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Source: Gisle Bjontegaard
Telenor Satellite Services
P.O.Box 6914 St.Olavs plass
N-0130 Oslo, Norway

Tel: +47 23 13 83 81
Fax: +47 22 77 79 80
Email: gisle.bjontegaard@telenor.com

Title: Use of adaptive switching between two VLCs for intra luma coefficients

Purpose: Information

1 Background

The UVLC defined in TML-4 performs reasonably well for most of the data elements in a bitstream over a large range of QP values. However, it has also been noticed that for intra coefficients and specially for small QP values the UVLC is not optimal because the statistics of the events are not very suitable for the UVLC.

Therefore we have made some experiments with a coding scheme for intra luma coefficients by automatic switch between two VLCs that are designed to better fit the event statistics.

The intention of the document is to show the potential gain with more optimal VLCs. However, introduction of a new VLC will break the "one-VLC-approach" and this should be kept in mind when deciding how to proceed.

2 The additional VLC

A second VLC (call it VLC2) has been used. The VLC may be written in a similar form as the UVLC (TML-4 2.4.1):

$$\begin{array}{ccccccc} & & 1 & & 0 & & \\ & & 1 & & 1 & & 0 \\ & & 1 & & 1 & & 1 \\ & & 0 & x_1 & 1 & x_0 & \\ 0 & x_2 & 0 & x_1 & 1 & x_0 & \\ & & \text{etc.} & & & & \end{array}$$

or in explicit form

Code number	Codewords
0	1 0
1	1 1 0
2	1 1 1
3	0 0 1 0
4	0 1 1 0
5	0 0 1 1
6	0 1 1 1
7	0 0 0 1 0
etc	

The main difference between UVLC and VLC2 is that the shortest codeword in VLC2 has 2 bits which is more suitable for EOB when there are on average several nonzero coefficients in a block. Hence there are shorter codewords left for coding of large coefficients. The use of codewords corresponding to each code number is the same as described in table 1 of TML-4.

3 The switch mechanism between UVLC and VLC2

First of all the switching mechanism is used only for 4x4 based intra luma blocks that uses double scan (QP<24). The switching rules are:

- When coding the first coefficient of a 4x4 block in a MB we use UVLC
- For the first coefficient of the remaining 4x4 blocks we use VLC2 if **abs(Level)** for the DC coefficient in the previously coded 4x4 block is larger than 1. Otherwise UVLC is used.
- For the remaining coefficients in a 4x4 block use UVLC if **abs(Level)/(Run +2) < 1** for the last nonzero (coded) coefficient. Otherwise use VLC2.

4 Simulation results

In document q15k28.xls there are RD plots for intra frames. The curves "TML4, Cpred, JustQPc" and "TML4, Cpred, JustQPc, AdVLC" show the gain in intra coding by using the adaptive VLC method defined in this document. The gain is seen to be (0 - 0.5) dB, with the highest gain for at the high bitrate end of the curves.