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Title: Solutions to the Quantiser Overload Problem

Source: UK, France, FRG, Italy, Netherlands, Norway, Sweden

This contribution catalogues possible means of dealing with the quantiser overload problem and presents them for information.

THE PROBLEM

With nominal values for black and white being 16 and 235, using intra mode coding of a block with 32 white pels on the left side and 32 black on the right, the magnitude of the first non-zero ac coefficient from the forward transform is 794. The nominal peak colour differences are 16 and 240, yielding a slightly larger equivalent result of 812. Using the extreme values of 0 and 255 gives 924.

Further results are given in the annex.

It is possible, though perhaps very unlikely, that inter mode coding could produce magnitudes of double the above. The remainder of this contribution assumes that this can be dismissed.

The 2-D VLC table of the flexible hardware specification (Annex 4 of Document #499) has 127 levels plus polarity. Step-sizes of 4 and 6 will permit magnitudes up to about 510 and 765 respectively to be encoded.

SOLUTIONS

Possible ways to tackle the difficulty are:

1. Non-linear quantisation. The number of quantisation levels is unchanged but the range they cover is increased. Such an approach was outlined in document #285 (Japan) where the finer quantisers had an abrupt change to a second step-size at higher input levels. Alternatively, an arrangement with a smoother variation, more like the A or mu law encoding in telephony, could meet the requirement.

This solution would mean a change to Appendix 2 of the hardware specification. Some implementers might oppose it because they are making use of the simple relationship between the input and output of a linear quantiser. For example, in DSP based codecs

it may be preferable to find the output of a quantiser or inverse quantiser by calculation, rather than by a look-up table.

2. Increase the code table size to allow more levels to be encoded. For example, a different escape code could indicate that the level is encoded with 9 bits instead of 8.

This solution would mean a change to Appendix 8 of the hardware specificaton. Finding and dealing with emulations of the start code might be more difficult.

3. Temporary and signalled change of step-size. A coder can use TYPE3 to temporarily increase the step-size if necessary. Whether a coder would automatically do this for intra macroblocks or first determine if any components had amplitudes such as to require the change would be left open to designers.

The overhead for signalling the change of step-size and its subsequent restoration is not trivial but reasonable in comparison with the number of bits needed for intra coded macroblocks.

This solution requires no modifications to the hardware specification.

4. Temporary but unsignalled change of step-size. This is variation on 3 above. If all coders did not check component amplitudes but used a step-size of at least 8 for intra blocks then the signalling overhead could be removed. On receipt of an intra block the decoder would automatically use a step-size of 8 if the currently declared one was smaller.

This solution is within the flexibility of the hardware specification, requiring reprogramming of the Selection Table of Figure 4 (Document #449 page 33).

CONCLUSION

Solutions 3 and 4 are permitted within the current Flexible Hardware Specification and seem promising, provided that the subjective effect of a minimum step-size of 8 for intra mode is satisfactory. This could be confirmed by simulation or experiments with flexible hardware or both.

Annex to Document #522

RANGE OF DCT COMPONENTS

The maximum range of DCT component values have been calculated in order to support the discussion of quantiser clipping. Although nominal pel values are in the range 16-240, the calculations are done with the range specified for p*64 kbit/s Flexible Hardware, namely 1-254. It has also been taken into account that the codec performs internal clipping to the range 0-255, so that input pels to the transformer have the range -254 to +254 in inter mode.

For each transform component, the worst possible block of pels was selected to obtain the largest value. This was done by setting each pel to the minimum or maximum value.

INTRA mode: Pixel range: +1 through +254

2032	917	935	917	1012	917	935	917
917	831	847	831	917	831	847	831
935	847	864	847	935	847	864	847
917	831	847	831	917	831	847	831
1012	917	935	917	1012	917	935	917
917	831	847	831	917	831	847	831
935	847	864	847	935	847	864	847
917	831	847	831	917	831	847	831

Table 1. Maximum values of DCT components in intra mode

INTER mode: Pixel range: -254 through +254

2032	1841	1877	1841	2032	1841	1877	1841
1841	1668	1701	1668	1841	1668	1701	1668
1877	1701	1734	1701	1877	1701	1734	1701
1841	1668	1701	1668	1841	1668	1701	1668
2032	1841	1877	1841	2032	1841	1877	1841
1841	1668	1701	1668	1841	1668	1701	1668
1877	1701	1734	1701	1877	1701	1734	1701
1841	1668	1701	1668	1841	1668	1701	1668

Table 2. Maximum values of DCT components in inter mode.