NEAR-BEST WPT COMPRESSION OF POLYSOMNOGRAMS

Juergen Niederholz and Carl Taswell
Computational Toolsmiths, Stanford, CA 94309-9925

Abstract— **Near-best and best wavelet packet transforms were compared with wavelet transforms for the compression of polysomnograms in a low bitrate telemonitoring application. Near-best wavelet packet transforms provided better overall performance with respect to efficiency of computation and compression, and amenability for use in more sophisticated quality-on-demand algorithms.**

Keywords— **near-best bases, wavelet packet transforms, compression, polysomnograms, telemedicine.**

I. Introduction

Electrocardiogram (ECG) signals can be compressed using non-adaptive discrete wavelet transforms (DWT) and adaptive wavelet packet transforms (WPT) [1]. No significant advantage has been demonstrated for the WPT over the DWT when using the best basis (BB) method for the adaptive search in the WPT [1]. For multi-channel multi-modal telemonitoring applications requiring both high compression and low complexity, we surmise that the near-best basis (NB) method [2] in the WPT will prove to be an effective solution. So we compare the DWT with the WPT using BB and NB methods by investigating their compression performance on polysomnograms containing four different signal modes: ECG, electroencephalogram (EEG), blood pressure (BP), and nasal thermistor (NT).

II. methods

We used the compression paradigm known as a "fixed M" experiment in [2]. For each signal segment of length N, we observed varying levels of distortion measured as the SNR in dB at fixed rates of M transform domain coefficients with $M << N$. The additive l^1 norm and non-additive l^1 data compression area were used as the cost functions, respectively, for the adaptive BB and NB search methods in the WPT [2]. Computational complexity for NB relative to BB was measured by the statistic $\hat{L}$ [2] for comparison with L the number of levels of the WPT. Experiments were performed using 5 polysomnographic records from the MIT-BIH Polysomnographic Database [3] with 552 segments of length $N = 64$ each, $L = 6$ levels in the transforms, and Daubechies real orthogonal least asymmetric filters of length 8.

III. results

Figure 1 displays the rate-distortion curves observed. The left plot shows the compression performance of the different methods on the ECG mode. Analogous results were observed for the other modes. The adaptive BB-WPT and NB-WPT achieved equivalent mean performance, both better than the non-adaptive DWT especially at low rates (small M). The right plot shows the performance of the NB-WPT on all of the modes. The NB-WPT statistic $\hat{L}$ ranged between means of 3.4 − 3.7 with standard deviations < 0.5 for all modes.

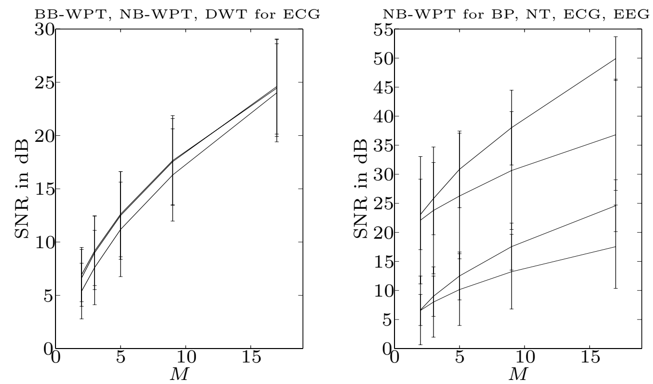

Fig. 1. Left: rate-distortion curves for BB-WPT, NB-WPT, and DWT compression of ECG; Right: NB-WPT compression of BP, NT, ECG, and EEG; both in decreasing order.

IV. discussion

The adaptive WPT achieves better mean compression performance than the non-adaptive DWT for all signal modes at high compression ratios. No advantage of the BB-WPT over the NB-WPT could be demonstrated in terms of compression. But the NB-WPT maintained an advantage in computation with a complexity of $\hat{L} \approx 3.5$ compared to $L = 6$, yielding an efficiency improvement of $\approx$ 40%. Further, the rate-distortion curves can be used to characterize the different requirements of the different signal modes in quality-on-demand telemonitoring that adaptively varies the quality levels and compression rates between the modes of the multi-modal signal. We are currently investigating alternative algorithms for this purpose based on the adaptive NB-WPT, and examining their performance statistics more rigorously with respect to statistical rank-order significance.

V. conclusions

In the setting of low bitrate compression of multi-modal signals (polysomnograms) for telemedicine, the adaptive NB-WPT performed better than both the adaptive BB-WPT and the non-adaptive DWT when the efficiency of both computation and compression were evaluated.

References

[1] M. L. Hilton, "Wavelet and wavelet packet compression of electrocardiograms," *IEEE Trans. Biomed. Eng.*, vol. 44, pp. 394–402, May 1997.
[2] C. Taswell, "Satisficing search algorithms for selecting near-best bases in adaptive tree-structured wavelet transforms," *IEEE Trans. Signal Process.*, pp. 2423–2438, Oct. 1996.
[3] G. Moody, "MIT-BIH polysomnographic database." CD-ROM, August 1992.

Tel/Fax: 650-323-4336/5779; Email: taswell@toolsmiths.com