Joint Design of Layered Coding Quantizers to Extract and Exploit Common Information

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Multimedia content is required at different quality levels due to heterogeneous network conditions and diverse consumption devices. A conventional scalable coder generates a layered bitstream, wherein a base layer produces a coarse reconstruction, and successive layers refine the quality, incrementally. However most multimedia sources are not successively refinable under their relevant distortion metrics. When a source is not successively refinable, conventional scalable coding introduces a performance penalty, while at the other extreme, independent coding is clearly wasteful in resources. As an alternative, we recently proposed a framework with a relaxed hierarchical structure to separate and transmit information common to different quality levels, along with individual bitstreams for each quality level. This framework offers the flexibility to operate at various tradeoff points between conventional scalable coding and independent coding.

In this paper we propose a technique to jointly design scalar quantizers across layers of this framework, while focusing on the setting of two quality levels. We need three layers for two quality levels, one common layer sent to both receivers and two individual layers, which refine the common layer to two different required quality levels. We propose an iterative approach for designing the three scalar quantizers, wherein at each iteration one quantizer's intervals are updated to minimize the overall cost function while the others are fixed, and the iterations are repeated until convergence. Given the common layer quantizer intervals, for each of the individual layer, refining quantizers for all the intervals of the common layer are jointly designed to minimize the overall cost function. We also develop ("Lloyd algorithm style") optimal interval update rules for the common layer quantizer that minimizes the overall cost while accounting for the current individual layer quantizers.

We provide experimental results for Laplacian sources, as many practical applications, model multimedia sources by the Laplacian distribution. The results clearly demonstrate that, by exploiting the concept of common information, the proposed approach can achieve all intermediate operating points at considerably better performance compared to the convex hull between non-scalable and scalable coding. Also we obtain interesting operating points, with distortions very close to non-scalable coding, but with a 14% reduction in total transmit rate compared to non-scalable coding.

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