Hybrid ARQ Using Serially Concatenated Block Codes for Real-Time Communication - An Iterative Decoding Approach

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Abstract

The ongoing wireless communication evolution offers improvements for industrial applications where traditional wireline solutions causes prohibitive problems in terms of cost and feasibility. Many of these new wireless applications are packet oriented and time-critical. The deadline dependent coding (DDC) communication protocol presented here is explicitly intended for wireless real-time applications. The objective of the work described in this thesis is therefore to develop the foundation for an efficient and reliable real-time communication protocol for critical deadline dependent communication over unreliable wireless channels. Since the communication is packet oriented, block codes are suitable for error control. Reed-Solomon codes are chosen and incorporated in a concatenated coding scheme using iterative detection with trellis based decoding algorithms. Performance bounds are given for parallel and serially concatenated Reed-Solomon codes using BPSK. The convergence behavior of the iterative decoding process for serially concatenated block codes is examined and two different stopping criteria are employed based on the log-likelihood ratio of the information bits. The stopping criteria are also used as a retransmission criterion, incorporating the serially concatenated block codes in a type-I hybrid ARQ (HARQ) protocol. Different packet combining techniques specifically adapted to the concatenated HARQ (CHARQ) scheme are used. The extrinsic information used in the iterative decoding process is saved and used when decoding after a retransmission. This technique can be seen as turbo code combining or concatenated code combining and is shown to improve performance. Saving the extrinsic information may also be seen as a doping criterion yielding faster convergence. As such, the extrinsic information can be used in conjunction with traditional diversity combining schemes. The performance in terms of bit error rate and convergence speed is improved with only negligible additional complexity. Consequently, CHARQ based on serially concatenated block codes using iterative detection creates a flexible and reliable scheme capable of meeting specified required real-time constraints.

Keywords: Serially concatenated block codes, iterative detection, ARQ, trellis, real-time.