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An efficient reconfigurable optimal source detection and beam allocation algorithm for signal subspace factorization

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ABSTRACT

Now a days, huge amount of data is communicated through channels in wireless network. It requires an efficient parallel operation for the optimal utilization of frequency, time allocation and coding model for signal subspace factorization in smart antenna. In view of this requirement, an efficient reconfigurable optimal source detection and beam allocation algorithm (RoSDBA) is proposed. The proposed algorithm is able to allocate desired signal to the user space to reduce the noise and also for efficient allocation of subspace to remove disturbance in all directions. The proposed method efficiently utilizes the antenna array elements by accurate identification and allocation of antenna array elements such as individual radiators, radiation beam, signal strength, and disturbance factor. With respect to simulation analysis, the proposed method shows better performance for the resolution, radiation beam allocations, identification bias, distribution factor and time taken for the detection of various array arrangements and source numbers.

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1. INTRODUCTION

Multiple independent blocks like detection block and beam-former block are used with the help of digital signal processing module embedded inside an array of sensors with the capability of cognizance. The first block is responsible for detecting the location of sources and the second block is responsible for sending the radiation towards the users. The detection module will compute the power spectrum and those angles where the value is maximum are treated as sources. The weights are then computed and these weights are applied to the sensors to send the beam of maximum power. Figure 1 shows the independent blocks of the system. As shown in the figure the detection block is responsible for finding the sources and then beam formation sends maximum signal towards the destination [1], [2].

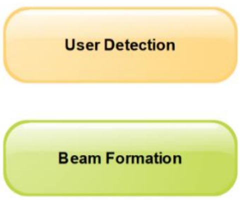

Figure 1. Independent blocks of system

2. BACKGROUND

The capacity of communication for mobile applications makes use of maximum ratio combination along with diversity combination. Duplex operation is executed on the system comprising reception and transmission. The receiver will analyze the electromagnetic waves, determine the detected directions and then send the maximum power to valid mobile users during the transmission phase [3]. The division of channels is done into time variant, code variant or frequency variant [4]. The bandwidth is divided into multiple sub divisions and then each division is used by the sources. If the number of sources is higher than divisions then sources will wait otherwise the division is future divided into sub-divisions and used by the user which in turn will reduce the quality. The long term evolution (LTE) systems along with orthogonal frequency division multiplexing (OFDM) can be used to achieve better volume of throughput [5]. The channel is divided in series of time slots. Each time slot is allocated to certain mobile source. The number of users served will be higher than frequency kind but will have a delay disadvantage. Also, there will be interference between channel a and channel b due to various interference values [6], [7]. The code model will assign unique code for each channel. The entire channel bandwidth is sub utilized in the format of frequency share with limited users having same frequency and can be used for both narrow and wide band propagation [8]. The channel is divided into multiple slots. Each slot will have its own unique spatial capacity. All the users will share same frequency value and time value but can have different space thereby increasing the capacity. The combination of spatial configuration along with bandwidth computation are responsible for communication between cells [9]. When there are multiple array elements in the base station then the delayed versions of electromagnetic waves will be obtained. The support vector value can be used to determine the direction using approximate ratios [10]. The combination of resolution and kernel will be used to compute signal to noise ratio with the help of L-shaped array. First the uncertainties are found after which such uncertainties in the phase value are eliminated with the help of auto correlation applied on the data and then reduce the error value [11].

The linear phase-based sensor matrix can be utilized for generating the steering beam for Wi-Fi and LTE based applications. The flat based configuration is used by combining four different elements of patch sensor. The resonances can be excited using rectangular ring slot with the help of rectangular patch placed at the ground level. By applying proper phase shift to individual antenna elements, the mean beam can be sent towards desired users with side lobe reduction [12].

The matrix of sensors is made of three facet system and performs the navigation of the beam to a wider angle. The steering vector will be computed across the zenith and then radiation is sent towards the destination sensors. The mutual coupling will be done based on combination of multiple sensor elements [13].

For the case of direction of arrival (DoA), the directions of the sources must be found accurately. The directivity and accuracy depend upon the arrangement of arrays as a co-prime. The radiation patterns created with the help of steering vector and the signal received at the base station should have low error. Multiple signal classification (MUSIC) and Lasso algorithms are applied for detection [14].

The two-dimensional direction of arrival detection occurs with the help of L-shaped antenna. The precision in the detection of users should be achieved keeping in mind the complexity of the system. A matrix is created based on signal falling on a uniform linear array and then dimension reduction is done. The polynomial root is found on the one-dimensional matrix to obtain the results of detection [15]. Global positioning system (GPS) does not perform accurate detection when the environment has factors like multi-path fading, no direct communication between sources and scattered sources. The amount of power spend by the users can be reduced by making use of the localization techniques on the network. The algorithm is developed using two steps. The first step is to compute the covariance matrix and the second step is the computation of spatial spectrum [16].

The ranking of the eigen value-based vectors is done for detecting the direction of the users and then compute the covariance matrix. After that smallest Eigenvalue is found, the power spectrum is computed. A map of Eigenvalue and power is used to compute the minimum threshold for the detection of sources [17].

The DoA is responsible for finding the direction of mobile users so that maximum radiation can be sent towards those directions. MUSIC method and Lasso based approaches can be used to determine those directions of end-users. Both the methods compute the steering vector and then the received signal at the base station is adjusted. The root mean square error (RMSE) of the MUSIC method is less as compared to Lasso for the case of two mobiles with directions as one degree and 4 degrees respectively [18].

The multiple-input multiple-output (MIMO) makes use of multiple sensors at both the transmitter and receiver end. The method will compute a flipped conjugate-based beam space value and the main aim of this method is to form maximum energy in a fixed area. This will help in increasing the strength of the signal and reduce the noise value. In order to form the radiation, steering vectors will be computed followed by direction estimation [19].

The dipole antenna elements are placed in a planar fashion and can get more directional space for the detection of directions of end-users. After getting values of power spectrum, the antennas are rotated mechanically to get better accuracy for detection of directions [20]. The estimation of directions is done by computing delay directional values of electromagnetic wave samples. After this the non-signal space and directional space are computed which thus require a lot of computational power. The sub matrices are divided into two kinds which are computed on top of co-variance method. This is done by making use of Nystrom based method rather than making use of whole eigen value decomposition for both signal and non-signal values [21], [22].

In the environment where mobile sources are moving at a faster pace, the synthesis method is computed which will find the weights and apply it for the various antenna elements. Zero placement for flat top based algorithm first computes the *z* domain, then takes the response signal and divides into two sub-portions. The first method will compute the weights by using Dolph-Chebyshev algorithm by having a lower beam width and low amount of side lobes. The second step is computation of conventional finite impulse response (FIR) based weights to steer the main beam [23].

The array elements are arranged in a linear fashion. When the elements position is changed then new patterns are found. MUSIC along with particle swarm optimization (PSO) are used to find the power spectrum and then detection of directions is done for the mobile users [24].

The traditional linear arrangement of elements in a straight fashion is not suitable for the underwater kind of environments. Joint processing-MUSIC (JMUSIC) algorithm can be used to determine the directions of mobile users by first finding the steering vectors, after that the array manifold vector is computed by combining the vectors from various directions. Modified MUSIC algorithm will do a Toeplitz computation on the signal correlation matrix by reducing noise effect. The modified MUSIC (MMUSIC) has high amount of accuracy as compared to MUSIC algorithm and also it has low errors [25].

Activity on arrow (AoA) method makes use of linear array which is placed at the base station. Space alternating generalized expectation-maximization (SAGE) algorithm method can be used in order to find the direction of mobile users so that direct impinging and reflected impinging-based signals can be combined together so that signal-to-noise ratio (SNR). can be increased and will help in determining the directions of mobile users in an outdoor environment [26]. The DoA algorithm makes use of MIMO antenna elements at the base station. The phase shifts will be applied to the antenna elements to find the signal matrix and then estimation of directions can be done.

3. METHOD

3.1. Bartlett method

The incident electromagnetic wave will hit the antenna array. The delayed versions of the signal are obtained by making use of antenna incident direction specific vector. After that the signal generated at mobile station is generated as the signal correlation. After that the noise vector are found based on noisy signal across the antenna elements. The power values are computed from -90 degree to 90 degree and then spectrum is formed is given in (1).

$$PS_{BM}(\theta) = \frac{IV_\theta^H\ CR\ IV_\theta}{Na^2} \tag{1}$$

IV_θ is represented the incident vector for the given direction θ, CR is described the correlation matrix obtained from the received signal at the base station that contains the noise vector as well along with signal generated at the mobile station. IV_θ^H is identified as Hermitian transpose of IV_θ and Na is represented the number of antenna elements.

3.2. Maximum likelihood method

Maximum likelihood method (MLM) or correlation inverse method is built on top of the auto correlation power spectrum method with an additional step of computing the inverse of the total correlation matrix at the base station. In MLM method of analysis, the principal includes a way of acquiring optimum values of the parameter that defines a particular model. If auto correlation function is performed on a power signal and Fourier transform of it is obtained, then it is nothing but the power spectrum density. This will help in computing the power spectrum is such a way that likelihood is high. The computation of directional power for correlation inverse method is given in (2).

$$P_{MLM} = \frac{1}{IV_\theta^H\ CR_{inv} IV_\theta} \tag{2}$$

CR_{inv} is the inverse correlation matrix obtained from the received signal at the base station that contains the noise vector as well along with signal generated at the mobile station. IV_θ^H is the Hermitian transpose of IV_θ.

3.3. Maximum entropy method

When the time graph is considered then it is assumed that on a specific time the entropy of the signal is maximized in a specific direction of the mobile user. It makes use of combination of auto correlation power spectrum method as well as correlation inverse method or maximum entropy method (MEM). The total received correlation vector at the base station is taken and inside its column corresponding to maximum value of entropy is found out to compute the value of directional spectrum is represented in (3).

$$P_{MEM} = \frac{1}{IV_\theta^H \; MEC \; MEC^H \; IV_\theta} \tag{3}$$

where, MEC is the column which corresponds to maximum value of entropy, MEC^H is the Hermitian transpose. IV_θ is the incident vector and then IV_θ^H is the Hermitian transpose of incident vector.

3.4. MUSIC

MUSIC or noise signal eigen vector this method will compute take the received correlation vector and then perform the eigen value finding on that matrix. Take out the lower eigen values and build up the eigen vector is given in (4) due to this mathematical model, the noise signal eigen vector method has been resolved for signal subspace factorization.

$$P_{MUSIC} = \frac{1}{IV_\theta^H \; NSE_V \; NSE_v^H \; IV_\theta} \tag{4}$$

where IV_θ is the incident signal vector for an angle θ, IV_θ^H is the Hermitian transpose of the incident signal for an angle θ and NSE_V is the matrix comprising of noise eigen vectors and NSE_v^H is the matrix obtained by applying the concept of Hermitian on top of NSE_v.

4. PROPOSED EFFICIENT RECONFIGURABLE OPTIMAL SOURCE DETECTION AND BEAM ALLOCATION ALGORITHM (RoSDBA)

The proposed method is built on top of both classical and eigen vector-based methods. The additional factorization is applied to achieve a better resolution because this factorization will reduce the effect of noise and also to have a reduced amount of disturbance in the side lobes radiation patterns. In order to achieve the side lobes suppression, we can apply the hamming window. The proposed method is described in detail as below.

Generate a training vector at the mobile station in such a way that the generated pure signal satisfies the Nyquist criteria. If there are "N_{mu}" mobile users, then the corresponding amplitude vectors can be found using (5) and (6) due to this equation the mobile station has been trained to optimize the beam forming.

$$AM_v = \begin{bmatrix} am_1 \\ am_2 \\ am_3 \\ . \\ . \\ . \\ . \\ . \\ . \\ am_n \end{bmatrix} \tag{5}$$

$$IV_m = \begin{bmatrix} 1 & 1 & 1 \\ e^{-j\pi \sin(\theta_1)} & e^{-j\pi \sin(\theta_2)} & e^{-j\pi \sin(\theta_{N_m})} \\ . & . & . \\ . & . & . \\ e^{-j\pi(N_e-1)\sin(\theta_1)} & e^{-j\pi(N_e-1)\sin(\theta_2)} & e^{-j\pi(N_e-1)\sin(\theta_{Nm})} \end{bmatrix} \tag{6}$$

The Hermitian transpose of IV_m is found out using IV_{MAM}^H. The received total correlation is obtained as given in (7).

$$RTC = IV_m \; CSIV_{MAM}^H + NV \tag{7}$$

In order to find the eigen values for RTC the (8) must be solved.

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

The solution to the (8) will be N_a eigen values given as $\lambda_1, \lambda_2, \lambda_3, \dots \dots \dots \dots . . \lambda N_a$. The eigen values are sorted in descending order and first Nmu values are taken out which corresponds to signal eigen values. Consider that the signal eigen values are represent by $\lambda se_1, \lambda se_2, \lambda se_3, \dots \dots \dots \dots \lambda seN_{mu}$. λse_k is the k^{th} eigen value corresponding to signal eigen value for each of the eigen values from the $\lambda se_1, \lambda se_2, \lambda se_3, \dots \dots \dots \dots \lambda seN_{mu}$ eigen vectors are found. Consider an eigen value λse_1 the eigen vector can be found by solving an equation given by in (10).

$$RTCU\lambda se_1 = \lambda e_1 U \lambda se_1 \tag{10}$$

when the (10) is expanded then it can be represented as (11),

$$\begin{bmatrix} rtc_{0,0} & rtc_{0,1} & \dots & rtc_{0,Ne} \\ rtc_{1,0} & rtc_{1,1} & \dots & rtc_{1,N_e} \\ \vdots & \vdots & \vdots & \vdots \\ rtc_{N_e,0} & rtc_{N_e,1} & \dots & rtc_{N_e,N_e} \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_{N_e} \end{bmatrix} = e \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_{N_e} \end{bmatrix} \tag{11}$$

The simultaneous equations in (12) can be solved since there are N_a unknowns and N_a number of equations hence it can be solved to obtain eigen vector is provided by (12).

$$\begin{aligned} & rtc_{0,0}e_1 + rtc_{0,1}e_2 + \dots \dots . + rtc_{0,N_{aqs}}e_{N_{aas}} = \lambda_a e_1 \\ & rtc_{1,0}e_1 + rtc_{1,1}e_2 + \dots . + rtc_{1,N_{antennas}}e_{aa} = \lambda_a e_2 \\ & \quad \vdots \quad \vdots \; \vdots \; \vdots \quad \vdots \qquad \vdots \\ & rtc_{Na0}e + rtc_{a1}d_2 + . . + rtc_{N_{antennas},N_{antennas}}e_{Na} = \lambda_a e_{N_{as}} \end{aligned} \tag{12}$$

where am_i is represented the amplitude of i^{th} mobile user. Am_v is the amplitude vector having amplitude information of all the sources which are sending the signal towards the base station. The Hermitian transpose of the amplitude vector is given by (13).

$$AM_v^H = [am_1^*, am_2^*, am_3^*, \dots \dots \dots \dots \dots \dots \dots \dots am_{N_{users}}^*] \tag{13}$$

where am_1^* is the conjugate the of i^{th} amplitude am_i. AM_v^H represents the Hermitian transpose of AM_v. The autocorrelation obtained by having cross correlation signal values as zero can be defined as (14) and (15).

$$CS = AM_v Am_v^H \tag{14}$$

$$CS = \begin{bmatrix} am_1, am_1^*, \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . . 0 \\ 0, am_2, am_2^* \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots 0 \\ . \\ \vdots \\ . \\ 0, \dots \dots \dots \dots \dots \dots \dots . am_{Nusers}, am_{N_{users}}^* \end{bmatrix} \tag{15}$$

In a similar fashion the noise vector is also obtained across all the antenna elements is represented in (16).

$$NV = \begin{bmatrix} ne_1 ne_1^* 0 \dots \dots \dots \dots \dots \dots \dots \dots . 0 \\ ne_2 ne_2^* 0 \dots \dots \dots \dots \dots \dots \dots \dots . 0 \\ . \\ . \\ . \\ 00 \dots \dots \dots \dots \dots \dots \dots . . ne_{Na} ne_{Na}^* \end{bmatrix} \tag{16}$$

The combination of incident vectors across N directions which has the delayed version of electromagnetic wave are given by a matrix as given in (17).

$$U\lambda se_1 = \begin{bmatrix} e\lambda se_{1,1} \\ e\lambda se_{1,2} \\ e\lambda se_{1,3} \\ \vdots \\ . \\ e\lambda se_{1,1}N_a \end{bmatrix} \quad (17)$$

$U\lambda se_1$ is the matrix of unknows with a dimension of $N_a * 1$ and after solving the above equation we get the eigen vector $U\lambda se1$. Like this process is repeated for all the signal eigen values and eigen vectors are given by (18).

$$\{U\lambda se_1, U\lambda se_2, \dots \dots .. U\lambda seN_a\} \quad (18)$$

when all the signal eigen values are combined then we get the following which is a signal subspace is given in (19).

$$SS = \{U\lambda se_1, U\lambda se_2, \dots \dots .. U\lambda seN_a\} \quad (19)$$

The *SS* matrix will be a $N_a * N_a$ matrix with each $U\lambda se1$ Representing the eigen vector. The expanded view of (19) can be represented in (20).

$$SS = \begin{bmatrix} e\lambda se_{1,1} & e\lambda se_{2,1} \dots \dots .. \dots .. e\lambda se_{1,}N_a \\ e\lambda se_{1,2} & e\lambda se_{2,2} \dots \dots .. \dots .. e\lambda se_{2,}N_a \\ & . \\ & . \\ e\lambda se_1 N_a & e\lambda se_2 N_a \dots \dots \dots .. e\lambda se_{2,}N_a \end{bmatrix} \quad (20)$$

where each value $e\lambda se_{k,,,,}l$ is representing a value present in k^{th} eigen vector with l^{th} row. The signal subspace *SS* must undergo factorization and the entire matrix must be divided into two separate matrices with first matrix as given in (21) having the magnitude of values only below the principal component and then the second matrix as given in (22) will have the magnitude values above the principal.

$$LM = \begin{bmatrix} 1 & 0 \dots \dots \dots \dots \dots \dots \dots ..0 \\ ML_{2,1} & 1 \dots \dots \dots \dots \dots \dots \dots ..0 \\ & . \\ & . \\ ML_{N_e,1} & ML_{N_e,2} \dots \dots \dots \dots \dots ..1 \end{bmatrix} \quad (21)$$

The second matrix is provided with magnitude values above the principal component.

$$UM = \begin{bmatrix} um_{11}, uem_2 \dots \dots \dots um_1 N_e \\ 0, um_{22}, \dots \dots \dots \dots \dots um_2 N_e \\ . \\ \vdots \\ . \\ 0,0, \dots \dots \dots \dots \dots \dots \dots umN_e N_e \end{bmatrix} \quad (22)$$

The factorization matrix *F* can be defined in (23).

$$F = LM * UM \quad (23)$$

The side lobe radiation can be reduced by making use of suppression technique like hamming window. The hamming window will be modified to have lesser magnitude is given in (24).

$$SLS = 0.54 - 0.46\, cos(\frac{2\pi n}{M-1}) \quad (24)$$

The power spectrum can be computed by making use of RoSDBA given by (25).

$$P_{FMHW} = \frac{1}{{IV^H}_{\theta} F F_f^H IV_{\theta}} * SLS \quad (25)$$

where IV_{θ} is represented as incident vector for angle θ, F^H is described as Hermitian transpose of factor value, F is identified as factorization signal, ${IV^H}_{\theta}$ is represented as Hermitian transpose for incident vector, SLS side lobe suppression signal.

5. PERFORMANCE MEASURE

For the performance analysis carried out between conventional methods with the proposed method has been identified by considering different simulation parameters such as resolution, bias, and bias error across board (BEAB) on the basis of which are computed can be defined as:

5.1. Resolution

Resolution beamforming specifically focuses on improving the spatial resolution of the beam pattern. It aims to narrow the main lobe of the beam and reduce the side lobes, allowing for better discrimination between different sources or targets in the environment When there are two nearly equal directional sources then how good the algorithm can distinguish between them.

5.2. Bias

It is defined as the accuracy of the estimated direction is given in (26).

$$Ba = |\theta_{estimated} - \theta_{actual}| \quad (26)$$

where $\theta_{estimated}$ is presented as estimated direction of mobile. θ_{actual} is described as actual direction of mobile.

5.3. BEAB

The BEAB, bias errors can arise due to various factors, including manufacturing variations, component tolerances, temperature effects, electromagnetic interference, aging, and voltage supply fluctuations. These errors can affect the accuracy and reliability of the system or device relying on the measurements. Is defined as the square root of bias mean values is computed using (27).

$$BEAB = \sqrt{Ba} \quad (27)$$

$\theta_{first} \leq \theta + 1^0 \leq \theta_{last}$, where θ_{first} is represented first value of direction, θ_{last} is described as last value of direction.

5.4. Side lobe radiation factor

The side lobe radiation factor refers to the measure of radiation or energy that is emitted in undesired directions, known as side lobes, in an antenna’s radiation pattern. It quantifies the level of energy radiated by an antenna away from its main lobe, which is the primary direction of maximum radiation this can be achieved by using (28).

$$SLRF = \sum_{i=1}^{Nd} PF(i) \quad (28)$$

where Nd is presented as number of directions apart from major lobes. $PF(i)$ is described as power factor of i^{th} direction.

5.5. Time taken for detection

The time taken for detection can vary depending on the specific context and the detection system being used. It is influenced by factors such as the type of detection method employed, the characteristics of the target or event being detected, the sensor technology, the processing algorithms, and the desired level of detection accuracy. Time taken for detection is defined as the difference between time at which the detection starts and time at which actual detection gets completed this can be achieved by using (29).

$$TT = t_{stop} - t_{start} \quad (29)$$

where t_{stop} is the time after detection is completed, t_{start} is the time while detection is started the proposed algorithm can be summarized in Figure 2.

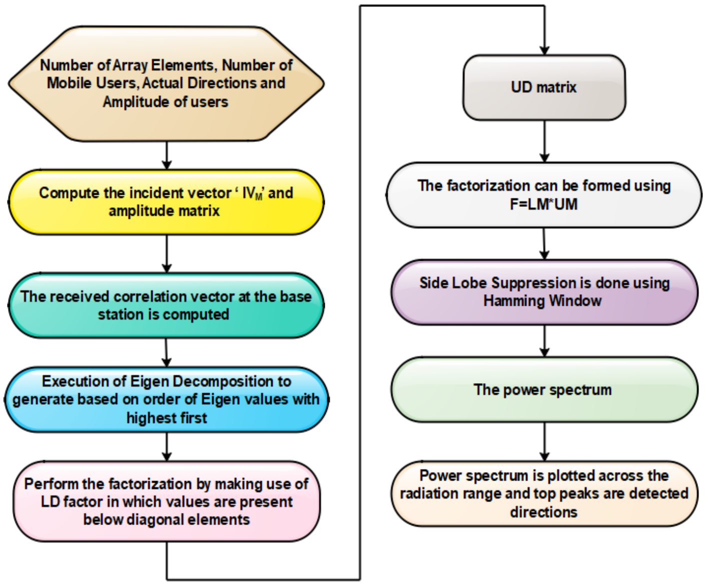

Figure 2. Fundamental flow chart of proposed RoSDBA

6. RESULTS

The arrangement of dipole antenna in a linear fashion with an equal distance between the elements. The experimental set up can be defined as in Table 1. The simulation analysis has been performed with respect to various array elements and user's direction. On the basis of this variation, a comparison has been done on time taken, bias and side lobe radiation factor (mW).

Table 1. Experimental set up

Name	Value
Type of element used in an array	Dipole
Arrangement kind	Linear fashion with equal distance
Directional range	$-90^0 \le \theta \le 90^0$
Distance of separation	$\frac{\lambda}{2}$

6.1. Case_1: Low array elements and long direction separable users

Table 2 shows comparison analysis between proposed method with existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources. Table 3 shows the comparison analysis between the proposed method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources. The analysis is carried out by considering case 1 parameters, the proposed RoSDBA method shows better performance as compared to existing methods.

Figures 3 to 5 show the performance analysis between the proposal method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources respectively. Due to this process, the proposed method has been effectively identified the optimal source detection and beam allocation using smart antenna.

Table 2. Case 1 simulation input

Algorithm name	Time taken (s)	Bias	Side lobe radiation factor (mW)
Bartlett	0.7308	3.8958	6.1256
MLM	0.7500	1.0310	0.0366
MUSIC	0.7456	0.2290	0.0161
MEM	0.7213	0.0119	0.0088
RoSDBA	0.0572	0.0193	0.0079

*Table 2 has been constructed by considering case 1 parameters

Table 3. Case 2 simulation input

Name	Value
Number of array elements	8
Number of sources	4
Amplitude of sources	[5 v 10 v 15 v 20 v]
Mobile source directions	[30 34 38 42]

*Table 3 has been constructed by considering case 2 parameters

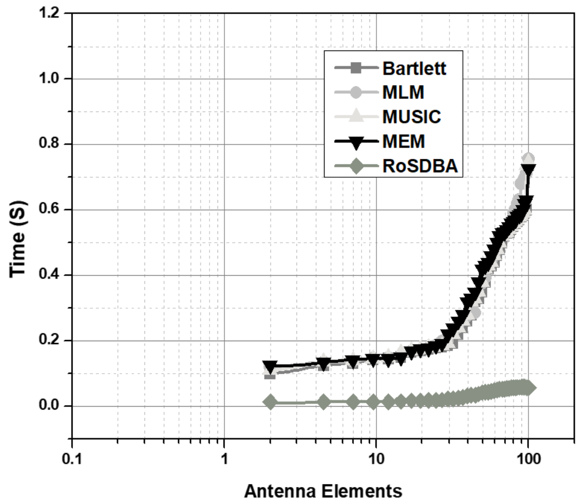

Figure 3. The performance analysis between proposal method with existing methods with respect to time taken

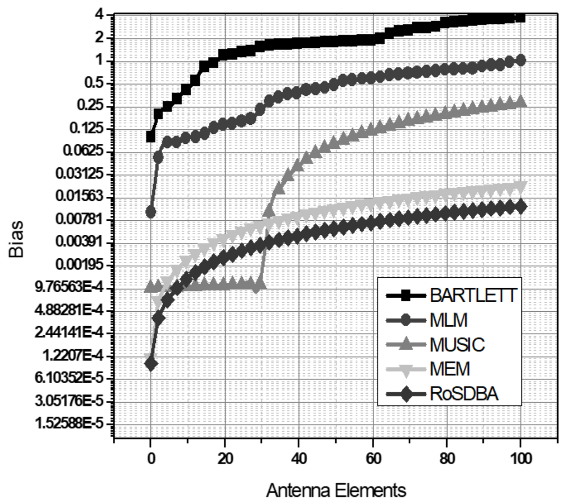

Figure 4. The performance analysis between proposal method with existing methods with respect to bias

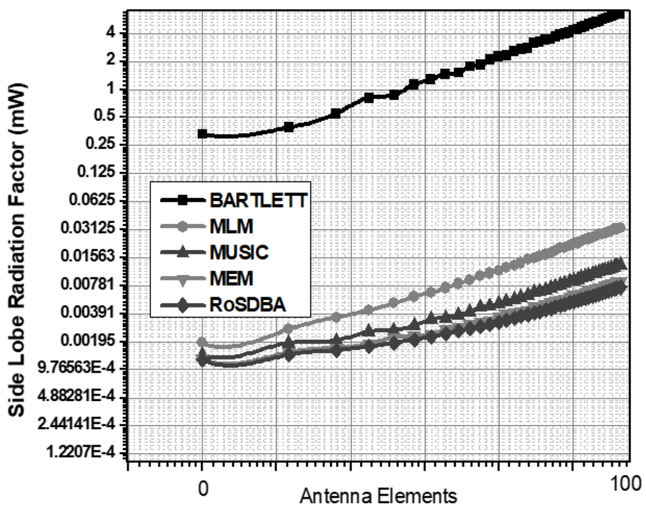

Figure 5. The performance analysis between proposal method with existing methods with respect to side lobe radiation factor (mW). (The analysis is carried out by considering case 1 parameters)

6.2. Case_2: Low array elements and nearby direction separable users

Table 3 shows the case 2 experimental setup. The analysis is carried out by considering case 2 parameters, the proposed RoSDBA method shows better performance as compared to existing methods. Figures 6 to 8 show the performance analysis between the proposal method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources respectively. Table 4 shows the comparison analysis between the proposed method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources.

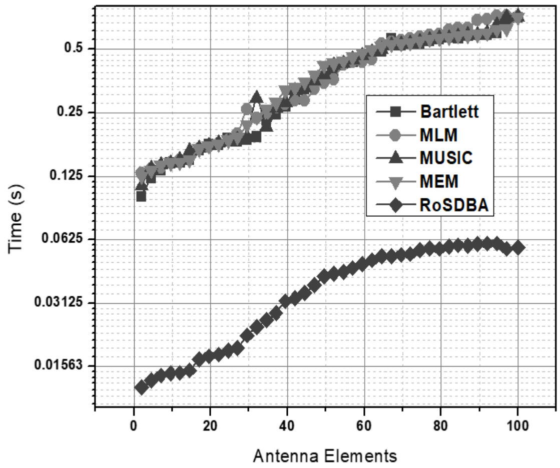

Figure 6. The performance analysis between proposal method with existing methods with respect to time taken

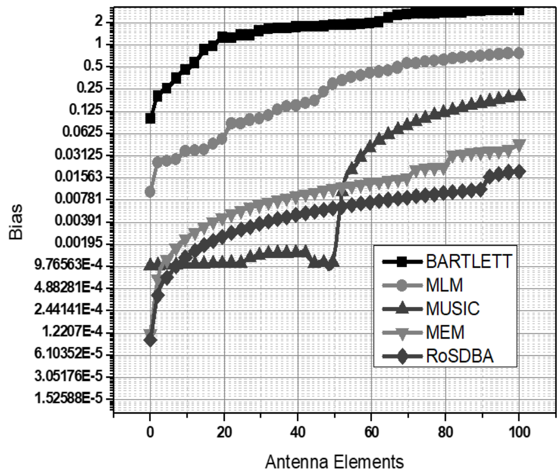

Figure 7. The performance analysis between proposal method with existing methods with respect to bias

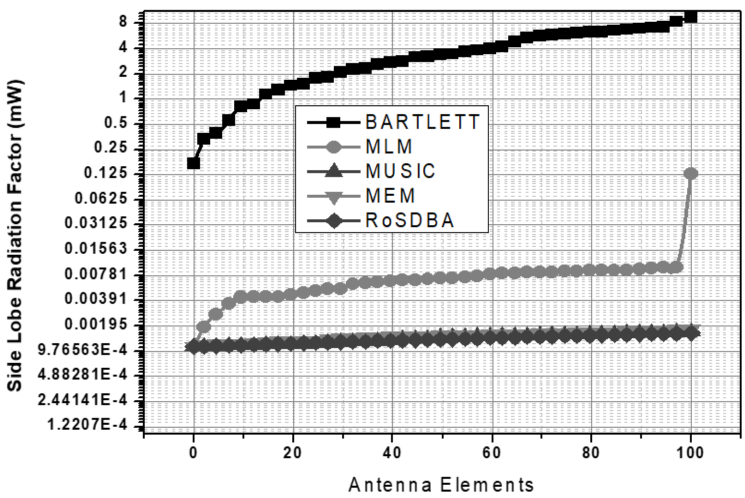

Figure 8. The performance analysis between proposal method with existing methods with respect to side lobe radiation factor (mW). (The analysis is carried out by considering case 2 parameters)

Table 4. Comparison analysis between proposed method with existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources

Algorithm Name	Time Taken (s)	Bias	Disturbance Factor (mW)
Bartlett	0.7147	2.5115	9.7909
MLM	0.7186	0.7927	0.0146
MUSIC	0.7181	.1329	0.0016
MEM	0.7189	0.0440	0.0016
RoSDBA	0.0574	0.0193	0.0013

6.3. Case_3: Large array elements and long direction separable users

Table 5 shows the case 3 experimental setup. The analysis is carried out by considering case 3 parameters, the proposed RoSDBA method shows better performance as compared to existing methods. The analysis is carried out by considering case 3 parameters, the proposed RoSDBA method shows better performance as compared to existing methods. Figures 9 to 11 show the performance analysis between the proposal method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources respectively. Table 6 shows the comparison analysis between the proposed method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources.

Table 5. Case 3 simulation input

Name	Value
Number of Array Elements	100
Number of Sources	4
Amplitude of Sources	[5 v 10 v 15 v 20 v]
Mobile Source Directions	[30 45 60 75]

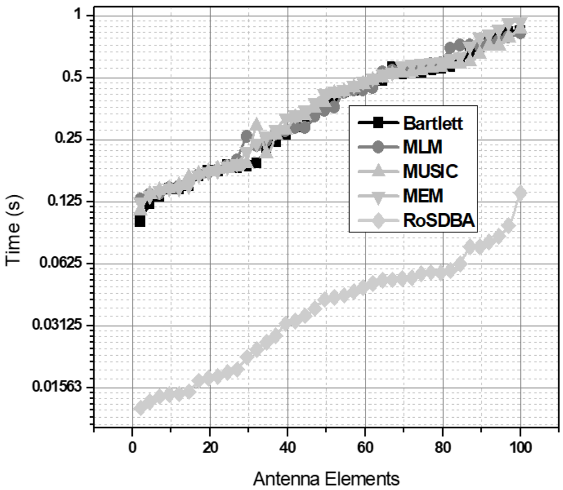

Figure 9. The performance analysis between proposal method with existing methods with respect to time taken

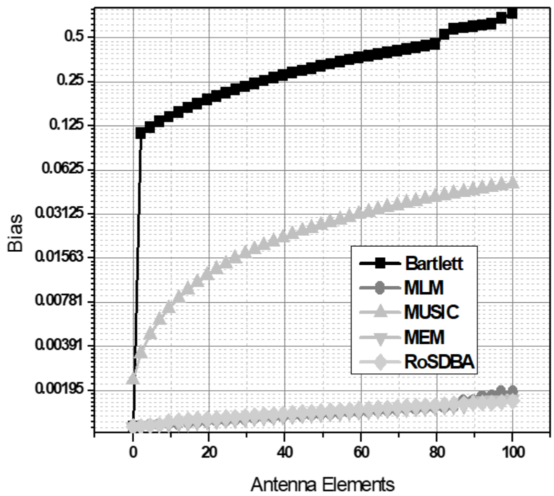

Figure 10. The performance analysis between proposal method with existing methods with respect to bias

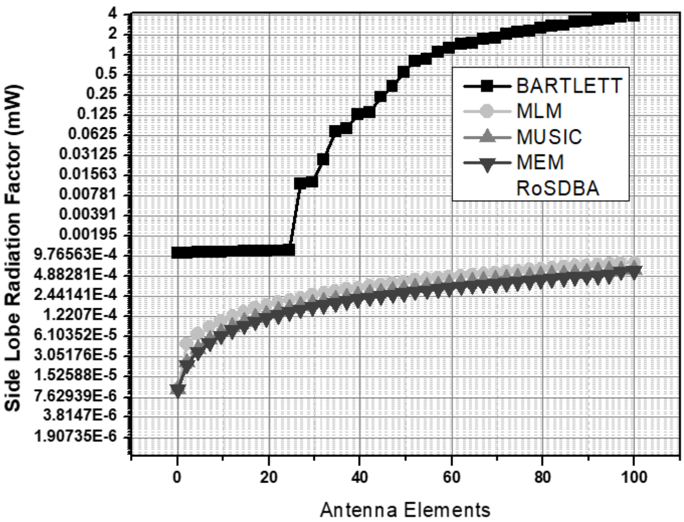

Figure 11. The performance analysis between proposal method with existing methods with respect to side lobe radiation factor (mW)

Table 6. Comparison analysis between proposed method with existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources

Algorithm Name	Time Taken (s)	Bias	Disturbance Factor (mW)
Bartlett	0.8015	0.7876	2.4350
MLM	0.8011	0.0193	0.00007
MUSIC	0.9445	0.0515	0.00007
MEM	0.8246	0.0118	0.00007
RoSDBA	0.1399	0.0118	0.00007

*Table 6 has been constructed by considering case 3 parameters

6.4. Case_4: Large array elements and nearby direction separable users

Table 7 shows the case 4 experimental setup. The analysis is carried out by considering case 4 parameters, the proposed RoSDBA method shows better performance as compared to existing methods. The analysis is carried out by considering case 4 parameters, the proposed RoSDBA method shows better performance as compared to existing methods. Due to this process, the proposed method has been effectively identified the optimal source detection and beam allocation using smart antenna.

Figures 12 to 14 show the performance analysis between the proposal method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources respectively. Table 8 shows the comparison analysis between the proposed method and existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources.

Table 7. Case 4 simulation set up

Name	Value
Number of array elements	100
Number of sources	4
Amplitude of sources	[5v 10v 15v 20v]
Mobile source directions	[30 35 40 45]

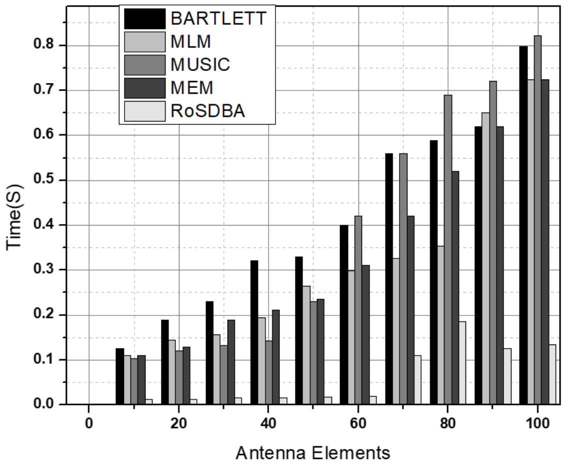

Figure 12. The performance analysis between proposal method with existing methods with respect to time taken

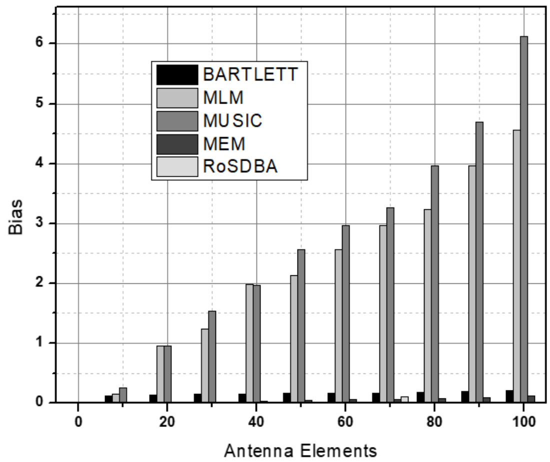

Figure 13. The performance analysis between proposal method with existing methods with respect to bias

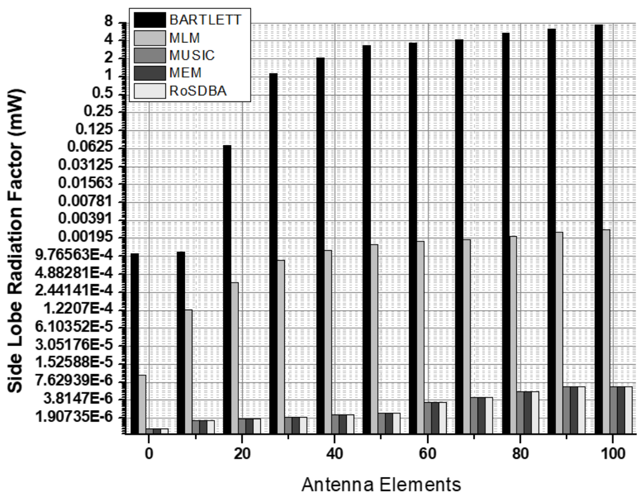

Figure 14. The performance analysis between proposal method with existing methods with respect to side lobe radiation factor (mW). (The analysis is carried out by considering case 4 parameters)

Table 8. Comparison analysis between proposed method with existing methods with respect to time taken, bias and side lobe radiation factor for the detection of sources

Algorithm name	Time taken (s)	Bias	Disturbance factor (mW)
Bartlett	0.7423	0.2180	7.5656
MLM	0.7557	4.9386	0.002
MUSIC	0.8329	6.4549	0.0000006
MEM	0.7404	0.1270	0.0000006
RoSDBA	0.1396	0.0193	0.0000006

7. CONCLUSION

In this paper, the proposed RoSDBA method efficiently detects the direction of mobile users as compared to the conventional methods for various scenario such as lesser antenna elements and widely separable sources, lesser antenna elements and closely separable sources, larger antenna elements and widely separable source and finally larger antenna elements and closely separable source. The analysis is carried out by considering all four case parameters and their average results as detailed below. The proposed method shows better performance as compared to conventional methods. The average value of time taken with respect to all four cases is 5.5%, 2.1%, 3.1%, and 1.5% as compared to conventional methods Bartlett, MLM, MUSIC and MEM respectively. The proposed method shows better performance as compared to conventional methods. The average value of bias with respect to all four cases is 2.4%, 1.1%, 0.9%, and 0.5% as compared to conventional methods Bartlett, MLM, MUSIC and MEM, respectively. The proposed method shows better performance as compared to conventional methods. The average value of side lobe radiation factor (mW) with respect to all four cases is 3.1%, 1.5%, 0.8%, and 0.4% as compared to conventional methods Bartlett, MLM, MUSIC and MEM, respectively.

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