Model Based Optimal Bit Allocation

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The problem of optimal bit allocation is conventionally defined as follows: given a signal $\mathbf{x}$ of size N divided into n non-overlapping subsignals $\mathbf{x}_i$ of size N_i, where $\sum_{i=1}^{n} N_i = N$, find the most efficient distribution of a given bit budget R among a number of available quantizers for the subsignals. The bit allocation algorithm of Shoham & Gersho [3] provides an optimal solution to the problem for an arbitrary set of quantizers. However, its computational complexity is high due to a need to compute the operational rate-distortion (R-D) characteristics for all available quantizers. Efficient analytical modelling of the operational R-D characteristics can significantly reduce the computational complexity of such an optimal bit allocation algorithm.

In this paper, analytical models for the empirical R-D behaviour are studied. The average distortion-rate function $D(R) = \sigma^2 2^{-2R}$ has traditionally been used for optimal bit allocation in image and video coding applications. However, as pointed in [1], there are two problems with using this function: first, it is useful only for bit rates of over 1 bits/pixel in the context of image coding; second, it assumes that the signal is a realization of a Gaussian source, an assumption which often does not hold for *natural* images or their transformations. We propose two new models for empirical R-D behaviour. Comparative results for operational R-D curve fitting using these two models, the aforementioned average distortion-rate function, and the low bit rate model of [1] are presented. Preliminary results show that the exponential-polynomial model often gives a better fit than all the other models studied. Model based bit allocation algorithm employed in an image coding framework gives promising results for overall visual quality. More details can be found in the technical report [2].

References

[1] S. Mallat and F. Falzon. Analysis of low bit rate image transform coding. *IEEE Transactions on Signal Processing*, April 1998.

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[3] Y. Shoham and A. Gersho. Efficient bit allocation for an arbitrary set of quantizers. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, 36(9):1445–1453, September 1988.

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