International Journal of Master of Engineering Research and Technology, 2394-6172-(O)
Volume-5, Issue-9, July 2018

DESIGN ADAPTIVE FREQUENCY REUSE IN MIMO CELLULAR NETWORKS FOR SCALABLE SOURCE TRANSMISSION

Akshay Bochare
M. Tech. Scholar
Digital Communication
PCST, Bhopal MP

Mukesh Saini
Asst. Professor
Department of Electronics & Communication
PCST, Bhopal MP

Abstract

The large scale multi user MIMO technique is introduced as a promising technique for the fifth-generation radio systems. Where recent researches validate that BSs, deploy an order of magnitude more antennas than scheduled users, have great capability to enhance the spectral efficiency in cellular systems and consequently, meet the fast growth in wireless-traffic of various multimedia applications. However, the major challenge is the contamination of channel-estimate due to reusing the same frequency's in nearby cells and this impairment is termed as frequency-contamination. In this paper, we focus on a frequency reuse based multiuser massive MIMO system, where each user is served by an allocated frequency. The numerical evaluation showed that, when a sequence of scalable packets is transmitted with unequal frequency reuse, the PSNR performance improve by nearly 1.5 dB at PSNR of 33 dB, which is in the range of PSNR we are usually interested in for images or video applications.

Keywords: - MIMO, Cellular Network, OFDM, AFR, SIR, SNR, PSNR, Packet.

INTRODUCTION

In recent years, there has been significant demand for the transmission of multimedia services over wireless channels, and this has motivated intense research for cross-layer optimization design, which is particularly important for mobile radio channels that exhibit time-variant channel- quality fluctuations[1]. Embedded image or scalable video coders employ a progressive manner of transmission such that as more bits are successfully received, the source can be reconstructed with better quality. Such progressive coders are usually sensitive to channel impairments. The use of multiple-input multiple-output (MIMO) is an important advance in wireless communications[2-4]. A large gain in transmission data rates can be provided by spatial multiplexing and link reliability can be significantly improved by transmit diversity schemes. we study the optimal design of such a MIMO system for the transmission of multimedia progressive sources. Progressive sources have the key feature that they have steadily decreasing importance for bits later in the stream, which makes unequal target error rates and/or transmission data rates in the stream very useful[5-8]. Hence, when progressive sources are transmitted over MIMO channels, and each block of the stream can be encoded with a different spacetime code, the tradeoff between the space–time codes under consideration should be clarified in terms of their target error rates and transmission data rates. The interference is major issue in frequency reuse. The process of frequency reuse increases the performance of massive MIMO system in cellular network. For the reduction of interference used various frequency reuse methods such as partial frequency reuse, fixed point frequency reuse and variable frequency reuse[9, 11]. In concern of frequency reuse the distance of base station and user is major factor. If the distance of user is increase from the user base station the possibility of interference and noise is raised[14]. The rise interference and noise grenades bit error rate and degraded the performance of cellular network. In this dissertation proposed adaptive frequency reuse methods for the massive MIMO system. The proposed algorithm maintains the user's variable distance according to their frequency use and reduces the value of interference. The performance of cellular network depends on the allocation of bandwidth and frequency reuse. The process of frequency reuse increases the value of SNR and decrease the value of PSNR and outage probability. For the enhancement of the performance various OFDM-MIMO model are published in current scenario of wireless technology. In paper dissertation proposed adaptive frequency reuse methods for the enhancement of the cellular network[10-13].

The rest of paper organized as in section II discuss the proposed model and algorithm. In section III discuss the experimental result analysis and finally in section IV discuss the conclusion and future work.

II. PROPOSED ALGORITHM & MODEL

To improve the data rates of users, we propose to allocate different frequency bands to the adjacent beams for data transmission so that the interference from adjacent beams, which contributes to most of the inter-beam interference, can be eliminated. A simple method is the fixed frequency reuse. Specifically, for a frequency reuse factor f < 1, the whole frequency band is equally divided into 1/f sub bands. These sub bands are then assigned to the beams from beam 1 to beam N, i.e., from the left-hand side to the right-hand side, regularly as Fig. 8 illustrates. Note that beam 1 and beam N can be seen as two adjacent beams since the largest sidelobe of beam 1 (beam N) is overlapped with the main lobe of beam N (beam 1). As the number of beams N is a power of 2 in a Butler network, to ensure that any two adjacent beams have different frequency bands allocated, the inverse of the frequency reuse factor, 1/f , must be even. A counter example is that if f = 1/3 with N = 16, both beam 1 and beam 16 use sub band 1 for data transmission which causes strong inter-beam interference.

With fixed frequency reuse factor f, let K_i^{fix} denote the set of users using sub band i for data transmission with $\cup_{i=1,2,\dots,1/f} K_i^{fix} = K_s$. The achievable data rate of user $k \in K_i^{fix}$ can be then obtained as

$$R_i^{fix} = f log_2\left(1 + \frac{P_k}{f\sigma_0^2 + I_k^{fix}}\right) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots(1)$$

where the inter-beam interference power received at user k is given by

$$I_k^{fix} = \sum_{j\in K_i^{fix}, j\neq k} P_{n_j^{(1)}} . D_{n_j^{(1)}(\theta_k) . P_k^{-\alpha}} \quad \dots\dots\dots\dots\dots\dots(2)$$

the achievable data rate R_k^{fix} of each served user $k \in K_s$ with the fixed frequency reuse factor $f = 1/2$. For the sake of comparison, the achievable data rate R_k^{uni} with universal frequency reuse, i.e., $f = 1$, with fixed frequency reuse factor $f = 1/2$, the data rates of low-data-rate users 2, 5 and 6 under universal frequency reuse are improved, thanks to the elimination of the dominant interference coming from the adjacent beams. However, the data rates of the other users are reduced significantly compared to those with universal frequency reuse due to only half the bandwidth being allocated, which results in a sacrifice in the sum data rate.

Algorithm: Adaptive Frequency Reuse

Input: $\Delta_{\psi th}, K_s, B_s$.

Initialization: $B_1^{adp} = \emptyset, B_2^{adp} = \emptyset, B_{full}^{adp} = \emptyset$;

For $k \in K_s$ do

$$n_k^{(1)} = arg \max_{n\in B} D_n(\theta_k), n_k^{(2)} = arg \max_{n\in B, n\neq n_k^{(1)}} D_n(\theta_k);$$

If $n_k^{(2)} \in B_s$ then

$$n\tilde{\ }k = \min\left\{n_k^{(1)}, n_k^{(2)}\right\}, \qquad \psi_k = \mathrm{I}\psi_k - \psi_{n\tilde{\ }k}^c \mathrm{I};$$

If $\Delta\psi_k \leq \Delta\psi_{th}$ then

If $n_k^{(1)}$ *is odd then*

$$B_1^{adp} = B_1^{adp} \cup \left\{n_k^{(1)}\right\}, B_2^{adp} = B_2^{adp} \cup \left\{n_k^{(2)}\right\};$$

Else

$$B_2^{adp} = B_2^{adp} \cup \left\{n_k^{(1)}\right\}, B_1^{adp} = B_1^{adp} \cup \left\{n_k^{(2)}\right\};$$

End if

End if

End if

End for

$$B_{full}^{adp} = B_s \backslash B_1^{adp} \backslash B_2^{adp}$$

Output: $B_1^{adp}, B_2^{adp}, B_{full}^{adp}$

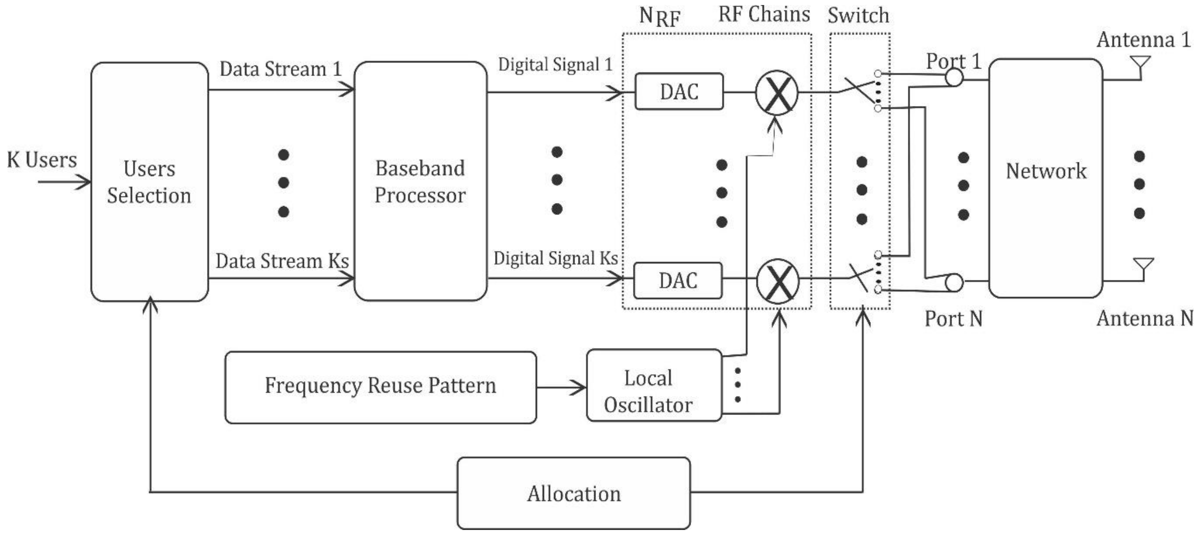

Figure 1: Proposed model of frequency reuse in MIMO cellular network.

III. EXPERIMENTAL RESULT ANALYSIS
RESULT ANALYSIS

SNR (dB)	**UFR Method**	**Proposed Method**
-5	0.9	0.5
0	0.09	0.05
5	0.006	0.001
10	0.00098	0.00056
15	0.00093	0.00043
20	0.00063	0.00027
25	0.00028	0.00013

Table 1: A bandwidth of W = 1 Hz is assumed in this case. The normalized distance is β = 0.61, the path-loss exponent is α = 4, and the partial frequency reuse factor is Nf = 4. Solid curves denote the outage probabilities for full frequency reuse, and dashed curves denote those for partial frequency reuse. For the rates of 0.5 bits/s/Hz, using UFR and Proposed Method.

SNR (dB)	**UFR Method**	**Proposed Method**
8	27	25
12	29.5	28
16	31	29.5
20	32	31
24	33	32
28	33.5	32.5
32	34	33

Table 2: The number of scalable packets is Np = 8, the normalized distance is β = 0.85, the path-loss exponent is α = 5, and the partial frequency reuse factor is Nf = 4. The unequal frequency reuse scheme supports either Nf,i = 1or4 (i = 1,. .., Np) for a sequence of Np scalable packets. Using URF and proposed method with respect to SNR in dB.

SNR (dB)	**UFR Method**	**Proposed Method**
10	20	10
20	35	20
30	48	35
40	60	42
50	70	57
60	85	70

Table 3: The number of scalable packets is Np = 10, the normalized distance is β = 0.85, the path-loss exponent is α = 5, and the partial frequency reuse factor is Nf = 4. The unequal frequency reuse scheme supports either Nf,i = 1or4 (i = 1,. .., Np) for a sequence of Np scalable packets. Using URF and proposed method with respect to SNR in dB.

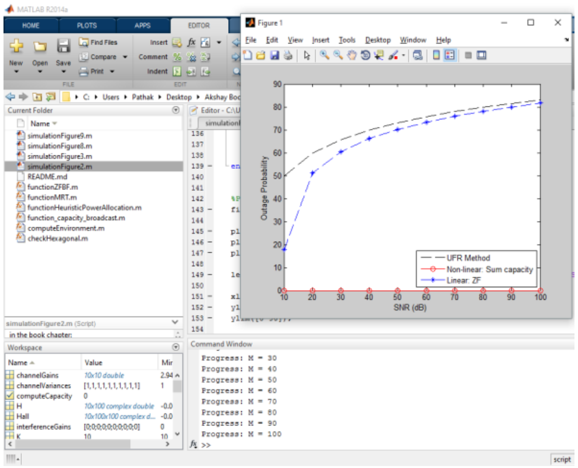

Figure 2: in the given window show that the output of compatibility between SNR(dB) and Outage Probability using UFR method.

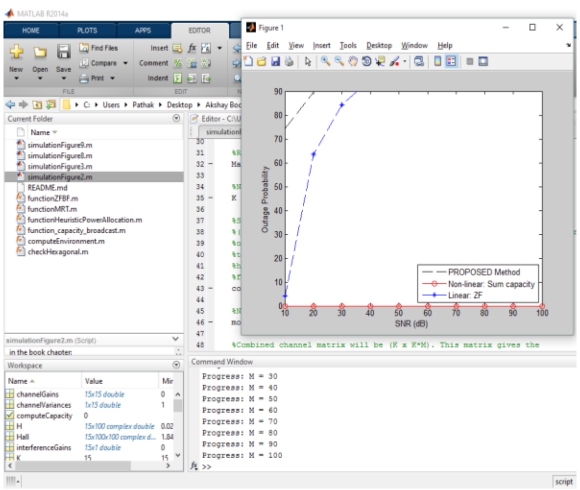

Figure 3: in the given window show that the output of compatibility between SNR(dB) and Outage Probability using Proposed method.

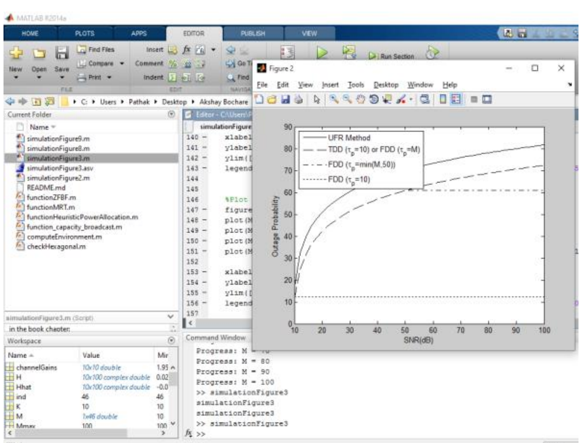

Figure 4: in the given window show that the output of compatibility between SNR(dB) and Outage Probability using UFR method.

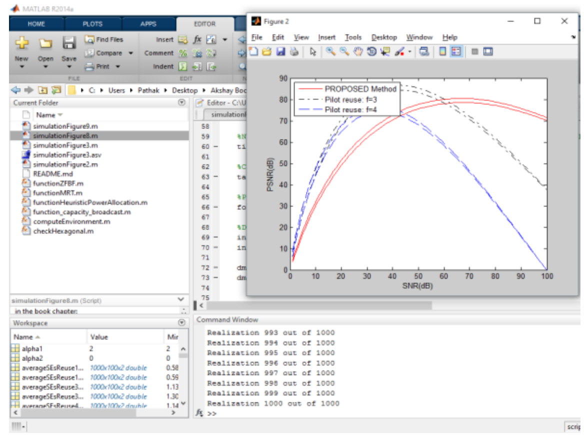

Figure 5: in the given window show that the output of compatibility between PSNR(dB) and SNR(dB) using Proposed method.

PERFORMANCE ANALYSIS

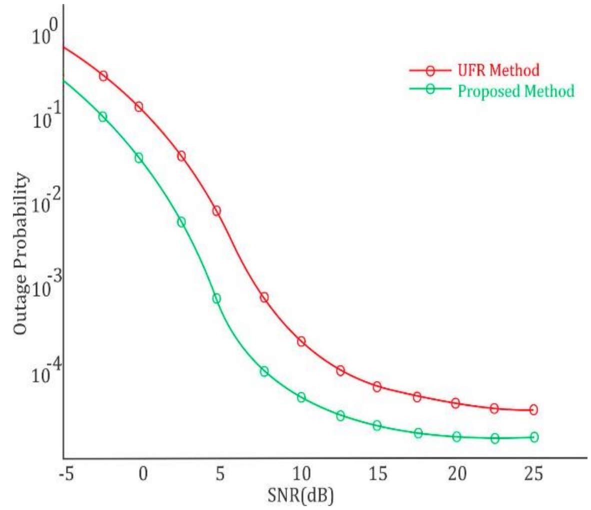

Figure 6: The outage probabilities for a 2 × 2 scheme. A bandwidth of W = 1 Hz is assumed in this case. The normalized distance is β = 0.61, the path-loss exponent is α = 4, and the partial frequency reuse factor is Nf = 4. Solid curves denote the outage probabilities for full frequency reuse, and dashed curves denote those for partial frequency reuse. The crossover points, calculated from (20), are denoted by the circles. For the rates of 0.5 bits/s/Hz, using UFR and Proposed Method.

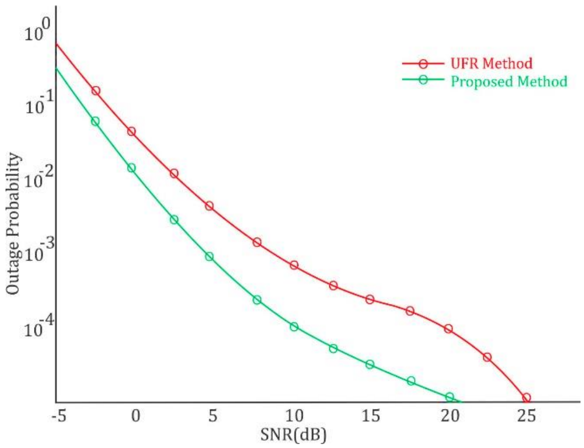

Figure: The outage probabilities for a 2 × 2 scheme. A bandwidth of W = 1 Hz is assumed in this case. The normalized distance is β = 0.65, the path-loss exponent is α = 4, and the partial frequency reuse factor is Nf = 4. Solid curves denote the outage probabilities for full frequency reuse, and dashed curves denote those for partial frequency reuse. The crossover points, calculated from (20), are denoted by the circles. For the rates of 1.1 bits/s/Hz, using UFR and Proposed Method.

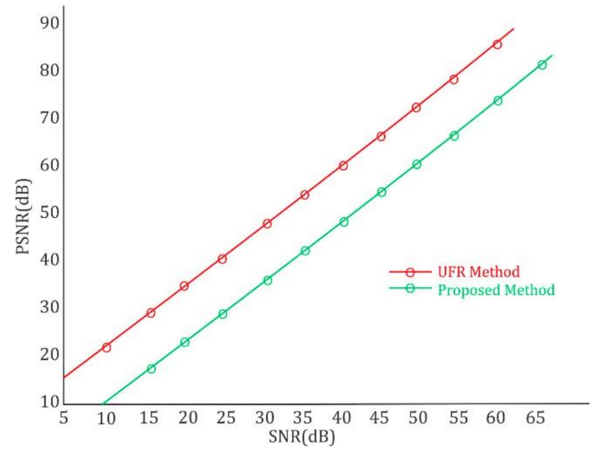

Figure: PSNR performance for the transmission of a scalable 8 bpp 512 × 512 Lena image with a rate of 1.1 bpp using the 2 × 1 scheme The SPIHT source coder is used. The number of scalable packets is Np = 10, the normalized distance is β = 0.85, the path-loss exponent is α = 5, and the partial frequency reuse factor is Nf = 4. The unequal frequency reuse scheme supports either Nf,i = 1or4 (i = 1,. .., Np) for a sequence of Np scalable packets.

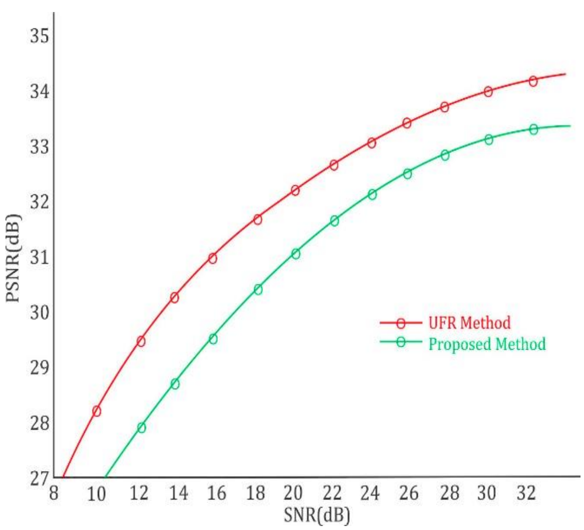

Figure: PSNR performance for the transmission of a scalable 8 bpp 512 × 512 Lena image with a rate of 0.5 bpp using the 2 × 1 scheme The SPIHT source coder is used. The number of scalable packets is Np = 8, the normalized distance is β = 0.85, the path-loss exponent is α = 5, and the partial frequency reuse factor is Nf = 4. The unequal frequency reuse scheme supports either Nf,i = 1or4 (i = 1,. .., Np) for a sequence of Np scalable packets.

IV. CONCLUSION & FUTURE WORK

The performance of cellular network depends on the allocation of bandwidth and frequency reuse. The process of frequency reuse increases the value of SNR and decrease the value of PSNR and outage probability. For the enhancement of the performance various OFDM-MIMO model are published in current scenario of wireless technology. In this dissertation proposed adaptive frequency reuse methods for the enhancement of the cellular network. The proposed adaptive algorithm used two space coding models one is OSTBC and V-BLAST. For the validation of model used MATLAB software and block set function of communication. Our experimental result shows that better performance of pervious model. Additionally, it has been shown that by adopting adaptive frequency reuse the average minimum data rate of the served users can be improved, which indicates that the max-min fairness is enhanced among the served users.

References

[1] Seok-Ho Chang, Hee-Gul Park, Jun Won Choi and Jihwan P. Choi "Scalable Source Transmission with Unequal Frequency Reuse in MIMO Cellular Networks", IEEE, 2017, Pp 4188-4204.

[2] Renaud-Alexandre Pitaval, Olav Tirkkonen, Risto Wichman, Kari Pajukoski, Eeva Lähetkangas and Esa

Tiirola "Full-duplex self-backhauling for small-cell 5g networks", IEEE, 2015, Pp 83-89.

[3] Naveen Jacob and U. Sripati "Bit Error Rate Analysis of Coded OFDM for Digital Audio Broadcasting System, Employing Parallel Concatenated Convolutional Turbo Codes", IEEE, 2015, Pp 1-5.

[4] Rony Kumer Saha, Poompat Saengudomlert and Chaodit Aswakul "Evolution Toward 5G Mobile Networks – A Survey on Enabling Technologies", Engineering Journal, 2016, Pp 87-119.

[5] Ekram Hossain and Monowar Hasan "5G Cellular: Key Enabling Technologies and Research Challenges", IEEE, 2015, Pp 1-23.

[6] Hossein Shokri-Ghadikolaei, Carlo Fischione, Gabor Fodor, Petar Popovski and Michele Zorzi "Millimeter Wave Cellular Networks: A MAC Layer Perspective", arXiv, 2015, Pp 1-21.

[7] Mohammad Vahid Jamali and Jawad A. Salehi "On the BER of Multiple-Input Multiple-Output Underwater Wireless Optical Communication Systems", arXiv, 2015, Pp 1-5.

[8] Yifei Huang, Ali A. Nasir, Salman Durrani and Xiangyun Zhou "Mode Selection, Resource Allocation and Power Control for D2D-Enabled Two-Tier Cellular Network", arXiv, 2016, Pp 1-30.

[9] Ertugrul Basar "Multiple-Input Multiple-Output OFDM with Index Modulation", IEEE, 2015, Pp 1-8.

[10] Ertugrul Basar "On Multiple-Input Multiple-Output OFDM with Index Modulation for Next Generation Wireless Networks", IEEE, 2016, Pp 1-19.

[11] Pimmy Gandotra and Rakesh Kumar Jha "Device-to-Device Communication in Cellular Networks: A Survey", IEEE, 2016, Pp 1-22.

[12] Martin Taranetz, Thomas Blazek, Thomas Kropfreiter, Martin Klaus Müller, Stefan Schwarz and Markus Rupp "Runtime Precoding: Enabling Multipoint Transmission in LTE-Advanced System-Level Simulations", IEEE, 2015, Pp 725-736.

[13] Akhil Gupta and Rakesh Kumar Jha "A Survey of 5G Network: Architecture and Emerging Technologies", IEEE, 2015, Pp 1207-1232.

[14] Navid Tadayon, Georges Kaddoum and Rita Noumeir "Inflight Broadband Connectivity Using Cellular Networks", IEEE, 2016, Pp 1559-1606.