UMIC Ultra high-speed Mobile Information and Communication

Joint UMIC (RA A) and TI seminar

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Threshold Saturation of LDPC Convolutional Codes

Low-density parity-check (LDPC) codes are currently among the most prominent schemes for forward error correction due to their near-capacity performance with low-complexity iterative decoding. It is well known that the performance of iterative belief propagation (BP) decoding of LDPC codes is strongly influenced by the degrees of the variable nodes and check nodes in their Tanner graph representation. In order to improve decoding performance, irregular code ensembles with a variety of node degrees are often used in practice. For the binary erasure channel (BEC), capacity achieving sequences of irregular LDPC codes can be found, for which a vanishing gap between the BP decoding threshold and the Shannon limit can be proven. On the other hand, ensembles with thresholds close to capacity usually have poor minimum distance properties compared to Gallager's original regular LDPC ensembles, resulting in comparatively high error floors.

In this talk, we present LDPC convolutional (LDPCC) code ensembles in which the blocks of different time instants are interconnected. Terminating regular LDPCCs leads to a slight irregularity at the ends of the Tanner graph, resulting in substantially better BP decoding thresholds compared to their tail-biting version or the block codes they are constructed from. This threshold improvement is even visible as the termination factor tends to infinity and both the code rate and the degree distributions approach those of the corresponding block codes. More recently, it has been proven analytically for the BEC that the BP decoding thresholds of some slightly modified LDPCC code ensembles approach the optimal maximum a posteriori probability (MAP) decoding thresholds of the corresponding LDPC block code ensembles. These thresholds in turn are known to approach capacity as the node degrees increase. At the same time, it can be shown that the minimum distance of the terminated ensembles grows linearly with the block length as the block length tends to infinity, i.e., they are asymptotically good. This remarkable combination of good distance properties and BP decoding thresholds close to the Shannon limit is observed for irregular LDPCC code ensembles as well. These code ensembles demonstrate that not only the average degrees but also the special structure of the Tanner graph has a substantial influence on the performance of LDPC code ensembles.

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Walter-Schottky-Haus, Sommerfeldstr. 24, 4th Floor, Room A 407

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