at Osmanabad. His research interested areas are Mobile Communication, Surface Mount Technology, Signal Processing and Multiple array communication. He has 26 years of teaching and 10 years of research experience.

