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Title: **Error Resilience and Frequency Scalable Coding**

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Purpose: Proposal

Abstract

This contribution discusses the advantages of "Frequency Scalability" coding schemes for error concealment. It is proposed to consider error robustness methods for the MPEG2 Core which incorporate basic scalability functionality. Document [1] provides more detailed results using this method.

Introduction

Frequency scalable layered coding has been discussed as a promising method for error concealment within the MPEG ATM Adhoc group. Results indicate, that especially under the assumption that lower DCT coefficients are transmitted in a high priority channel with low cell loss expectancy good cell loss recovery can be achieved [2]. It is worth noting that the idea of coefficient scanning, which is the subject of Core Experiment F5, is closely related to Frequency Scalability. In the following the idea of Frequency Scalability is briefly reviewed and discussed in the context of error robustness features.

Frequency Scalability Functionality

Frequency Scalability has been introduced into MPEG to provide encoded video with scalable features. A bitstream is generated which allows the decoder to display video at multiple scales [3]. These scales could be based on spatial video resolution, SNR or complexity features. The receiver has the choice to display video at various spatial resolutions (resolution scalability). Alternatively video can be displayed at highest resolution but with reduced quality (SNR scalability). In both cases only parts of the bitstream may have to be decoded. The term complexity scalability relates to the fact that coders which are only capable of displaying, or willing to display, lower video resolution can be implemented with a complexity proportional to the image resolution. In particular the complexity of a Frequency Scalability decoder designed to reconstruct only the lowest possible video resolution may be small enough to be implemented in software.

It is important to note, that the most basic Frequency Scalability Pyramid layered scheme can be implemented as a simple extension of the MPEG2 single layer coder. Figure 1 shows the MPEG2 coder plus the additional blocks needed to implement a two layer scheme. Note, that also the decoder complexity is only slightly larger then a MPEG2 Core decoder.

The layering is based on coefficient scanning in the DCT domain in a structured form, which allows the transmission of particular DCT-coefficients in specific layers with appropriate network priority if necessary. To this end every 8x8 DCT-domain block in the prediction error loop (Figure 1) is divided into two DCT domain partitions. One partition is provided for the lower 4x4 coefficients transmitted in the lower layer and a second partition can contain information about all 8x8 DCT coefficients to be transmitted in the higher layer (Figure 2). Note, that not all lower 4x4 DCT-coefficients neeu to be transmitted in the lower layer. The selected lower 4x4 coefficients are quantised using a quantiser QP4 and are next scanned and transmitted in the lower layer. In a second step the already coded coefficients from the lower 4x4 partition are reconstructed and subtracted from the original DCT coefficients. They are again quantised (QP8) and scanned for transmission together with the remaining 48 coefficients.
At the decoder the coefficients contained in both layers are simply individually reconstructed (IQP4, IQP8) and added before being treated the same as in a single layer MPEG2 Core decoder.

In addition to its simple implementation Frequency Scalability layered coders can achieve an efficiency comparable to, or close to, a single layer MPEG2 implementation [1].

Frequency Scalability and Error Robustness

Frequency Scalability can combine the advantages and functionality of a simple layered implementation for resolution and SNR scaling with error robustness features. In particular the Frequency Scalability syntax can be used to provide two bitstreams suitable for transmission in B-ISDN. One bitstream containing the most important DCT-coefficients may then be allocated to a high priority virtual channel.

For error robustness the following functionality provided by the Frequency Scalability syntax is emphasized:

¤ *Dynamic allocation of coefficients into priority channels*

Note, that not all of the lower 4x4 coefficients have to be transmitted in the lower layer. Depending on bitrate constraints or visual perceptibility, the lower 4x4 DCT-coefficients can be allocated to either the high or low priority channel. In the extreme, if none of the lower coefficients is transmitted in the lower 4x4 layer, the coefficients are re-scanned for transmission in the higher layer. In this case the video is coded similar to a single layer implementation.

¤ *Flexible allocation of bitrate between channels*

The pyramid structure with quantisers QP4 and QP8 and re-scanning of lower layer coefficients in the higher layers enables the flexible allocation of bitrates between layers. Frequency scalability provides a "scalable side information" extension for transmission of the lower layer at low target bitrates [4].

¤ *The scheme can be implemented with only minor hardware extension to a MPEG2 core coder*

Only additional blocks for quantisation, inverse quantisation, summation and subtraction of lower layer 4x4 coefficients are required at the encoder. The decoder requires one additional inverse quantiser and one summation element.

Conclusion and Recommendation

As outlined above Frequency Scalability can combine the advantages of scalable coding and error robustness with only minor hardware extensions added to a MPEG2 Core coder. Providing limited scalability features (but not the full capability offered by the scalability extension) would be an advantage that is a by-product of providing significant error resilience in this manner. We propose that an error resilience method with scalable extensions be considered for the MPEG2 core.

In addition, because of the similarity of this scheme with the "Coefficient Scanning" approach in Core Experiment F5, we propose to consider converging these two techniques to add additional functionality to both methods.

References

[1] S. Dunstan and M.Leditschke
"Results for Frequency Scalable Coder Error Resilience"
ISO/IEC JTC 1/SC 29/WG 11, MPEG 93, Rome, January 1993.

[2] Australian UVC Consortium
"Results on layered coder error resilience"
ISO/IEC JTC 1/SC 29/WG 11, MPEG 92 Doc. 590, London, November 1993.

[3] C.Gonzales and E.Viscito
"MPEG-SX: A Test Model based on MPEGHG-1 plus Scalability eXtensions"
ISO/IEC JTC 1/SC 29/WG 11, MPEG 91, January, January 1991.

[4] MPEG2, Test Model 3
ISO/IEC JTC 1/SC 29/WG 11, MPEG 93, November 1991, pp. 154-158.

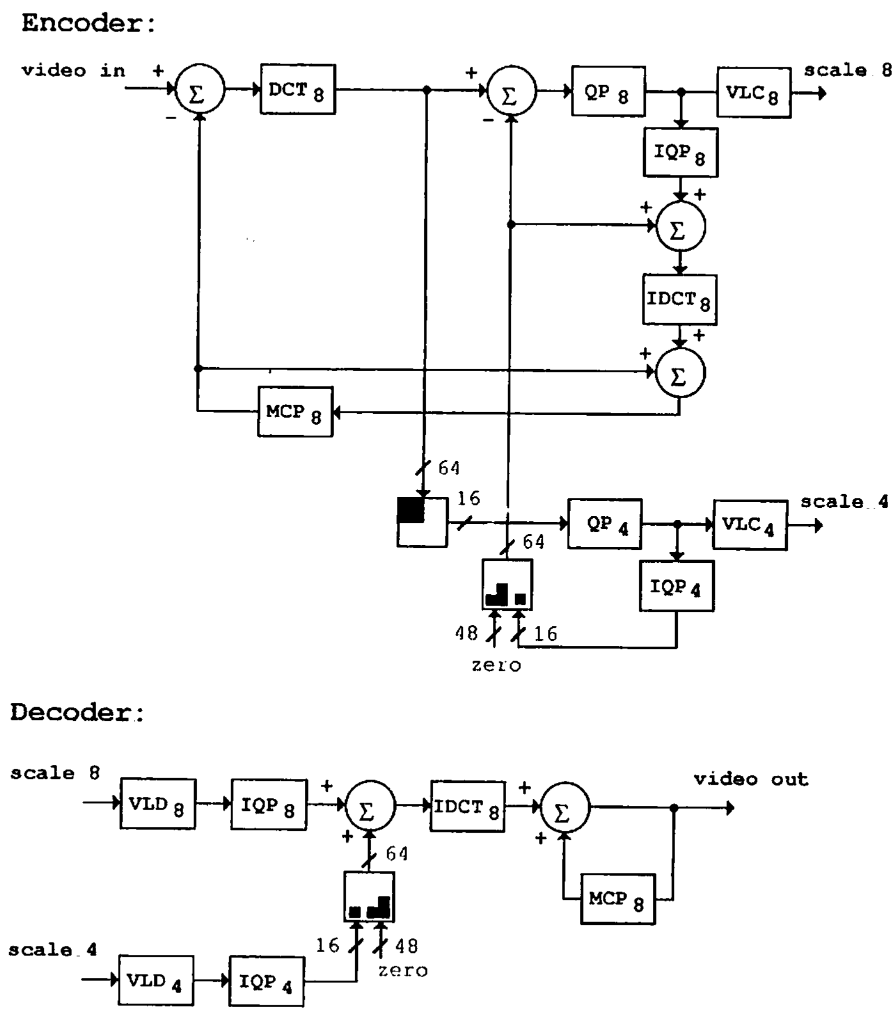

Figure 1: Two layer Frequency Scalable encoder and decoder structure.

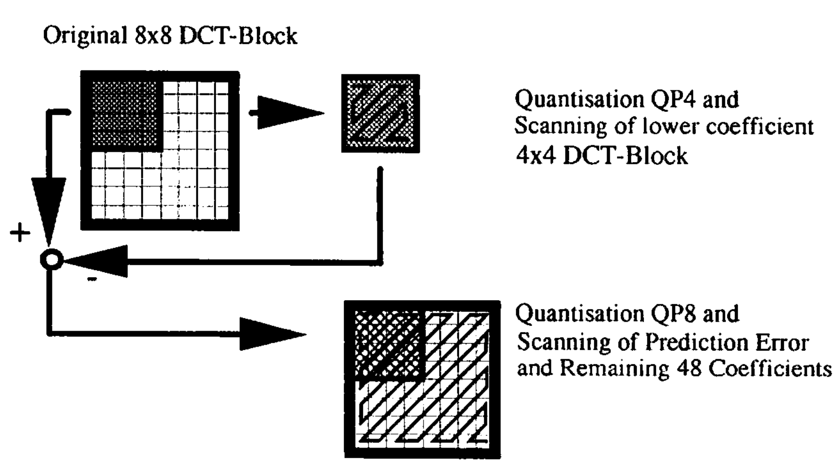

Figure 2: Partitioning, Quantisation and Scanning of DCT-coefficients in a two layer Frequency Scalable Pyramid coding scheme.