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A NOVEL TECHNIQUE FOR INCREASING USER CAPACITY FOR MOBILE COMMUNICATION BASED ON SMART ANTENNA

Harish T.S
Student, M.Tech Department of E&C.
U.B.D.T College of Engg, Davangere, Karnataka, India.
Email id: harshujji@gmail.com.

T.D. Shashikala
Assistant Professor, Department of E&C.
U.B.D.T College of Engg, Davangere , Karnataka, India.
Email id: itagappam77@gmail.com.

Abstract— **Smart antennas are widely used in wireless mobile communications as they can increase the channel capacity and coverage range. In smart antenna, to locate the desired signal, various direction of arrival (DOA) estimation algorithms are used. In this paper, a new Eigen Vector algorithm for direction of arrival (DOA) estimation is developed, based on eigen value decomposition and normalization of covariance matrix. Unlike the classical Maximum Likelihood Method (MLM) and Maximum Entropy Method (MEM) algorithms the proposed method only involves the determination of noise subspace eigen vectors which provides better resolution and bias as compared to existing DOA algorithms. In order to reduce handover delay caused by handover failure in cellular networks radio resource is reserved for handover users not only at target cell, but also at prepared cells. The discussed scheme reserves a resource pool at prepared cells which is shared among multiple users. The comparison of the probability of successful handover for both traditional and proposed novel scheme is discussed for both FDMA-TDMA and FDMA-SDMA based combined multiple access systems.**

***Index Terms*— array signal processing, direction of arrival, MUSIC, MLM, MEM, handover.**

I. INTRODUCTION

MOBILE COMMUNICATION networks face ever-changing demands on their spectrum and infrastructure resources. Increased minutes of use, capacity-intensive data applications, and the steady growth of worldwide wireless subscribers mean carriers will have to find effective ways to accommodate increased wireless traffic in their networks. However, deploying new cell sites is not the most economical or efficient means of increasing capacity. Wireless carriers have begun to explore new ways to maximize the spectral efficiency of their networks. Smart antennas[1] have emerged as one of the leading innovations for achieving highly efficient networks that maximize capacity and improve quality and coverage. Smart antennas provide greater capacity and performance benefits than standard antennas because they can be used to customize and fine-tune antenna coverage patterns to the changing traffic or radio frequency (RF), conditions[11]. A smart antenna system at the base station of a cellular mobile system is depicted in Fig. 1. It consists of a uniform linear antenna array for which the current amplitudes are adjusted by a set of complex weights using an adaptive beamforming algorithm [2].

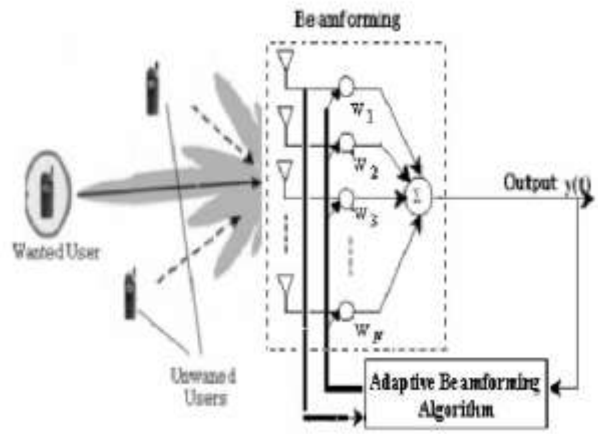

Fig. 1. Smart Antenna System.

The adaptive beamforming algorithm optimizes the array output beam pattern such that maximum radiated power is produced in the directions of desired mobile users and deep nulls are generated in the directions of undesired signals representing co-channel interference from mobile users in adjacent cells. Prior to adaptive beamforming, the directions of users and interferes must be obtained using a direction-of arrival estimation algorithm. There are several types of direction of arrival algorithms like Classical (MLM, MEM) and Subspace based (MUSIC) methods. These algorithms are implemented in DSP processor of smart antenna for real-time working in practical wireless environment.

The paper is organized as follows: Section II provides brief Literature survey for proposed research.Section III describes the theory of smart antenna systems Section IV describes delay and sum (Maximum Likelihood) method. Section V describes Maximum Entropy Method; Section VI describes Multiple Signal Classification (MUSIC) method for Direction of arrival. Section VII describes Resource reservation scheme. Section VIII presents performance results for the smart antenna Direction of Arrival algorithms, Resource reservation capacity and results of successful probability of handover for traditional and proposed methods. Finally, conclusions are given in section IX.

II.LITERATURE SURVEY

1. Smart Antennas

This reference provides basic information about Smart antennas and its characteristics. Smart antennas have the property of spatial filtering, which makes it possible to receive energy from a particular direction while simultaneously blocking it from another direction. This property makes smart antennas a very effective tool in detecting and locating an underwater source of sound such as a submarine without using active sonar. The capacity of smart antennas to direct transmitting energy toward a desired direction makes them useful for medical diagnostic purposes. This characteristic also makes them very useful in canceling an unwanted jamming signal. In a communications system, an unwanted jamming signal is produced by a transmitter in a direction other than the direction of the desired signal. For a medical doctor trying to listen to the sound of a pregnant mother's heart, the jamming signal is the sound of the baby's heart. Processing signals from different sensors involves amplifying each signal before combining them. The amount of gain of each amplifier dictates the properties of the antenna array. To obtain the best possible cancellation of unwanted interferences, the gains of these amplifiers must be adjusted. How to go about doing this depends on many conditions including signal type and overall objectives. For optimal processing, the typical objective is maximizing the output signal-to-noise ratio (SNR). For an array with a specified response in the direction of the desired signal, this is achieved by minimizing the mean output power of the processor subject to specified constraints. In the absence of errors, the beam pattern of the optimized array has the desired response in the signal direction and reduced response in the directions of unwanted interference.

The smart antenna field has been a very active area of research for over four decades. During this time, many types of processors for smart antennas have been proposed and their performance has been studied. Practical use of smart antennas was limited due to excessive amounts of processing power required. This limitation has now been overcome to some extent due to availability of powerful computers. Currently, the use of smart antennas in mobile communications to increase the capacity of communication channels has reignited research and development in this very exciting field.

2. Application of Antenna arrays to wireless communication:

Array processing involves manipulation of signals induced on various antenna elements. Its capabilities of steering nulls to reduce cochannel interferences and pointing independent beams toward various mobiles, as well as its ability to provide estimates of directions of radiating sources, make it attractive to a mobile communications system designer. Array processing is expected to play an important role in fulfilling the increased demands of various mobile communications services.

This reference provides a comprehensive and detailed treatment of different beam-forming schemes, adaptive algorithms to adjust the required weighting on antennas, direction-of-arrival estimation methods including their performance comparison and effects of errors on the performance of an array system, as well as schemes to alleviate them. This reference brings together almost all aspects of array signal processing.

3. Direction of arrival algorithms

Direction of arrival (DOA) is one of the most important parameters that needs to be estimated in most applications. For radar, DOA estimation is the most important factor to localize targets. For communications, DOA estimation can give spatial diversity to the receiver to enable multi-user scenarios. There are a large number of algorithms for DOA estimation because of its importance in array signal processing. Classical methods of DOA include Maximum Likelihood estimation derived from Minimum variance distortionless response algorithm, Maximum Entropy method of estimation. Signal subspace methods are very well known as DOA estimation methods with high performance and relatively low computational cost. MUSIC (MUltiple Signal Classification) fall into this category. Most of these methods take advantage of the fact that there is only a phase difference between sensor outputs, when the signals are narrowband. Therefore, the subspace methods work exclusively with narrowband signals.

4. Resource Reservation Technique:

This reference gives comparison between target cell based handover and prepared cell based handover. Provision of fast and reliable handover and resource reservation for new handover requests is of prime importance in today's mobile wireless communications. A handover procedure can typical be divided into three steps measurements, decision and execution. Base station makes handover decision based on the channel measurements report from users, and informs user its target cell. Handover execution is the process made at the User Equipment (UE) to change its serving cell to the target cell. Many researches have been focused to improve the handover performance, including sufficient measurements algorithms, and handover decision and execution considering UE's mobility, neighboring cells load and user service type. In other aspect, in order to reduce the handover execution time and improve the handover successful probability, softer handover, architecture for seamless handover and handover preparation were studied.

Usually, handover may fail in two cases. One is the admission control failure in the preferred target cell, the other is the random access failure in the target cell. In order to avoid handover failure resulted in by admission control failure, handover preparation was introduced, which means target cell performs admission control before handover execution. But admission control in preferred target cell during handover preparation maybe failed too. In this case, source cell will send 'handover request' to another neighboring cell (i.e prepared cell) with the second strongest signal strength and 'handover preparation' will be performed at cell2 to reestablish Radio Resource Control (RRC) connection. In addition, there may be other reasons that result in handover failure, e.g. radio link failure in source cell, so UE does not receive 'handover command'; radio link failure in target cell, so UE cannot detect the target cell or 'handover complete' cannot be transmitted successfully. Resource reservation at the target cell is also to be considered for handover failure or delay. So an efficient resource reservation scheme using prepared cell concept for users and employing adaptive array antennas at the basestation is to be designed.

III. PROBLEM FORMULATION

A. Signal Model

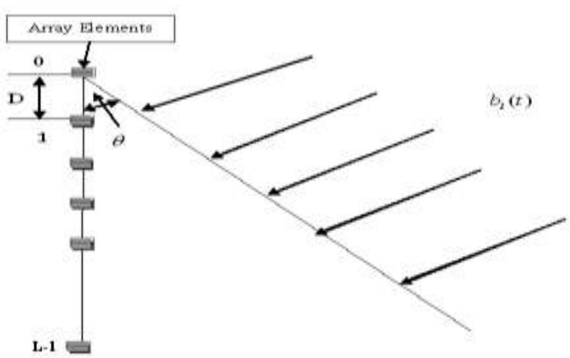

Fig. 2. Uniform Linear Array.

Consider a uniform linear array geometry with L elements numbered 0, 1, ..., L - 1. Consider that the array elements have half-a-wavelength spacing between them. Because the array elements are closely spaced, we can assume that the signals received by the different elements are correlated[3][4]. The Steering vector is such measure and for a L antenna elements array it is given by

$$S_\theta = \begin{bmatrix} 1 \\ e^{i2\pi d \sin\theta} \\ \vdots \\ \vdots \\ e^{i2\pi d(L-1)\sin\theta} \end{bmatrix} \tag{1}$$

The combination of all possible steering vectors forms a matrix A known as the array manifold matrix[14]. Hence, the received signal vector x(t) of (1) can be expressed in terms of A as:

$$x_k(n) \approx \sum_{i=0}^{M-1} b_i(n)\, a(\theta_i) \tag{2}$$

B. Formation of Array Correlation Matrix

The spatial covariance matrix of the antenna array can be computed as follows. Assume that b_n (signal) and n_n (noise) are uncorrelated, n_n is a vector of Gaussian white noise samples with zero mean. The spatial covariance matrix R is given by

$$R = E[x_n x_n^H] = E[(Ab_n + n_n)(Ab_n + n_n)^H] \tag{3}$$

The spatial covariance matrix is divide into signal and noise subspaces and hence we obtain

$$R = A\, R_{ss}\, A^H + \sigma^2 I \tag{4}$$

Where, R is Array Correlation Matrix or Spatial Correlation matrix, A is Array Manifold Vector, A^H is hermitian transpose of A, σ^2 is noise variance.

IV. MAXIMUM LIKELIHOOD METHOD

The Capon AOA estimate is known as a Minimum Variance Distortionless Response (MVDR)[5]. It is also alternatively a maximum likelihood estimate of the power arriving from one direction while all other sources are considered as interference. Thus the goal is to maximize the Signal to Interference Ratio (SIR) while passing the signal of interest undistorted in phase and amplitude. The source correlation matrix R_{ss} is assumed to be diagonal. This maximized SIR is accomplished with a set of array weights given by

$$w_{MVDR} = \frac{R_{xx}^{-1}\, a(\theta)}{a^H(\theta)\, R_{xx}^{-1}\, a(\theta)} \tag{5}$$

Where, R_{xx}^{-1} is the inverse of un-weighted array correlation matrix R_{xx} and $a(\theta)$ is the steering vector for an angle θ. The MLM pseudo spectrum is given by

$$P_{MLM} = \frac{1}{a^H(\theta)\, R_{inv}\, a(\theta)} \tag{6}$$

Where, $a^H(\theta)$ is the hermitian transpose of $a(\theta)$ and R_{inv} is the inverse of Array Correlation matrix.

V. MAXIMUM ENTROPY METHOD

This method finds a power spectrum such that its Fourier transform equals the measured correlation subjected to the constraint that its entropy is maximized[6]. The solution to this problem requires an infinite dimensional search. The problem has to be transformed to a finite dimensional search. One of the algorithms proposed by Lang and McClellan has power spectrum given by

$$P_{ME} = \frac{1}{[S_\theta{}^H\, C C^H\, S_\theta]} \tag{7}$$

Where, C is column of R^{-1} and S_θ is the steering vector[6]. $P_{ME}(\theta)$ is based on selecting one of L^{th} array elements as a reference and attempting to find weights to be applied to the remaining L-1 received signals to permit their sum with a minimum mean square error fit to the reference. Since there are L possible references, there are L generally different $P_{ME}(\theta)$ obtained from the L possible column selections of R^{-1}.

VI. MUSIC METHOD

MUSIC Method promises to provide unbiased estimates of the number of signals, the angles of arrival and the strengths of the waveforms[7]. EV-method makes the assumption that the noise in each channel is uncorrelated making the noise correlation matrix diagonal. The incident signals may be correlated creating a non diagonal signal correlation matrix. However, under high Signal correlation the traditional MUSIC algorithm breaks down and EV Method must be implemented to correct this problem.

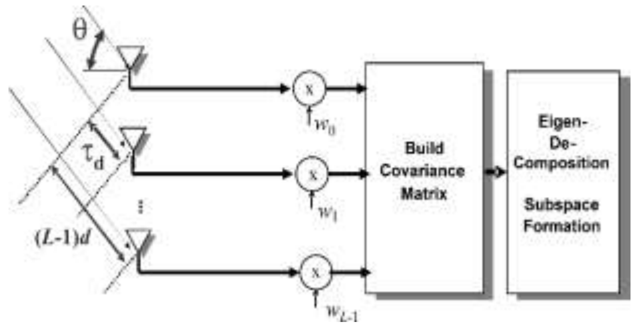

Fig. 3. MUSIC System.

As shown in Fig. 3 the EV algorithm estimates the covariance matrix and then performs Eigen vector Decomposition to form the subspace. Eigen values and eigenvectors provide useful and important information about a matrix. It is possible to determine whether a matrix is positive definite, invertible, indicate how sensitive determination of inverse will be to numerical errors. The Eigen values of LxL Array Correlation matrix R obtained in equation (3) is found by solving the characteristic equation given by

$$|R - \lambda I| = 0 \tag{8}$$

The solution to equation (8) gives L Eigen values $\{\lambda_1, \lambda_2, \ldots\ldots, \lambda_L\}$.

The Eigen Vector for specific Eigen value λa is found by solving the equation given by

$$R\, V_n = \lambda_a V_n \tag{9}$$

Where V_n is Lx1 matrix comprising of unknown variables.

Expanding equation (9) in matrix notation, one can obtain

$$\begin{bmatrix} R_{0,0} & R_{0,1} & \ldots & R_{0,L} \\ R_{1,0} & R_{1,1} & \ldots & R_{1,L} \\ \vdots & \vdots & \vdots & \vdots \\ R_{L,0} & R_{L,1} & \ldots & R_{L,L} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_L \end{bmatrix} = \lambda_a \begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_L \end{bmatrix} \tag{10}$$

Multiplying the matrices, a set of simultaneous equations as defined in (11) are obtained

$$\begin{aligned} &R_{0,0} V_1 + R_{0,1} V_2 + \ldots\ldots\ldots\ldots + R_{0,L} V_L = \lambda_a V_1 \\ &R_{1,0} V_1 + R_{1,1} V_2 + \ldots\ldots\ldots\ldots + R_{1,L} V_L = \lambda_a V_2 \\ &\vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots \; \vdots \\ &R_{L,0} V_1 + R_{L,1} V_2 + \ldots\ldots\ldots\ldots + R_{L,L} V_L = \lambda_a V_L \end{aligned} \tag{11}$$

Since there are L Unknowns we have L simultaneous equations which can be solved to obtain $V_1, V_2, \ldots\ldots, V_L$.

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These L values form Eigen vector matrix. The Noise subspace is then normalized to obtain better resolution as compared to few previous DOA algorithms. The Eigen values and eigenvectors for correlation matrix R is found. M eigenvectors associated with the signals and L−M eigenvectors associated with the noise are separated. The eigenvectors associated with the smallest Eigen values are chosen to calculate power spectrum. For uncorrelated signals, the smallest Eigen values are equal to the variance of the noise. The L× (L− M) dimensional subspace spanned by the noise eigenvectors is given by

$$E_N = [e_1\, e_2\, e_3 \,................\, e_{L-M}] \qquad (12)$$

Where, e_i is the i[th] Eigen Value.

The noise subspace Eigen vectors are orthogonal to the array steering vectors at the angles of arrival $\theta_1, \theta_2, ...\theta_M$. Because of this orthogonality condition, one can show that the Euclidean distance $d^2 = a(\theta)^H E_N E_N^H a(\theta) = 0$ for each and every angle of arrival $\theta_1, \theta_2, ...\theta_M$ .Placing this distance expression in the denominator creates sharp peaks at the angles of arrival.

The MUSIC pseudo spectrum is given by

$$P_{MUSIC} = \left[\frac{1}{a(\theta)^H E_N E_N^H a(\theta)}\right] \qquad (13)$$

Where, $a(\theta)$ is steering vector for an angle θ , E_N is a matrix comprising of noise Eigen vectors and λ_i is the i[th] eigen value.

VII. RESOURCE RESERVATION SCHEME

A. Handover Preparation Scheme

Prepared cell is introduced to recover the handover failure. It means more than one neighboring cells perform handover preparation. The following steps are followed for handover:

1. Upon receiving the measurement report, source basestation makes handover decision and sends handover requests to multiple neighboring cells with better channel condition.
2. Handover preparation is performed by those neighboring basestations. And after that, handover request response will be sent to the source basestation.
3. Soure basestation selects a target cell from accessible cells and leaves others as prepared cells.
4. If handover fails in target cell, UE will select a suitable cell to perform RRC connection reestablishment, which will not succeed unless the suitable cell is prepared. Here the more the prepared cells, the higher the connection successful probability.
5. Release resources.

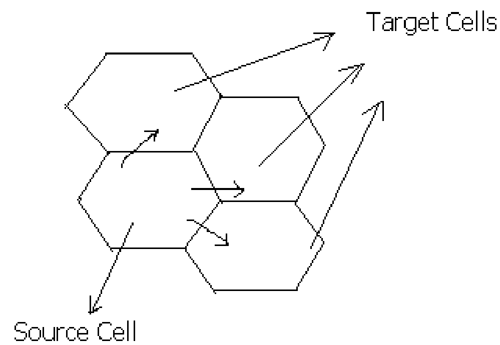

Fig4. Target cell based handover.

In the above fig.4 if a mobile is to be handover to any of the 3 target cells, fixed amount of resources are reserved to service handover requests, if the user number exceeds the available resource handover failure occurs which results in handover delay. So in order to solve this prepared cell based handover technique is developed in which if the handover fails in the target cell then handover request is sent to the other prepared cells depending on the second largest signal strength received compared to the strength of signal received from the target cell basestation [8][9].

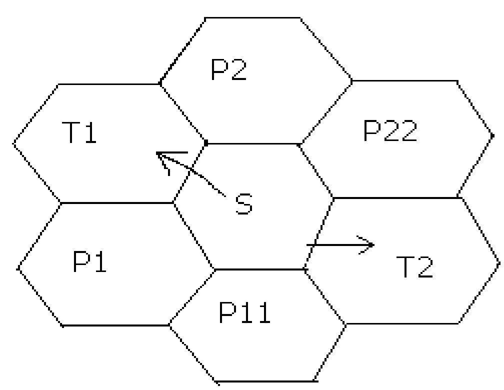

Fig 5.Prepared cell based handover.

In the above fig.5 two target cells are considered for handover based on the direction of movement of mobile equipment. In case of handover failure in T1, handover is preformed at either P1 or P2 prepared cells. Similarly for T2 cell P11 and P22 act as prepared cells.

B. Sharing a Resource Pool in Prepared Cell

It assumes that cell #1 has received *n*-1 handover requests and reserved resource C_{ho} for them. The total resource of the cell is C , and the present in-use resource is C_{used}. Then for the n_{th} handover request, the available resource C_a can be calculated by using

$$C_a = C - C_{used} - C_{ho} \tag{14}$$

Where, $C_a = available capacity$

$C_{used} = capacity in use$

$C_{ho} = hand\ over\ capacity$

$C = total\ capacity$

The handover capacity is given by

$$C_{ho} = \sum_{i=1}^{n-1} C_{ri} \tag{15}$$

Where, C_{ri} is the resource reserved for ith user.

Apparently, among the *n*-1 UEs, for example, *m* UEs want to take cell #1 as target cell and others want to take cell #1 as prepared cell. However, in traditional, cell #1 will reserve a dedicated resource for each UE. Hence the C_{ho} can be generalized as equation

$$C_{ho} = (n-1)C_n \tag{16}$$

Where, $C_n = resource\ \ reserved\ \ for\ nth\ \ user$

While in the proposal, cell #1 will not reserve a dedicated resource for UEs that want to take it as prepared cell and provide them a resource pool. Hence the C_{ho} can be generalized as

$$C_{ho} = mC_n + \left[\frac{n-1-m}{w}\right] C_n \tag{17}$$

Where *w* is a sharing factor which is no less than 1. The bigger the *w* , the smaller the resource pool. With the C_{ho} in theproposal, C_a for the n_{th} handover request is increased greatly.

B. Successful Handover Probability

Handover will not succeed until random access succeeds in target cell or in prepared cell. Successful handover probability P_{HO_succ} equals P_{tar} in target cell plus P_{pre} in prepared cell. It can be generalized as follows:

$$P_{ho} = P_{tar} + P_{pre} \tag{18}$$

Where, $P_{tar} = t\arg et\ probability$

$P_{pre} = \Pr epared \Pr obability$

The target probability is given by

$$P_{tar} = (1-(1-P_{admi})^2)(1-P_{raf}) \tag{19}$$

Where, $P_{admi} is the\ admission\ probability$

And

$P_{raf} = random\ access\ failure\ probability$

The probability of the prepared cell is given by

$$P_{pre} = P_{adm}^2 P_{raf} \sum_{n=0}^{N-1} p_n\, q_n \tag{20}$$

Where

$P_n =$ Probability of n UEs failing in random access.

$q_n =$ is the probability of UE accepted by the cell in the Case of n UEs selecting the cell as suitable cell after Failing in the target cell.

P_n and q_n are calculated based upon by considering probability of random access failure as binomial random variable[12].

VIII . SIMULATION RESULTS

Here the DOA algorithms namely; MLM, MEM, and new Eigen Vector method are simulated using MATLAB.

Assumptions

1. Distance between antenna elements is to avoid grating lobes.
2. Signal and Noise is un-correlated.

Case1: Widely spaced source with less number of antenna elements

Table1: Input to MLM, MEM and MUSIC Method

Number of array elements	**Number of sources**	**Directions of Sources**	**Amplitude of sources**
8	2	[10^0 , 50^0]	[1, 2]v

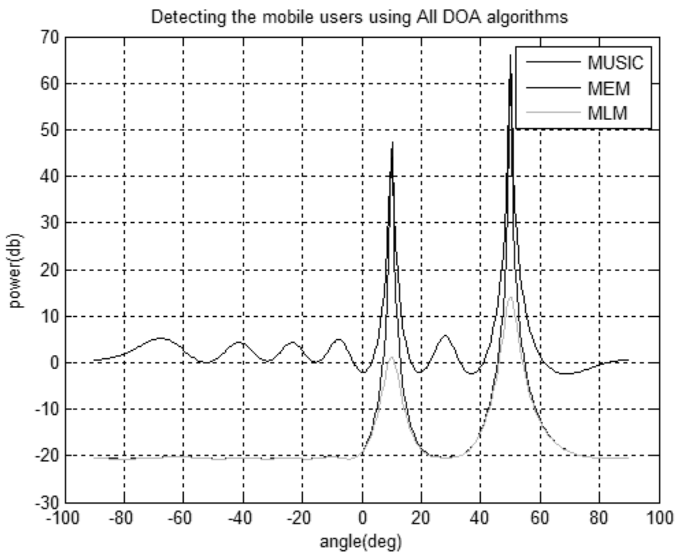

Fig. 6. Comparisons of MLM, MEM and MUSIC Method for widely spaced sources with less antenna elements.

Given a case when sources are widely apart and less number of antenna elements are used as shown in Fig 6 it is found that, MLM, MEM and EV(Eigen vector decomposition) method detect direction of sources and all DOA algorithms produces best output.

Case2: Closely spaced sources with less number of antenna elements

Table2: Input to MLM, MEM and MUSIC Method

Number of array elements	Number of sources	Directions of Sources	Amplitude of sources
8	2	[25^0 ,30^0]	[1, 1]v

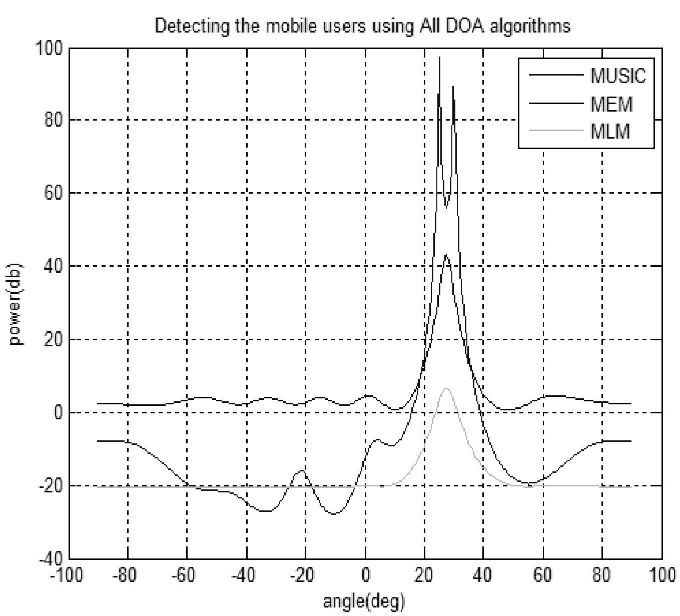

Fig. 7. Comparisons of MLM, MEM and MUSIC Method for closely spaced sources with less antenna elements.

Given a case when sources are closely spaced and less number of antenna elements are used as shown in Fig. 7 it is found that Bartlett and MEM perform badly and new EV method yields better output.

Case3: Widely spaced sources with more number of antenna elements

Table3: Input to MLM, MEM and MUSIC Method

Number of array elements	Number of sources	Directions of Sources	Amplitude of sources
50	2	[20^0, 60^0]	[1, 3]v

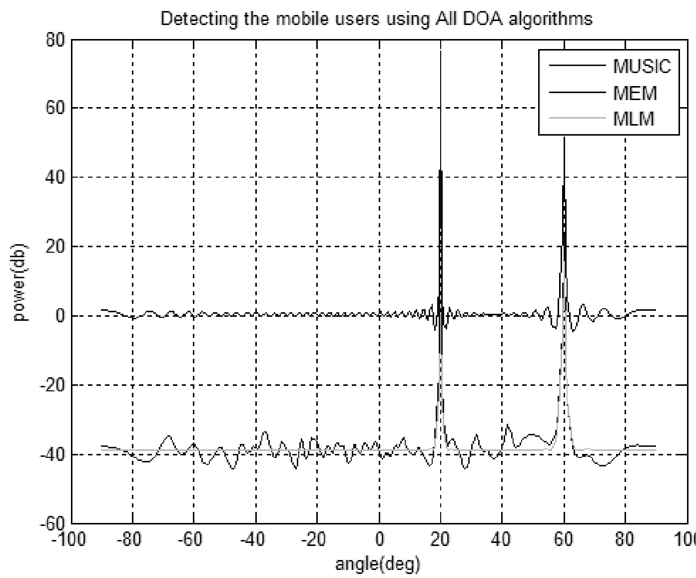

Fig. 8. Comparisons of MLM, MEM and MUSIC Method for widely spaced sources with less antenna elements.

Given a case when sources are widely apart and more number of antenna elements are used as shown in fig 8, it is found that performance of MLM, MEM and EV methods is good.

Case4: Closely spaced sources with more number of antenna elements

Table4:Input to MLM, MEM and MUSIC Method

Number of array elements	Number of sources	Directions of Sources	Amplitude of sources
70	2	[30^0 ,33^0]	[1 ,2]v

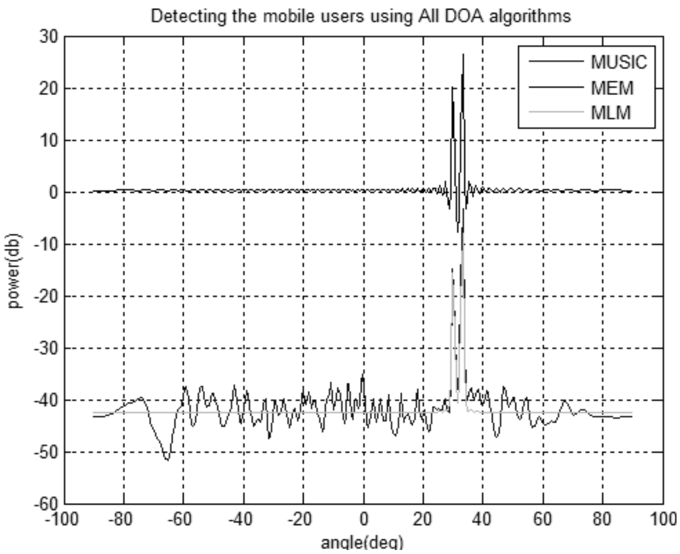

Fig. 9. Comparisons of MLM, MEM and MUSIC Method for closely spaced sources with more antenna elements.

Given a case when sources are closely spaced and more number of antenna elements are used as shown in fig 9, it is found that performance of D&S, MEM and EV methods is good because EM wave strikes more number of antenna elements.

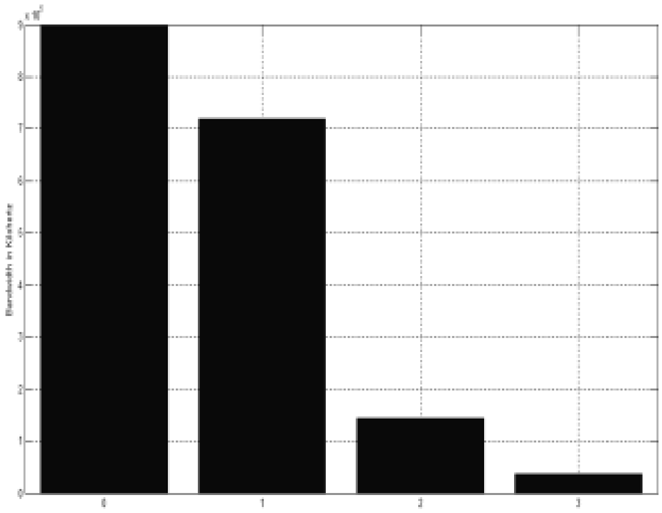

Fig10. Traditional Capacity calculation for FDMA-TDMA based system for a cell.

From Fig 10 the first bar indicates the total user capacity, the second indicates the used capacity for connected users. The third indicates the available capacity for current handover users and fourth indicates the available capacity for future handover requests for traditional resource allocation scheme for FDMA-TDMA system based on target cell based handover technique. In this GSM(Global system for mobile) standard is taken as comparative reference for performance calculation of a system combining Prepared cell concept for intercellular handover and SDMA to increase user capacity by using spatial diversity.

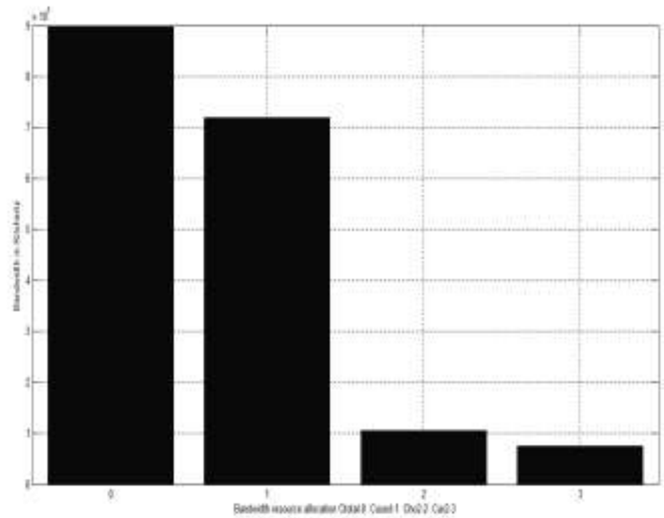

Fig11. Novel capacity calculation for FDMA-TDMA based system for a cell.

From Fig 11 the first bar indicates the total capacity, the second indicates the used capacity for connected users. The third indicates the available capacity for current handover users and fourth indicates the available capacity for future handover requests for traditional resource allocation scheme for FDMA-TDMA system.

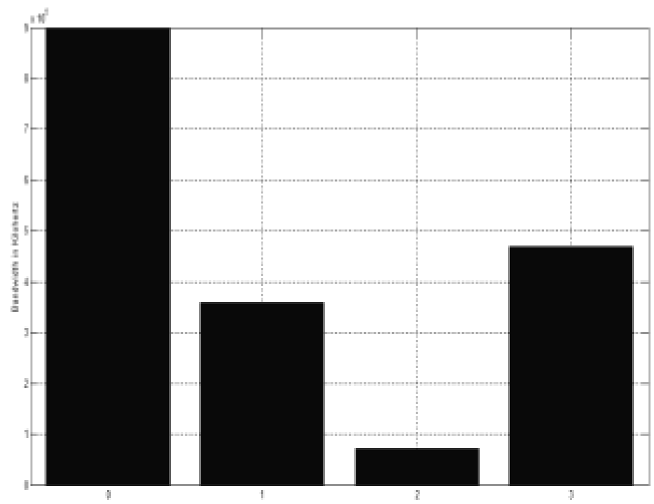

Fig12. Traditional capacity calculation for FDMA-SDMA based system for a cell.

From Fig12 the first bar indicates the total capacity, the second indicates the used capacity for connected users. The third indicates the available capacity for current handover users and fourth indicates the available capacity for future handover requests for traditional resource allocation scheme for FDMA-SDMA system. As compared to FDMA-TDMA capacity has increased by a large amount for future handover requests. In FDMA-SDMA based system consideration is taken that different users at different angular locations use same frequency channel [13].

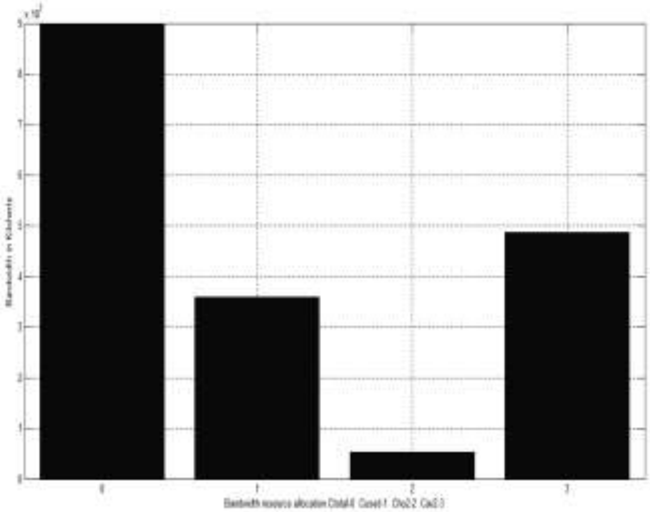

Fig 13. Novel capacity calculation for FDMA-SDMA based system for a cell.

From Fig13 the first bar indicates the total capacity, the second indicates the used capacity for connected users. The third indicates the available capacity for current handover users and fourth indicates the available capacity for future handover requests for novel resource allocation scheme for FDMA-SDMA system. As compared to FDMA-TDMA capacity has increased by a large amount for future handover requests.

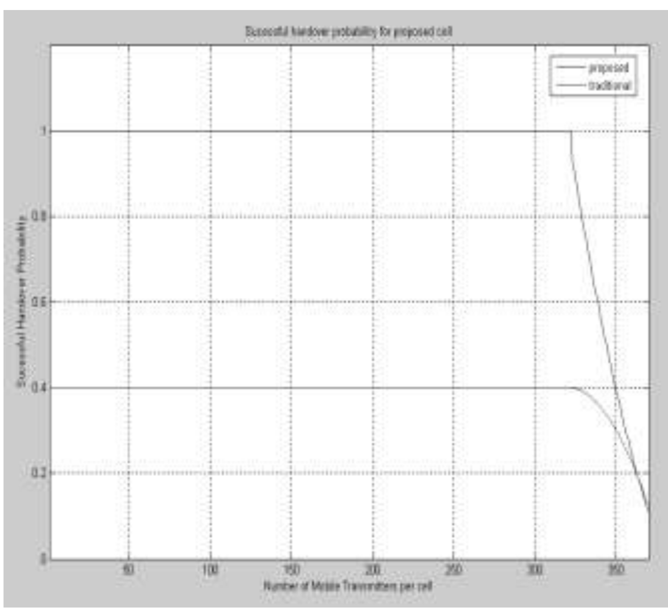

Fig14: Comparison of traditional and novel successful handover probability.

From the fig 14 one can infer that the proposed method has better handover probability as compared to traditional scheme. Here successful handover probability of a user equipment is calculated for a particular cell by taking only target cell in the traditional technique. But in the proposed novel technique both traditional and prepared cells are considered for handover process. In traditional technique only successful handover probability P_{tar} is calculated, but in novel technique the sum of P_{tar} and P_{pre} is calculated and thus it achieves increase in successful handover probability than the traditional technique.

IX.CONCLUSION

The Direction of Arrival (DOA) block of smart antenna systems based on classical and subspace methods are presented. The new MUSIC Vector method is compared with existing MEM and MLM method. From the simulation results of MATLAB it may be concluded that when the sources are widely spaced and less number antenna elements are used, performance of MLM, MEM and a new MUSIC method are good. When the sources are closely spaced and less number of antenna elements are used performance of MLM and MEM is worst and MUSIC algorithm is best suited in this case. When the sources are widely spaced and more number of antenna elements are used all algorithms perform well. When the sources are closely spaced and more number of antenna elements are used performance of MLM, MEM and MUSIC algorithms are improved. The capacity graphs also prove that the available capacities have been significantly improved as compared to traditional scheme. The probability of successful handover graph also shows that the successful handover is improved in a novel scheme. This infers that prepared cell based handover will achieve better increase in resource reservation than target cell based handover. And also with the Increased computational efficiency of DSP processors made to achieve increased resolution of DOA estimation algorithms like MUSIC than MLM and MEM methods, which improved and made it possible to implement SDMA(Spatial Dvision Multiple Access) along with FDMA multiple access technique for Wireless mobile communications.

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Harish T.S received his degree in Bachelor of Engineering from Visvesvaraya technological university, Belgaum, Karnataka, India. Currently he is achieving the Master of Technology degree in Digital Communication & networking from U.B.D.T College of Engg, Davangere, Karnataka, India. His areas of research interests include Wireless Communications, Antennas and propagation, Signal Processing.

T.D Shashikala received her degree in Master of Technology degree in Digital Communication from Visvesvaraya technological university, Belgaum India. Currently she is working as a Assistant Professor in the department of Electronics and Communication at U.B.D.T College of Engg, Davangere, Karnataka, India. Her areas of research and teaching interests include Digital Communication systems, Antennas and MIMO systems, Wireless Communications, has presented papers in many national, international conferences and journals.