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Specialists Group on Coding for Visual Telephony

SOURCE : NTT, KDD, NEC and FUJITSU
TITLE : INVESTIGATION OF BASIC CODING ALGORITHM FOR THE STANDARD 384 kbit/s CODEC

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1. Introduction

It is required that the picture quality of the 384 kbit/s codec satisfies the following conditions:

1. Picture quality at the nominal transmission rate must be essentially comparable to that of the current H.120 standard codec.
2. Picture quality at 384*n (n 2) kbit/s transmission, especially that by the digital primary group transmission, should be significantly improved over that of the presently available codecs.
3. The hardware complexity should be so determined that its standardization is possible within the next 4 years and that the future compactization is duely feasible.

The specific compression rate per picture element cannot be yet determined until the respective basic coding parameters are settled. However it is assumed that temporal and spatial resolution will be essentially the same as that of the current Rec. H.120 codec and thus it will be necessary to reduce the number of bits per picture element to the one fourth; in other words it is necessary to increase the coding efficiency about 4 times. For the reason (3), on the otherhand, prototype hardware should be completed within the next 3 years and the codec should be evaluated from the standpoint of whether it has a possibility fitting to the same spatial volume as the presently available codecs.

This contribution introduces basic concepts of the coding methods being investigated by the various organizations in Japan, together with the other elemental coding technologies considered as promising in fulfilling the purpose.

2 Elemental technologies

The 384 kbit/s videoconferencing codec will exploit the high frame-to-frame correlation in one way or the other. Considering this and the block structures used in the general inter-frame codecs, resulting coding structure can be described as in Figure 1. This section lists up the elemental technologies at each coding functional block.

1) Pre-processing
   1. Noise reduction filter / non-linear filter (NR)
   2. Subsampling filter (SBS)
   3. Sub-field/frame processing filter (SBF)

2) Source coding 1
   1. Discrete cosine transform (DCT) / other transforms (OT)
      two- or three-dimensional
   2. Vector quantizer (VQ)
      two- or three-dimensional
   3. Block truncuation coding (BTC)
3) Source coding 2
   1. Intra-frame prediction (DPCM)
   2. Inter-frame prediction (FD)
   3. Motion compensated prediction (MC)
   4. Background prediction (BGP)
   5. Interpolative prediction (IP)
   6. Motion compensated interpolative prediction (MIP)
   7. Two-dimensional DCT
   8. Two-dimensional VQ
4) Quantization and transformation
   1. Scalar quantization (Q)
   2. DCT
   3. VQ
5) Entropy coding
   1. Huffman coding (HM)
   2. Run-length coding (RL)
   3. Arithmetic coding (AC)
   4. Block basis coding (BLK)
6) Post-processing
   1. NR
   2. Spatial interpolation (SBI)
   3. Temporal interpolation (SFI)
   4. Motion compensated interpolation (MCI)

In addition, based on a slightly different criteria:

7) Adaptive controll methods
   1. Conditional replenishment (CR)
   2. Adaptive quantization (AQ)
   3. Adaptive prediction (AP)
   4. Adaptive transform processing (AT)
   5. Adaptive entropy coding (AEC)

In addition,

8) Synthetic coding

can be also considered but it is not yet clear as for how this coding element will be involved in the 384 kbit/s codec.

3.Particular coding methods considered to be promising

The 384 kbit/s codec to be developed would be composed of some of the above technologies, and some of their improvements and new applications. Inclusion of all these technologies is not practical from a hardware standpoint. The coding methods presently investigated by some organizations in Japan are as follows:

1. The combination of the DCT and the motion-compensated inter-frame prediction (MC). Relatively small movements within the movement compensation range would be compensated by the movement compensation and violent movements outside the compensation range are masked by the DCT coding.

2. Above further with the addition of the vector quantization (VQ) allows compression of the overall information.
3. The combination of (1) with spatial subsampling, temporal subsampling and interpolation processing (SBS, SBF, SBI, SFI).
4. The combination of the motion-compensated inter-frame prediction coding (MC), the interpolative prediction based on motion compensation (MIP), and the intra-field interpolative prediction (IP), to provide a motion-compensated inter/extrapolation prediction parallel coding method for high compression and smooth coding mode controll.

The outline of the block diagram for these methods is shown in Figures 2 and 3.

At present, all of these methods are not at the final stage and only the simulation experiments have been performed to evaluate the coding efficiency.

Table 1 shows the combinations of elemental coding technologies listed above for the investigated codecs and the codec in Parts 1 and 3 of Rec. H. 120.

4. Summary

The elemental technologies that should be examined were organized to provide a reference background for the investigation of the coding algorithms for the 384 kbit/s codec standard and the methods being investigated by various groups in Japan were introduced.

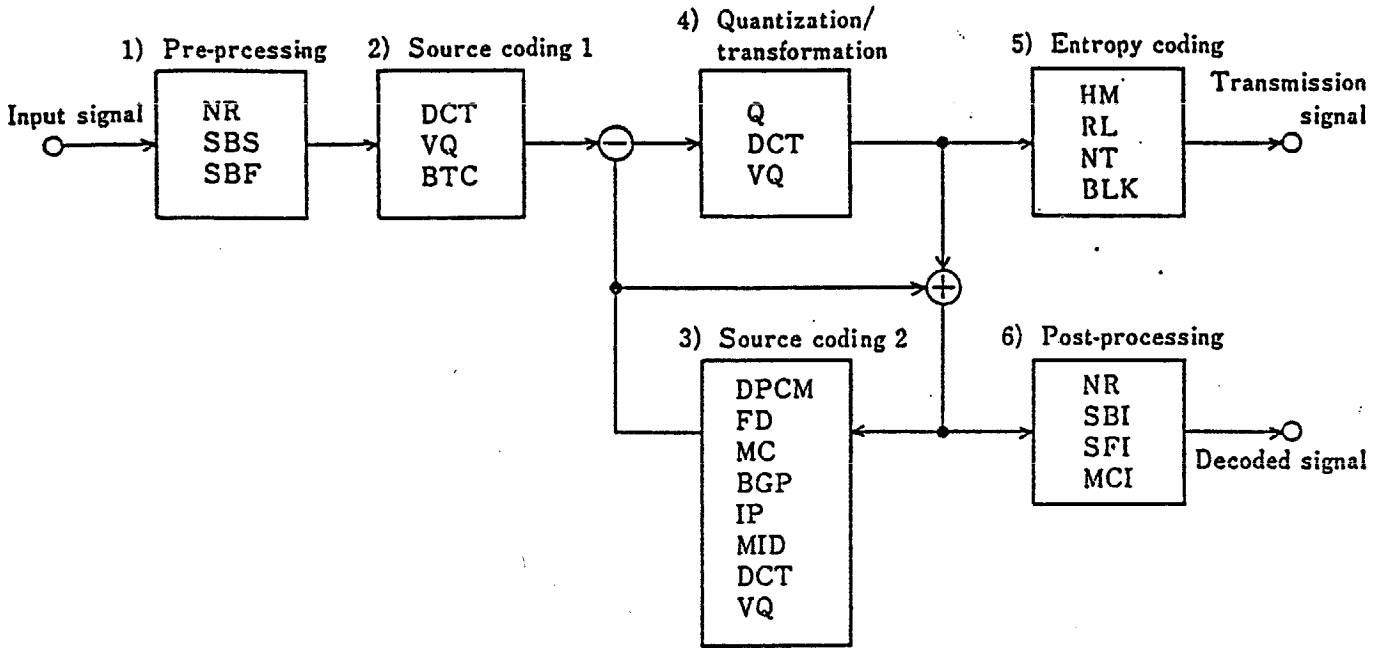
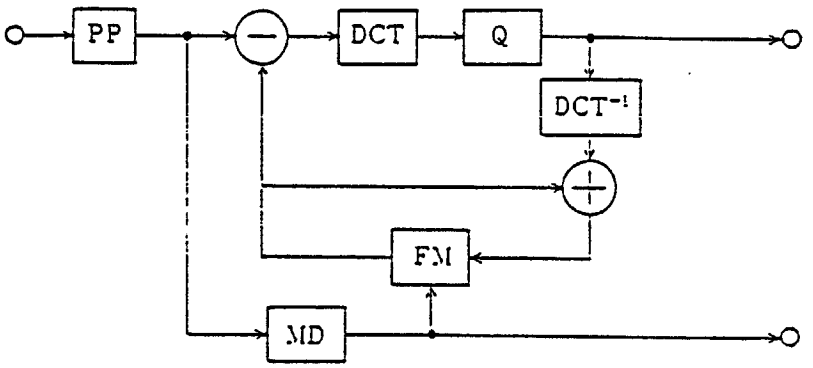


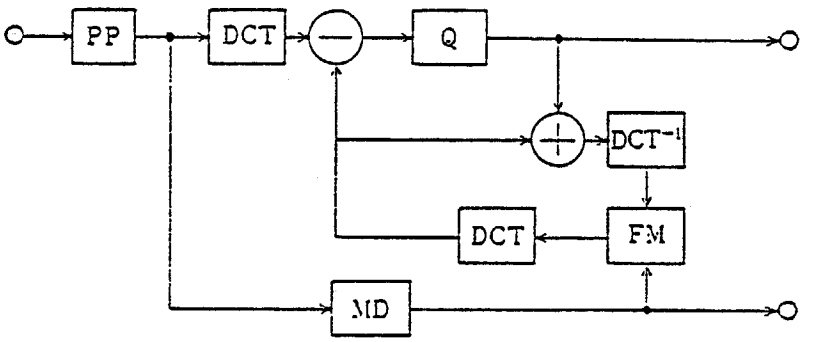
Figure 1 Elemental technologies for the standard codec

Table 1 Combinations of coding elemental coding technologies

	1) Pre-Processing			2) Source coding 1			3) Source coding 2								4) Quantization/ Transformation			5) Entropy coding				6) Post-Processing			
	NR	SBS	SBF	DCT	VQ	BTC	DPCM	FD	MC	BGP	IP	MIP	DCT	VQ	Q	DCT	VQ	HM	RL	AC	BLK	NR	SBI	SFI	MCI
H.120 Part 1	○	?	?				○	○							○			○					○	○	
H.120 Part 3 (D.1)	○	○					○		○	○					○			○	○				○	○	
(D.2 Annex A)	?	?	?	○				○							○			○	○			?	?	?	
(1)	○			○					○	(○)			○		○			○	○		(○)			○	
(2)	○			○					○	(○)			○				○	○	○		(○)			○	
(3)	○	○	○	○					○	(○)			○		○			○	○		(○)	○	○	○	
(4)	○	○	○				○		○	○	○	○			○			○	○						



a) DCT coding with the motion-compensated predicion



b) Motion-compensated predictive coding with the DCT coded signal

Note : Variations of these systems. such as changing the motion-compensated inter-frame prediction into the simple inter-frame prediction or changing scalar quantization into vector quantization are also being considered.

Figure 2 Block diagram for the DCT and the motion-compensated prediction combining coding method

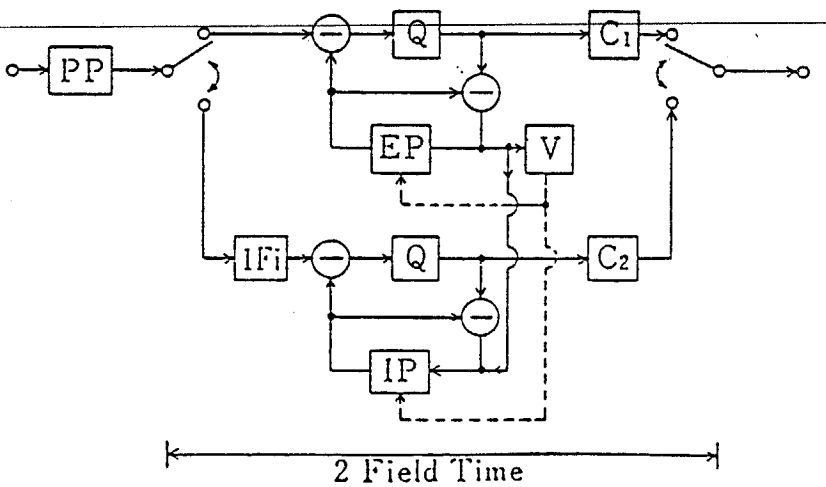


Figure 3 Block diagram for the interpolative/extrapolative parallel prediction coding