# Robust Geometry-Based User Scheduling for Large MIMO Systems

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Massive multiple-input multiple-output (MIMO) systems, having a large number of antennas at the base station (BS), is a promising technique for fifth generation (5G) communications. The problem of user scheduling with reduced overhead of channel estimation in the uplink of Massive MIMO systems has been considered. A realistic COST 2100 channel model has been considered. In this paper, we first propose a new user selection algorithm based on knowledge of the geometry of the service area and of location of clusters, without having full channel state information (CSI) at the BS. We then show that the correlation in geometry-based stochastic channel models (GSCMs) arises from the common clusters in the area. The analytical results then are verified by simulations. It is shown in GSCMs by analysing the capacity upper-bound that the capacity at high SNR strongly depends on the position of clusters and users in the system. Simulation results show that although the BS receiver does not require the channel information of all users, by the proposed geometry-based user scheduling (GUS) algorithm the sum-rate of the system is only slightly less than the well-known greedy weight clique (GWC) scheme [1]. Finally, the robustness of the proposed algorithm to cluster localization is verified by the simulation results.

**Contributions of This Work: 1)** In GSCMs, multipath components (MPCs) from common clusters cause high correlation which reduce the rank of the channel. In this paper, we investigate the effect of common clusters on the system performance. The performance analysis show the significant effect of the distinct clusters on the system throughput. We prove that to maximize the capacity of system, it is required to select users with visibility of the maximum number of distinct clusters in the area. Close analytical approximations for Massive MIMO systems are found. **2)** We investigate user scheduling by considering the large MIMO assumption. Using the map of the area and positions of users, a new user scheduling scheme under the assumption of no CSI at the BS is proposed. For large number of transmit antennas and users, it is shown that the throughput benefits from multiuser diversity, even under the no-CSI condition. Simulation results show significant performance improvement compared to the conventional user scheduling algorithms, especially for indoor and outdoor of micro-cells. The proposed scheme significantly reduces the overhead of channel estimation in Massive MIMO systems. **3)** In this paper, we assume that the space-alternating generalized expectation (SAGE) algorithm [2] is used (offline) to estimate the direction of arrival (DoA) and the delay of the path. Then, we show that the position of clusters in the area can be given by geometrical calculation. To investigate the robustness of the proposed algorithm to cluster localization, the performance degradation is shown for different values of the error in cluster localization and simulation results show the robustness of the proposed user scheduling algorithm to poor cluster localization.

**Proposed Geometry-based User Scheduling (GUS):** An algorithm is proposed for increasing the system throughput based on the geometry of the system and without estimating the channels of all the users in the area. Once the set of active users has been determined, the receiver BS estimates the channels of the selected users and the users transmit data. Next, the performance of the proposed user selection algorithm to maximize the sum-rate is evaluated. In large MIMO systems with large numbers of users estimating the channels of all users is practically difficult. So the proposed user scheduling algorithm can be an efficient way to reduce the overhead of channel estimation. The average sum-rate is evaluated for the three scenarios. In the GUS scheme, it has been proposed that the receiver BS selects users that maximize the number of distinct clusters in the cell. We evaluate the average throughput of the GWC scheme [1] and random selection (RS) of users. For the case of GWC, similar to [1], we set the optimal channel direction constraint to achieve the best performance for GWC, so the complexity of GWC is much higher than GUS. The results show that while sum-rate slightly decreases along with the reduced overhead of channel estimation, the proposed algorithm can be an efficient scheme to reduce the complexity of user scheduling in Massive MIMO systems.

[1] T. Yoo, and A. Goldsmith, ``Sum-rate optimal multi-antenna downlink beamforming strategy based on clique search,'' in *Proc. IEEE Globecom*, vol. 3, Dec. 2005.

[2] B.H.Fleury, M.Tschudin, R.Heddergott, and D.Dahlhaus, ``“Channel parameter estimation in mobile radio environments using the SAGE algorithm,'' *IEEE J. Sel. Areas Commun*., March 1999.