Efficient transmission of multimedia data over noisy channels

by Vladimir Stanković

March 7, 2003

Abstract

Transmission of image and video data over unreliable channels has become an attractive problem with the development of the Internet and wireless networks. To enable reliable communication over noisy channels, an optimal error protection is needed. Determining an optimal protection is very difficult and time consuming. For time-constraint applications, a fast approximation is therefore preferable.

We provide methods that find an optimal or near-optimal error protection for different source coders and transmission environments.

First, we propose algorithms for optimizing the system that transmits fractal codes over binary symmetric channel (BSC). Then, the protection of embedded data is elaborated. Recently, Sherwood and Zeger proposed an efficient system for BSC which uses a concatenation of a cyclic redundancy check and a rate-compatible error-correction coder. The performance of the system may be measured by expected distortion or by expected number of correctly decoded source bits. We significantly accelerate the algorithm of Chande and Farvardin that determines a rate-based optimal solution for such systems, by finding an explicit formula for the number of successive packets that should be protected with the same channel code.

The computation of a distortion-based optimal solution is prohibitive. Under the assumption of the convexity of the operational distortion-rate function of the source coder, we find a lower bound on the expected distortion of an optimal solution. We further provide a fast algorithm that starts from a rate-based optimal solution and converges to a local minimum of the expected distortion. Experimental results show that the solution given by our local search is close to optimal, whereas its complexity is much lower than that of previous best solution of Banister, Belzer, and Fisher.

We also consider progressive transmission, where a good performance is important not only at target rate, but at all intermediate rates, as well. We develop linear-time algorithm that determines a progressive rate-optimal protection.

Unequal loss protection with Reed-Solomon codes allows reliable transmission of scalable data over packet erasure channels. The design of a fast algorithm with low memory requirements for computation of an unequal loss protection solution is essential for real-time applications. We present an algorithm that rapidly determines a near optimal solution. We further extend the work to product code system of Sachs, Anand, and Ramchandran for transmission over wireless networks. Experimental results show that our algorithms provide quality performance close to optimal, while their time complexity is significantly lower than that of all previous solutions.