|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**  7th Meeting: Geneva, CH, 21-30 November, 2011 | Document: JCTVC-G491 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Hybrid Horizontal/Vertical with Diagonal Mode Dependent Coefficient Scan** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | K. Sharman, J. Gamei, N. Saunders, P. Silcock  Sony BPRL  Jays Close, Viables, Basingstoke RG22 4SB, UK | Tel: Email: | +44 1256 355011 karl.sharman@eu.sony.com |
| *Source:* | Sony Europe Limited | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

This contribution presents two additional Mode Dependent Coefficient Scan-orders (MDCS) for larger block sizes, dependent on the intra prediction direction. These scan orders are a combination of a Horizontal/Vertical scan with a Diagonal scan, and it is indicated that they can be implemented without a look-up table. Simulations report Luma BD-rate changes of -0.15% and ­0.39% for Intra HE and Intra LC, respectively. An additional technique that claims to reduce the burden of adding a scan order to larger blocks on ‘speculation’ is also described, with a reported Luma BD-rate change of -0.13% for Intra HE.

# Hybrid Algorithm

In HM4.0, the scan order for Intra coded coefficients is selected depending on the Intra prediction direction, and is chosen out of three possible scan orders: Horizontal, Vertical and Up-Right Diagonal (note CAVLC uses Zig-Zag instead of Up-Right Diagonal). Only blocks of size 4x4/8x8 can use Horizontal/Vertical scan orders; larger blocks will always use the Up-Right Diagonal scan order. shows the current mapping used in HM4.0:

Table : Current Luma mapping between Intra-prediction direction and scan order for HM 4.0



(There is a discrepancy between the HM4.0 C Model and the WD4 regarding the mapping of small blocks for Chroma. The above table reflects what is represented in the HM4.0 C Model – see *TComDataCU::getCoefScanIdx* where the input ‘*uiWidth*’ is that of the coefficients for the current channel which is then adjusted prior to accessing *aucIntraDirToScanIdx* to be equivalent to the Luma size, vs section 8.5.2 where *nS* is used to access ‘*ScanType*’ and definition of the range of *nS* in Eqn 8-152.)

For certain Intra-prediction directions, more of the energy in the DCT is compacted in the top row/left-most column. This document proposes the addition of two new ‘Hybrid’ scan orders for 'larger blocks' that are a combination of Horizontal/Vertical and Diagonal scan orders.

The two new ‘Hybrid’ scan orders are illustrated in , with the associated proposed scan order mappings given in . For clarification, the term ‘larger blocks’ describes block sizes 16x16/32x32 for Luma and the corresponding 8x8/16x16 for Chroma. The scan orders could be implemented without a look-up table, as they are only small modifications to the default Diagonal (Up-Right) pattern.

Figure : Proposed 'Hybrid' scan orders



Table : Proposed Luma scan order mapping



# Hybrid + Speculation-friendly Algorithm (CABAC only)

For a system that decodes multiple CABAC encoded coefficients at a time, ‘speculation’ is required. This algorithm aims to reduce the burden of speculation when a proposed Hybrid scan order from Section  is used.

This algorithm aims to ensure adjacent coefficients are processed temporally as far apart as possible. For a block that selects a Hybrid scan order, this is achieved as follows:

* Find the End-Of-Block (EOB) coefficient using the chosen Hybrid scan order, as in HM4.0. This determines the area of the block that is ‘valid’ (see ).
* Scan the coefficients as per the usual HM4.0 CABAC process, however, the scan order is now changed to a Diagonal scan, and only the ‘valid area’ of the block is scanned (see ).

Figure : Determine EOB using Hybrid scan. Area of the block that is not 'valid' has been greyed out.



Figure : Once EOB is known, Diagonal scan over 'valid' region



# Simulation Results

Simulations using the standard configurations have been run for the Hybrid MDCS method and also the ‘speculation-friendly’ Hybrid MDCS version, with comparisons against the base HM4.0 code. A summary of the results are shown in the tables below.

We would like to thank MediaTek for offering to cross-check the results (JCTVC-G943).



# Conclusion

Alternative Intra-prediction direction Hybrid scan orders have been presented for larger block sizes that show {Y, U, V} BD-rate changes of {-0.15%, -0.41%, -0.41%} for Intra HE, and {-0.39%, -0.78%, ‑0.73%} for Intra LC.

A ‘speculation-friendly’ version of the Hybrid scan order algorithm is also presented, which shows BD-rate changes of {-0.13%, -0.32%, -0.31%} for Intra HE.

Both algorithms show no increase in encoder/decoder processing times.

# Patent rights declaration(s)

**Sony Corporation or Sony Group companies may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**