Rate-adaptive LDPC Code Construction for Free-Viewpoint Television

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Keywords

Free-Viewpoint Television; Slepian Wolf source coding; LDPC codes; Rate-adaptive codes; Protographs

1. Introduction

Free-Viewpoint Television (FTV) is a system for watching videos in which the user can choose its viewpoint freely and change it instantaneously at anytime [1]. For instance, in a football game, a user may decide to follow a player or to focus on the goal. A practical FTV system requires to store all the views of the video on a server which should be able to handle a large number of users.

In this system, each user can request to the server a random subset of the views of the video. In order to reduce the amount of transmitted data from the server to the user, we would like to exploit the fact that the previously requested views are still available when the current view is decoded by the user. This can be represented as a problem of source coding with side information available at the decoder, where the current requested view is the source X and the previous requested view is the side information Y [2], see Figure 1. However, the statistical correlation between the source and the side information varies depending on the previous user request. Therefore, the coding rate must be adapted on the fly depending on the previous request.

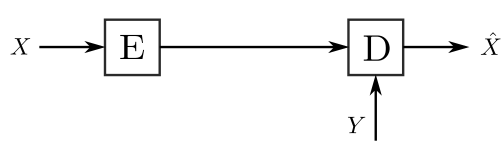

Figure 1: Slepian-Wolf Source Coding

Low-density parity-check (LDPC) codes were first introduced for channel coding [3], but they can also be used for the problem of source coding with side information at the decoder, as proposed in [4]. In this paper, we propose a novel LDPC code construction for the problem of source coding with side information. Our code construction allows the server to adapt the coding rate on the fly, depending on the previous request of the user.

2. Proposed Method

To construct good LDPC codes for source coding, we can combine different methods. A protograph [5] is a small Tanner Graph that represents connections between different types of variable nodes and check nodes. An LDPC code can be generated from a protograph by repeating the protograph structure, and by interleaving the connections between the variable nodes and the check nodes of the corresponding types, see Figure 2 for an example. The performance of an LDPC code highly depends on its underlying protograph, and in the case where no rate-adaptation is needed, several methods were proposed to optimize the code protograph [3].

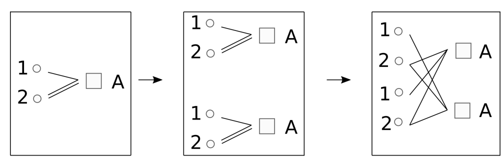

Figure 2: Construction of an LDPC code from a protograph. Left figure is the initial protograph. Middle figure is the protograph duplication. Right figure is the interleaving.

When rate-adaptation is required, several standard rate-adaptive code construction methods can be applied [6, 7]. The most standard one is the Low Density Parity Check Accumulated (LDPCA) construction [7] which permits to obtain low rate codes from an initial high rate code. LDPCA construction combines several lines together in order to construct lower rate codes. However, it does not leave the choice of line combinations (accumulated structure) and bad combinations can generate a lot of short cycles. As short cycles may highly degrade the code performance, we propose a new rate-adaptive construction that limits the number of short cycles.

In this method, we choose line combinations that add the least number of cycles. In this way, we generate a sequence of rate-adaptive codes that perform better than LDPCA. In addition, since the code protograph can help us choose lines combinations that improve the convergence of LDPC decoders, we propose a method that can optimize the protographs for all the considered rates.

Our final rate-adaptive LDPC code construction combines protograph optimization at all the considered rates and great reduction of the number of cycles in the constructed codes. It shows a great performance improvement of up to an order of magnitude compared to LDPCA.

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