Performance Bounds for Erasure, List and Feedback Schemes with Linear Block Codes

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Abstract

A message independence property and some new performance upper bounds are derived in this work for erasure, list and decision-feedback schemes with linear block codes transmitted over memoryless symmetric channels. Similarly to the classical work of Forney, this work is focused on the derivation of some Gallager-type bounds on the achievable tradeoffs for these coding schemes, where the main novelty is the suitability of the bounds for both random and structured linear block codes (or code ensembles). The bounds are applicable to finite-length codes and to the asymptotic case of infinite block length, and they are applied to low-density parity-check (LDPC) code ensembles.

Index Terms

Automatic repeat request (ARQ), erasures, error exponents, feedback, linear codes, list decoding, low-density parity-check (LDPC) codes.

I. Introduction

Exponential error bounds were derived and studied by Forney [13], referring to the following two situations:

1) A decoder is allowed not to make a decision on a received signal, or rejecting all estimates; this output is called an *erasure*. The event where the decoder makes in this case a decision on the transmitted message, and it is wrong, is called an *undetected error*.
2) A decoder is allowed to make more than one estimate of the received signal. The output of this decoder forms a list of codewords, and the event where the transmitted message is not on the list is called a *list error event*.

Throughout this paper, decoding rules for these two situations are called *generalized decoding rules* since they apply to the general setting where the decoder does not necessarily need to make a single decision about the codeword which was sent. As explained in [13], erasure and list options may be useful when the transmitted data contains some redundancy, when a feedback channel is available, or when several stages of coding (e.g., concatenation) are used.

The size of the decoded list in [13] is allowed to vary according to the received signal. This decoding rule has to be distinguished from [12], and [34] where the size of the list is predetermined and fixed.

By allowing a decoder to increase the probability of erasures in the first case, the undetected error probability can be reduced. In the second case, by allowing the decoder to increase the size of the list, the list error probability

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