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Specialists Group on Coding for Visual Telephony

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Title: Number of scanning paths for efficient coding

Source: CSELT,NTA

Adaptive scanning of transform coefficients appears to be an attractive technique to increase the coding efficiency. Such improvement of performances is obtained at the expenses of the overhead information that must be spent to inform the receiver about the selected scanning path.

Experiences were conducted at CSELT and NTA with the aim of providing an answer about the final balance between the saved and wasted information. Tests covered a wide spectrum of possibilities including large and small number of scanning paths and both "a posteriori" and "a priori" classifications. This latter were obtained with rather sophisticated procedures.

The results, both in objective and subjective terms, clearly showed that there is an insignificant gain in using this kind of classification. As a conclusion, for the bitrate of 60 kbit/s (p=1) used in the simulation tests, only one scanning path - the zig-zag one - should be maintained. Further work is required to create the sufficient evidence at $p > 1$.

Annex I is attached as an example of the obtained results with a short description of the used techniques.

Annex I

COST 211 bis
Simulation subgroup

Document SIM/88/79

Source : CSELT

Title: Use of adaptive scanning path with "a priori" and "a posteriori" block classification

1 INTRODUCTION

Adaptive scanning of transform coefficients results in a reduction of the amount of information required to transmit the position of the coefficients which are above the threshold with both 1-D and 2-D VLC.

Unfortunately the increase of performances of such adaptive technique is nearly vanished due to the overhead information necessary to inform the receiver about the used scanning path (SP).

This document describes an attempt to classify the blocks "a priori", i.e. making use of just the already transmitted information. The results obtained with the "a posteriori" classification are also reported.

2 TEST DESCRIPTION

The observation which is at the base of the work is that the motion compensation produces a difference signal where the object contours are really evident. An observer would judge the difference signal very similar to that one obtained through the application of a 2-D high pass filter, for instance a gradient extractor.

According to this consideration a simulation test was made according to the following steps:

1. filtering of the prediction block (available to the receiver without additional information) to get the object contour;

2. DCT computation of the filtered block;

3. "a posteriori" selection of the optimum scanning

4. coding of the actual difference block using the scanning determined at the previous point.

Eight different scannig classes were used, determined with the usual criterion of privileging vertical, horizontal, diagonal directions and combination of them.

In addition to this test the results obtained with the "a posteriori" criterion and pure RM6 (zig-zag scanning) are also reported.

3 CONCLUSION

The comparison of the three simulation tests show that the "a priori" classification technique allows to obtain unappreciable gain with respect to the zig-zag scanning while the "a posteriori" selection is a little worst than the other two.

The gain of the "a priori" technique is far away from justifying the amount of extra complexity required for its implementation. However there is still room for the optimization of the combination of filters used, of the way in which the energy of the filtered signal is related to the energy of the original one and of the scanning paths themselves.

For the "a posteriori" classification it is possible to conclude that it has no chances to give better performances with respect to the zig-zag scanning.

Reference Model 6 (RM6)

Sequence: CLAIRE Bit rate: 59.4 Kbps
Coded frames: 50 Frame rate: 10 Hz

Coded blocks	:	274.9
Not coded MB (buffer full)	:	0.1
Clipped coefficients	:	0.0
Coded coefficients	:	798.9
Bits for the classes	:	266.0
Bits for relative addr.	:	262.8
rmse for luminance	:	3.2471
rmse for chrominance U	:	1.8230
rmse for chrominance V	:	2.8067
SNR for luminance	:	37.9474
SNR for chrominance U	:	42.9332
SNR for chrominance V	:	39.1904
Mean value of step size (gob)	:	19.90
Mean value of step size (coef)	:	20.35
Mean nbr of nzc/block Y	:	3.10
Mean nbr of nzc/block C	:	1.58
Mean value of runs/block Y	:	6.18
Mean value of runs/block C	:	2.70

BLOCK TYPE OF MACRO

Fixed	:	266.4
Inter_Coded MC	:	56.9
Fixed MC	:	9.0
Inter_Coded	:	63.5
Intra_Coded	:	0.1

BLOCK TYPE OF Y

Fixed	:	1226.0
Inter_Coded MC	:	144.9
Fixed MC	:	119.0
Inter_Coded	:	93.6
Intra_Coded	:	0.3

BLOCK TYPE OF UV

Fixed	:	648.9
Inter_Coded MC	:	25.1
Fixed MC	:	106.8
Inter_Coded	:	10.8
Intra_Coded	:	0.2

NUMBER OF BITS

Macro attributes	:	528.8
End of block	:	839.6
Motion vectors	:	363.8
Coeff. Y	:	3851.8
Coeff. U	:	71.3
Coeff. V	:	186.8
Coeff. total	:	4109.9
Total	:	5842.1

Modified RM6: "a priori" classification.

Sequence: CLAIRE Bit rate: 59.4 Kbps
Coded frames: 50 Frame rate: 10 Hz

Coded blocks	:	285.4
Not coded MB (buffer full)	:	0.1
Clipped coefficients	:	0.0
Coded coefficients	:	867.2
Bits for the classes	:	207.5
Bits for relative addr.	:	265.9
rmse for luminance	:	3.1931
rmse for chrominance U	:	1.7951
rmse for chrominance V	:	2.7926
SNR for luminance	:	38.0963
SNR for chrominance U	:	43.0707
SNR for chrominance V	:	39.2356
Mean value of step size (gob)	:	19.4005
Mean value of step size (coef)	:	19.4982
Mean nbr of nzc/block Y	:	3.26
Mean nbr of nzc/block C	:	1.62
Mean value of runs/block Y	:	5.47
Mean value of runs/block C	:	2.45

BLOCK TYPE OF MACRO

Fixed	:	263.1
Inter_Coded MC	:	58.6
Fixed MC	:	8.4
Inter_Coded	:	65.8
Intra_Coded	:	0.2

BLOCK TYPE OF Y

Fixed	:	1219.5
Inter_Coded MC	:	149.7
Fixed MC	:	118.0
Inter_Coded	:	95.9
Intra_Coded	:	0.5

BLOCK TYPE OF UV

Fixed	:	645.7
Inter_Coded MC	:	27.1
Fixed MC	:	106.8
Inter_Coded	:	11.9
Intra_Coded	:	0.3

NUMBER OF BITS

Macro attributes	:	473.4
End of block	:	873.5
Motion vectors	:	362.1
Coeff. Y	:	3854.4
Coeff. U	:	77.2
Coeff. V	:	198.7
Coeff. total	:	4130.3
Total	:	5839.3

Modified RM6: "a posteriori" classification.

Sequence: CLAIRE Bit rate: 59.4 Kbps
Coded frames: 50 Frame rate: 10 Hz

Coded blocks	:	268.1
Not coded MB (buffer full)	:	0.1
Clipped coefficients	:	0.0
Coded coefficients	:	752.5
Bits for the classes	:	261.4
Bits for relative addr.	:	259.7
rmse for luminance	:	3.2855
rmse for chrominance U	:	1.8464
rmse for chrominance V	:	2.8714
SNR for luminance	:	37.8459
SNR for chrominance U	:	42.8221
SNR for chrominance V	:	38.9883
Mean value of step size (gob)	:	19.8796
Mean value of step size (coef)	:	19.9060
Mean nbr of nzc/block Y	:	3.00
Mean nbr of nzc/block C	:	1.50
Mean value of runs/block Y	:	3.80
Mean value of runs/block C	:	1.53

BLOCK TYPE OF MACRO

Fixed	:	267.8
Inter_Coded MC	:	56.8
Fixed MC	:	9.5
Inter_Coded	:	61.7
Intra_Coded	:	0.2

BLOCK TYPE OF Y

Fixed	:	1227.7
Inter_Coded MC	:	141.8
Fixed MC	:	123.4
Inter_Coded	:	90.3
Intra_Coded	:	0.5

BLOCK TYPE OF UV

Fixed	:	649.0
Inter_Coded MC	:	25.1
Fixed MC	:	107.5
Inter_Coded	:	10.0
Intra_Coded	:	0.3

NUMBER OF BITS

Macro attributes	:	521.1
End of block	:	821.6
Motion vectors	:	364.3
Coeff. Y	:	3397.3
Coeff. U	:	65.6
Coeff. V	:	161.5
Coeff. total	:	3624.4
Total	:	5331.4

Reference Model 6 (RM6)

Sequence: MISS AMERICA Bit rate: 59.4 Kbps
Coded frames: 50 Frame rate: 10 Hz

Coded blocks	:	328.7
Not coded MB (buffer full)	:	0.3
Clipped coefficients	:	0.0
Coded coefficients	:	662.3
Bits for the classes	:	373.6
Bits for relative addr.	:	318.4
rmse for luminance	:	3.2715
rmse for chrominance U	:	3.0518
rmse for chrominance V	:	3.2543
SNR for luminance	:	37.8776
SNR for chrominance U	:	38.6202
SNR for chrominance V	:	37.8930
Mean value of step size (gob)	:	20.4444
Mean value of step size (coef)	:	20.7836
Mean nbr of nzc/block Y	:	2.30
Mean nbr of nzc/block C	:	1.47
Mean value of runs/block Y	:	4.40
Mean value of runs/block C	:	2.23

BLOCK TYPE OF MACRO

Fixed	:	204.0
Inter_Coded MC	:	87.0
Fixed MC	:	28.4
Inter_Coded	:	76.5
Intra_Coded	:	0.1

BLOCK TYPE OF Y

Fixed	:	1054.0
Inter_Coded MC	:	147.0
Fixed MC	:	314.6
Inter_Coded	:	66.9
Intra_Coded	:	0.4

BLOCK TYPE OF UV

Fixed	:	505.4
Inter_Coded MC	:	59.2
Fixed MC	:	171.6
Inter_Coded	:	55.1
Intra_Coded	:	0.2

NUMBER OF BITS

Macro attributes	:	692.0
End of block	:	1186.0
Motion vectors	:	705.2
Coeff. Y	:	2475.7
Coeff. U	:	456.9
Coeff. V	:	336.6
Coeff. total	:	3269.1
Total	:	5852.3

Modified RM6: "a priori" classification.

Sequence: MISS AMERICA Bit rate: 59.4 Kbps
Coded frames: 50 Frame rate: 10 Hz

Coded blocks	:	348.5
Not coded MB (buffer full)	:	0.1
Clipped coefficients	:	0.0
Coded coefficients	:	712.5
Bits for the classes	:	306.9
Bits for relative addr.	:	319.5
rmse for luminance	:	3.2367
rmse for chrominance U	:	2.9159
rmse for chrominance V	:	3.2459
SNR for luminance	:	37.9523
SNR for chrominance U	:	38.8597
SNR for chrominance V	:	37.9129
Mean value of step size (gob)	:	19.9421
Mean value of step size (coef)	:	19.9780
Mean nbr of nzc/block Y	:	2.33
Mean nbr of nzc/block C	:	1.52
Mean value of runs/block Y	:	3.75
Mean value of runs/block C	:	1.62

BLOCK TYPE OF MACRO

Fixed	:	197.9
Inter_Coded MC	:	89.4
Fixed MC	:	27.2
Inter_Coded	:	81.4
Intra_Coded	:	0.1

BLOCK TYPE OF Y

Fixed	:	1045.5
Inter_Coded MC	:	151.7
Fixed MC	:	314.9
Inter_Coded	:	71.0
Intra_Coded	:	0.3

BLOCK TYPE OF UV

Fixed	:	496.3
Inter_Coded MC	:	63.4
Fixed MC	:	169.9
Inter_Coded	:	62.0
Intra_Coded	:	0.1

NUMBER OF BITS

Macro attributes	:	626.4
End of block	:	1255.8
Motion vectors	:	710.6
Coeff. Y	:	2429.4
Coeff. U	:	454.8
Coeff. V	:	374.8
Coeff. total	:	3258.9
Total	:	5851.7

Modified RM6: "a posteriori" classification.

Sequence: MISS AMERICA Bit rate: 59.4 Kbps
Coded frames: 50 Frame rate: 10 Hz

Coded blocks	:	316.4
Not coded MB (buffer full)	:	0.1
Clipped coefficients	:	0.0
Coded coefficients	:	611.2
Bits for the classes	:	370.7
Bits for relative addr.	:	319.8
rmse for luminance	:	3.3070
rmse for chrominance U	:	3.0285
rmse for chrominance V	:	3.3075
SNR for luminance	:	37.7710
SNR for chrominance U	:	38.5388
SNR for chrominance V	:	37.7499
Mean value of step size (gob)	:	20.0926
Mean value of step size (coef)	:	19.8649
Mean nbr of nzc/block Y	:	2.18
Mean nbr of nzc/block C	:	1.42
Mean value of runs/block Y	:	2.86
Mean value of runs/block C	:	0.91

BLOCK TYPE OF MACRO

Fixed	:	205.8
Inter_Coded MC	:	84.8
Fixed MC	:	30.3
Inter_Coded	:	74.9
Intra_Coded	:	0.2

BLOCK TYPE OF Y

Fixed	:	1057.9
Inter_Coded MC	:	144.8
Fixed MC	:	315.5
Inter_Coded	:	64.7
Intra_Coded	:	0.6

BLOCK TYPE OF UV

Fixed	:	508.1
Inter_Coded MC	:	52.8
Fixed MC	:	177.3
Inter_Coded	:	53.1
Intra_Coded	:	0.4

NUMBER OF BITS

Macro attributes	:	690.5
End of block	:	1141.5
Motion vectors	:	699.5
Coeff. Y	:	2175.0
Coeff. U	:	382.2
Coeff. V	:	257.7
Coeff. total	:	2814.8
Total	:	5346.3

Reference Model 6 (RM6)

Sequence: TREVOR Bit rate: 59.4 Kbps
Coded frames: 30 Frame rate: 10 Hz

Coded blocks	:	302.6
Not coded MB (buffer full)	:	1.0
Clipped coefficients	:	0.0
Coded coefficients	:	616.5
Bits for the classes	:	313.7
Bits for relative addr.	:	296.0
rmse for luminance	:	5.4301
rmse for chrominance U	:	2.8150
rmse for chrominance V	:	2.2823
SNR for luminance	:	33.5235
SNR for chrominance U	:	39.1495
SNR for chrominance V	:	40.9894
Mean value of step size (gob)	:	37.8770
Mean value of step size (coef)	:	37.9606
Mean nbr of nzc/block Y	:	2.12
Mean nbr of nzc/block C	:	1.06
Mean value of runs/block Y	:	3.13
Mean value of runs/block C	:	0.22

BLOCK TYPE OF MACRO

Fixed	:	204.1
Inter_Coded MC	:	97.8
Fixed MC	:	66.4
Inter_Coded	:	14.7
Intra_Coded	:	13.0

BLOCK TYPE OF Y

Fixed	:	862.0
Inter_Coded MC	:	217.0
Fixed MC	:	439.7
Inter_Coded	:	23.5
Intra_Coded	:	37.9

BLOCK TYPE OF UV

Fixed	:	443.3
Inter_Coded MC	:	5.9
Fixed MC	:	322.4
Inter_Coded	:	2.5
Intra_Coded	:	15.9

NUMBER OF BITS

Macro attributes	:	609.7
End of block	:	892.5
Motion vectors	:	1300.4
Coeff. Y	:	2838.3
Coeff. U	:	67.6
Coeff. V	:	34.3
Coeff. total	:	2940.1
Total	:	5742.8

Modified RM6: "a priori" classification.

Sequence: TREVOR Bit rate: 59.4 Kbps
Coded frames: 30 Frame rate: 10 Hz

Coded blocks	:	309.1
Not coded MB (buffer full)	:	1.1
Clipped coefficients	:	0.0
Coded coefficients	:	627.1
Bits for the classes	:	297.9
Bits for relative addr.	:	295.6
rmse for luminance	:	5.4145
rmse for chrominance U	:	2.8074
rmse for chrominance V	:	2.2927
SNR for luminance	:	33.5478
SNR for chrominance U	:	39.1719
SNR for chrominance V	:	40.9496
Mean value of step size (gob)	:	37.8095
Mean value of step size (coef)	:	37.7450
Mean nbr of nzc/block Y	:	2.11457658
Mean nbr of nzc/block C	:	1.05823851
Mean value of runs/block Y	:	2.91271520
Mean value of runs/block C	:	0.21590908

BLOCK TYPE OF MACRO

Fixed	:	204.7
Inter_Coded MC	:	98.1
Fixed MC	:	64.3
Inter_Coded	:	15.6
Intra_Coded	:	13.3

BLOCK TYPE OF Y

Fixed	:	864.7
Inter_Coded MC	:	218.5
Fixed MC	:	430.9
Inter_Coded	:	26.1
Intra_Coded	:	39.3

BLOCK TYPE OF UV

Fixed	:	446.7
Inter_Coded MC	:	6.8
Fixed MC	:	317.9
Inter_Coded	:	2.3
Intra_Coded	:	16.0

NUMBER OF BITS

Macro attributes	:	593.5
End of block	:	908.8
Motion vectors	:	1281.2
Coeff. Y	:	2956.8
Coeff. U	:	67.7
Coeff. V	:	35.5
Coeff. total	:	3060.0
Total	:	5843.4

Modified RM6: "a posteriori" classification.

Sequence: TREVOR Bit rate: 59.4 Kbps
Coded frames: 30 Frame rate: 10 Hz

Coded blocks	:	292.3
Not coded MB (buffer full)	:	0.9
Clipped coefficients	:	0.0
Coded coefficients	:	567.6
Bits for the classes	:	314.4
Bits for relative addr.	:	292.0
rmse for luminance	:	5.5396
rmse for chrominance U	:	2.8305
rmse for chrominance V	:	2.3033
SNR for luminance	:	33.3477
SNR for chrominance U	:	39.1033
SNR for chrominance V	:	40.9105
Mean value of step size (gob)	:	38.1667
Mean value of step size (coef)	:	37.5337
Mean nbr of nzc/block Y	:	2.02
Mean nbr of nzc/block C	:	1.06
Mean value of runs/block Y	:	1.54
Mean value of runs/block C	:	0.09

BLOCK TYPE OF MACRO

Fixed	:	205.3
Inter_Coded MC	:	95.3
Fixed MC	:	67.1
Inter_Coded	:	14.6
Intra_Coded	:	13.7

BLOCK TYPE OF Y

Fixed	:	868.5
Inter_Coded MC	:	205.8
Fixed MC	:	444.0
Inter_Coded	:	22.8
Intra_Coded	:	39.4

BLOCK TYPE OF UV

Fixed	:	447.0
Inter_Coded MC	:	6.1
Fixed MC	:	318.7
Inter_Coded	:	2.1
Intra_Coded	:	16.3

NUMBER OF BITS

Macro attributes	:	606.5
End of block	:	871.1
Motion vectors	:	1289.1
Coeff. Y	:	2546.4
Coeff. U	:	66.9
Coeff. V	:	32.3
Coeff. total	:	2645.6
Total	:	5412.3