CCITT SGXV
Working Party XV/1
Specialist Group on Coding
for Visual Telephony

Doc #260
October 1987

Title: Adaptive zonal scanning for a 384kbit/s video codec
Source: UK

Examination of statistics generated from a 384kbit/s hybrid coding model indicates that the ratio of non-zero to zero coefficients transmitted is typically 1:3. This large number of transmitted zero coefficients constitutes a significant percentage of the overall bit-stream generated. A method which attempts to reduce the ratio of non-zero to zero coefficients is described here.

One may conceive several sources of zero coefficients. These could be:

1] Inappropriate scanning of the block.

2] Spurious high sequency coefficients.

3] Genuine data which could be caused by either a bad prediction or wideband input data.

It was thought that sources 1 and 2 were often responsible for excessive numbers of zeros transmitted; therefore some method could be devised to reduce their number .

Examination of a number of quantised transform blocks revealed that the majority of coefficient energy was close to the DC coefficient, but small coefficients were often randomly distributed in the block. Transmitting these few high sequency coefficients would cost heavily in terms of zero coefficients transmitted. Further it was considered that very high sequency coefficients would be undesirable if generated with very coarse quantisation.

An adaptive zone was developed. This zone would adapt as a function of quantiser step size thus requiring no additional overhead information to be transmitted. In order to develop the zones correctly a coder was run open loop with several different buffer status values (or quantiser step sizes). The buffer status was kept fixed throughout the coding of a whole frame of data. For coded blocks the effect of placing sub scanning zones upon those blocks was examined. These sub zones consisted of all possible rectangular zones extending from the DC coefficient within the original block. The number of excluded zeros and the energy of the excluded non-zero coefficients for the differing sub-zones were examined.

The scanning classes indicated in Figure 1 were produced from this data.

Simulations were performed with RM4 with the modified scanning procedure. EOB codes were included as for RM4. A significant and visually noticeable improvement in image quality was present on the Split Screen Trevor sequence, in particular a reduction in block edge artifacts. A reduction in the number of zeros transmitted was produced.

Conclusion

The adaptive scanning process would appear to improve the subjective and objective performance of the codec.

SEQUENCE : SPLIT / TREV
SIMULATION : RM4.
DATE : MAY 87.

Item			FRAME	FRAME 15	AVERAGE
1)RMS FOR LUMINANCE				4·08	3·31
2)SNR FOR LUMINANCE				35.9	37.9
3Mean value for step size				17	13·5
4)Mean value Non-zero coef				3·8	4·18
5)Mean value of Tx'd zeros				6·64	6·98
6) Block type of Y	Fixed			634	775
	Intra			13	42
	Filtered Fixed			114	75
	Non-filt Fixed MC			96	50
	Filtered Fixed MC			94	39
	Non-filt Inter			190	147
	Filtered Inter			49	40
	Non-filt Inter MC			223	209
	Filtered Inter MC			171	203
	Filtered			428	357
7) Block of type C	Fixed			455	496
	Intra			20	9
	Filtered Fixed			146	133
	Non-filt Inter			98	97
	Filtered Inter			73	55
	Filtered			219	168
8) Number of bits	Attributes	Y		2741	3247
		Cr		341	327
		Cb		401	309
		TOTAL		3213	2883
	Class indicies			1292	1285
	EOB			1674	1608
	Motion vectors			584*8	503*8
	Coefficients	Y		14201	15996
		Cr		1295	830
		Cb		945	899
		TOTAL		16441	17725
	TOTAL			29838	29654

SEQ : SPLIT/TREV

RM14 with modified scanning

Item			FRAME	FRAME	AVERAGE
1)RMS FOR LUMINANCE					2.616
2)SNR FOR LUMINANCE					40.0
3Mean value for step size			11		9.13
4)Mean value Non-zero coef			2.05		2.53
5)Mean value of Tx'd zeros			3.78		5.26
6) Block type of Y	Fixed		598		718
	Intra		15		41
	Filtered Fixed		89		93
	Non-filt Fixed MC		68		38
	Filtered Fixed MC		42		25
	Non-filt Inter		263		191
	Filtered Inter		48		39
	Non-filt Inter MC		296		231
	Filtered Inter MC		165		202
	Filtered				
7) Block of type C	Fixed		445		470
	Intra		22		9
	Filtered Fixed		74		106
	Non-filt Inter		152		138
	Filtered Inter		99		66
	Filtered				
8) Number of bits	Attributes	Y	2703		2348
		Cr	304		338
		Cb	334		281
		TOTAL			
	Class indicies		1574		1413
	EOB		2120		1842
	Motion vectors				
	Coefficients	Y	12528		14768
		Cr	2009		1266
		Cb	1500		1394
		TOTAL			
	TOTAL		29918		29806

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RM 4. Statistics

MISSA

Item			FRAME	FRAME 15	AVERAGE
1)RMS FOR LUMINANCE				2·4	2·56
2)SNR FOR LUMINANCE				40·53	39.96
3Mean value for step size				10	11·36
4)Mean value Non-zero coef				2·59	2·57
5)Mean value of Tx'd zeros				8·58	7·03
6) Block type of Y	Fixed			839	800
	Intra			Ø	1
	Filtered Fixed			278	280
	Non-filt Fixed MC			46	103
	Filtered Fixed MC			11	36
	Non-filt Inter			270	149
	Filtered Inter			68	41
	Non-filt Inter MC			48	107
	Filtered Inter MC			24	64
	Filtered			381	421
7) Block of type C	Fixed			296	310
	Intra			Ø	1
	Filtered Fixed			116	130
	Non-filt Inter			287	240
	Filtered Inter			93	109
	Filtered			209	239
8) Number of bits	Attributes	Y		2066	2318
		Cr		362	399
		Cb		459	454
		TOTAL		2887	3171
	Class indicies			820	726
	EOB			1580	1428
	Motion vectors			129*8	311*8
	Coefficients	Y		6783	5782
		Cr		1429	1531
		Cb		3064	2406
		TOTAL		11276	9719
	TOTAL (includes Addressing)			19938	19879
Buffer Status (0-100%)				30·16%	36·8%

MISSA: with adaptive scanning

Item			FRAME (15)	FRAME	AVERAGE
1)RMS FOR LUMINANCE			2.28		2.37
2)SNR FOR LUMINANCE			40.9		40.6
3Mean value for step size			8		8.97
4)Mean value Non-zero coef			1.5		1.43
5)Mean value of Tx'd zeros			6.58		4.97
6) Block type of Y	Fixed		844		804
	Intra		0		1
	Filtered Fixed		255		234
	Non-filt Fixed MC		34		90
	Filtered Fixed MC		9		29
	Non-filt Inter		294		196
	Filtered Inter		63		51
	Non-filt Inter MC		55		109
	Filtered Inter MC		30		65
	Filtered				
7) Block of type C	Fixed		265		267
	Intra		0		1
	Filtered Fixed		81		90
	Non-filt Inter		320		294
	Filtered Inter		126		137
	Filtered				
8) Number of bits	Attributes	Y	2002		2249
		Cr	349		382
		Cb	466		462
		TOTAL			
	Class indicies		884		848
	EOB		1776		1715
	Motion vectors				
	Coefficients	Y	6139		4886
		Cr	1292		1690
		Cb	3314		2941
		TOTAL			
	TOTAL		19600		19877

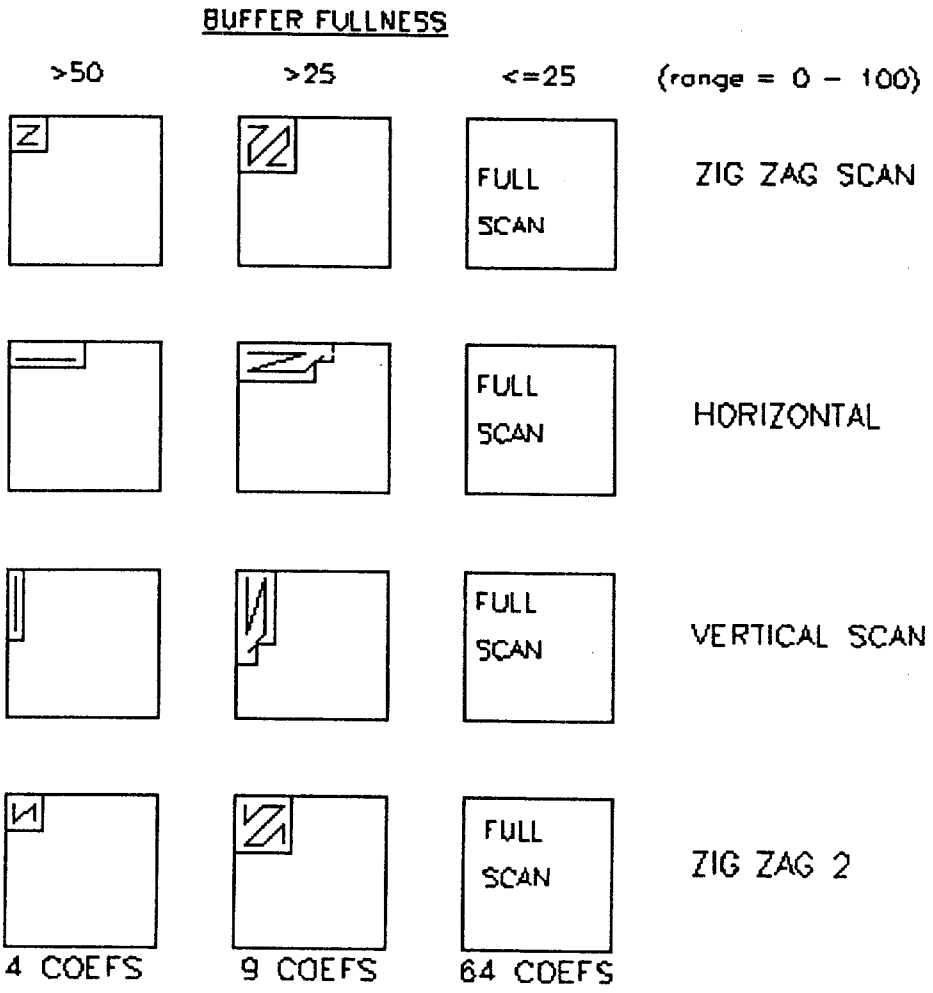

FIGURE 1 SCANNING CLASSES