Optimum Solution for Tractable Beamforming in BDMA by using Successive Modulus Matrix Algorithm

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Abstract

In the present scenario, the mobile user/subscriber becomes more aware with the cellular phone technology and its application, he will seek for an appropriate package all together, and including all the advanced features of a mobile phone can have. BDMA which used in future communication system is known as 5G mobile communication which initially releases in year 2020. In this paper, we discuss the Beam division multiple access technology its applications feature and how is differ from their previous generation multiple access. The 5G Wireless networks have various integration like cloud computing, virtual network access and provide fully VoIP base network. In BDMA technology the beam is generated according to the moving speed and position of the mobile phone and generates required power. The 5G network technology has quality of service and robust software and hardware system configuration. The fifth-generation wireless network is very intelligently distributes the Internet access to individual nodes within the cluster.

Keywords: - ***BDMA (Beam Division Multiple Access), Successive Modulus matrix, VoIP (Voice over Internet Protocol), Cloud Based Network, MIMO.***

INTRODUCTION

Communication technology has experienced a revolutionary change during the past decades and it is expected to technologically proliferate even more in years to come. Owing to this revolution, technology in cellular mobile communication has also become more advanced. With each day passing the subscriber and mobile users are also increasing, consequently, there is a growing demand for the mobile networks with higher capacity, better reliability and enhanced coverage that too at effective affordable cost. This as a result put forth challenges for the research community across the entire world to keep with data rate, quality of service (QoS) and other applications [1]. The Fifth generation (5G) cellular mobile networks are being developed to fulfill the dramatically growing data traffic rate among all the mobile devices with the various high-speed multi-media applications. A new generation emerges about every decade to significantly improve the data transmission speed and support more feature/applications. These comprise Internet wireless switched network systems which technique using in BDMA (Beam Division multiple Access technology) [5]. The Fifth generation (5G) system is capable of delivering the real-time wireless network and capable of supporting WWWW i.e (Wireless World Wide Web) application. 5G wireless cellular networks are expected to have much higher capacity and provide min. 1Gbps data rate for each user to support multi-media applications with demanding the quality of service (QoS) requirements [3]. The capacity of 5G technology extends far beyond the previous of mobile communication technology. For the examples it provides very high speed data rates, low latency, greater reliability, energy efficiency and billions of device connectivity, and will be realized by the new multiple access technologies i.e. BDMA. The key technology elements include extension of the higher frequency bands, cloud computing, D to D communication, flexible spectrum usage, MIMO transmission, ultra-lean design, and subscriber/control separation [10]. In section II. Discuss the 5G Architecture, in section III discuss mmwave Beamforming in 5G and in the section IV, System Model described. In section V discuss Successive Modulus Matrix Algorithm and in section VI Performance Evaluation. Finally discuss conclusion and future work in section VII.

II. 5G ARCHITECTURE

5G architecture is based on the design principles that leverage the structural separation of hardware and software, as well as the programmability offered by, cloud network and E-E management system. The architecture comprises three layers and an E2E management and orchestration entity [11]. The infrastructure resource layer consists of the bodily assets of a fixed-cell converged network, comprising get entry to nodes, cloud nodes (which could be processing or storage resources), 5G devices (i.e. Smartphone's, wearable devices, machine type modules and others), networking nodes and associated links. 5G devices may have multiple configurable capabilities and may act as a relay/ hub or a computing/ storage resource, depending on the context. APIs are provided on the relevant reference points to support multiple use cases, value creation and business models [6]. This architecture is shown below in Figure 3.1.

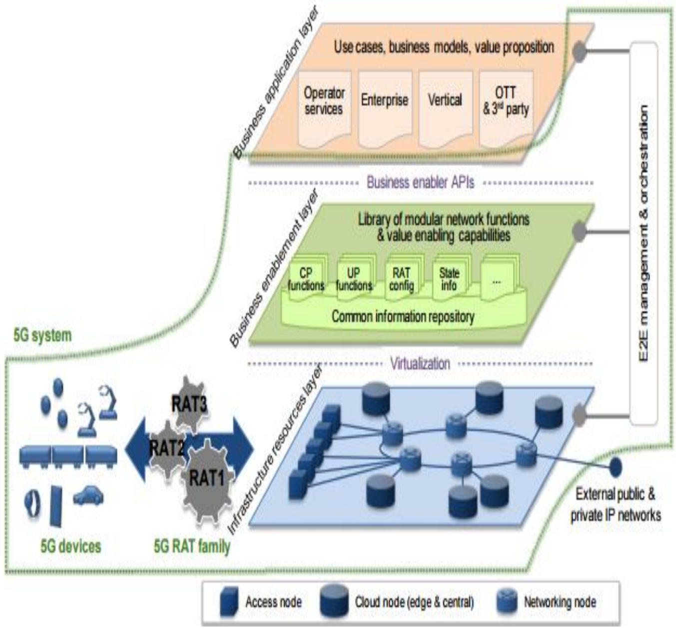

Figure 1: 5G Architecture

III. MmWave BEAMFORMING IN 5G

Millimeter beamforming technique focus on the transmitted and/or received signal in a particular direction in order to overcome the undesirable path loss is one of the major problem for wireless network at millimeter Wave frequency bands. The small wavelengths of millimeter Wave frequencies facilitate the use of a large number of antennas in a compact form factor to composite highly directional beams corresponding to large array gains [4]. Depending on the beamforming architecture, the directive beam could be applied in analog or digital domain. In mmWave the Digital beamforming is done by the digital proceeding that multiplies a particular coefficient to the modulated baseband signal per RF chain. And for the analog beamforming it is the complex coefficients are applied to manipulate the Radio frequency signals by means of variable gain amplifiers (VGAs). When the mmWave combined with OFDM system, digital beamforming is carried out on a sub-carrier basis before the IFFT operation at the transmitter and after the FFT operation at the receiver, whereas analog beamforming is performed in the time domain after the IFFT operation at the transmitter and before the FFT operation at the receiver.

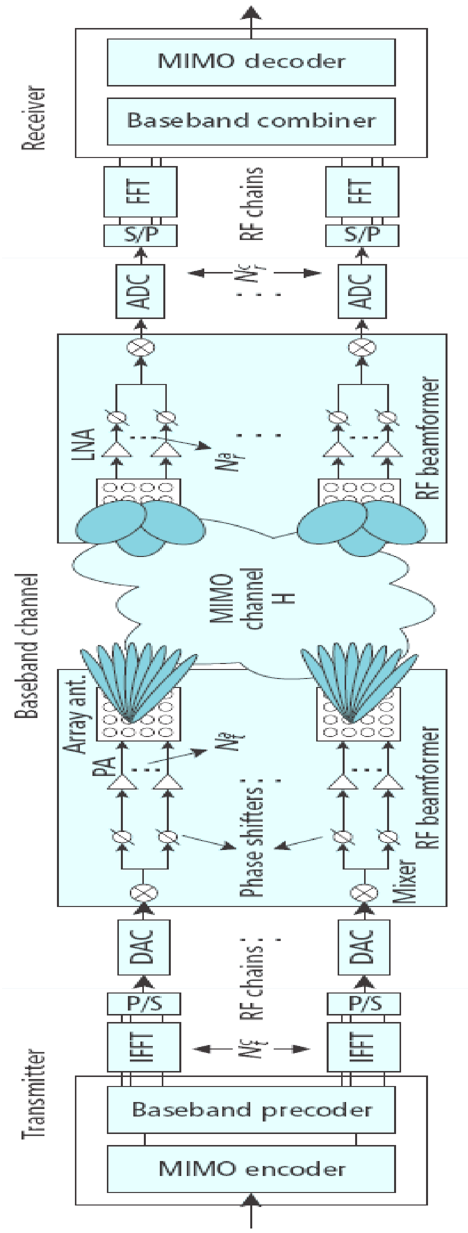

Figure 2: Block diagram of a beamforming architecture.

Generally, the digital beamforming provides a higher degree of freedom and offers better performance at the expense of increased complexity and cost due to the fact that separate FFT/IFFT blocks, digital to analog converters (DACs) and analog to digital converters (ADCs) are required per each RF chain. In the other side Analog beamforming, is a simple and effective method of generating high beamforming gains from a number of antennas but less flexible than digital beamforming [6].

IV. SYSTEM MODEL

We consider the downlink scenario of a single-tier wireless network in which the BSs are distributed on the two dimensional Euclidean plane R^2 according to a homogeneous spatial PPP with density λ_b denoted by $\Phi_b = \{ r_i \}_{i\in N}$, where $r_i \in R^2$ is the location of the i-th BS. The mobile UTs are distributed on the same plane according to an independent homogeneous PPP with density $\lambda_u > \lambda_b$ which is denoted by $\Phi_u = \{ S_j \}_{j \in N}$ with $s_j \in R^2$ being the location of the j-th user. Without loss of generality, we focus on a typical UT (or users) placed at the origin of the particular coordinate system for calculating the key performance metrics of interest.

In this system model, we assume that the signal transmitted from a given BS is subject to two propagation phenomena before reaching a UT (user): (i) a distance dependent pathloss regulated by the pathloss function $g(r) = br^{-\alpha}$, where b is the pathloss coefficient and α is the pathloss exponent and (ii) Rayleigh fading with mean 1. Therefore, the signal strength from the i-th Base Station as received by the typical user can be expressed as

$$p_i(r_i)=h_iPbr_i^{-\alpha} \quad (1)$$

where, the random variable hi denotes the power of Rayleigh fading and P is the transmitted power.

In addition, we assume that background noise is present in the signal, with variance $\sigma^2 = {}_{\beta}\lambda_b$, with

$$\beta = B\ \frac{1}{\lambda}\ \frac{FkT}{b},$$

where B is the total available bandwidth, F is the noise figure of receiver, k is Boltzmann constant, and T is the ambient temperature. As alluded earlier, the typical user connected to the i-th BS receives a signal of power $p_i(r_i)$. This in turn means that the sum of the received signal powers from the rest of the BSs contributes to the interference to this signal. As a result, the received SINR at the typical user is given by

$$\text{SINR} = \frac{h_i g(r_i) P}{\sigma^2 + I_i} \quad (2)$$

Where $I_i = \sum r_j \in \Phi b / r_i p_j(r_j)$ is the cumulative interference experienced from all the BSs except the i-th BS.

In a downlink frequency, although the typical user may technically be served from any Base Station, a connection with a particular BS has to be established according to a different algorithm that satisfies a certain performance metric, e.g. ensuring QoS.

In this work, we consider that a mobile user connects to the BS that provides the maximum SINR. This is formally expressed as

$$\max_{r_i \in \Phi_b} SINR\ (i) > \gamma, \quad (3)$$

where, γ is the target SINR.

Given the above definition, the typical user is said to be covered when there is at least one Base Station that offers an SINR > γ If not, we say that the typical user is not covered. We assume that $\gamma > 1$, which is needed to ensure that there is at maximum one BS that provides the highest SINR for a user at a given instant.

V. SUCCESIVE MODULUS MATRIX ALGORITHM

In Successive Modulus Matrix algorithm, we propose an improvement in SIC which is performed by limiting the reliability condition check for predefined number of layers. The reliability criteria are checked only for limited number of layers and for the remaining layers only conventional SIC algorithm is performed. In the proposed Successive Modulus Matrix algorithms, the reliability criteria (shadow region criteria) of MFSIC is checked only upto N_t=2 layers. After N_t=2 layers the conventional SIC algorithms is followed for the remaining N_t=2 layers. The idea behind MOD1 is that it helps in limiting the computations of the algorithm by performing SIC only up to limited number of layers when compared with the conventional SIC algorithm. Furthermore, the selection of such modification is that the lower layers in SIC do not cause much error propagation and therefore the bit error rate will not degrade much.

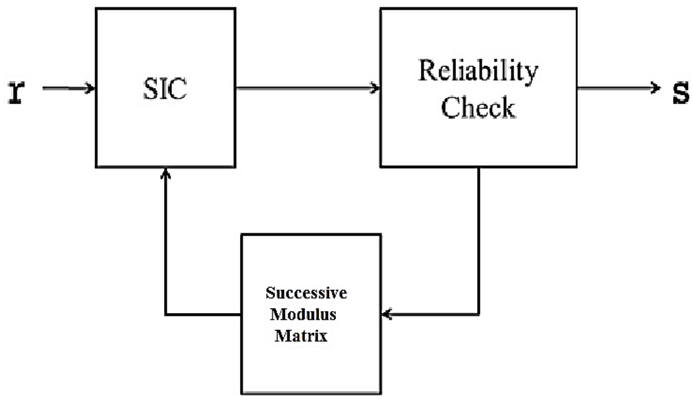

Figure 3: Modulation Feedback based block diagram.

The pseudo code of the proposed Successive Modulus Matrix algorithm is shown in Algorithm 1 where for N_t=2 Layers, Successive Modulus Matrix algorithm is used and for the remaining N_t=2 layers a normal SIC is used.

Algorithm 1 Successive Modulus Matrix algorithm

input: y, H, N_t,N_r;
for i = 1 : 1 : N_t do
  if i ≤ N_t/2 then
    Use SIC for detection of path
  else
    Use Successive Modulus Matrix algorithm for detection of path
  end if
end for
output: ^s = [^s1^s2……^sN_t] is output solution vector

To start with, we assume the complete knowledge of channel gain matrix H at the receiver end. Following steps are involved in the proposed method.

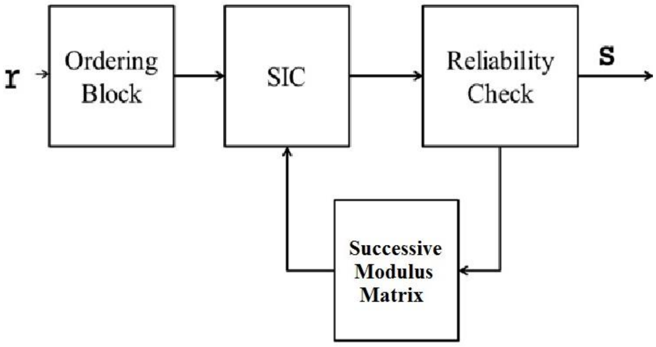

Figure 4: Channel norm ordered Successive Modulus Matrix algorithm block diagram.

Step 1:
Consider each column hi for i = 1,2,…,N_t of the channel gain matrix H.
Step 2:
Compute the 2-norm of each column hi of the channel matrix as

$$g_i = (h_i^H h_i) = ||h_i||^2 \qquad (4)$$

Step 3:
Arrange the values gi for for i = 1,2,…,N_t in decreasing order and compute the ordering
pattern p which is used to order the detection sequence.
Step 4:
For each layer compute the threshold distance of the reliability region as

$$d_{th}(i) = \ 0.1 + \frac{2*g_i}{\sum_{k=1}^{N_t} g_k} \qquad (5)$$

Step 5:
Used the threshold radius values computed in Step 4 in the MF-SIC with the ordering
sequence given by p and generate the output solution.

VI. PERFORMANCE EVALUTION

The simulations results of the proposed Successive Modulus Matrix algorithm. The results are also compared with the SIC and the Successive Modulus Matrix algorithm for providing useful insights on the performance complexity tradeoff of the proposed modifications. The simulation results are shown in three different Figures 3where the BER performance versus the SNR curves are plotted.
In the Figure 3, we present the bit error performance with respect to the signal to noise ratio (dB) for 4-QAM modulated 10 x 10 modulus matrix systems. And Figure 3 shows the bit error performance of SIC, MF-SIC and OMB-SIC.

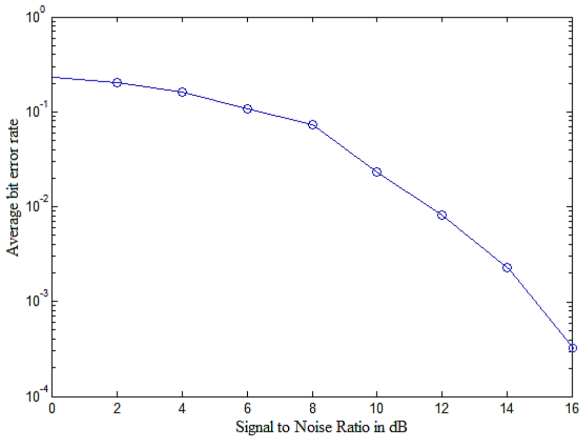

Figure 5: Bit error rate performance of Successive Modulus Matrix.

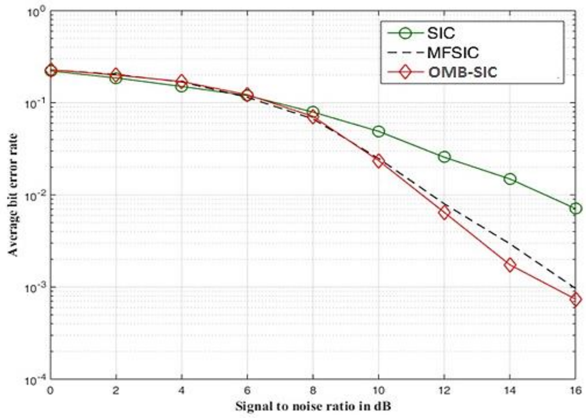

Figure 6: Bit error performance of SIC, MF-SIC and OMB-SIC.

Further, in Table 1, we present the comparison of computational complexity of different detectors i.e. comparison of Successive Modulus Matrix algorithm, MFSIC, and SIC, respectively. It is observed that the computations of successive modulus matrix systems are significantly less than that of the MFSIC and SIC. Hence, the proposed Successive Modulus Matrix algorithm can be used as an alternative to achieve comparable performance with comparatively less computations than that of the Successive Modulus Matrix algorithm.

Table 1: Comparison of bit error rate Complexity of Proposed Successive Modulus Matrix algorithm with SIC, MF-SIC & OMB-SIC.

Sr. No.	Detection Algorithms	Bit Error Rate
1.	SIC	$4.8x10^{-2}$
2.	MF-SIC	$1.2x10^{-2}$
3.	OMB-SIC	$9.5x10^{-3}$
4.	SMM	$4.7x10^{-3}$

VII. CONCLUSION

A modified approach for tractable path selection by Successive Modulus Matrix algorithm strategy aided successive interference cancellation (SIC) based detectors is proposed for detecting the best path selection. Simulation results for bit error rate versus signal to noise ratio have been performed for 10 x 10 modulus matrix System. The bit error rate performance of the proposed modifications is comparable to the original multiple feedback SIC performance but the reduction in complexity can be achieved by our approaches Successive Modulus Matrix algorithm. Further, we have also proposed channel norm based on Successive Modulus Matrix algorithm where we have used column norm of the channel matrix for ordering the detection sequence as well as for defining the threshold power of the shadow region. The BER performance of channel norm based on SMM is superior to that of the MFSIC and OMB performance.

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