3D MIMO Beamforming Using Spatial Distance SVM Algorithm and Interference Mitigation for 5G Wireless Communication Network

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ABSTRACT

In recent decades, multiple-input multiple-output beamforming is deliberated as the vital technology enablers for 5G mobile radio services since it provides noticeable improvement regarding throughput and coverage measures in 5G networks. Primarily, 3D MIMO executed beamforming using the modified support vector machine algorithm which forms beam effectually to the users. The interference is mitigated in two stages that are small cell interference and macro cell interference by measuring the interference power from the cells. To provide better security to the data transmitted over device-to-device communication, advanced encryption standard algorithm is used. The results attained from the simulations are auspicious in terms of metrics including throughput, signal to interference plus noise ratio (SINR), and signal to noise ratio (SNR). From the simulation results, the authors prove that the ML-3DIM method increases throughput, SINR, SNR by up to 20%, 30%, and 35%, respectively, compared to the existing methods including PABM, ULABM, and NOMA.

KEYWORDS

5G, AES, D2D Communication, Spatial Distance, SVM, Three Dimensional, Three-Dimensional MIMO Beamforming

1. INTRODUCTION

As an augmentation in the quantity of wireless data traffic incessantly, there is a demand to provision this proliferation in 5G networks. MIMO technologies are one of the candidates for the physical layer model of 5G networks. MIMO based on transmitting disparate signals over manifold antennas to gain capacity. Multiple antenna technologies containing 3D MIMO beamforming have drawn much interest among academia and research communal (Liu et al., 2017; Yadav and Tripathi, 2020) and (Zhang et al., 2018). It forms the three-dimensional beam between the transmitter as well as receiver by the antenna array (Zhang, Jon et al., 2017). In traditional 2D MIMO beamforming approaches, consider only the azimuth angle, and constant vertical patterns. It introduces difficulty in providing

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access to multiple users for communication (Liu, Feng et al., 2018). To resolve issues in the 2D-MIMO beamforming, 3D-MIMO beamforming has emerged.

Figure 1. 3D MIMO beamforming

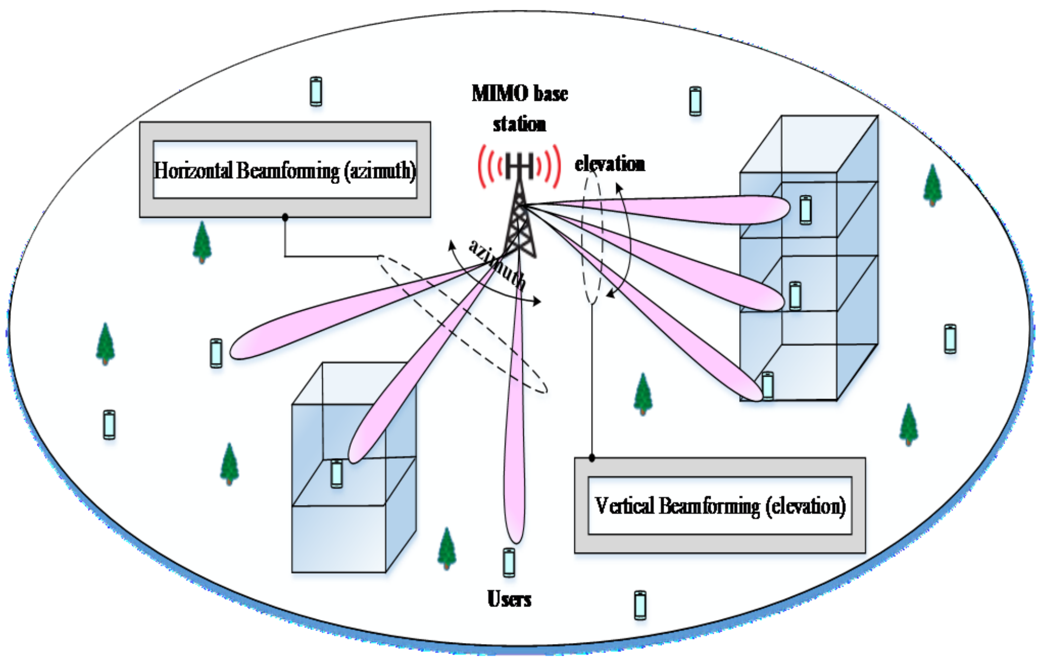


Figure 1 elucidates the 3D-MIMO beamforming in the 5G networks. Here, vertical together with horizontal BF procedures are shown in detail. By exploiting BF in both the dimension provides better signal strength during communication (AissaouiFerhi et al., 2019). There have been many works concentrating on BF in the MIMO system. Authors (Rachard et al., 2019; Yadav and Tripathi, 2021) consider the spatial distribution of the user locations to form the 3D MIMO beamforming in 5G networks. An optimization algorithm is considered for the 3D MIMO beamforming in 5G networks (Yuan et al., 2015). In recent days, artificial intelligence techniques, says ML, have grown drastically in wireless terminals (Xie, Ji et al., 2019). A most propitious artificial intelligence tool is ML, which is implemented to model different technical problems of smart wireless terminals or next-generation networks. Additionally, the computational intricacy augments exponentially with the augmentation of the system scale aimed at resource allocation issues, which are complicated to solve. BF is a sort of these problems. But, a possible technical approach is rendered by ML for solving such problems. Some of the works have concentrated on utilizing the ML algorithm in BF (Kwon, Lee et al., 2019). Here, the MIMO antenna based Base Station (BS) is utilized to perform BF in the network. In this BF, the network capability together with spectral efficiency is considered for attaining a higher gain.

First, to augment the network capacity, the cell-based networks have arisen (Sheng et al., 2016). Here, the MC network comprises multiple SC networks to enhance the capacity of the network (Nguyen et al., 2015). Here, the SC networks are considered as the lower power nodes, which also function as the vital capacity driver intended for outdoor and indoor hotspots (Li, Jin, Gao et al., 2018). The interference is a major issue in the MIMO beamforming in 5G cell-based networks (Ali et al., 2019). Even though, 3D MIMO beamforming considerably reduces the interferences contrasted with the 2D

MIMO beamforming approaches, still, there is a need to evade interference in 5G networks. Authors (Lim et al., 2017) concentrated on a random antenna selection approach to lessen the interference during the 3D MIMO beamforming. The positioning aware BF is performed to lessen the interference among the user equipment (Lazarev et al., 2019).

Second, to enhance the spectral efficiencies of the 5G MIMO system, D2D communication is emerged (Ghadyani et al., 2018). Here, the D2D user communicates with one another without the assistance of the BS. All sorts of communication should be regarded for security issues, especially when it comes to wireless communication. Security is a chief constraint during transmission between D2D users (Vijay et al., 2019). It is made sure via the security providing algorithm that encrypts the data in the transmitter side afore to the transmission. To save the data from the eavesdropper during the D2D communication, authors in (Jaysinghe et al., 2015) introduces the physical-layer network coding approaches. The opportunistic control access technique is used to provide safe Data Transmission (DT) in D2D communication (Chen et al., 2017).

1.1 Issues of the 3D MIMO Beamforming in 5G Network

From the aforesaid studies, it is perceived that 3D MIMO beamforming, secure DT in a 5G network faces some issues. They are listed:

- Lack of effective mechanism to perform 3D beamforming to enhance the throughput in the 5G network.
- Mitigating interference betwixt user equipment is difficult because of a large scale network.
- Absence of data security during D2D communication in 5G MIMO systems.

1.2 Objectives and Contributions

To overwhelm the aforesaid issues in the proposed ML-3DIM approach, the upcoming objective function are formulated:

- To design an effective 3D MIMO beamforming system utilizing ML approach.
- To utilize an efficient antenna array for achieving a better result in the 3D MIMO beamforming.
- To evade interference during the communication betwixt the user equipment and BS.
- To provide better security during DT between D2D devices.

To attain the aforesaid objective, ML-3DIM method contributes succeeding processes:

- The throughput of the network is enhanced through an effective 3D MIMO beamforming process. It is accomplished using the spatial distance SVM algorithm. The Spatial distance SVM in 3D MIMO beamforming in 5Gnetwork is utilized. Here, the rectangular array is exploited to attain a better outcome in the BF.

- The interference in the 5G MIMO network is mitigated in two different stages for both SC and the MC. Thus, improves the DT performance in the 5G MIMO system.
- The security during the DT between D2D communications is ensured using the AES algorithm. The CTR mode is utilized for AES encryption. It performs better in safeguarding the data during transmission in an effective manner compared to the other means of operation.
- The ML-3DIM system's performance is validated using the three measures that are throughput, SINR, and SNR.

The chief motivation of this paper is to render an extremely optimal solution in 3D MIMO beamforming, after that, alleviate the SC interference along with MC interference, and secures D2D communications. The novelty comes in the sense of utilizing modified SVM in 3D MIMO beamforming and upholds the secure transmission AES and the proposed work exploited the CTR mode for AES.

Paper Outline: Outline of this paper is succinct as: Section 2 elucidates the prior works that exist in the MIMO beamforming in the 5G network. Section 3 explains the problems that occur in previous works. Section 4 renders a brief study of our ML-3DIM with our exploited algorithms. Section 5 exhibits the numerical outcomes attained from the experimentation and also compares it with existing methods. Finally, this paper is ended with section 6 that concludes the contribution and also provides some comments on future direction.

2. RELATED WORK

In this section, we review the works that are associated with the proposed ML-3DIM approach. Here, the three significant processes are discussed that are MIMO beamforming, Interference Mitigation (IM), and security in D2D communication.

2.1 3D MIMO Beamforming

BF techniques for wireless communication systems utilizing manifold antenna arrays for transmission as well as reception to augment the signal to interferences and noise ratios (SINR) have been expansively investigated in preceding studies. However, BF only in the horizontal dimension doesn't provide enough free-space gain. It is vital to propose an ameliorated BF algorithm, which provides the gain in the vertical dimension. Thus, most of the prevailing works performed the 3D MIMO beamforming methods for attaining significant gain, therefore, the prevailing studies are illustrated as,

Authors (Li et al., 2016) offered the Lagrange dual method for 3D MIMO beamforming. In this, the dynamic BF approaches were exploited to form the beams to the user equipment. Here, the lag range dual method was utilized to perform the vertical BF in the MIMO system. Furthermore, this paper enhances spectrum efficiency through the iterative mechanism. Authors (Gao et al., 2018) have pointed out the smart 3D coverage optimization method. The exploited 3D coverage optimization method provided the optimized weights to vertical and horizontal planes that were given in the antenna array. After allocating weights to both planes, horizontal together with vertical planes were integrated. The final 3D MIMO beamforming patterns were achieved by the integration of the vertical together with horizontal planes.

Authors (Li, Jin, Suraweera et al., 2016) introduced statistical 3D BF procedures in MIMO systems. Here, the statistical 3D MIMO beamforming transmission algorithm was utilized to establish the BF in networks. The uniform planar antenna array was utilized in the 3D MIMO base-station. In this, the exact closed-form expressions and simple ergodic sum-rate were obtained. Based on the estimated sum rate, it formed beams respective to the BS. The user height impact based 3D MIMO BF was introduced by authors (Baianifar et al., 2017). The 3D MIMO beamforming was performed via the estimation of the user height. It was estimated using the coverage probability estimation. Here, the estimated coverage probability was considered as the objective function to establish the 3D MIMO beamforming. Based on the obtained coverage probability, 3D MIMO beamforming was achieved in this paper. Authors (Seleem et al., 2015) pointed out the two-stage multi-user access based 3D MIMO beamforming. Here, the optimum detector algorithm was utilized to attain the better result MIMO beamforming. The GLRT based detector was used to establish the 3D MIMO beamforming. Based on these detector procedures, this paper formed the 3D MIMO method.

Authors (Aylapogu PramodKumar et al., 2020) generated high BF with the aid of mutual coupling amongst the '4' antenna elements to encourage ameliorated transit capacity as well as empower the communication bandwidths at extremely large data rates aimed at 5G Technology. The designed antenna was developed with a MIMO patch antenna with extensive aspects. The frequency space from 2.2 GHz to 4.8 GHz was operated. The antenna was developed with FR4 material with a 4.4 di-electric consistent, 0.02 loss tangent together with a1.6 mm density. The designed antenna was more appropriate for approaching 5G mobile applications.

2.2 Interference Mitigation

Interference is a major impediment to reliable and efficient wireless transmissions, and can negatively impact performance and coverage in mobile systems. Mitigation of this interference is a critical problem for wireless systems. Numerous mitigation techniques are handled by the prevailing works that are listed as,

Authors (Xu et al., 2016) offered the minimal mean square error based 3D beamforming in MIMO systems. Here, the interference during the 3D beamforming was mitigated through the estimation of the minimal mean square error. In this, the weights were allocated to each horizontal and vertical antenna array in order to reduce the interference between users via minimizing the minimal mean square error. Authors (Ishihara et al., 2017) pointed out the mitigation of intercell interference in the MIMO system. Here, the interference was mitigated using the transmit BF procedures. Here, the transmit BF and null BF procedures were applied based on the estimated intercell IP. Here, the transmit BF and null BF were used dynamically based on their threshold constraints satisfaction.

Authors (Grassi et al., 2018) concentrated on the interference coordination for MIMO systems. In this, the channel state information (CSI) of the different users was considered to reduce the interference during the DT. Furthermore, this paper also exploited the two-stage coding procedures to achieve better results in the BF. Authors (Fan et al., 2015) offered the co-ordinated BF procedures to mitigate the interference in the system. Here, both SC and MC were considered to mitigate the interference. In the codebooks were allocated to each user equipment, the codebook which introduced more interference to the SC were discarded from the network. In this way, this paper mitigated the interference between the SC and MC. Authors (Qin et al., 2018) concentrated on the IM in the MIMO system. Here, the interference between the users was mitigated through the fractional frequency reuse (FFR) method. Along with that, it utilized the 3D beamforming transmission algorithm to further mitigate the interference between the users that was presented in the network.

2.3 Secure D2D Communication

For 5G, D2D is becoming an integrative term of emerging technologies that take advantage of the proximity of communicating entities in licensed and unlicensed spectra. However, the D2D suffer as of the security issues. The prevailing works concentrated on to resolve the security issues of the D2D that are enlisted as,

Authors (Liu, Wang, RazaZaidi et al., 2016) pointed out the secure D2D communication in MIMO systems. Here, the security during the D2D communication was accomplished via the secrecy outage probability (SOP). For secrecy outage probability, this paper proposed the new analytical expressions. Based on the constructed analytical expressions, this paper provided security to the data transmitted over D2D communication. Authors (Jiang et al., 2017) offered secure D2D communication in the MIMO system. It was achieved by the non-convex problem-based approximation procedures. Here, the Karush-Kuhn-Tucker (KKT) conditions were utilized to provide secure D2D communication in the MIMO system. In this, security was provided based on the two different phases, such as first and second.

Authors (Zhang et al., 2017) introduced a robust lightweight security scheme to the D2D communication. Here, the security was provided by the Generalized SignCryption algorithm. It was performed based on the three consecutive processes that are signcryption, signature, and the encryption process. In this, the encryption process encrypted the data to be transmitted over the D2D communication. From these processes, this paper secured the data to be transmitted. Authors (Gope et al., 2019) pointed out the lightweight anonymous authentication protocol for D2D communication.

Here, the privacy-preserving secure architecture was proposed to secure the data transmitted over the D2D communication. In this, three lightweight authentication protocols were used to secure DT. The one-way function and exclusive OR schemes were exploited to secure the D2D communication. Authors (Abd-Elrahman et al., 2015) concentrated on proposing the Identity-based Encryption (IBE) method to secure DT in D2D communication. Here, the hybrid approach was exploited to secure the data transmitted over the D2D communication. In this, the IBE and curve cryptographic algorithms to encrypt the data are transmitted over the network. Authors (Ana Paula Golembiouski Lopes et al., 2020) commenced an Authentications and Key Agreement (AKA) protocol aimed at D2D groups of devices centerd on asymmetric cryptography as well as aggregated signatures. The chief focus was given to robust security as well as diminution in computational and communication expenses. It was contrasted with regard to security and overhead diminution with the other group AKA protocols. And it yielded better outcomes. Automated Validations of Internets Security Protocols and Applications tools (AVISPA) conducted a formal validation, which proved its robustness.

2.4. Drawbacks of Prior Work

This section is devoted to summarizing the issues that existed in the papers that are reviewed in the preceding sections, which are listed in table 1.

Table 1. Drawback of Prior Work

Topics	Methodology Proposed	Drawbacks
3D MIMO BF	Lagrange Dual method, coverage optimization method, coverage probability, statistical 3D beamforming, Two-stage method	Lack of optimal solution in 3D MIMO beamforming because of ineffective mechanism. Uniform linear array-based BF isn't able to cover 360^0
Interference Mitigation	Minimal Mean Square Error, Transmit BF, CSI, FFR, Codebook based IM method	Lack of parameter consideration during IM. Tedious computation process.
Secure D2D communication	SOP, KKT, Generalized SignCryption, lightweight anonymous authentication protocol, IBE	Consumes more time to encrypt during the security process. Slow processing

The top-notch methods have an issue as exhibited in table 1, so to trounce those issues, the proposed methodology manages the modified SVM centered 3D MIMO beamforming technology and to alleviate the SC as well as MC interferences and utilizes the AES algorithm for achieving the secure D2D communication.

3. PROBLEM STATEMENT

In this section, the problems present in the existing 3D MIMO beamforming, IM, and secure D2D communication are discussed. We initially defined problems from the works related to the MIMO beamforming in the 5G network. Some of the works have utilized the phased array antenna and uniform linear array antenna in the MIMO base station to perform BF in the 5G network (Jo et al., 2017) and (Lota et al., 2017). These antenna arrays are not suitable for BF in 5G networks. Since these antenna arrays provide limited coverage to the users present in the 5G network i.e. 120^0. Thus, results in ineffective BF in the 5G network. The employment of optimization algorithms aimed at BF just locates a local optimum and had difficulty in resolving discrete optimization issues. They are complex algorithms and are hard to implement efficiently and prone to numerical noise. The intercell interference was mitigated through the sectoring process (Ali, Elsawy et al., 2017). This way of sectoring the network leads to an increase in the handoff requirement. Besides, it also creates difficulties in BS communication. The approaches for IM surveyed in the literature rely on the channel vectors' independence or the employment of linear antenna arrays. Additionally, the column space of the channel was not considered. It brought about the little interference as the interference's null space is not completely satisfied. The approaches' performance for IM requires further enhancement as more signal power could well be amassed when more dimension of the interference's null space is utilized. When D2D communications are implemented to the future 5G systems, it confronts numerous security challenges. D2D communication security was achieved through the authentication process (Kumar et al., 2018). Here, the authentication credentials were transmitted to the BS without securing it via encryption. Thus, may leads to the forging of user credentials by the eavesdropper. Furthermore, some of the works in the 5G network don't concentrate on securing D2D communication, thus, leads to the forging of data by eavesdropper (Zhang et al., 2017). To overwhelm these problems in the existing work, our ML-3DIM method is designed to answer the succeeding research questions:

- How to design the novel 3D MIMO beamforming in 5G network with high coverage providence?
- How to mitigate the interference from the neighbour cells in the network?
- How to secure DT in D2D communication in the network?

The paper is presented by answering the above-given '3' questions with the help of effectual BF, interference mitigation, as well as secures D2D communication strategies. The SVM is chosen for doing BF. A novel algorithm that is exhibited in sections 4.4.1 and 4.4.2 is taken to alleviate the interferences (macro cell and small cell mitigation) of the networks. Lastly, AES performs secure data transmission in the D2D communication network. The proposed technique's results are contrasted with some prevailing techniques for analyzing its efficiency, which is exhibited in section 5.

4. SYSTEM MODEL

This section is dedicated to providing a brief description of the proposed ML-3DIM approach. Here, the proposed ML-3DIM processes are discussed in detail, aiming to enhance the throughput and to reduce the SINR and SNR.

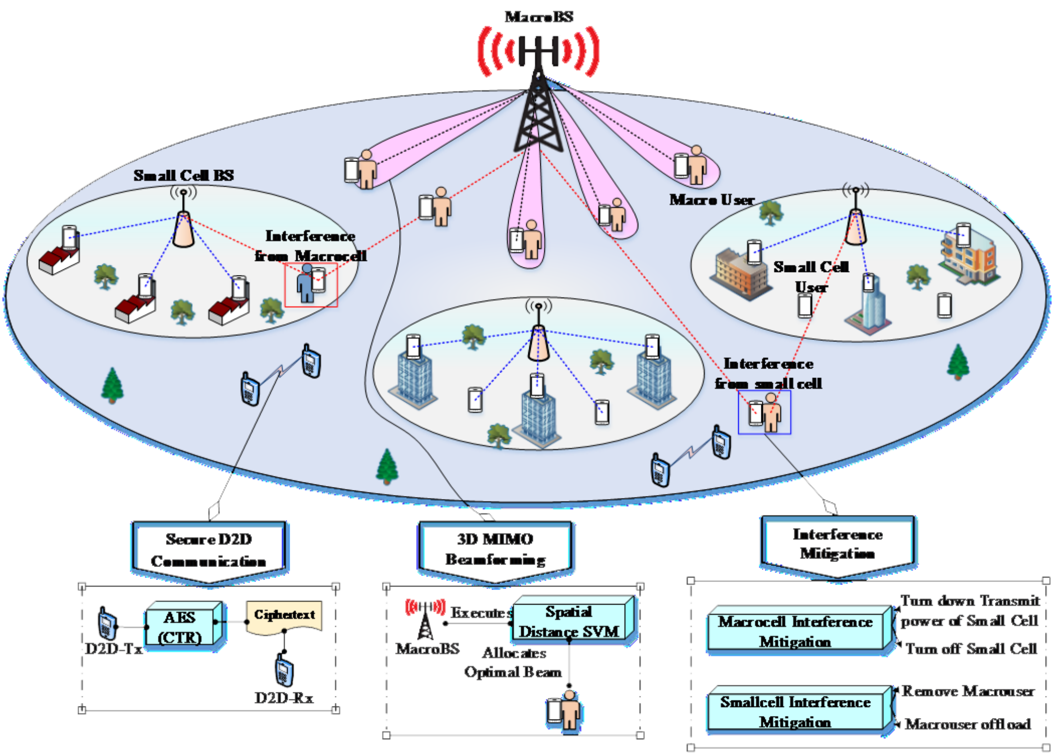
4.1 Network Architecture

In our work, we have considered the downlink DT in the 5G network, which is formed by the single macro base station (M-BS) algorithm with multiple SC as depicted in figure 2. Here, the M-BS guarantees inclusive coverage where the small cell assists hotspots. The M-BS equipped with the 5G massive MIMO with a rectangular antenna array in the 3D grid. In this, 'N' macro users ('m') to be scheduled, the total number of macro users 'm' assisted by the 5G macro base station is denoted as T_m. Here, each SC with MIMO antenna is represented as the total number of users T_s which is served by the SC base station. All the transmissions that occurred in our networks take place in the flat fading channels. Each BS present in the network comprises of $N_{\mathbb{T}}$ transmit antenna and user equipment present in the network comprises $N_{\mathbb{R}}$ receiving antenna.

4.2 Conceptual Overview

Our ML-3DIM network adopts both MIMO technology and D2D communication in a 5G network. Our proposed ML-3DIM approach comprises three significant processes to enhance throughput and

Figure 2. Architecture for proposed ML-3DIM method



to reduce SINR and SNR. They are 3D MIMO beamforming, IM, and Secure D2D communication. We proposed a spatial distance SVM algorithm to design an effective 3D MIMO beamforming in a 5G network. Here, we utilized the 3D rectangular array antenna in 5G MIMO base station to provide better coverage to the users present in the network. In our work, we have concentrated on both SC and MC interference. It is achieved through measuring IP from the cells. In addition to these processes, our ML-3DIM method also provides security to the data transmitted over the network. To evaluate the performance of the ML-3DIM method, we utilize three performance measures. They are throughput, SINR, and SNR. Here, the throughput is measured by varying the number of users and distance.

4.3 Machine Learning-based 3D MIMO Beamforming

The 3D MIMO beamforming is a crucial process in the 5G wireless network to maximize the performance of the downlink DT. In our work, we have concentrated on ML-based 3D MIMO beamforming. There have been a very few numbers of works only concentrating on the ML-based MIMO beamforming. Hence, we aimed to propose a spatial distance SVM algorithm to perform BF in the 5G MIMO based system. The reason for choosing SM over other ML algorithms is that it can well be utilized in avoiding the difficulties of utilizing linear functions on the high-dimensional feature space, as well as the optimization issue is transmuted into dual convex quadratic programs. In instances, such as the number of dimensions is above the total samples, it is extremely effective. Additionally, SVM is relatively memory efficient. To the best of our knowledge, this paper is first to propose a Spatial distance SVM algorithm in 3D MIMO beamforming in 5G macro and SC-based networks.

Figure 3. 3D MIMO beamforming

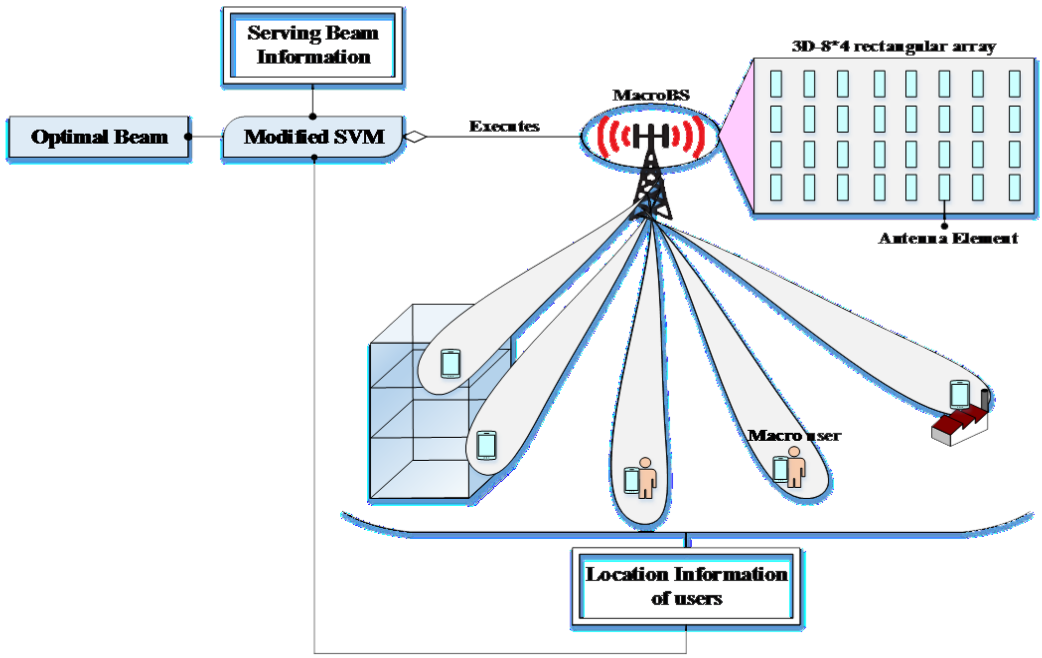


Figure 3 depicts the 3D MIMO beamforming using the spatial distance SVM algorithm. Our proposed ML-3DIM method provides BF in both horizontal and vertical directions with different angles. In our work, we have utilized a 5G MIMO macro base-station with a 3D rectangular antenna array. The reason behind selecting this antenna array is to provide a high coverage area and to increase the throughput of the data communication.

Algorithm 1: Spatial distance SVM based BF

Data: , , , **Output: Optimal beam for users**
//Initialization Procedures *Collect*Location information as expressed in equ. (1); *Collect*set of beamforming ID using equ. (2); *Construct*Beamlocation information using equ. (3); *//Beamforming process* **For** (each) *Construct*Hyperplane using equ. (4); *Evaluate* Optimal parameter () for kernel function using equ. (5); *Construct* kernel function using equ. (9); *Evaluate* Decision function () using equ. (10); **End For**

The algorithm 1 illustrates the 3D MIMO beamforming procedures using the spatial distance SVM algorithm. The proposed 5G M-BS utilizes the 3D rectangular antenna array. It comprises 4 rows with an 8 column antenna format, i.e. 8*4 of rectangular antenna elements. Our proposed BF comprises the two significant processes that are, initialization process and optimal BF process. These processes are discussed as follows:

4.3.1 Initialization Process

In this initialization process, the accuracy of the beam information collected from the user equipment UE is ensured by providing an optimal solution in 3D MIMO beamforming. Here, the user equipment positions are considered as the feature vectors for the optimal beam selection process. The positions of user equipment are gathered and stored for optimal BF process. The collected position information of the user equipment is represented as follows:

$$\mathcal{P} = \left[\left(\delta_1,\varphi_1\right),\ \left(\delta_2,\varphi_2\right),\ldots\left(\delta_n,\varphi_n\right)\right] \tag{1}$$

Here, δ represents the mean vertical, and φ denotes the mean horizontal. The Spatial distance SVM algorithm considers the set of serving beams for communication, which is expressed as follows:

$$B_s = ID_b;\left\{1 \leq b \leq \mathbb{N}\right\} \tag{2}$$

Where, $\mathbb{N}$ denotes the total amount of serving beams and $\mathcal{S}_k$ represents the ID of the b^{th} serving beam.

After completion of the initialization procedure, the location beam information is constructed as follows:

$$L_B = \left\{\left(L_k, E_k\right)\right\};\ L_k \in L_k^{\ n},\ E_k \in E_k^{\ n} \tag{3}$$

Here, L_B represented as the location information, like height, latitude, longitude, and angle of departure in three dimensional. E_k represents the identity of the k^{th} user equipment suitable as a serving beam. Here, the k denotes the total amount of information gathered in the library.

4.3.2 3D MIMO Beamforming Process

In this section, 3D MIMO beamforming processes are discussed. In this, the proposed Spatial distance SVM algorithm location information is considered as the features and the beam information is considered as a class for MIMO beamforming. This information is used in the training process of the SVM. In our work, the Spatial distance SVM algorithm is used to predict the optimal serving beam for the user equipment since it has better classification performance even for a limited number of samples. In this work, the multiclass SVM, i.e. one against one method, is considered for the multi-class classification purpose. Let us assumed that, the size of the b^{th} beam location is represented as the $\mathbb{S}_b$ .The hyperplane of the SVM classifier is expressed as follows:

$$\mathfrak{w}.x + bi = 0 \tag{4}$$

During classification, the positive class beam is labeled as the $+1$. And the negative class beam is labeled as the -1. The performance of the SVM is based on the kernel function where the optimal parameter selection provides a better result in the generalization performance. In our work, modification of the traditional SVM algorithm comes with the selection of the optimal parameter τ .

In this, we have selected the optimal parameter with the use of the spatial distance approach. The problem of the optimal parameter selection is constructed as follows:

$$\min_{\tau} \text{¦} \left(\zeta_i\right) - \text{¦} \left(\zeta_j\right)^2,\ y_i y_j = 1$$

$$\max_{\tau} \text{¦} \left(\zeta_i\right) - \text{¦} \left(\zeta_j\right)^2,\ y_i y_j = -1 \tag{5}$$

The problem discussed above is reformulated as below,

$$\tau = \sum_{i=1}^{n} \sum_{j=1}^{n} y_i y_j \chi \varepsilon_{ij} \tag{6}$$

Here, y_i and y_j signifies the hyperplane parameters and the χ is computed as below expression,

$$\chi = -\frac{1}{2\tau^2} \tag{7}$$

And, ε_{ij} implies the kernel function and it is estimated as follows,

$$\varepsilon_{ij} = \zeta_i - \zeta_j^{\ 2} \tag{8}$$

Wherein, ζ_i and ζ_j signifies the '2' disparate classes and with the above expression, we selected optimal parameter for kernel function, which provides the better result in the 3DMIMO beamforming. With the estimated optimal parameter τ, kernel functions to separate the two different classes are radial basis function. The reason behind selecting this kernel function is that it provides better results and less complexity compared to the other kernel function. It can be expressed as follows:

$$r\left(f_i - f_j\right) = e^{-\tau f_i - f_j^2} \tag{9}$$

Here, $f_i - f_j$ denotes the difference between the two feature vectors. τ is obtained optimal parameters from the aforesaid processes. In our proposed spatial distance SVM beamforming algorithm, two classifiers are constructed for decision making. If a positive class is obtained as decision results, then it will get a vote, or else negative class gets a vote. The decision function of the considered two class classifier is expressed as follows:

$$f\left(x\right) = sign\left(\sum_{i=0}^{n} (\varrho_i \left(f_i f_j + 1\right)^{\tau} + bi\right) \tag{10}$$

Wherein, bi implies the bias function and with the aid of this decision function, each class in the proposed Spatial distance SVM classifier obtains the vote for the positive and negative class. Based on the obtained vote for each beam in the beam set, our proposed spatial distance SVM allocates an optimal beam to the user equipment.

4.4 Interference Mitigation

The interference is a critical issue in the 5G MIMO based network. It must be mitigated to attain an excellent result in the 5G MIMO system. In the proposed ML-3DIM method, IM is done in "2" stages that are: i) Small Cell IM and ii) Macro Cell IM.

The algorithm 2 describes the processes embraced in the IM of the ML-3DIM approach.

Algorithm 2: Interference Mitigation

Data: SINR, T_p, α
Output: Interference Mitigated

//Small cell interference mitigation
For (each m $\in T_m$)
Estimate $\rightarrow$ Interference power from small cell using equ.(11);
Estimate $\rightarrow$ Beneficial signal power using equ. (12);
Compute $\rightarrow IF_m$ using equ. (13);
If ($IF_m > \vartheta_1$)
Turn down $\rightarrow T_{p,s}$;
Else If ($IF_m == Very\ Strong$)
Turn off $\rightarrow$ SC**;**
Else
No Interference;
End If;
End For;
//Macro cell interference mitigation
For (each s $\in T_s$)
Estimate $\rightarrow$ Interference power from macro cell basestation using equ.(14);
Estimate $\rightarrow$ Useful signal power using equ. (15);
Compute $\rightarrow IF_s$ using equ. (16);
If ($IF_s > \vartheta_2$)
Estimate $\rightarrow \Delta_s$ using equ. (17);
If ($IF_m > \Delta_s$)
Remove $\rightarrow$ Macro user 'm' from scheduled list**;**
Else
Offload $\rightarrow$ Macro user 'm';
Else
No interference;
End If;
End For;

4.4.1. Small Cell Interference Mitigation

In this subsection, the interference occurred by the small cell (SC) is mitigated. Here, the macro cell (MC) users are significantly influenced by the interference of the SCs. The interference power (IP) of the macro user (MU) ‘m’ acquired as of the SC is expressed as:

$$I_{p,m} = \sum_{i=1}^{n} T_{pi} \alpha_{i} SINR_{i} \tag{11}$$

Here, T_{pi} Transmit Power (TP) of the SC i, α_{mi} referred to as the f of i and $SINR_{i}$ signifies the signal to noise plus interference ratio. The beneficial signal power acquired by the MU ‘m’ is estimated as follows:

$$S_{p,m} = \frac{T_{p,m}, \alpha_{m} \gamma_{v,m} \gamma_{h,m}}{t_{m}} \tag{12}$$

Where, $T_{p,m}$ represents the TP of the MU ‘m’, α_{m} represents the CSI of the MU ‘m’ and $\gamma_{v,m}$ and $\gamma_{h,m}$ signify the vertical diagonal and horizontal elements. Using this IP and beneficial signal power of the MU, the interference factor is calculated, which is represented as follows:

$$IF_{m} = \frac{I_{p,m}}{S_{p,m}} \tag{13}$$

The interference factor estimated from the above expression is compared with the interference threshold ϑ_{1} . A threshold is basically a performance value that can well be set for a metric. It will be reflected visually on the Real-Time Operations page if the threshold is met or exceeded. The network allots some value that is perceived to be a threshold value to know the network’s interference level. The achieved interference factor is checked with this assigned value of the network that means the network’s threshold to know the interference level. If the estimated IF_{m} is greater on considering the interference threshold ϑ_{1} i.e. $IF_{m} > \vartheta_{1}$, then the TP of the SC α_{i} is turned down. If the interference factor IF_{m} from the SC to the MU ‘m’ is very high, then we turn off the SC. In this way, interference caused by the SC is mitigated in our proposed ML-3DIMapproach.

4.4.2. Macro Cell Interference Mitigation

This portion dealt with the mitigation of interference from the M-BS to the SC user. For rendering better communication performance to the SC users, the proposed method required that the SINR of each SC user is beyond a certain threshold. In this, the interference from the M-BS to the SC user is expressed as follows:

$$I_{p,s} = \frac{T_{pj} \alpha_{j} SINR_{j}}{T_{a}} \tag{14}$$

Where, T_{pj} signifies the TP of the M-BS j, α_j represents the CSI of M-BS j, $SINR_j$ denotes the SINR of M-BS jand T_a specifies the total antenna present in the M-BS. The useful signal power acquired as of the M-BS is expressed as:

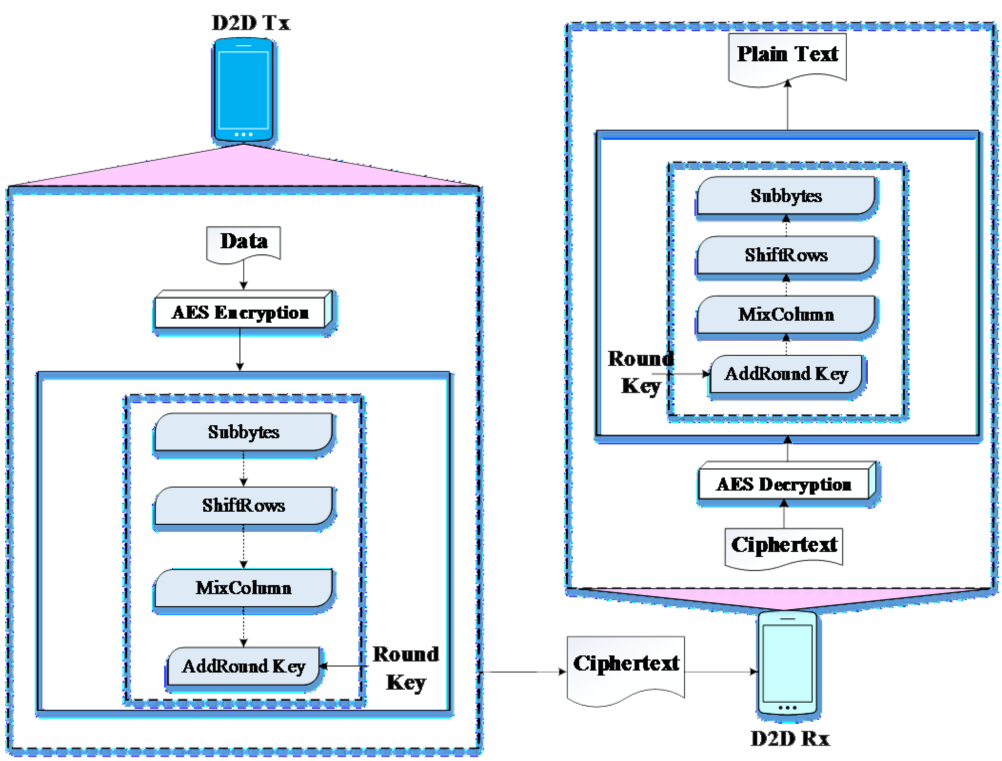
$$S_{p,s} = \frac{T_s, \alpha_s \gamma_{v,s} \gamma_{h,s}}{T_s} \tag{15}$$

Here, T_s represents the TP of the SC user's', α_s signifies the CSI of the SC user 's'and $\gamma_{v,s}$ and $\gamma_{h,s}$ indicates the vertical diagonal and horizontal diagonal elements. As of these expressions, the interference factor for SC user is approximated as:

(16)

The estimated interference factor for SCs (IF_s) is contrasted to the interference threshold ϑ_2. If the IF_s > threshold ϑ_2, then check the offload condition is. It is estimated utilizing the below expression:

Figure 4. Secure DT in D2D communication



$$\Delta_s = \frac{T_m \left(T_a - T_{si}\right) T_{pj} \alpha_j}{T_s T_m \alpha_m \gamma_{v,s} \gamma_{h,s}} \tag{17}$$

If the above-expressed condition satisfies the interference threshold ϑ_3, then the MU is offloaded to the SC. Else, the MU is removed as of the M-BS user list.

4.5 Secure D2D Communication

Security is a chief concern during DT between D2D devices. In the proposed ML-3DIM approach, security is ensured using the AES algorithm. A lightweight cryptographic encryption algorithm termed AES has low cost, high security, and consumes less hardware to process.

In this work, the counter mode (CTR) of the AES is exploited. This operation mode in the AES algorithm renders excellent results contrasted to the other modes. The proposed CTR centric AES algorithm offers less propagation error and also provides parallelism in encryption and decryption process. Besides, CTR based AES algorithm also consumes less time for encrypting process and decrypting contrasted to other modes of the operation. It is a highly secure algorithm than other lightweight cryptographic algorithms, which utilizes the higher length key sizes, such as 256, 192, and 128 bits. The eavesdropper cannot decrypt the information using the AES algorithm. Since they have to put 2^{128} attempts to forge the details send by the D2D communication. This is why the AES algorithm is chosen in the ML-3DIM approach to render security in D2D communication.

The proposed AES algorithm follows the succeeding conventional processes for effectively securing the data during DT. They are as follows:

- Subbytes
- Shiftrows
- Mixcolumns
- AddRound Key

Fig 4 evinces the secure DT in D2D communication. In this work, the D2D-Tx transmits data $\mathfrak{d}$ in Ciphertext $\mathcal{C}_{\mathfrak{d}}$ form utilizing the AES encryption procedures. Here, both AES encryption and AES decryption procedures are depicted. Here, the D2D transmitter encrypts the data afore to transmission using the AES encryption procedures. It encompasses "4" steps as discussed above and are elucidated as follows:

Step 1: *Subbytes*- This is the initial step in the AES centric encryption scheme named as bytes substitution. As its name says in this step, 16bytes are substituted via looking up of fixed table i.e. S-box.

Step 2: *ShiftRows*-In this step, every four rows in the matrix are shifted to the left only if any entries that required being inserted in the matrix are placed on the right of the row. The steps embraced in the shift rows step are enlisted below:

- 1^{st} rows present in the matrix are not shifted
- 2^{nd} row existent in the matrix is shifted 1 position left
- 3^{rd} row of the matrix is shifted 2 positions to the left
- 4^{th} row is shifted 3 positions to the left.

The resultant output matrix is considered as the 16 bytes of matrix respective to the input matrix but shifted with each other.

Step 3: *MixColumns*-This step processes each input in the column of the matrix individually. Here, each column of four bytes is transformed into a special mathematical function. This function considers

the input like the one column where four bytes are residing. For this given input, it provides the output as four bytes, which replaces the given input. The mix-column process is not executed in the final round of the encryption process.
Step 4: *AddRoundkey*-In this step, the results acquired from the previous step are processed into the XOR operation with 128bits of the round key. The result acquired from this round is considered as the cipher data. This data transmitted by the D2D transmitter during D2D communication.

These processes are used to encrypt the data present in the D2D transmitter. It provides the Ciphertext $\mathcal{C}_0$ which is transmitted to the D2D receiver. For decryption process, inversion of encryption steps is performed that is AddRound key, Mixcolumns, Shiftrows, and Subbytes. Here, the AES algorithm uses a symmetric key for both encryption and decryption processes. With the aid of these processes, our proposed ML-3DIM approach secures the data transmitted during the D2D communication.

5 EXPERIMENTAL EVALUATION

This section dealt with the evaluation of the proposed ML-3DIM method performance. Our proposed ML-3DIM method is modeled using the NS3 simulator. The utilized NS3 simulator is named as the discrete event simulator, which can be suitable for various kind of the network. It also provides better performance in different kinds of networks. The AnyLogic PLE simulation software was utilized by the NS3 simulation tool intended for the implementation that unites discrete event, system dynamics, as well as agent-centered simulation techniques, which models real-world system or process. Our simulation environment comprises 15 user equipment and one 5G MIMO base station.

Figure 5. simulation environment of ML-3DIM

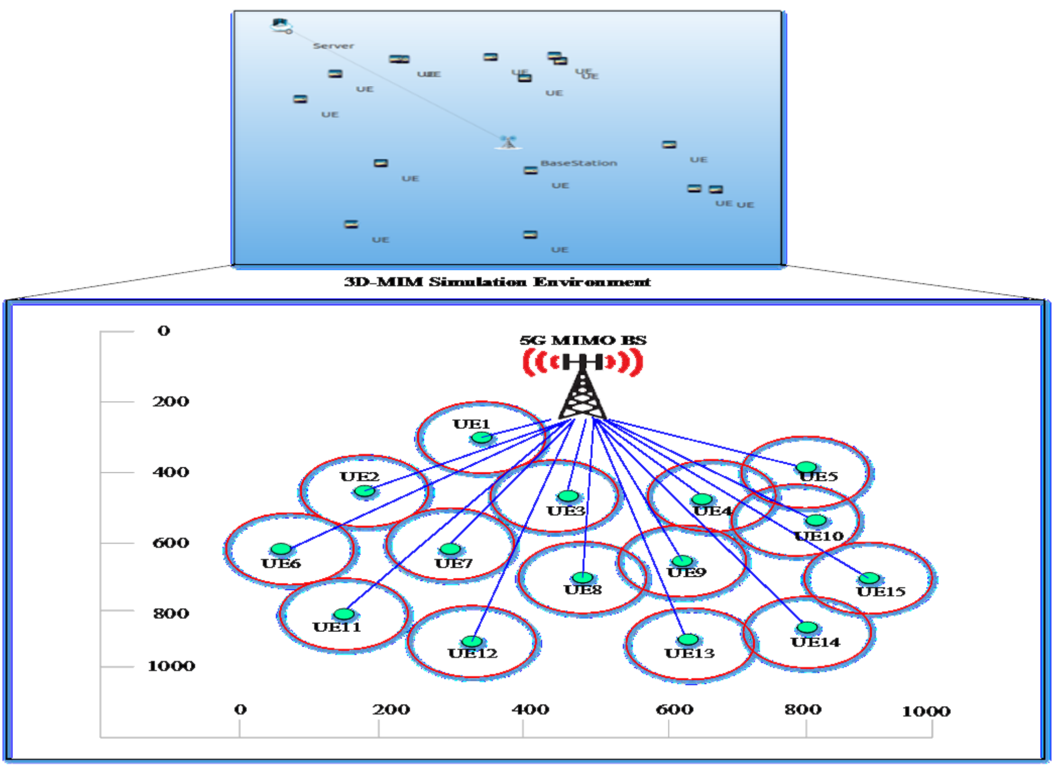


Figure 5 elucidates the simulation environment of the ML-3DIM method where one 5G MIMO macro base station with 15 user equipment is positioned in the 1000*1000 simulation area. In our simulation environment, both macro and small cell users are distributed uniformly. The parameters utilized in our proposed simulation environment are described in table 2.

In table 2, the parameters that are exploited in the proposed ML-3DIM method simulations are discussed with its value. Here, the parameters related to the base station and processes, such as interference security, are deliberated.

Table 2 Simulation Parameters

Parameters	Value
Simulation Area	1000*1000m
Number of Base station	1
Number of User Equipment	15
Mobility Model	Constant mobility model
Transmit power of base station	50dBm
Path loss exponent	3.97
Number of antenna rows at base station	4
Number of antenna elements in each rows	8
Interference threshold ϑ_1	0.15
Interference threshold ϑ_2	0.1
Interference threshold ϑ_3	0.48
AES key length	128 bits
AES block size	128bits
Possible key	2^{128}
Simulation Time	100s

We validate the performance of the ML-3DIM method using three parameters that are throughput, SINR, and SNR. These parameters are described as follows:

a) Throughput

The throughput metric plays a vital role in analyzing the performance of the proposed ML-3DIM method. It measures the number of packets that are successfully transmitted over the network. We measure the throughput of the ML-3DIM method with the help of the number of users and distance parameters. It is expressed in mathematical form as follows:

$$\mathcal{T} = \frac{\mathfrak{S}_d}{t} \tag{18}$$

Here, $\mathfrak{S}_d$ represents the data successfully delivered over the network over time t.

b) SINR

The SINR is defined as the power of the interested signal with respect to the summation of the interference power and some background noise. It is measured by varying the number of users in the network. This metric defines the efficacy of the proposed ML-3DIM method in interference avoidance. It is expressed as follows:

$$SINR = \frac{P_I}{I_p + \mathfrak{N}} \tag{19}$$

In this eq. (19), the $\mathfrak{N}$ represents the noise, I_p represents the interference power from the other signal, and P_I represents the power of the interested signal.

c) SNR

The SNR metric is expressed as the signal to noise ratio of the network. It is defined as the ratio of the power of the signal transmitted to that of the background noise. It is measured using the below expression,

$$SNR = \frac{AP_s}{AP_n} \tag{20}$$

Here, AP_s represents the average signal power and AP_n denotes the average noise power.

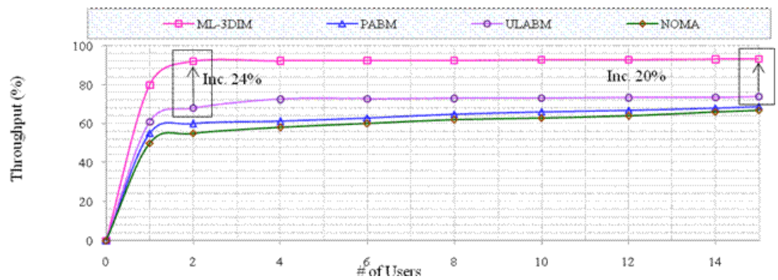
5.1. Results Analysis

In this section, the results obtained from the simulations are analyzed. The simulation results of proposed and existing methods are analyzed. The existing methods considered for analysis are PABM, ULABM, and NOMA methods. The reason for selecting these methods is that the contributions of these methods are similar to the contribution of the proposed ML-3DIM method. Physical array antenna-centered 5G-MIMO beamforming (PABM) is the '1st' prevailing approach, which encompasses the competence to electronically as well as digitally manipulate and steer the radiation pattern of an antenna array, and adjust it to the environment, maximizing its performance together with efficiency. Uniform Linear Array BeamForming (ULABM) is the '2nd' approach, which is '2'-level BF architecture aimed at uniform linear arrays that leverages the formation of spatial lobes. A single array is employed which could utilize single or multiple beams for BF. It can well be utilized in low as well as high SNR MIMO settings. Non-orthogonal multiple access (NOMA) is the '3rd' prevailing approach that is promoted as a key element of 5G cellular networks. NOMA operation commences intra-cell interference to the cellular operation.

5.1.1 Throughput

The efficacy of the proposed ML-3DIM method in terms of network reliability is measured through the throughput parameter. The performance of the throughput parameter is simulated by varying the number of users and the distance between the users in the network. This metric must be high as much as possible to propose better performance in the 5G wireless network.

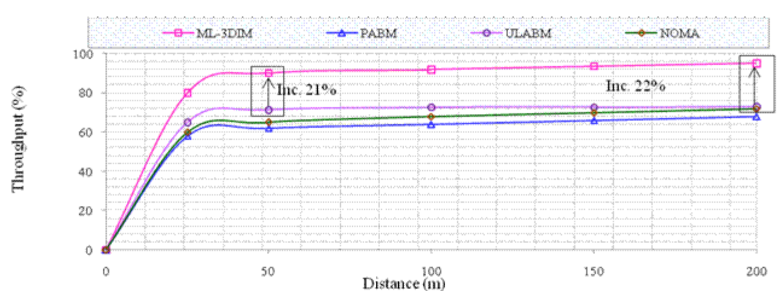
Figure 6. Comparison on throughput vs No. of users



As represented in figure 6, the throughput performance of the proposed ML-3DIM is compared with the existing methods including PABM, ULABM, and NOMA with respect to the number of users. From this figure, it is perceived that the performance of the proposed ML-3DIM approach is better than the existing methods. Our ML-3DIM method increases throughput by up to 24% at a low density of users and 20% at the high density of the users. It is because of our proposed 3D MIMO beamforming method. In our work, BF is achieved via the ML algorithm. It provides optimal results in the allocation of the beam to the user requirement based on the user location and beam set information. Thus, enhances the BF performance which in-turn increases the DT. Besides, our work utilizes the performance CTR based AES algorithm in secure D2D communication. It encrypts the data accurately with less amount of time and decrypts the data effectually without losing any input details. Thus, also enhances the data delivery performance in the network. Hence, our method achieves high throughput in 5G MIMO based wireless network. On the contrary, methods like PABM, ULABM, and NOMA acquire fewer throughputs compared to the proposed ML-3DIM method. Since these method doesn't utilize the effective mechanism to execute BF in 5G MIMO system. Thus, reduces the throughput performance of the existing methods compared to our proposed method.

Figure 7 compares the throughput of the proposed and existing methods with respect to the distance measure. It is observed that the performance of the ML-3DIM method better when compared to the existing methods. Our ML-3DIM method increases throughput by up to 21% at a low density

Figure 7. Comparison on throughput vs distance



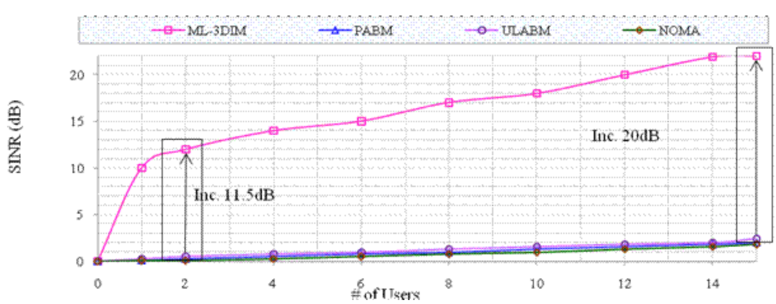
of users and 22% at the high density of the users. Above 80% throughput is attained in the distance 50m, and when the distance is 200m, the throughput is 90% for the proposed ML-3DIM. Likewise, the proposed system attains a higher throughput rate for the remaining distances. This is achieved via the proposed spatial distance SVM algorithm. It provides the optimal beam to each user equipments present in the network. In addition to it, the proposed CTR centered AES algorithm performed better in the encryption as well as decryption efficiently with less quantity of time. Thus, enhances the data transmission performance in the 5G wireless network. Hence, our method achieves better throughput even increase in the distance between the user equipment and base station. In contrast, the existing method, like PABM and ULABM methods, achieves fewer throughputs because of their antenna array. These methods utilize the phase array and uniform linear array in the MIMO BF, which doesn't provide better coverage to the users present in the network. Thus, leads to a reduction in throughput performance. Likewise, the NOMA method also achieves fewer throughputs because of its poor performance in BF. Therefore, the existing methods achieve fewer throughputs compared to the proposed ML-3DIM method.

5.1.2 SINR

The SINR metric is used to measure the proposed ML-3DIM method efficacy in terms of the mitigation of the interference in the network. It is measured via varying the number of users in the network.

Figure 8 represents the SNIR performance of the proposed and existing methods with respect to the number of users. It achieves the SINR of 12dB when the number of users is '2' while prevailing PABM, ULABM, and NOMA achieve the SINR of 0, 0, and 0.2 that are very low when weighed against the proposed work. Likewise, for the remaining number of users also, the SINR of the proposed work is augmented gradually, but the prevailing algorithms' SINR was lower contrasted with the proposed technique. They just have slight augmentation for the other number of users. From this figure, it is perceived that our ML-3DIM method achieves a high SINR rate compared to the other methods. Our ML-3DIM method increases SINR by up to 11.5dB at a low density of users and 20dB at a high density of the users. It is accomplished by the proposed interference mitigation method. In our work, we have mitigated both the macro cell and small cell interference. It is achieved by turning down the transmit power of the small cell, turn off small cell, and offloading mechanisms. This way of mitigating interference provides a better result in the improvement of the SINR. Here, the SINR performance is varied centered on a number of users. The user ranges start as of 0 and end with 14 users. When the user count is 14, the proposed ML-3DIM attains above 20dB.

Figure 8. Comparison on SINR



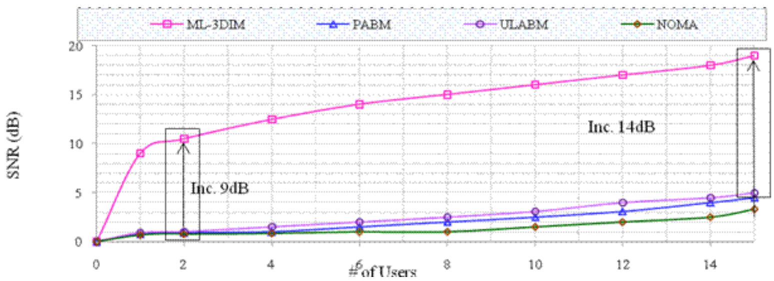
On the other hand, the existing methods, like PABM and ULABM, achieves less SINR. This is due to the absence of an interference mitigation mechanism in the 5G MIMO network. Likewise, the

NOMA method achieves less SINR in simulations. Since it follows the sectoring based interference mitigation method, which doesn't resolve the interference issue in the MIMO system. Hence, these methods achieve less SINR in the 5G MIMO network.

5.1.3 SNR

The SNR metric plays an essential role in the proposed ML-3DIM method performance evaluation. It shows our ML-3DIM method performance in terms of interference avoidance ability. It is also measured by simulating the performance of increasing the number of users present in the network.

Figure 9. Comparison of SNR



As depicted in figure 9, the SNR performance of the proposed work is compared with the existing methods, like PABM, ULABM, and NOMA. The SNR performance is increased via our proposed effective interference mitigation scheme. When the total users is 2, the proposed method attains the SNR of 10.99 whereas prevailing PABM, ULABM, and NOMA render the SNR of 1dB that is very low when contrasted with ML-3DIM. Our ML-3DIM method increases throughput by up to 9dB at a low density of users and 14dB at a high density of the users. Similarly, when contrasting the attained SNR value of techniques for other numbers of users, the proposed work achieves a higher performance of SNR than others. The proposed ML-3DIM method concentrates on the mitigation interference from both small cell and macro cell to the users present in the system. Here, the interference mitigation by macrocell is achieved by removing the user and offloading the user to the neighbour cell. Likewise, the interference by the small cell is mitigated through the turning down and turning off the small cell. This way of mitigation increases the SNR rate compared to the other existing methods. On the contrary, the performance of the existing methods in the SNR measure is less compared to our method. This is because of the absence of interference mitigation and lack of concentration in the selected mechanism for interference mitigation. Therefore, the existing methods, like PABM, ULABM, and NOMA, acquire less SNR rate compared to the proposed method.

5.1.4 D2D Scalability

Here,the secure discovery phase time of the proposed CTR-AES and existing KKT, IBE and generalized signencryption algorithm is analyzed and the parameter is mathematically expressed as,

$$\psi_{(t)} = \psi_{end(t)} - \psi_{start(t)} \tag{21}$$

Where, $\psi_{end(t)}$ denotes the encryption ending time and $\psi_{start(t)}$ indicates the encryption starting time and $\psi_{(t)}$ represents the encryption time that is demonstrated in table 3,

Table 3. D2D Performance Analysis

D2D users count	Proposed CTR-AES	KKT	IBE	Generalized signencryption
1000	5s	14s	10s	15s
5000	10s	25s	20s	23s
10000	20s	55s	50s	60s
50000	60s	110s	100s	115s

Table 3 shows the performance analysis of the proposed CTR-AES with the existing KKT, IBE, and generalized sign encryption centered on the discovery phase time (i.e. encryption time). Here, the performance is varied centered on the D2D count. When the D2D count is 1000, the proposed system takes 5s, but the existing KKT, IBE, and generalized sign encryption has 14s, 10s, and 15s discovery phase time respectively. Similarly, for the remaining D2D count, the proposed system takes less time than the existing methods that means the existing methods take more time for encryption.

5.1.5 Data Rate Analysis

Here, the data rate of the presented ML-3DIM is analyzed, which is shown in table 4:

Table 4. Data Rate Analysis

SNR (dB)	ML-3DIM
5	55
10	58
15	70
20	78

Table 4 exhibits the data rate analysis of the presented ML-3DIM method. The data rate is varied based on SNR variation. When the SNR is 20dB, the ML-3DIM has 78 bits/s/Hz data same as the ML-3DIM has a different data rate based on SNR variation.

5.2. Discussion on Evaluation Result

This section discusses the evaluation results of the proposed ML-3DIM method compared to the existing methods. The performance of the proposed ML-3DIM method is evaluated using the three performance metrics that are throughput, SINR, and SNR. Our proposed ML-3DIM method is compared with the three existing methods including PABM, ULABM, and NOMA. Our proposed ML-3DIM method increases the throughput of up to 20% compared to the existing methods when an increase in the number of users and distance. Likewise, the SINR of the proposed ML-3DIM method is increased up to 30% compared to the existing methods. The performance of ML-3DIM in SNR measures is increased by up to 35% compared to the existing methods. The reason behind the better performance of the ML-3DIM method is that our proposed ML is based on 3D MIMO beamforming. Our proposed spatial distance SVM based learning algorithm provides optimal results in the 3D MIMO beamforming. Besides, we have also utilized a 3D rectangular antenna array in 5G MIMO base station. Besides, our D2D communication also performed in a secure manner with an effective CTR based AES algorithm. It performs fastly in encryption and decryption processes. It also provides a better result in encryption and decryption with the aid of CTR mode. This increases data transmission performance effectually. Thus, enhances the coverage area and data transmission performance of the proposed work. This leads to the enhancement of the throughput measure. Likewise, SINR and SNR performance measures are enhanced through interference mitigation procedures. In our work, we have mitigated interferences from both small cell and macro cell networks. Thus, also enhances the throughput performance effectually.

Table 5 depicts the comparison of the proposed and existing methods including PABM, ULABM, and NOMA. Here, the methods with their description and simulation statements are illustrated. In this, the three simulation measures are discussed that are throughput, SINR, and SNR. Thus shows that the performance of the ML-3DIM method is better than the other existing methods in terms of the throughput with distance and number of users, SINR, and SNR measures. The results shown in table 5 are the average measure of the respective validation metrics.

Table 5. COMPARISONS of Proposed and Existing Methods

Method	Description	Simulation Statements			
		Throughput (%)		SINR (dB)	SNR (dB)
		No. of users	Distance (m)		
PABM	5G MIMO beamforming using phase array antenna	64.9	95	11.15	2.43
ULABM	Two level approach based beamforming using uniform linear array antenna	72.5	72.4	1.42	2.94
NOMA	Interference mitigation in 5G MIMO systems	61.8	68.7	0.91	1.61
ML-3DIM	ML-3DIMO beamforming using 3D rectangular antenna array, interference mitigation and secure D2D communication	**92.75**	**92.6**	**17.4**	**15.25**

6 CONCLUSION

To date, 3D MIMO beamforming technology has drawn much interest among researchers and educationists owing to its amenities in the 5G network. However, there has been a limited number of works only concentrating on utilizing a machine-learning algorithm in MIMO beamforming. Hence, in this paper, we have proposed spatial distance SVM based 3D MIMO beamforming, interference mitigation, and secure D2D communication. Initially, it executes the 3D MIMO beamforming process. It is accomplished via the spatial distance SVM algorithm. And then, it mitigates the interference from the neighbour cells by measuring the interference power. Our proposed ML-3DIM method provides secure data transmission to the D2D communication. Here, the secure data communication is achieved through the CTR based AES algorithm. It exploits CTR mode in the AES encryption and decryption process, thus, enhances the security during the data transmission. Using these processes, we acquired better throughput, reduced SINR and SNR in experimentation. The simulations of the proposed ML-3DIM method are analyzed through the NS3.26 tool. Here, the three validation measures are utilized to know the proposed ML-3DIM performance in simulation. They are throughput, SINR, and SNR. The simulation results of proposed ML-3DIM are compared with the existing methods including the PABM, ULABM, and NOMA. From the comparison, we concluded that our ML-3DIM outperforms other existing methods, such as PABM, ULABM, and NOMA. In the future, we intend to propose deep learning techniques to establish 3D MIMO beamforming to further enhance the performance in beamforming.

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