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| *Title:* | **Parallelizable context for significance coding of large transform blocks** | | |
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# Abstract

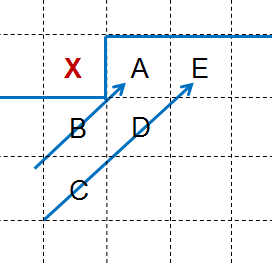
This contribution proposes a modification to context modeling of significant coefficient coding/decoding in CABAC. The intention is to allow same level of parallelism for mode dependent coefficient scanning (MDCS) as what is currently available for the diagonal scans in large intra coded blocks. This is accomplished by excluding the latest coded coefficient in the context model and removing the neighboring dependencies along the same scanning line. The scheme is integrated to two different MDCS methods used for large transform blocks. It is reported that the proposed context model has negligible effect on BD bitrate and both MDCS schemes studied provide a -0.1% BD-rate gain in AI\_HE configuration when utilizing the proposed context definition.

# Introduction

## Context selection of significance map coding in HM4.0

There were several efforts to reduce the neighboring dependency in context selection, and the HM 4.0 design adopts a reverse diagonal scanning order enhancing the parallel processing [1, 2]. The idea was to avoid the most recently coded bin being used in the context as shown in Fig.1.

HM 4.0 utilizes 15 contexts for a 4x4 block and 16 contexts for a 8x8 block. The context derivation is solely dependent on the position of the current coefficient, and thus there is no dependency problem. Meanwhile, in large block sizes such as 16x16 and 32x32, the context numbers are assigned using neighbor coefficients, as shown in Fig. 1. The context of the current significance is determined by the existences of the neighbor non-zero coefficients such as ‘A’, ‘B’, ‘C’, ‘D’, and ‘E’.



**Fig. 1 Context selection of ‘X’ in significance map coding used for a large transform block, based on the summation of the significances at A, B, C, D, and E.**

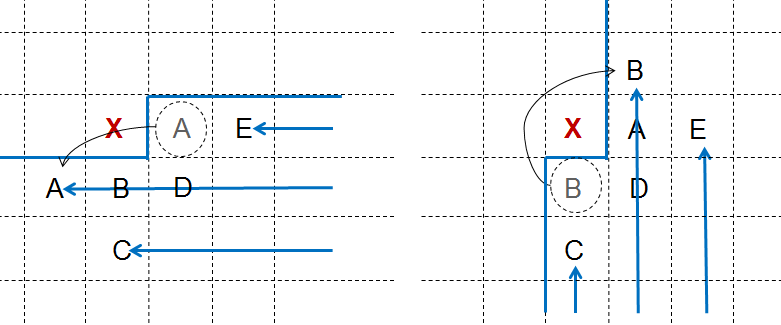
## Issue – MDCS in large blocks and parallel processing problem with the current context model

A mode dependent coefficient scanning (MDCS) method in intra coding was extended to the large block sizes, e.g. 16x16 and 32x32, and they are tested in CE 11 now [3]. The different MDCS choose different scanning methods among diagonal, horizontal, vertical, and adaptive scanning pattern, depending on prediction direction. However, the new scanning methods in transform blocks larger than 8x8 can obstruct the parallel processing in decoding without the proper modification of the context model in significance map coding.

This contribution proposes parallelizable context modeling on the top of the MDCS in large transform blocks. Two MDCS are used for the evaluation.

# Algorithm

The basic principle of the algorithm is to exclude the latest coded coefficient in a context model, if it is along the same scanning line. Fig. 2 shows the modified context selection when the horizontal or vertical scanning order is used for the significance map coding. For example, in Fig. 2 (a), the position ‘A’ is moved from the right position of the current coefficient position ‘X’ to the bottom left position. Otherwise, the significance coding in ‘X’ cannot start until the significance coding/decoding in the right position is completed. This problem can stop the parallel processing particularly in decoder side. The same principle is applied to the vertical scanning.



1. (b)

**Fig. 2 The proposed context selection of ‘X’ in significance map coding used for large transform blocks: applied to (a) the horizontal scanning pattern and (b) the vertical scanning pattern.**

Because the MDCS in large transform blocks is not a part of HM4.0 yet, we exemplify two patterns integrated into the proposed context selection for the evaluation. The one is conventional horizontal and vertical scanning pattern extended to large blocks, and the other is the adaptive MDCS simplified from the table based scanning method [4]. The proposed context model is implemented into the HM4.1.

## Example 1: with Horizontal/Vertical Scanning

The proposed context model is applied to the horizontal and vertical scanning patterns when the block size is either 16x16 or 32x32.The context of ‘X’, CTX(X) is derived as the sum of significances in the position of A, B, C, D, and E, respectively defined in Fig.2, as follows:

CTX (X) = min{4, SIG(A)+ SIG (B)+ SIG (C)+ SIG (D)+ SIG (E)},

where SIG(.) is 0 when the corresponding coefficient is zero or the position is not valid. Otherwise, SIG(.) is 1.

From the experimental results, the modified context affects the coding efficiency minimally, while enhancing the parallel processing. Tables below summarize the results.

Table 1. BD-rate of MDCS in 2.1 with the modified context

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra HE** | | |
|  | Y | U | V |
| Class A | 0.1% | -0.2% | -0.2% |
| Class B | -0.1% | -0.6% | -0.6% |
| Class C | 0.0% | -0.2% | -0.2% |
| Class D | 0.0% | -0.3% | -0.2% |
| Class E | -0.2% | -0.4% | -0.3% |
| Class F | - | - | - |
| **Overall** | -0.1% | -0.3% | -0.3% |
|  | -0.1% | -0.3% | -0.3% |
| Enc Time[%] | 100% | | |
| Dec Time[%] | 99% | | |

Table 2. BD-rate of MDCS in 2.1 with the conventional context

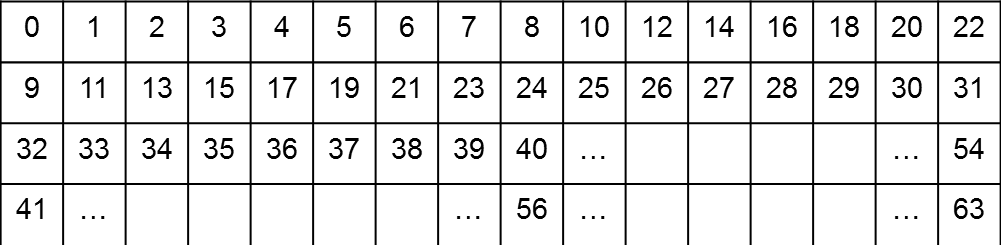
|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra HE** | | |
|  | Y | U | V |
| Class A | 0.0% | -0.3% | -0.3% |
| Class B | -0.2% | -0.7% | -0.7% |
| Class C | -0.1% | -0.3% | -0.3% |
| Class D | -0.1% | -0.3% | -0.3% |
| Class E | -0.4% | -0.8% | -0.7% |
| Class F | - | - | - |
| **Overall** | -0.1% | -0.5% | -0.5% |
|  | -0.1% | -0.5% | -0.5% |
| Enc Time[%] | 100% | | |
| Dec Time[%] | 99% | | |

As additional information, the coding performance of the MDCS in All intra/low complexity configuration is provided as below:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra LC** | | |
|  | Y | U | V |
| Class A | 0.0% | -0.4% | -0.4% |
| Class B | -0.6% | -1.4% | -1.4% |
| Class C | -0.2% | -0.5% | -0.5% |
| Class D | -0.2% | -0.4% | -0.3% |
| Class E | -0.5% | -1.0% | -0.8% |
| Class F | - | - | - |
| **Overall** | -0.3% | -0.8% | -0.7% |
|  | -0.3% | -0.8% | -0.7% |
| Enc Time[%] | 99% | | |
| Dec Time[%] | 99% | | |

## Example 2: with the simplified MDCS from [4]

In this example we study the effects of proposed context modeling for the large block size MDCS variant proposed in [4]. Fig.3 shows a horizontal scanning pattern order used for 16x16 blocks according to that proposal. As shown in Fig.3, the horizontal scanning pattern is partially used for the significance coding. The same context model described in 2.1 of this contribution is applied for 16x16 and 32x32 blocks when horizontal or vertical scan of [4] is utilized in order to remove the dependency.



**Fig. 3 the numbers represent the horizontal scanning order of 16x16, shown in [4].**

The table below summarizes the results in the case of proposed method applied to the abovementioned scanning.

Table 4. BD-rate of MDCS in 2.2 with the modified context

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra HE** | | |
|  | Y | U | V |
| Class A | 0.0% | -0.2% | -0.2% |
| Class B | -0.1% | -0.6% | -0.6% |
| Class C | 0.0% | -0.2% | -0.2% |
| Class D | 0.0% | -0.3% | -0.2% |
| Class E | -0.2% | -0.6% | -0.4% |
| Class F | - | - | - |
| **Overall** | -0.1% | -0.4% | -0.3% |
|  | -0.1% | -0.4% | -0.3% |
| Enc Time[%] | 100% | | |
| Dec Time[%] | 100% | | |

Table 5. BD-rate of MDCS in 2.2 with the conventional context [4]

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra HE** | | |
|  | Y | U | V |
| Class A | 0.0% | -0.3% | -0.3% |
| Class B | -0.2% | -0.7% | -0.7% |
| Class C | -0.1% | -0.3% | -0.3% |
| Class D | -0.1% | -0.4% | -0.3% |
| Class E | -0.4% | -0.9% | -0.8% |
| Class F | - | - | - |
| **Overall** | -0.1% | -0.5% | -0.5% |
|  | -0.1% | -0.5% | -0.5% |
| Enc Time[%] | 100 % | | |
| Dec Time[%] | 97 % | | |

# Conclusion

The proposal modifies the parallelizable context selection in the significance map coding that is used for MDCS in large block sizes. The new context model is applied to two MDCS patterns. The BD-rate gains for the AI\_HE configuration are -0.1℅, -0.4℅, and -0.3℅ for Y, U and V components, respectively.

# References

[1] J. Sole, R. Joshi, M. Karczewicz, “CE11: *Unified scans for the significance map and coefficient level coding in high coding efficiency,*” JCTVC-F288, 6th JCT-VC Meeting, Torino, IT, Jul. 2011.

[2] Vivienne Sze, Madhukar Budagavi, “CE11: *Parallelization of HHI\_TRANSFORM\_CODING (Fixed Diagonal Scan from C227),*” JCTVC-F129, 6th JCT-VC Meeting, Torino, IT, Jul. 2011.

[3] Vivienne Sze, *et.al*. “Description of Core Experiment (CE11): Coefficient scanning and coding,”JCTVC-F911, 6th JCT-VC Meeting, Torino, IT, Jul. 2011.

[4] A simplified version of JCTVC-F124, released by MediaTek via the CE 11 reflector.

# Patent rights declaration(s)

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