ABSTRACT

Incremental redundancy hybrid automatic repeat request (IR-HARQ) based on quasi-cyclic (QC) low density parity check (LDPC) codes can improve transmission robustness with a trade-off of additional latency. This thesis proposes an IR-HARQ with packet combining scheme, called superposed IR-HARQ (SIR-HARQ), for the fifth telecommunication generation (5G) new radio (NR) communications and beyond. The proposed SIR-HARQ can maximize data rate such that number of required slots for re-transmission can be minimized to support ultra reliable and low latency communications (URLLC) applications. The proposed SIR-HARQ performs a packet combining of two packets, i.e., (i) the parity of unrecoverable packets and (ii) the parity of new packet to be transmitted together using XOR operations, following LDPC rules.

This thesis performs a series of computer simulations to evaluate bit-error-rate (BER) performances and decoding behavior of the proposed SIR-HARQ scheme under Additive White Gaussian Noise (AWGN), slow Rayleigh fading, and fast Rayleigh fading channels. Extrinsic information transfer (EXIT) chart analysis is also performed in this thesis to evaluate the decoding behavior of the codes.

This thesis has revealed the IR mechanism of 5G NR QC-LDPC codes due to the use of extended parity (EP), such that, 5G NR QC-LDPC codes should be made rateless to support IR-HARQ. From the obtained results, this thesis found that the proposed SIR-HARQ requires signals having mutual information (MI) beyond 0.5 to effectively decode the packet, which is still practical since the MI can be estimated even only using the log-likelihood ratio without knowing the information. This thesis found that SIR-HARQ based on MI can outperform the conventional IR-HARQ in terms of BER performances and data rate. The proposed SIR-HARQ is expected to be used for ultra reliable low latency communication (URLLC) and enhanced mobile broadband (EMBB).

Keywords: 5G NR QC-LDPC codes, EXIT Analysis, Superposed codes, IR-HARQ.