CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

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SOURCE: Australia

TITLE: Flexible Frame Rates

PURPOSE: Proposal

Abstract

In this document the concept of flexible coder frame rates is discussed. Rates which are related to the maximum by integer factors can be dealt with easily. The ability to code sources which have frame rates not related by integer factors to the 59.94 Hz coder rate proposed for SCIF is essential to provide high end to end quality in certain applications. A simple extension is discussed which could provide this capability.

1. Introduction

Flexibility in coded frame rate is essential if the codec is to be suitable for a range of applications. For example, the quality requirements of video-phone services can be met by frame rates much lower than 59.94 Hz. There is a wide range of material, which will need to be coded, that is not available at a rate of 59.94 Hz, including film (24 Frames/sec) and European and Australian video sources. The quality requirements of some applications make frame rate conversion unacceptable.

Two steps towards a flexible frame rate capability are examined in this document. The first, which results in a limited flexibility through frame dropping, is already a part of H.261 and should be a part of the new standard. A subsequent step to allow the system to code and decode sources with arbitrary frame rates and extract the precise timing of the video source at the decoder is also discussed. It is argued that this capability could be provided by an incremental change to the system used for H.261.

2. Limited Flexible Frame Rates

Within CCITT Rec. H.261, the frame rate defined for CIF is a maximum, rather than a fixed number. Coding at frame rates which, when multiplied by integer factors, give the CIF frame rate, is straight-forward and used extensively for low-rate video-phone coding. This is achieved in the H.261 standard by numbering frames and allowing the coder to drop frames within a sequence. The advantages of this capability are:

- It provides flexibility to trade frame rate (temporal resolution) for bit-rate.
- The system is suitable for a wider range of applications.

To cater for the different frame rates, decoders can use simple frame repeat rate conversion which does not add significantly to decoder complexity. More sophisticated frame rate conversion is possible, however, providing this is a manufacturer's choice rather than a subject for standardisation. *This limited form of flexibility in the coded frame rate must be a part of the new standard.*

3. Fully Flexible Frame Rates

Although H.261 provides some flexibility in the coded frame rate, this rate must still be related to the 29.97 Hz rate used for CIF in the way discussed above. To code material which does not exist within this limited subset of frame rates, conversion is required. For video-phone and video-conference the reduction in quality which results from this conversion is acceptable. For high quality video-conferencing it may also be acceptable to convert material at different source rates to the SCIF frame rate of 59.94 Hz. This quality reduction, however, will not be acceptable for other applications, in particular broadcast TV and video-on-demand services. The terms of reference of the Experts Group clearly indicate that a coding scheme which is suitable for a wide range of applications is the final goal and therefore the requirements of other applications must be considered.

The main objection to dealing with a wide range of frame rates is complexity in the conversions required for display and the need for a Multi-point Control Unit (MCU), which is combining coded video streams to produce a single coded output stream, to deal with multiple input frame rates.

One solution to this problem is to use the existing H.261-like framework for SCIF. That is, provide 59.94 coded frames each second. A coder treats these frames as available slots which can be filled with a coded frame or left empty. This concept is illustrated in figures AVC-220/1 and AVC-220/2 for two different source frame rates. To allow a decoder to reconstruct the sequence at the original source frame rate each frame is labelled with precise frame timing information.

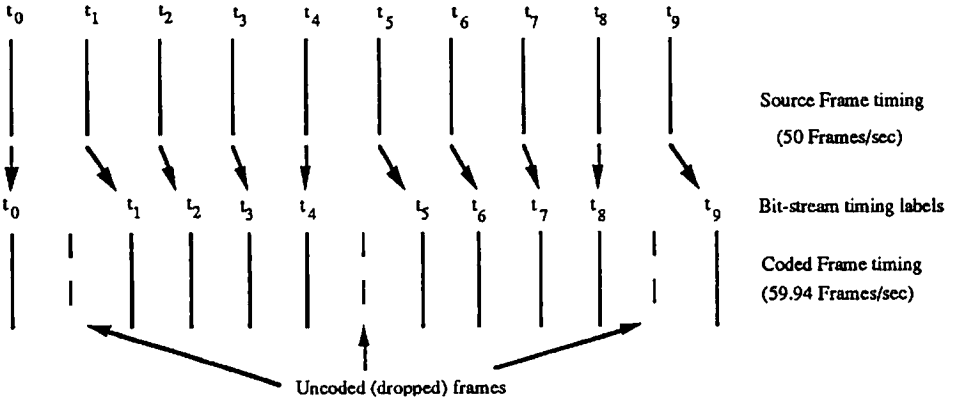

Figure AVC-220/1. Coding 50 frames/sec within a H.261-like framework. Note that the bit-stream should contain information of the precise timing of source frames.

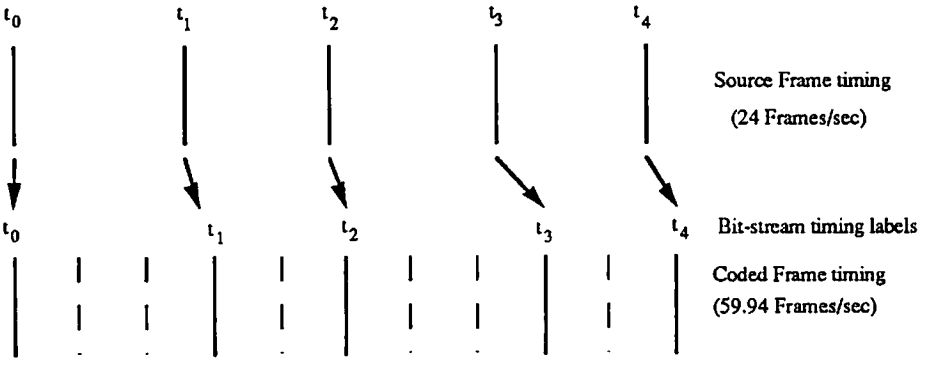

Figure AVC-220/2. Coding 24 Frames/sec within a H.261-like framework.

This approach allows any rate below 59.94 Hz to be coded. High quality coding can be provided without frame rate conversion. The quality of the final display depends on the design of the display conversion in the decoder. Manufacturers can choose either unsophisticated conversion methods which ignore the timing of the source, or more sophisticated methods which extract timing information and provide high quality reconstruction. This approach maintains the compatibility across international boundaries provided by SCIF and also allows simple backward compatibility with H.261. Methods for video clock recovery are discussed in [AVC-121].

4. Conclusion

The Experts Group should explicitly recognise that the limited flexible frame rate capability which is already a part of the H.261 standard will be a part of the new standard. Australia proposes that the Experts Group consider introducing mechanisms which allow the standard to be used for high quality coding at a range of frame rates. This will require video source timing to be recoverable at the decoder. This capability is essential if the coding system developed is to be suitable for a wide range of applications. One simple mechanism which involves inserting explicit source frame timing information in the bit-stream has been proposed as a starting point for discussion. This method has the advantage that backward compatibility with H.261 is straight-forward and designing MCUs is easier because there is a single coded frame rate.