INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

In this thesis, we present detailed performance analysis and optimization of non-orthogonal multiple access (NOMA) systems aided by massive multiple input multiple output (MIMO) and intelligent reflecting surface (IRS). To being with, we analyze the uplink of a massive MIMO-NOMA system and deduce new lower bounds on the achievable spectral efficiency (SE) based on zero-forcing (ZF) decoding at the base station (BS). User grouping and power allocation are employed to regulate the performance of users in a NOMA system. To cancel the inter-group interference, the ZF decoder is designed as a function of channel estimates acquired based on two low overhead channel estimation schemes, namely, Scheme-I and Scheme-S. Further, to ensure uniform quality-of-service to all users, we obtain the max-min power control coefficients which maximize the minimum achievable SE.

In the second part of the thesis, we quantify the joint impact of channel outdatedness, pilot contamination and imperfect successive interference cancellation (SIC) on the achievable SE in uplink of a massive MIMO-NOMA system. We compute novel closed-form expressions for achievable SE (i) for both ZF and MR decoders based on outdated channel estimates obtained using Scheme-I and Scheme-S, and (ii) for ZF and MR decoders based on the channel predicted using Wiener linear predictor (WLP). We formulate and solve optimization problems for max-min and proportional fairness power control using convex programming. Proportional fairness power control provides higher per-user SE than max-min power control while maintaining fairness to a significant extent.

In the last part of the thesis, we consider an IRS-aided NOMA system as a cost-efficient alternative to large antenna systems. Here, we analyze the error performance of IRS-aided NOMA systems with Rayleigh faded direct path (BS to each user) and independently Rician faded reflected paths (BS to IRS and IRS to each user). We deduce novel approximate analytical expressions for average symbol error probability (SEP) for pulse amplitude modulation (PAM) and quadrature amplitude modulation (QAM). We also analyze the multi-user scenario by deriving novel approximate analytical expressions for (i) the average SEP for multicast transmission and (ii) the average pairwise error probability (PEP) for unicast transmission. We also formulate and solve a constrained optimization problem to determine the fraction of elements to be activated at any IRS to guarantee near-identical SEP performance for both the users. Analysis incorporates practical aspects of IRS-aided systems.