AN APPROACH TO REDUCE THE PERFORMANCE REQUIREMENT IN NOMA RESOURCE ALLOCATION PROBLEM

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ABSTRACT

This paper proposes a resource allocation algorithm for a Non-Orthogonal Multiple Access (NOMA) system. Primary focus or goal of this research is to develop an algorithm which focuses on the Green Radio (GR) that is Energy Efficiency (EE) of the system. One downlink NOMA system model has been designed to mimic the problem statement and the algorithm is developed taking the parameters like sub-carrier assignment and power allocation into con-sideration. Sorting of users is done on the basis of their channel gains and required power levels. This approach also focuses on reducing the processing power required for the algorithm to work and allocate resources like power levels etc. to user. Simulation results show the reduced processing power requirement by the algorithm and generated improved NOMA uplink signals

KEYWORDS

Non-orthogonal multiple access (NOMA), user pairing, resource allocation, Energy Efficiency (EE), channel gain and power ratio.

1. INTRODUCTION

Swift growth in the smart device users, development of technologies based on IoT, online gaming, holographic communication etc. have paved the way for a new communication technology which satisfies the data rate demand, low latency and better connectivity. Non-orthogonal multiple access (NOMA) technique has shown the capacity to fulfil these requirements, as it has high spectral efficiency and it is highly efficient in combining with the other technologies which are be-ing used in 5G, like multiple-input multiple-output (MIMO).

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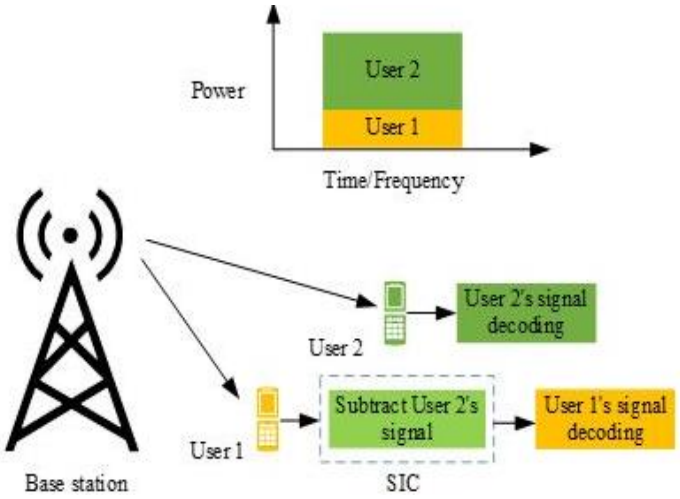


Figure 1. NOMA Transmission [1]

NOMA technique separate users on the basis of their power requirements for successful communication, so the power domain of a channel is allocated to different users to use simultaneously. Since users have different power levels from each other they can use channel resources like spreading code, freq. and time simultaneously. Use of these resources parallelly results in significance improvement in the spectral efficiency of the channel.

In 5G and B5G networks, the cell size is going to decrease and number of required antennas will increase. So, it is a requirement that resource allocation algorithms uses as less processing power as possible, since higher processing power is going to increase the budget of communication network. The proposed algorithm uses the less complex generation and sorting method to determine the power ratio of users and allocate the power levels to them.

2. LITERATURE SURVEY

As NOMA has potential to get used in 5G and beyond 5G (B5G) many researches have been done on different NOMA systems, especially on the research allocation problems. There is always a trade-off between spectral efficiency (SE) and energy efficiency (EE). Usually with increment in spectral efficiency the complexity of the system increases which in turn reduces the energy efficiency of the system.

Table 1. Literature Survey

Ref.	Author & Year of Publication	Objective	Methodology	Conclusion
[2]	Antonino Masaracchio Et al. (2019)	Development of user pairing scheme for NOMA System	PSO Based approach for user pairing and application-based execution	User pairing for linear superposition of different users is done using PSO for optimization
[3]	Krishna Murthy Kattiyan Ramamoorthy Et al. (2021)	Pricing Scheme for NOMA Resource Block Selection and Power Allocation	To achieve the optimality, Nash equilibrium-based algorithm is demonstrated	By enabling network users to do resource management and then using dynamic pricing for NOMA resource block, higher utilities can be achieved.

[4]	Kunhao Huang Et al. (2019)	Resource allocation algorithm for Machine Type communication in MC-NOMA	Algorithm is based on Penalty function method and Dinkelbach algorithm	Two step algorithm is used and proves the effectiveness of NOMA over OFDMA
[5]	Qiuqi Han, Guangyuan Zheng, Chen Xu (2020)	Resource Allocation for mobile edge computing in NOMA-enabled small cell networks	Resource allocation is done by using heuristic Computation based approach	Proposed algorithm can achieve higher performance than the other algorithms from energy POV.
[6]	Naziha GLEI, Rhaimi Belgacem CHIBANI (2019)	Energy efficient resource allocation for NOMA System	Maximizing the EE by using the minimum SE conditions for RB allocation	Proposed approach can achieve its objective to reduce the complexity and improve the speed by using minimum SE condition and focusing on EE parameters.
[7]	Xianbang Diao Et al. (2019)	Development of a Resource, power and channel allocation method for D2D assisted and NOMA based MEC	A power allocation algorithm and then D2D pairing approach is proposed based on PSO	Results shows that the proposed approach results in lowering down the total cost and outperforms the other referred algorithms.
[8]	Mylene Pischella, Didier Le Ruyet (2019)	NOMA-Relevant clustering and resource allocation for proportional fair uplink communications	Clustering algorithm is used with weight matching based approach for RB allocation	Proposed algorithm gives a better balance between rate improvement and network latency
[9]	Naziha GLEI, Rhaimi Belgacem CHIBANI (2019)	Development of an approach for power allocation for energy-efficient downlink NOMA systems	low complexity power allocation approach for each user and optimization problem's solution is achieved when optimal power values are obtained.	Results obtained show the effectiveness of proposed allocation strategy. NOMA actually offers better improvements in EE compared than conventional non-orthogonal access.
[10]	Sifat Rezwan, Wooyeol Choi (2021)	Priority-based joint resource allocation with deep Q-learning for heterogeneous NOMA systems	Karush-Kuhn-Tucker (KKT) optimality conditions along with deep Q-learning algorithms is used	Proposed approach shows promising improvement in the sum rate and system fairness. Deep Q-learning based algorithm results in the improved QoS and network performance.
[11]	Chin-Liang Wang, Chen-Wei Hung (2020)	Development of a proportional-fairness resource allocation for a downlink multicarrier NOMA system	User selection is done on the basis of user proportionality and then user pairing and subcarrier allocation is done by using their power ratios.	Proposed scheme shows lower time complexity in the resource allocation algorithm and it achieves better system performance than the conventional algorithms.

[12]	Xinchen Wei Et el. (2020)	Development of a resource allocation technique for hybrid TDMA-NOMA system with opportunistic time assignment	A hybrid TDMA-NOMA system is proposed and a joint resource allocation technique is used for RB allocation.	Proposed technique gives improved performance results from minimum achieved rate and overall system throughput perspective than the conventional techniques.
[13]	Gunhee Jang Et el. (2020)	For uplink IoT NOMA system throughput maximization is done with optimum resource allocation	A method for sub-channel matching scheme considering intra-interference and inter-interference generated by applying NOMA has been proposed.	Analysis proves that proposed algorithm converges within a finite number of iterations, in UAV-assisted IoT network with NOMA systems.

3. SYSTEM MODEL & ALGORITHM

System model for this problem has been designed as one downlink NOMA system with N-users. Maximum distance of the user from base station is taken as Dmax which then will be used for the normalization purposes. Squared Distance of the users from base station can be given as: -

$$D_E = \sum_{i=1}^{n} {D_i}^2$$

Where Di = Euclidian distance of ith users from base station

According to the free space path loss model the transmission power is inversely proportional to the square of the distance, hence by using this proportionality relation the path loss variable can be taken into the account. So, the power of users can be given as follows: -

$$P_{User\ i} = {P_t}^2 . {D_i}^2 / D_E$$

Where PUser i = Power required by ith user
and Pt = Total Power

Using rand() function with mean as 0.5 a binary signal stream for each user is generated, which is then going to get used as user's digital signal. Superposition coding is done by multiplying the signal in time domain. This also can be done by convolving the signal in frequency domain.

$$S_{enc} = S_0 + \sum_{i=1}^{n} \sqrt{P_{user\ i}} . S_i$$

Where Senc = Encoded signal
and Si = Signal of ith user

The Algorithm which is being used for resource allocation of NOMA system starts by sorting the users on the basis of their distances from the base station, then user pairing is done on the basis of their power ratio, users with highest power ratio are paired and then iteration stops when all the

users are paired. After this user pairing one superposition encoded signal is generated for these paired users, which is then modulated and amplified for the transmission.

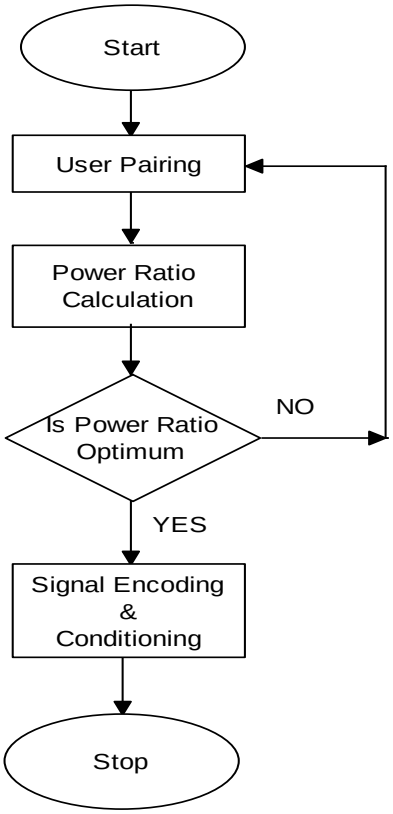
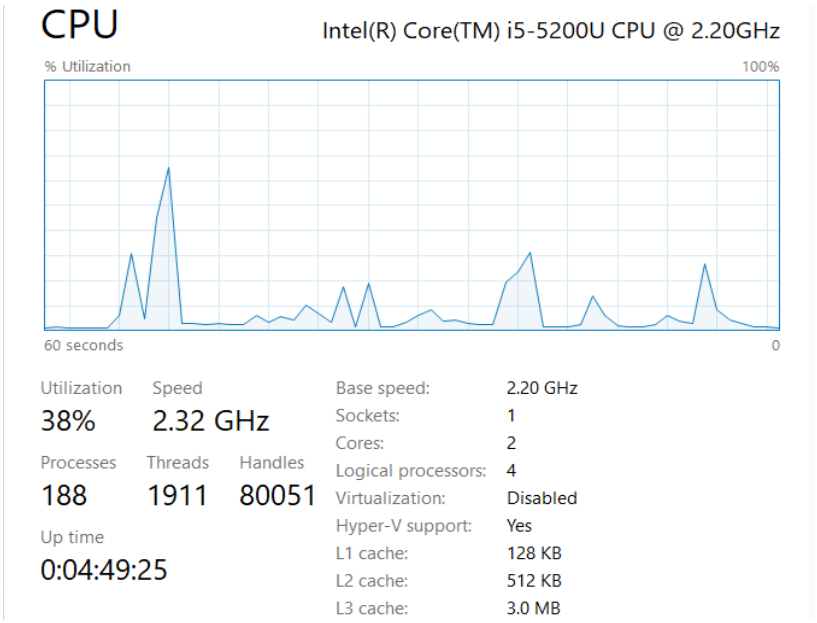


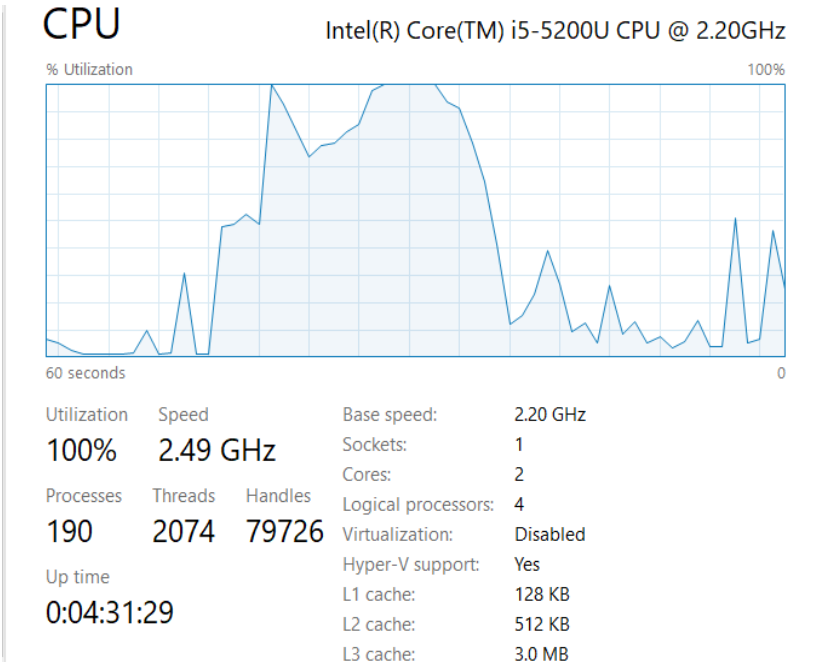
Figure 2. flow chart of Proposed algorithm

4. SIMULATION RESULTS

Fig. 3 shows the difference between the power uses of proposed energy efficient algorithm and conventionally used algorithm. This can clearly be depicted from the diagrams that the proposed algorithm uses almost 31% lesser power than the avg. conventional algorithm.



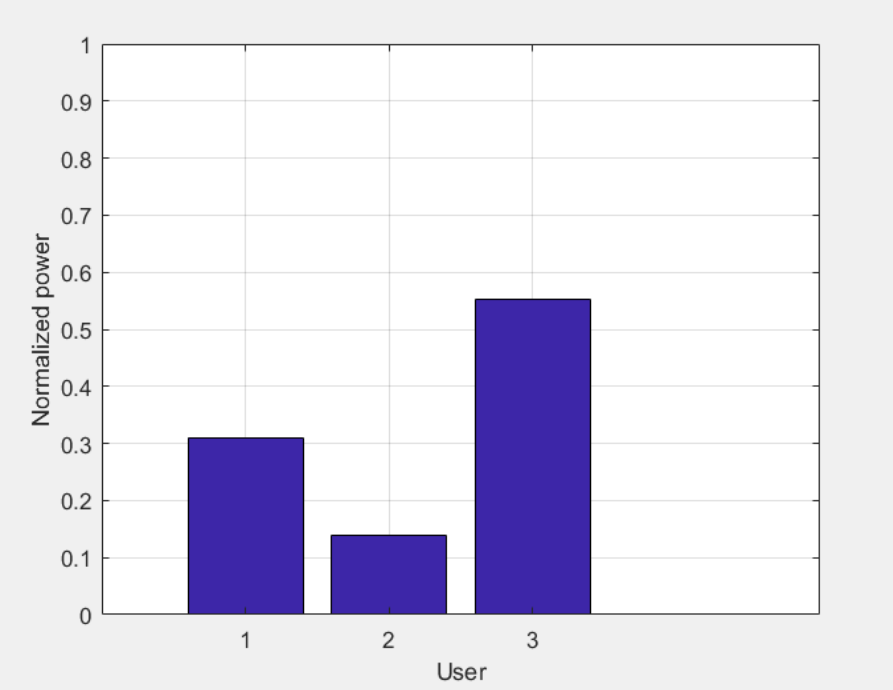
(a)



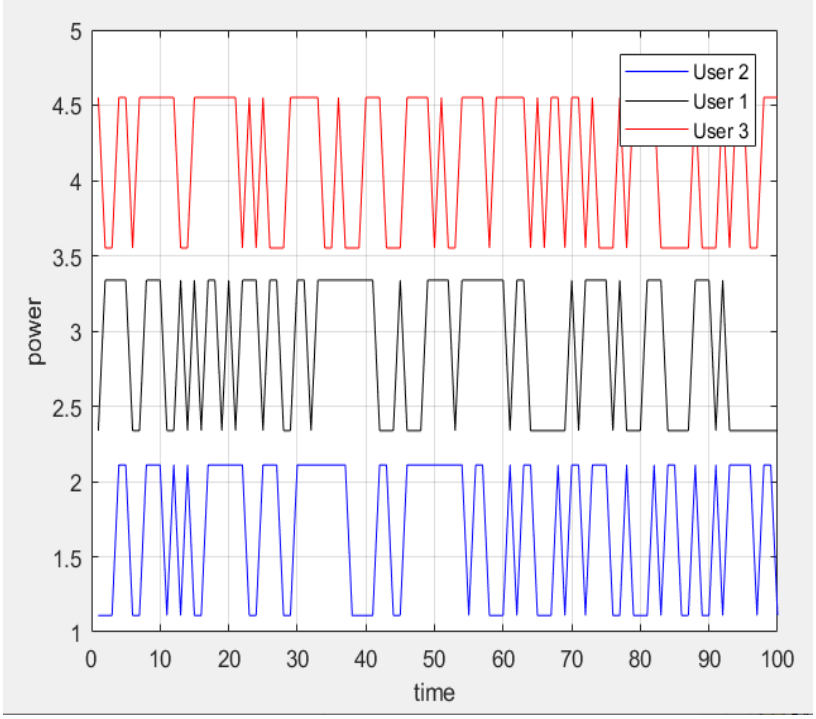
(b)

Figure 3: - Processing power uses of (a) proposed algorithm and (b) conventional algorithm

Fig. 4 shows the allocated normalized power for a user pair (a) and their signals (b) which will be encoded using superposition encoding.



(a)



(b)

Figure 4. (a) Power allocation for user pair (b) user's signals

5. CONCLUSION & FUTURE WORK

In this paper we proposed an algorithm which focuses on the energy efficiency aspect of the research allocation problem. Simulation results show the improved power efficiency and allocated power levels on the basis of user's power ratio. This technique can further be improved by including empirical formulas for path loss estimation which will improve the precision in power ratio calculation. Also, different optimized sorting algorithms can be compared and used for better user sorting and pairing.

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