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TITLE: Flexible Layered Coding Efficiency

PURPOSE: Information

Abstract

A layered coding structure for interworking between different service classes, which implements the flexible layering concept, is outlined. A number of potential sources of inefficiency in layered coders have been identified. Work is currently being carried out to remove these sources of inefficiency.

1. Introduction

The concept of a flexible layered architecture has been described in [AVC-35, AVC-73]. This architecture allows a range of interworking codecs to be developed and includes single layer coding and fully layered coding as special cases.

Layered coders are thought to be less efficient than their equivalent non-layered counter-parts. Although there are a number of advantages which layered coding provides (cell loss concealment and interworking), it is important that coding efficiency be maximised. In our work we have identified a number of potential sources of inefficiency in layered coding, while exploring a particular layered coding architecture. The architecture and the sources of inefficiency are highlighted in the next two sections.

2. Architecture

Figure AVC-135/1 depicts the three main functional blocks of the layered coder. In our work we have used CIF and QCIF resolutions for the upper and lower layer signals respectively. The decomposition step is implemented using a DCT. The lower layer signal consists of the low frequency coefficients from the DCT. This lower layer signal is coded independently. Information from the lower layer is passed to the upper layer coding block. This block codes both the higher frequency coefficients and a correction signal, representing incremental information to enhance the quality of the layer 0 signal. This is necessary to allow independent bit-rate assignment in both layers.

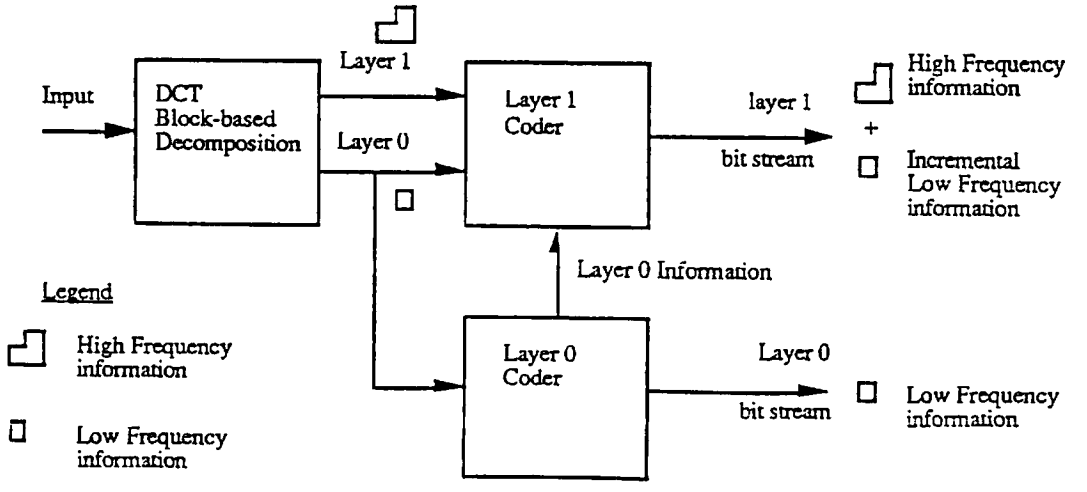

Figure AVC-135/1. Simplified block diagram of the decomposition and coding scheme.

This architecture can be extended to multiple layers. The number of layers which are used for coding is flexible. Both intermediate and/or lower layers can be dropped. Independent intra/inter/inter-MC decisions are made on all layers. This provides one potential enhancement over single layer coders, where the coding mode is the same for all transform coefficients, i.e. this adaptability can lead to rate savings.

This type of layered coder can provide cell loss concealment. If the lower layer signal is sent with high priority, and hence very low cell loss, cell loss in the upper layer will not cause a complete loss of picture quality. This is true regardless of whether the upper layer is coded in intra mode or in inter/MC mode.

3. Sources of Inefficiency

In our investigations we have identified potential sources of inefficiency which arise from layered coding. These are:

1. Motion compensation in the lower layer to single pixel accuracy results in inefficiency. Since the lower layer signal is effectively half the resolution of the complete signal, a single pixel motion represent two pixel motion in the complete signal. Sub-pixel accuracy motion compensation is necessary to remove this inefficiency.
2. In addition, the block size used for motion compensation in the lower layer should be half that used in the upper layer. This implies that exactly the same number of motion vectors are used in both layers and the same region in the scene is covered by a single block.
3. Critical sampling improves efficiency. That is, if the coding can be arranged so that the upper layer incremental signal is zero, coding efficiency improves. This is not generally the case when there are different quality requirements on both layers.
4. Great care must be taken to code the incremental signal efficiently when it is non-zero, i.e., when the lower layer is more coarsely quantised than the upper layer.

We are currently investigating methods for removing these inefficiencies. When all these problems are addressed we are quite hopeful that a layered codec which is very efficient will result.

5. Conclusions

In this document we have outlined a method for layered coding currently being investigated in Australia. The potential sources of inefficiency which result from layered coding have been identified. With further work we believe that a very efficient layered coding system will result.