to increase frame rate

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Title: RM7 improvement by Conditional Motion-compensated Interpolation.

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Introduction

Many typical videophone scenes, may contain low-to-moderate amount of spatial detail, as well as slow-to-moderate movement. While a good coding scheme should somehow be able to adjust to varying spatio-temporal detail, any realistic coding scheme is forced to apriori choose various parameters. In low bit-rate coding, one of the often used techniques to cut-down on rate of generation of coded-bits, involves reduction in processed frame-rate. Typically, in RM7 simulations, a frame-rate of 10 Hz is often employed for coding as compared to 30 Hz input, at low bit-rates (q=1), even though some of the test-scenes employed contain moderate movements. At the receiver, in order to acheive the full frame-rate necessary, frame-repetition or frame-averaging is often resorted to, resulting in jerkiness or blurring of movement. We propose a conditional motion-compensated interpolation (CMCI) scheme, that can improve the temporal resolution, even at low bit-rates, thus preserving smooth motion.

resort to
to make use of
to turn to
(something) for help

In CMCI based coding scheme, the traditional motion-compensated predictive coding structure is exploited to code temporally distant frames, while the intermediate frames are coded by motion-interpolative coding, using the reconstructed neighbouring frames. An example of the basic principle is shown in Fig. 1. Both the motion-compensated prediction error (MCPE) and motion-compensated interpolation errors (MCIE), if significant, can be coded. This combined MCPE and MCIE approach used in CMCI based coding, is economical in motion and related overhead bits; fewer overhead bits are sufficient as compared to the MCPE only coding approach. Moreover, both MCIE and MCPE can be coded independently, with quantization parameters best suited to their individual needs. This is possible because, the quantized MCIE frames, do not feed-back quantization-errors into the MCPE coding loop.

Details

In table 1.1 some examples are shown to compare possible distribution of bits to MCPE and MCIE coded frames. /simulation: Command not found. This is possible because for MCIE frames motion-related and other overhead bits can be substantially reduced. To form the motion-compensated interpolated frames, motion-estimates from MCPE coded frames are simply scaled and utilized. Also, the MCIE frames are outside of the predictive coding loop, and therefore the quantized interpolation errors are not fed-back into the loop. Thus the combined MCPE and MCIE approach used in CMCI based coding, can outperform the traditional MCPE coding approach.

Since moving/non-moving macro-blocks are known in the frames surrounding the ones to be interpolated, the motion-related overhead for MCIE coded frames, can be eliminated. Further, in the simplest case, all classification attributes of the neighboring MCPE coded frame can be utilized for the MCIE coded frame, such that, only quantized coefficients and end-of-block signal may be transmitted. This may imply even use of the pattern information (eob-bit reduction strategy) from MCPE coded frames. If this results in inadequate performance some overhead-bits can be included for MCIE frames.

Simulations at low bit-rates are in progress, using Reference Model (RM7) algorithm and its modification, to allow comparisons of CMCI based and traditional motion-compensated coding schemes, on several test-sequences.

Features

(1) For a given bit-rate, allows improved temporal-rendition. For a given temporal resolution, at the expense of added delay, improvement in spatial-quality is also possible as improved distribution of bits between frames is utilized. Moreover, RM7 can be modified with only very few changes to incorporate CMCI, and is referred to as RM7-CMCI.

(2) The RM7-CMCI coding approach is conservative in spending bits on motion and other overhead information, in particular, for interpolated frames, no motion-estimation related bits are necessary. The additional bits can thus be used to improve spatial or temporal quality.

(3) In RM7-CMCI, interpolative coding is external to the predictive coding loop; the coding errors are not fed-back.

(4) Its exact implementation can be proprietary - even though CMCI based coding scheme will follow modified reference-model scheme, exact choice of parameters can be proprietary. An incompatible decoder can easily disregard or follow a prespecified default approach.

Results

Initial results show that, for a given bit-rate, the CMCI based coding scheme, can provide improved motion rendition, while maintaining picture quality comparable to RM7 type motion-compensated coding schemes. Alternately, for a given bit-rate and frame-rate, it allows improvement in picture quality, at the expense of added delay.

Further investigations are in progress to determine the best distribution of bits between motion-compensated predictive and interpolative coded frames, as several tradeoffs exist. As pointed out earlier, from initial experiments bit distributions shown in Table 1.1 seem reasonable, and can be adopted.

Conclusion

For a given bit-rate, CMCI offers potential for improved temporal-rendition, at the expense of minimal loss in the spatial-rendition. Alternately, for a given temporal resolution, it offers the potential of improved spatial-rendition.

Table 1.1 RM7 & RM7-CMCI, Coding bits distribution

CIF resolution : 59.4 kb/s (q = 1)						
frame rate Hz	Predictive Coding		Interpolative Coding		bits per frame pair	Scheme
	bits/frame	bits/macro	bits/frame	bits/macro		
10	5940 (50%)	15	0	0	11880	RM7
10	8910 (75%)	22.5	2970 (25%)	7.5	11880	RM7-CMCI
10	8316 (70%)	21	3564 (30%)	9	11880	RM7-CMCI
15	3960 (50%)	10	0	0	7920	RM7
15	6336 (80%)	16	1584 (20%)	4	7920	RM7-CMCI
15	6138 (77.5%)	15.5	1782 (22.5%)	4.5	7920	RM7-CMCI
15	5940 (75%)	15	1980 (25%)	5	7920	RM7-CMCI

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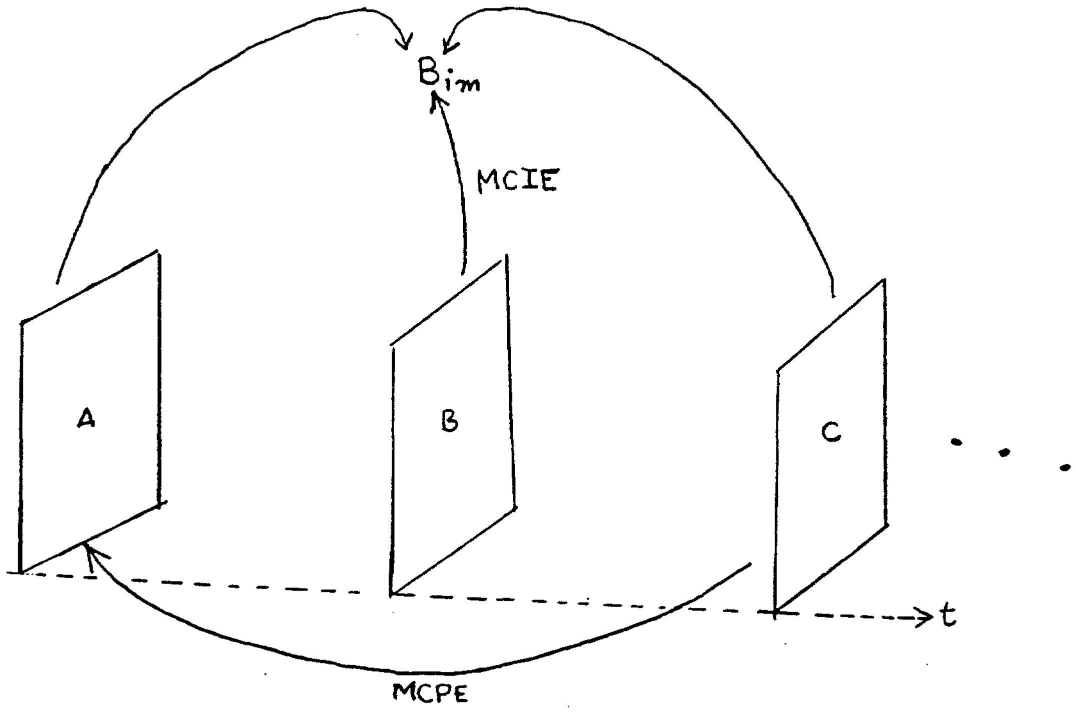

Figure 1 Example showing the principle of CMCI based coding scheme.

Prediction error (PE), $e_p = C - \hat{A}$ (1.1)

Mot. comp. prediction error (MCPE), $e_{pm} = C - \hat{A}_m$ (1.2)

Interpolation error (IE), $e_i = B - [\frac{\hat{A} + \hat{C}}{2}]$ (1.3)

Mot. comp. interpolation error (MCIE), $e_{im} = B - [\frac{\hat{A}_M + \hat{C}_M}{2}]$ (1.4)

Where,

$A, B, C,$ are original frames.

$\hat{A}, \hat{B}, \hat{C},$ are the reconstructed frames.

$\hat{A}_m,$ is the motion-compensated prediction frame.

$\hat{B}_i = [\frac{\hat{A} + \hat{C}}{2}],$ is the interpolation frame.

$\hat{B}_{im} = [\frac{\hat{A}_M + \hat{C}_M}{2}],$ is the motion-compensated interpolation frame.

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