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| Question: | 6/21 (VCEG) | | |
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| Title: | **Proposal for replacement of DST-II by DST-IV in biomedical waveform coding** | | |
| Purpose: | Proposal | | |

**Abstract**

The current draft of the H.BWC codec supports block-residual transform coding, using either the type-2 discrete cosine transform (DCT-II) or the type-2 discrete sine transform (DST-II). Herein, we propose to replace the DST-II transform kernel by an integer-only realization of the DST-IV, in order to achieve an improvement in coding efficiency. The BD-rate improvement is reported to be

* between –0.45% and –0.61% on the ECG dataset, with dec. time between 97% and 97.5%,
* between –0.09% and –0.14% on the EMG dataset, with dec. time between 97.3% and 98%,

depending on the configuration of the encoder’s RDO, with encoding time overhead of 3% or less, measured for lossy ECG operation. No changes occur for lossless operation (DST coding isn't used there). Since RDO evaluation of the DST is deactivated on the other datasets and prior experiments indicated that the BD-rate benefit of this proposal is minor there, no results for the other datasets are provided. Furthermore, it is suggested to keep the DST-II implementation in (potential) modes in which perceptual optimization techniques such as deblocking (see VCEG-BW12) are to be used.

1. **Description of Proposal**

In H.BWC, all residual block signals resulting from block prediction can, prior to quantization, be subjected to optional trigonometric transformation, using either a DCT-II or DST-II. The kernel of the latter transform is sin[(*n* + ½) · (*k* +1) · π/*N*], where *N* is the block length and *k* is the frequency index. In this document, it is proposed to switch to the DST-IV kernel sin[(*n* + ½) · (*k* + **½**) · π/*N*], whenever DST-type residual transformation is chosen, and signalled, for a given block and channel and all (potential) perceptual optimizations are disabled. All transform type related syntax remains unchanged. Conceptually, the software implementation of the DST-IV is very similar to the current implementation of the DST-II but preliminary evaluation indicates that it may run somewhat faster.

1. **Performance Results**

The effect of replacing the DST-II with a DST-IV kernel was assessed using PRD based BD-rate evaluation [1], in lossy codec operation mode (DST coding is not used in lossless mode) on top of a slightly accelerated version of the current H.BWC reference software. Two encoder tunings were evaluated: one with less RDO testing of DST-IV coding candidates and lower encoder runtime and one with more RDO tests of DST-IV candidates and higher encoder time. The results are as follow:

* fewer tests: *ECG*: BDR –0.45%, ET101%, DT 97%, *EMG*: BDR –0.09%, ET103%, DT 97%
* **more** tests: *ECG*: BDR –0.61%, ET103%, DT 98%, *EMG*: BDR –0.14%, ET107%, DT 98%

Detailed per-sequence results on the ECG and EMG datasets and a software patch can be provided.

Given these results, it is requested to adopt the proposed change of DST kernel but to keep usage of the DST disabled on the EMG set in the default configuration (*--UseDST*=0 in files *...EMG.cfg*).

1. **References**

[1] J. Pfaff, C. Fersch, and Rapporteur Q6/21, “Common test conditions and evaluation procedures for H.BWC technical experiments,” *ITU-T document SG21-TD68/WP3*, Geneva, Jan. 2025. 🌍: <https://www.itu.int/wftp3/av-arch/video-site/2501_Gen/T25-SG21-TD-WP3-068-BWC-CTC.docx>.

[2] VCEG, “Reference software for biomedical waveform data compression,” tag BWC-1.0. 🌍: <https://vcgit.hhi.fraunhofer.de/vceg-sw/bwc/-/tags>, presets *combined...cfg* in directory*bwc/cfg*

1. **Patent Rights Declaration**

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