Matching Based User Pairing for Mobile Users in Non-Orthogonal Multiple Access Network

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Abstract

Number of devices have been dramatically increased with the emergence of 5G and beyond (B5G) communication networks. Non-orthogonal multiple access (NOMA) technique becomes an integral part of 5G cellular systems due its support for massive connectivity with high data rates. In NOMA, optimal user positions and power allocations have significant effect on individual as well as sum rate of the system. Further, users have instantaneous channel gains during user mobility. Therefore, in this work, we propose a distributive user pairing technique for mobile users in NOMA to maximize the sum rate. Moreover, a comparison between the existing user pairing techniques like best with best and best with worst user pairing is graphically presented. Simulation results show that the proposed matching based user pairing scheme with dynamic power allocation outperforms the existing schemes in terms of sum capacity.

Ⅰ. Introduction and Background Study

Due to the orthogonality among different sub-carriers and the relatively high bandwidth separation requirements among them, orthogonal frequency-division multiple access (OFDMA), which is used on 4G networks, may not provide an efficient solution for future generation networks. Therefore, Power Domain NOMA (simply termed as NOMA) has gained significant research interest as a promising candidate for 5G and beyond due to its high spectral efficiency.

NOMA is proposed for inclusion in the 3GPP long-term evolution advanced (LTE-A) standard, and is referred as multi-user superposition transmission (MUST). Further, the NOMA technique has been adopted lately by the 3GPP release-16 standards (5G). Moreover, NOMA is mentioned as an important key enabler for massive Machine Type Communication (MTC) in 6G due to its support for efficient massive connectivity of low-power and low-complexity devices while attaining high spectral efficiency [1].

Power domain NOMA exploits the user power allocation factor (user data is coded with different transmit powers but the frequency band remains the same) and users with high channel gain difference are paired to achieve high spectral efficiency. Additionally, in NOMA system, position of users has significant impact on constraints i.e. capacity, error rate etc. Therefore, user pairing (selection of appropriate users in a pair) is important for NOMA system. In, user pairing techniques are analyzed in detail and the impact of user pairing on the performance of NOMA is discussed. Mostly, NOMA based solutions focus on the downlink transmission where the randomness of the user's activity is not addressed [2]. Moreover, there are some matching based user pairing and power allocation techniques which focus on distributive user pairing approach instead of centralized approach [3],[4],[5]. Therefore, in this paper, we are targeting the issues related to the randomness of the users at different distances from the base station (BS). We compare different user pairing techniques and we propose a hybrid user pairing technique to maximize capacity.

Ⅱ. System Model and Proposed Scheme

In the proposed scheme, we have considered a downlink NOMA system that uses superposition coding (SC) and schedules the concurrent transmission of users over the entire channel i.e. time/frequency/code using the whole bandwidth. Interference cancellation technique i.e. successive interference cancellation (SIC) is used at the receiver side to decode the received signals. Ten users with different distance from the BS are considered.

In the considered scenario, the users are paired to perform NOMA on the basis of their channel conditions. In best with best user pairing technique, the near users with best channel condition are paired with the far users with best channel condition or having maximum rate. While, in the best with worst technique the near users with the best channel condition are paired with the far users with worst channel condition. In this paper, we have proposed the matching based user pairing technique to maximize the performance in terms of pair sum capacity and proposed a user pairing approach with dynamic power allocation. The proposed technique performs better in the considered NOMA system with random user behavior and it is shown in section-III that it can achieve better pair sum capacity than the existing fixed power user pairing techniques.

III. Results Discussion

In order to analyze the impact of multiple user pairing techniques like: best with best (Greedy), best with worst (Non-Greedy) and the proposed matching based user pairing scheme, we performed simulations considering the above three techniques in a downlink

NOMA system. In Fig 1., the matching technique performs better than the best with best (Greedy) technique at the farthest positions because the latter technique pairs the near user with best channel condition to the far user with best channel condition and almost paired the best pairs for nearest users from the BS. For the farther pairs the only choice remains is to be paired with users with worst channel condition. In the proposed technique we have addressed the above discussed problem. Thereby, achieved maximum pair sum rate in the farthest pairs.

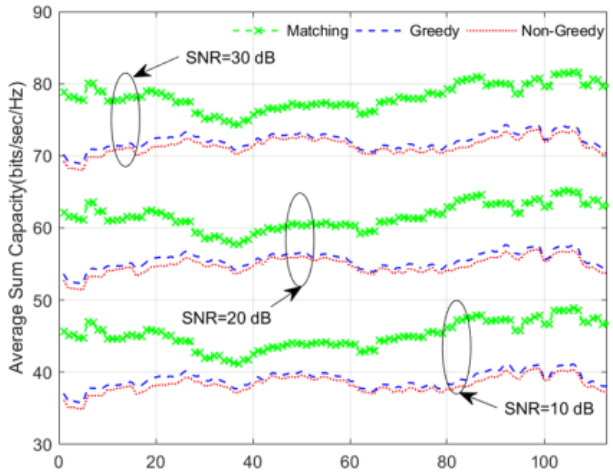

Figure 1: Average sum Capacity Comparison at different transmit SNR.

In addition, it is shown in Fig. 2., that if only the best with best pairing approach is used than the farthest pairs can suffer or if only best with worst pairing technique is used than nearest user pairs can have low rates. Therefore, a matching based approach can perform better if a NOMA system with random user behavior is considered along with the user mobility.

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IV. Conclusion

In this work, we proposed a distributive user pairing technique for mobile users in NOMA to maximize the

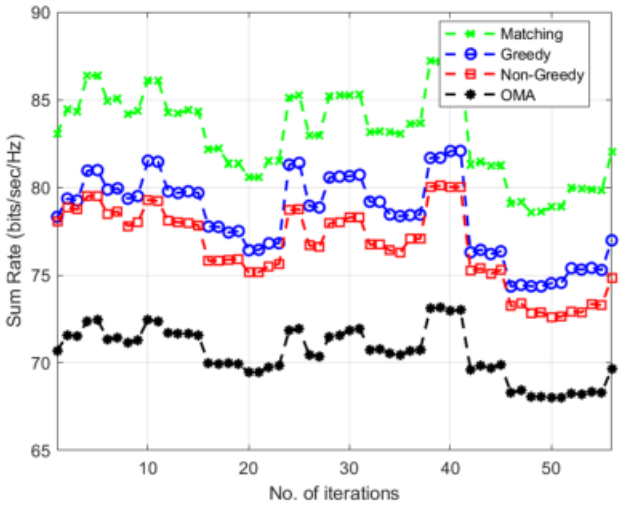

Figure 2: Average sum Capacity Comparison with OMA for K=20 users.

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ACKNOWLEDGMENT

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government. (MSIT) (No. 2019R1A2C1089542).

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