Radio Resource Allocation Optimization for Cellular Wireless Networks

by
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Abstract

This thesis focuses on the radio resources (feedback budget, spectrum, power) allocation optimization in cellular wireless networks. In channel state information (CSI) feedback based downlink precoding systems, partitioned vector quantization (P-VQ) is an efficient technique that reduces the CSI quantization complexity in terms of reducing the codebook size, and enhancing the codevector search latency. However, in order to optimize the CSI quantization efficiency, the feedback budgets of the users should be allocated optimally among the partitions and respective channel quality indicator (CQI) and channel direction indicator (CDI). Furthermore, in a typical multiuser cellular system, different users have different types of services requirements, which can be categorized into different classes, such as minimum target data-rate requirements, desired quality of services etc. Furthermore, because of the scarcity of wireless bandwidth and transmitting power constraints, the resources need to be allocated judiciously among the users to optimize the system objectives while meeting the users service requirements under various constraints. Unfortunately, most of the times, the resource allocation optimization problems are not convex. To achieve the optimum system objective, we need to be reliant on the global optimal approaches, which are computationally very expensive, and are not applicable in practical communication systems operating under stringent time limit.

To solve the feedback budget allocation optimization problem, we proposed an efficient heuristic approach quantifying the quantization mean-square-error measure (Q-MSE). For a given feedback budget per user, the optimal number of partitions and the corresponding CQI and CDI budgets are derived such that minimum Q-MSE is incurred. The applicability of our proposed optimization approach in frequency-selective channel scenarios and in the systems with users having diverse signal-to-noise (SNR) is also discussed.

For the resource allocation optimization problem in multiuser-orthogonal frequency division multiplexing (MU-OFDM) systems, we have considered several design objectives. An efficient suboptimal resource allocation technique based on sequential parametric convex approximation approach is proposed for a system aiming to optimize the weighted sum-rate under transmitting power constraints. A more simplified approach for the same resource allocation problem is also proposed, which is formulated as an optimization of an exponential function. Both of the proposed solutions are fast, computationally less-complex and provably convergent. We, then, consider the power minimization problem while meeting the users' desired quality of services (QoS) for a single cell system. In particular, we have proposed two efficient suboptimal solutions. The fist proposed approach is based on Lagrange dual decomposition and, the second proposed solution is based on separating the subcarrier and power allocation. Simulation results reveal that the performances of the proposed solutions are very close to the optimal solution.

Finally, we study the resource allocation optimization problem that maximizes the sum-rate of a single cell MU-OFDM system under transmitting power constraint with proportional data rate fairness among the users. We adopt a two-stage optimization process and propose an efficient and low-complexity suboptimal solution that separates the subcarrier and power allocation. The simulation results show that the proposed solution has the best adherence to the desired proportional data rate fairness while achieving the maximum system throughput when compared to the other existing solutions.