Joint Spatial-Temporal Layer Bit Allocation with *S*-Domain Dependent R-D Modeling

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H.264/SVC, as a scalable extension of H.264/AVC, is finally standardized in 2007 [1]. Scalable video stream has achieved great flexibility and adaptability in terms of frame rates, display resolutions and quality levels. With three dimensions of the scalability, each coding unit in an H.264/SVC video is subject to highly complicated inter-dependency, which gives one of major challenges for bit allocating. In this work, we study an optimal solution to joint spatial-temporal (S-T) bit allocation problem with self-domain R-D modeling. The self-domain (*S*-domain) analysis employs the R-D characteristics of the reference layer as the observation domain of those of dependent layers.

The difficulty of modeling dependent rate and distortion characteristics comes from the fact that the rate and distortion functions of a dependent coding unit can be expressed in multi-variable functional form. We propose an *S*-domain analysis to understand the effect of quantization parameters on the rate and the distortion functions. The advantage of the *S*-domain analysis is that it enables the dependent rate or distortion function to be expressed by the rate or distortion function of the base layer. As a result, the number of variables in the dependent rate or distortion models can be reduced to that of the base layer. By employing the rate or distortion model of the base layer as the observation domain, a multi-variable rate or distortion function can be simplified to be a linear combination of single variable rate or distortion items.

After obtaining the proposed *S*-domain R-D models, a joint S-T bit allocation problem is examined as an application of the proposed R-D models. The optimal joint S-T bit allocation problem is formulated using the Lagrangian optimization framework and solved numerically by the gradient method. It is shown by experimental results that the new R-D models achieve an efficient bit allocation scheme with a significant coding gain over the FixedQPEncoder of the JSVM reference codec based on the SVC testing conditions JVT-Q205 defined in [2].

The PSNR performance of comparison results show that significant coding gain is achieved by the proposed algorithm over JSVM9.12 [3] about 1.19dB on average. The method also yields the desired rate with a small deviation (less than 0.4% of the target rate). These experimental results demonstrate the effectiveness and the robustness of the proposed algorithm for video sequences with various characteristics.

References

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