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| *Title:* | **CE5: Improved coefficient coding with LCEC** | | |
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# Abstract

In this report, coding results of improvements on coefficient coding are reported. Results are available for both the cases of applying the proposed coefficient coding alone, as well as applying it together with adaptive scan. In addition, the same idea is extended to the case of 16x16 coefficient coding with results reported.

Introduction

According to the current TM, transform coefficient coding is done in run mode followed by level mode. In run mode coding, the number of zero coefficients is signaled starting from the previous nonzero coefficient. The syntax element *isLevelOne\_run* combines information about the *run* and the *levelID*. *Run* is defined as the number of zero coefficients between the current nonzero coefficient at position *k* and the next nonzero coefficient in the reverse scanning order. The *levelID* indicates whether the absolute value of that coefficient level is 1 (*levelID* =0) or great than 1(*levelID=1)*. The mapping between {*levelID, run*} pair and code number *cn* is also dependent on value *k*. There are 29 VLC tables specified for different values of *k*, with up to 128 entries in the table. Currently the same mapping tables are used both for intra and inter coded blocks.

# Proposed Approach

In the last JCT-VC meeting in Guangzhou, it was reported in proposals [1] that coefficient coding can be improved with different mapping tables used for intra blocks in coding the {*levelID, run*} pair.

According to the proposed scheme, the current tables in TM that map the {*levelID, run*} pair to code number are only used for inter blocks. New mappings are introduced for blocks coded in intra mode. In addition, for an intra block the selection of the table is dependent both on the position *k* of the current nonzero coefficient and a parameter *n*. Parameter *n* is defined as zero if the absolute value of any of the coefficient levels coded so far (in the inverse scan order) is larger than 1. Otherwise, it is defined as the number of non-zero coded coefficients, clipped to 4.

To minimize memory usage, we design the introduced mapping for intra block to have a structured format. As a result, no addition table is needed and a code number *cn* can be directly calculated given values of *leveleID*, *run*, *k* and *n* as follows:

if (levelID==0){

if (run<c0)

cn=run;

else

cn=2\*run-c0+1;

}

else{

if (run>(k-c0 +1))

cn=k+run+2;

else

cn=c0 +2\*run;

}

where *c0* represents the code number when *run=0* and *levelID=1*. Only values of *c0*, which are dependent both on parameter *k* and *n*, have to be stored.

Such a coding scheme is tested both with and without adaptive scan. In case of adaptive scans three scans are used: horizontal, vertical and zigzag. The scan order for first few coefficients (up to 64) is adaptively adjusted based on previously coded coefficients (as described in the document JCTVC-C250). For large blocks with a size bigger than 16x16, they share the same scan with 16x16 block.

Since the proposed idea is found to work well for 4x4 and 8x8 coefficient coding, we also extended the same scheme to 16x16 coefficient coding. To code {*levelID, run*} pair, the tables used for 8x8 coding are re-used for 16x16. To code {*levelID, lastPos*} pair for 4x4 and 8x8 blocks there is a mapping table between value of *m=64\*levelID + lastPos* and code number *cn*. The mapping table is made adaptive. To avoid adding another table, in case of 16x16 blocks we designed structured mapping between *m* and code number *cn*, hence value of *cn* can be just calculated for a given *m*. We also had to modify RDOQ scheme to better support 16x16 blocks, mainly by modifying the selection of the last nonzero coefficient.

# Simulation Results

Based on test conditions specified in CE5, simulations are performed using all three low complexity configurations. Detailed results can be found in the associated excel data sheet.

The results show that when applying the proposed coefficient coding scheme alone, an average coding gain of 1.6% can be obtained with all intra configuration, an average of 0.6% gain with random access configuration and 0.1% with low delay configuration. The coding gain is consistent through all test sequences.

Additionally, an improved version of RDOQ is also jointly tested with the proposed scheme. In this new RDOQ, unlike its previous version, it is first determined which coefficient should be the last non-zero coefficient. The determination is done using pre-quantized coefficients. Pre-quantized coefficients are obtained by applying dead-zone quantization.

With this new RDOQ, the coding gain with all intra configuration is increased to 2.1% for all intra configuration, 0.8% for random access and 0.6% for low delay.

If extending the proposed scheme to 16x16 coefficient coding as explained above, the average coding gain can reach 3.9% with all intra configuration. A 1.7% coding gain is observed with random access configuration, and 2.1% gain with low delay configuration.

When applying the proposed technologies jointly with adaptive scan the improvements are 6.2% for all intra coding, 2.6% for random access and 2.5 for low delay.

# Conclusion

This contribution presents CE results on improved coefficient coding. Results show that the proposed scheme works regardless it is used together with addition scan or not. The same coding scheme can also be easily extended to 16x16 coefficient coding, which brings substantial coding gain for LCEC. Based on the results, we recommend the proposed coefficient coding scheme be adopted into HM.

# References

[1] M. Karczewicz, W.-J. Chien, X.Wang “Improvements on VLC”, JCTVC-C263, Guangzhou, China, Oct 2010.

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