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| *Title:* | **CE6.b: Experimental results of DCIM** | | |
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# Abstract

Differential Coding of Intra Modes (DCIM) was presented as an effective Intra prediction tool in [1], particularly, for sequences with a lot of sharp strong edges. In this document a brief summary of DCIM and its development since the original proposal as well as its experimental results under the test conditions defined for Core Experiment 6 . On average, DCIM achieved 2.1% and 2.3% gain compared to HM anchors for High Efficiency (HE) and Low Complexity (LoCo) settings, respectively

# Algorithm description

DCIM uses neighborhood edge estimation to predict Intra prediction direction and differentially encodes the selected direction with respect to the predicted direction. This enables a higher accuracy in the Intra prediction directions (modes) without substantially increasing the mode signaling overhead. An additional flag bit is transmitted per Prediction Unit (PU) to signal to the decoder whether DCIM is used. The decoder needs to perform edge detection only for the PUs for which the DCIM flag is on.

Although edge detection typically provides a fairly accurate edge direction especially under low noise conditions, we limit the number of possible directions to a set of 128 directions (nearly 1.4 degrees apart). This ensures that a 5-bit precision is sufficient to conduct the pixel interpolation necessary for the construction of the prediction signal. Therefore, the process of obtaining the Intra prediction signal for DCIM is very similar to that of Unified Intra (UI), except that DCIM offers more feasible directions based on the edge information. Furthermore, for the luma component, in addition to the direction which is directly provided by edge detection, a number of additional directions are also considered around the estimated edge direction as shown in Figure 1. These additional directions are always chosen from the Unified Intra (UI) directions which are closest to the estimated edge direction. The average angle between these directions is therefore approximately 5.6 degrees.

The process of mode decision at the encoder, then, chooses the best direction (mode) among all possible DCIM and UI directions (modes). If the selected mode is one of the DCIM modes, a 1-bit flag is first transmitted to the decoder to signal a DCIM mode. Then, the selected direction for luma component is signaled differentially with respect to the estimated edge using a signed truncated unary code. The two chroma channels only have one DCIM mode which is obtained, for each channel independently, by the edge detection process. As a result, for chroma components, no extra bit is transmitted after the DCIM flag.



Figure 1. An example of the DCIM directions around a detected edge.

# Results

The proposed algorithm was implemented into the TMuC software 0.9. Test conditions are as defined in Core Experiment 6 and the results are compared with the original TMuC software 0.9. Table 1 shows the average of BD-rates for each class for both high efficiency and low complexity settings. The encoding and decoding times (compared to that of the original software) is also shown in the table for both cases. The maximum gain due to DCIM is observed for the “Basketball Drill” sequence which is 4.9% and 6.6% for high efficiency and low complexity settings, respectively. This shows the effectiveness of DCIM in dealing with video sequences with many strong edges.

Table 1. Summary of DCIM results compared to HM Anchors.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Intra | | | Intra LoCo | | |
| Y BD-rate | U BD-rate | V BD-rate | Y BD-rate | U BD-rate | V BD-rate |
| Class A | -1.7 | -0.6 | -0.3 | -1.5 | -0.8 | -0.4 |
| Class B | -2.1 | -1.1 | -1.2 | -2.2 | -1.8 | -1.9 |
| Class C | -2.4 | -1.1 | -1.2 | -2.9 | -1.9 | -2.0 |
| Class D | -1.5 | -0.4 | -0.3 | -1.8 | -0.8 | -1.0 |
| Class E | -3.1 | -2.2 | -1.9 | -3.1 | -1.5 | -1.7 |
| All | -2.1 | -1.1 | -1.0 | -2.3 | -1.4 | -1.5 |
| Enc Time[%] | 108% | | | 115% | | |
| Dec Time[%] | 105% | | | 116% | | |

# References

1. E. Maani, W. Liu, “Differential Coding of Intra Modes (DCIM)”, Doc. JCTVC-B109, Geneva, Switzerland, Jul 2010
2. Ali Tabatabai, “Core Experiment 6: Intra Prediction Improvement”, Doc. JCTVC-C506\_r3, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Guangzhou, July 2010.

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