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Question: 4/XV (Specialists Group on Video Coding)

STUDY GROUP XV

SOURCE : United States of America

TITLE : DISCUSSION OF SUB-RATE CODING ISSUES

1. Introduction

This document discusses basic picture coding parameters for consideration in the specification of a single worldwide standard for sub-rate codecs. The issues studied are:
(a) Dual Mode Receiver operation versus Single Intermediate format
(b) Number of coded pixels per line.
(c) Number of coded lines per picture.
(d) Number of transmitted pictures per second.
(e) Sampling structure (Orthogonal or Quincunx).
(f) Interlaced versus Progressive Scan.
(g) Parameters for Chrominance Coding.

2. Discussion

(a) Dual Mode Receiver Operation versus Single Intermediate Format

Early discussions on sub-rate coding issues assumed, as a requirement, the production of a new single low-resolution picture format, on which all sub-rate codecs would operate. Each region (PAL or NTSC) would convert pictures to and from the single intermediate format before encoding. Unfortunately in this system, intra-regional communications also become burdened with unnecessary standards conversions to and from the intermediate format, even though there exists the same picture standards at each end. Furthermore, the intermediate format is likely to to be based on 'compromise' coding parameters which will be sub-optimal for one or both regions.

In the interests of of minimising overall codec complexity, processing delay and picture degradations, it is recommended that a dual mode decoding system is adopted.

In such a scheme, coding parameters for each of the two picture standards are optimised separately. However, allowance is made in the choosing of individual parameters to ensure reasonable conversion processes between the two systems. The receiver is designed to decode data from either source standard, and to reconstruct the picture as required locally.

This limits the burden of standards conversion to the receiver and for inter-regional communications only. Dual Mode operation ensures the highest attainable quality for all intra-regional operations.

(b) Number of Coded Pixels Per Line.

In view of the above recommendation for a dual mode system, it is now no longer necessary to define a specific number of pixels to be coded per line in a single intermediate format. Different pixel sample rates suitable for local equipment can be used with the dual mode approach. The number of coded pixels per line is likely to be at least 360 in either mode, and this figure could be used in early simulations of algorithms. The final figures for this parameter are yet to be decided.

This degree of freedom in the selection of basic sampling rate will produce considerable savings in the cost of the codec, because of the resulting simplification in the processing stages converting between composite and component signal formats.

(c) Number of Coded Lines Per Picture.

Assuming dual mode operation is employed, and approximately the same number of pixels are coded per line in both PAL and NTSC codecs, then suitable numbers of lines to be coded per picture can be chosen which are convenient for the local picture standards. When these numbers are considered in conjunction with those for picture rate (see below), it can be seen that some commonality between systems can be preserved which will aid subsequent standards conversion.

It is suggested that in NTSC countries, Graphics images should use 480 lines and consist of both fields. For motion (face to face) images, nominally a single field of 240 lines should be employed, with allowance being made for the possible extension of the resolution capabilities up to 480 lines where this is found to be necessary (eg. for NTSC codecs operating at n x 384 kbit/s, where $n > 1$).

It is suggested that in PAL countries, Graphics images should use 576 lines and consist of both fields. For motion (face to face) images, nominally a single field of 288 lines should be employed, with allowance being made for the possible extension of resolution capabilities up to 576 lines, where necessary.

(d) Number of Transmitted Pictures Per Second.

Assuming dual mode operation, convenient transmitted picture rates can be derived from local picture standards. The relationship between the PAL and NTSC transmitted picture rates can be used to compensate for the difference between the two systems in suitable numbers of coded lines per picture. For example, the number of coded pixels produced in systems based on picture parameters of 240 lines at 15 Hz rate, and 288 lines at 12.5 Hz rate will be similar. This relationship will aid the design of the dual mode of operation and standards conversion at the receiver.

In NTSC countries it is recommended that a transmitted picture rate of 30/I is employed. The precise value of the integer I depends on the value of n, for an n x 384 kbit/s codec, and the selection of other basic system parameters (see above).

Similarly, it is recommended that a basic transmitted picture rate of 25/I is employed in PAL countries.

(e) Sampling Structure (Orthogonal or Quincunx)

For Graphics images, quincunx sampling would seem to be

preferable because it can allow for higher horizontal and vertical resolution with proper pre- and post-filtering.

However, where two-dimensional transform coding is being employed as the coding algorithm, there may be certain problems due to interaction between the two processes (sampling and transformation), and a loss of efficiency in the transformation may be apparent. Further investigation of this problem is required.

(f) Interlaced versus Progressive Scan.

For stationary Graphics images, both interlaced fields should be employed.

For basic motion (face to face) imagery in an n x 384 kbit/s codec where n is small, it is recommended that progresive scanning through a single field of 240 lines (NTSC codec) or 288 lines (PAL codec) be used. The problem of progressive versus interlaced scan disappears if part of the codec's data reduction process is the dropping of alternate fields from an interlaced scan source.

Some interest has been expressed in both progressive and interlaced scanning of an increased number of lines, if and where necessary in the stationary parts of the motion image (eg. uncovered background or when n > 1). The appearance in the future of progressively scanned charge coupled device (CCD) cameras may also be of interest in this area.

(g) Parameters For Chrominance Coding.

It is recommended that the coded chrominance signals should be I and Q in NTSC countries , and U and V in PAL countries, consistent with locally available equipment.

For n x 384 kbit/s codecs where n=1, it is recommended that 4:1 subsampling horizontally, and 2:1 subsampling vertically within a source field, be employed. Further discussion is needed to arrive at suitable subsampling ratios, and to ascertain whether satisfactory chrominance quality can be achieved from a single source field, when n > 1. Where the positioning of lower resolution chrominance samples is ambiguous in relation to the positioning of the luminance samples, co-siting of the leading edge of all samples is recommended.

It may also be noted that the I and Q axes were optimised for natural image scenes, rather than Graphics. It is hoped that some current work at Bell Communications Research will report on the suitability of I and Q axes for Graphics chrominance data, and the subjective limits for bandwidth reduction of chrominance signals in both face to face and Graphics source conditions.