

Title : Demonstrations of Hybrid coding at $n * 384\text{ kbit/s}$
and $m * 64\text{ kbit/s}$

Source : The Netherlands, Fed.Rep.Germany, France

1 Algorithm description

The generic structure of the reference model depicted in figure 1 is based on:

- Discrete Cosine Transform (DCT) (8×8)
- A uniform quantizer
- 2-D Variable length coding
- A zig-zag scanning of quantized coefficients
- Macro blocks
- Displacement estimation
- Buffer control adapting the quantizer

Figure 1 Hybrid transform/DPCM encoder

1.1 Macro block approach

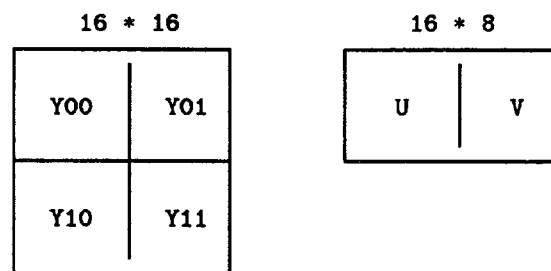
The Y macro block (MB) is divided into 4 blocks (see document #234) : Y00, Y01, Y10, Y11. These are transmitted followed by U and V. After each block an EOB is inserted. The Data Per Block (DPB) is only transmitted if the macro block is not fixed.

NOTE :

A macro block is considered fixed if all blocks within the macro block are fixed. In this way the number of bits for the block attributes is reduced. Motion compensation is also applied on macro blocks, which means that less bits have to be spent for the motion vectors.

So the macro block approach results in a big reduction of the number of overhead bits.

The construction of a macro block is depicted in the figure below.



NOTE:

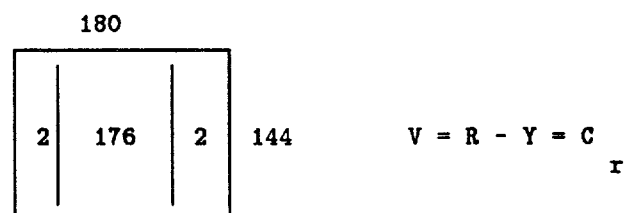
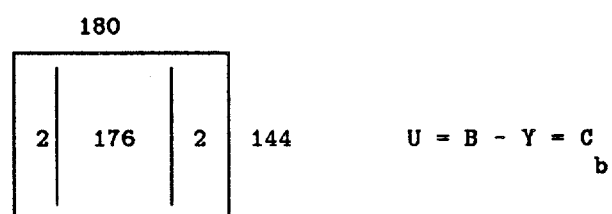
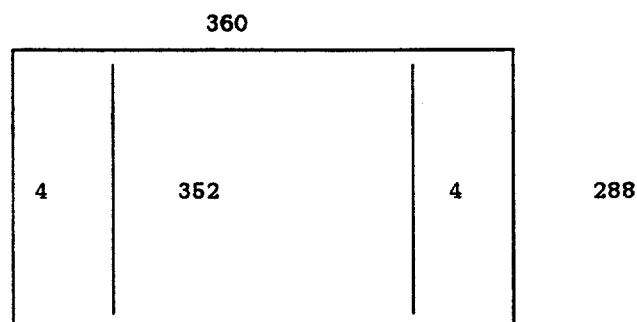
A 16 x 16 Luminance block and the two corresponding 8 x 8 U and V chrominance blocks have the same physical size.

The 16 x 16 Luminance block and the two corresponding 8 x 8 U and V chrominance blocks are called a macro block (MB).

- There are 22 MB in a GOB
- There are 18 GOB in a frame.
- There are 396 MB. (1584 Y blocks, 396 U blocks and 396 V blocks.

2 Video demonstration

2.1 Used Input Format



Definition significant pel area

2.2 Different comparisons

To evaluate the coding performance the following simulations were performed:

- 64 kbit/s (10 Hz)
 - Miss America
 - Trevor
 - Claire 64 kbit/s
- 384 kbit/s
 - Split/Trevor, 10 Hz
 - Miss America 15 Hz
 - Checked Jacket 15 Hz
- 2 Mbit/s
 - Split/Trevor, 30 Hz
 - Miss America 30 Hz
 - Checked Jacket 30 Hz

3 Conclusion

The macro block approach reduces the overhead significantly. Comparing the results of the CCITT RM4 reference model and the reference model adopting the macro block one could conclude that the latter configuration could be a candidate for the down wards compatibility.

With the introduction of this attribute, the compatibility towards the 384 kbit/s approach could be guaranteed.

STATISTICS REFERENCE MODEL :

DATE : 8 - 10 - 1987

ITEM : 64 KBIT/S - SEQUENCES (10 HZ) WITH MACRO BLOCKS

SEQUENCE :

CLAIRE

MISS AMERICA

TREVOR

ITEM	15th pict	Mean seq	15th pict	Mean seq	15th pict	Mean seq		
1. RMS for luminance	3.549	3.751	3.322	3.603	5.654	6.337		
2. SNR	37.128	36.647	37.702	36.998	33.084	32.093		
3. Mean value of step size	22.947	27.918	23.579	28.500	39.684	50.207		
4. Mean value of the no. of non-zero coefficients	2.616	2.687	2.088	1.846	2.053	1.978		
5. Mean value of the no. of zeroes before the last NZ-coef.	8.235	7.239	4.389	3.544	4.358	3.325		
6. Block type MACRO	FIXED CODED MC FIXED MC CODED	265 36 1 94	285 48 3 58	247 81 22 46	221 102 30 41	244 90 20 42	243 96 25 31	
7. Block type of Y	FIXED CODED MC FIXED MC CODED	1290 112 36 146	1281 128 78 95	1114 166 246 58	1003 167 365 48	1071 196 244 73	1031 221 265 66	
8. Block type of UV	FIXED CODED	769 23	746 45	720 72	691 100	779 13	776 15	
9. Number of bits	Macro attributes	657	613	672	715	680	676	
	Classification indexes	0	0	0	0	0	0	
	End of block	1560	1284	1524	1730	1584	1531	
	Motion vectors	296	414	824	1064	880	973	
	Coefficients	Y U V Total	3830 123 68 4021	3573 221 107 3902	2792 208 201 3201	2170 223 418 2812	2912 26 20 2958	2951 25 30 3007
	Total	6534	6214	6221	6322	6102	6188	

STATISTICS REFERENCE MODEL :

DATE : 9 - 10 - 1987

ITEM : 300 KBIT/S - SEQUENCES WITH MACRO BLOCKS

SEQUENCE : SPLIT / TREVOR

CHECKED JACKET

ITEM	15th pict Mean seq	15th pict Mean seq
1. RMS for luminance	4.17	3.52
2. SNR	35.73	37.21
3. Mean value of step size	17.84	14.78
4. Mean value of the no. of non-zero coefficients	4.40	4.62
5. Mean value of the no. of zeroes before the last M2-coeff.	9.00	9.90
6. Block type FIXED CODED MC FIXED MC MACRO CODED	112 141 3 140 115	158 18 0 220 238
7. Block type FIXED CODED MC FIXED MC CODED	679 464 112 329 253	797 481 51 455 476
8. Block type FIXED CODED of UV	584 208 161	645 147 162
9. Macro attributes	961	891
Number of bits	3372	2971
Classification indexes	0	0
End of block	3372	2971
Motion vectors	1152	1089
Coefficients	Y 22637 U 945 V 1565 Total 25147	23160 827 812 24801
Total	30632	29753

STATISTICS RM4

DATE : 18 - 5 - 1987

SEQUENCE : SPLIT / TREVOR

COMPARISON :

COMPARISON :			RM3		RM4	
ITEM			15th pict Mean seq		15th pict	Mean seq
1. RMS for luminance			4.11	3.40	3.94	3.25
2. SNR			35.85	37.49	36.22	37.89
3. Mean value of step size			11.33	8.84	14.78	11.77
4. Mean value of the no. of non-zero coefficients			3.54	3.70	3.65	4.01
5. Mean value of the no. of zeroes before the last NZ-coef.			6.45	6.61	6.64	7.16
6. Block type of Y	FIXED		685	818	666	784
	INTRA		9	40	8	40
	FILTERED	FIXED	73	38	53	40
	NON-FILT	INTER	93	56	70	41
	FILTERED	INTER	157	70	130	59
	NON-FILT	FIXED MC	167	129	197	154
	FILTERED	FIXED MC	34	31	42	39
	NON-FILT	INTER MC	195	202	210	207
	FILTERED	INTER MC	171	196	208	216
	Filtered	435	336	433	356	
7. Block type of UV	FIXED		540	581	526	558
	INTRA		21	11	23	11
	FILTERED	FIXED	46	31	39	35
	NON-FILT	INTER	101	108	102	112
	FILTERED	INTER	84	59	102	74
	Filtered		130	91	141	109
8. Number of bits	Attributes	Rel addr	1987	1860	2021	1905
		Y	3120	2766	2599	2206
		U	481	483	215	207
		V	496	476	277	193
		Total	6084	5586	5112	4514
	Classification index		1152	1200	1330	1315
	End of block		2346	2337	2676	1711
	Motion vectors		4928	4207	4944	4196
	Coefficients	Y	12962	14290	13702	15564
		U	972	1089	1153	1224
		V	1366	979	1723	1124
		Total	15300	16359	16578	17913
Total		29810	29691	30640	29650	

Source :
Date :
Comment:
Source file :
Code file :
Bitrate : (in 1000 bit)
Frame-frequency
Scene cut :
Block size :
Output frames :
Different output frames :

P K I
8.10.1987
macro concept (2Mbit/s)
CIFM
Vmx3
0.00
30.00
0
8
100
99

(Miss America)

Item	Mean	1	2	3	4	5	15
R.M.S. for luminance	2.0	1.8	1.9	1.9	1.9	1.9	1.9
SNR for luminance	42.2	42.9	42.7	42.7	42.6	42.6	42.5
Mean value of the step size	4.2	4.0	4.0	4.0	4.0	4.0	4.0
Mean value of non-zero coeff.	4.2	3.7	4.1	4.2	4.3	4.3	4.2
Mean value of zero coeff.	26.2	13.5	19.4	24.6	24.9	25.5	25.8
Block type of Y							
Intra	1	1584	0	0	0	0	4
Fixed (Inter/No MC/no coded)	440	0	520	542	491	504	500
Inter (Inter/No MC/coded)	658	0	652	638	665	716	656
Fixed MC (Inter/MC/no coded)	41	0	45	19	29	13	26
Inter MC (Inter/MC/coded)	445	0	367	385	399	351	398
filtered	486	0	412	404	428	364	424
Block type of C							
Intra	1	792	0	0	0	0	0
Fixed (Inter/No MC/no coded)	141	0	153	141	143	149	154
Inter (Inter/No MC/coded)	650	0	639	651	649	643	638
filtered	0	0	0	0	0	0	0
Number of bits							
Block attributes							
Y	2559	0	2513	2497	2539	2555	2507
total	3744	0	3701	3685	3727	3743	3695
Classification indexes	0	0	0	0	0	0	0
EOB words	3508	4752	3316	3348	3426	3420	3392
Motion Vectors	971	0	824	808	856	728	848
Coefficients	34701	64775	30386	34429	36386	36487	34208
Y	52235	88968	45502	48931	51626	51973	49593
total	60459	93720	53343	56772	59635	59864	57528
Total							

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Source :	F K I
Date :	8.10.1987
Comment:	macro concept (2Mbit/s)
Source file :	CIFs
Code file :	VsX3
Bitrate : (in 1000 bit)	0.00
Frame-frequency	30.00
Scene cut :	61
Block size :	8
Output frames :	100
Different output frames :	98

(Split/TREVER)

Item	Mean	1	2	3	4	5	15
R.M.S. for luminance	1.9	2.6	2.5	2.2	2.1	2.2	2.0
SNR for luminance	42.5	39.8	40.1	41.1	41.6	41.4	42.1
Mean value of the step size	4.2	5.1	6.5	5.2	5.0	5.0	4.5
Mean value of non-zero coeff.	6.7	7.0	6.8	7.3	6.9	7.1	7.2
Mean value of zero coeff.	16.3	7.5	13.2	16.4	15.2	15.7	15.8
Block type of Y							
Intra	18	1584	100	32	40	32	8
Fixed (Inter/No MC/no coded)	721	0	659	661	627	672	677
Inter (Inter/No MC/coded)	462	0	385	547	585	556	443
Fixed MC (Inter/MC/no coded)	25	0	46	15	24	18	33
Inter MC (Inter/MC/coded)	358	0	394	329	308	306	423
filtered	383	0	440	344	332	324	456
Block type of C							
Intra	0	792	0	4	0	0	0
Fixed (Inter/No MC/no coded)	543	0	593	495	490	477	491
Inter (Inter/No MC/coded)	249	0	199	293	302	315	301
filtered	0	0	0	0	0	0	0
Number of bits							
Block attributes							
Y	1963	0	1915	1996	2101	2007	1986
total	2693	0	2613	2854	2949	2860	2809
Classification indexes	0	0	0	0	0	0	0
EOB words	2176	4752	2156	2410	2470	2418	2350
Motion Vectors	766	0	880	688	664	648	912
Coefficients	42612126796	45579	50575	49602	48501	47446	
Y	47738149854	48945	56049	54708	54374	54034	
total	53373154606	54594	62001	60791	60300	60105	
Total							

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Source :
Date :
Comment :
Source file :
Code file :
Bitrate : (in 1000 bit)
Frame-frequency
Scene cut :
Block size :
Output frames :
Different output frames :

P K I
8.10.1987
macro-concept (384kbit/s)
CIFJ
VJx2
300.00
15.00
0
8
30
29

(Jacked 7.)

Item	Mean	1	2	3	4	5	15
R.M.S. for luminance	3.1	3.9	3.9	3.5	3.4	3.3	3.2
SNR for luminance	38.3	36.2	36.2	37.2	37.4	37.6	37.9
Mean value of the step size	7.6	11.0	14.0	10.7	10.0	8.8	8.1
Mean value of non-zero coeff.	3.2	2.0	3.7	4.1	3.8	3.9	3.3
Mean value of zero coeff.	11.1	4.4	12.8	13.8	12.5	13.4	9.8
Block type of Y							
Intra	7	1584	52	8	4	4	8
Fixed (Inter/No MC/no coded)	937	0	1011	992	1003	995	947
Inter (Inter/No MC/coded)	494	0	181	304	265	333	469
Fixed MC (Inter/MC/no coded)	39	0	149	74	95	62	43
Inter MC (Inter/MC/coded)	107	0	191	206	217	190	117
filtered	146	0	340	280	312	252	160
Block type of C							
Intra	0	792	0	0	0	0	0
Fixed (Inter/No MC/no coded)	605	0	747	699	675	672	631
Inter (Inter/No MC/coded)	187	0	45	93	117	120	161
filtered	0	0	0	0	0	0	0
Number of bits							
Block attributes							
Y	1861	0	1398	1526	1563	1716	1822
total	2517	0	1741	1984	2091	2269	2470
Classification indexes	0	0	0	0	0	0	0
EOB words	1591	4752	938	1222	1206	1294	1510
Motion Vectors	292	0	680	560	624	504	320
Coefficients	13959	44693	10851	14285	13057	14455	14176
Y	15104	53170	11173	15015	13788	15184	15054
total	19505	57922	14532	18781	17709	19251	19354
Total							

P.4/2

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Source :
 Date :
 Comment :
 Source file :
 Code file :
 Bitrate : (in 1000 bit)
 Frame-frequency
 Scene cut :
 Block size :
 Output frames :
 Different output frames :

P K I
 8.10.1987
 macro concept (384kbit/s)
 CIFM
 Vmx2 (Miss America)
 300.00
 15.00
 0
 8
 75
 74

Item	Mean	1	2	3	4	5	15
R.M.S. for luminance	2.4	2.6	2.6	2.5	2.4	2.4	2.4
SNR for luminance	40.4	39.9	39.9	40.1	40.5	40.7	40.7
Mean value of the step size	7.5	8.5	8.9	8.1	7.3	7.0	6.8
Mean value of non-zero coeff.	2.8	1.5	2.8	2.5	3.1	3.2	2.7
Mean value of zero coeff.	12.3	2.9	11.9	13.4	11.5	13.5	13.4
Block type of Y							
Intra	2	1584	12	8	4	4	0
Fixed (Inter/No MC/no coded)	976	0	861	1075	1108	1106	1065
Inter (Inter/No MC/coded)	228	0	115	237	340	402	439
Fixed MC (Inter/MC/no coded)	163	0	297	106	55	16	34
Inter MC (Inter/MC/coded)	215	0	299	158	77	56	46
filtered	379	0	596	264	132	72	80
Block type of C							
Intra	2	792	0	0	0	0	0
Fixed (Inter/No MC/no coded)	403	0	459	453	433	484	368
Inter (Inter/No MC/coded)	387	0	333	339	359	308	424
filtered	0	0	0	0	0	0	0
Number of bits							
Block attributes							
Y	1630	0	1434	1428	1668	1645	1876
total	2641	0	2332	2371	2661	2573	2959
Classification indexes	0	0	0	0	0	0	0
EOB words	1667	4752	1518	1484	1560	1540	1818
Motion Vectors	757	0	1192	528	264	144	160
Coefficients	9468	33341	9517	8829	9503	11202	9794
Y	14838	45792	13629	12620	14814	15489	15905
total	19903	50544	18671	17003	19299	19746	20842
Total							

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P.3/7

Source : P K I
Date : 8.10.1987
Comment: macro concept (64kbit/s)
Source file : CIFM (Miss America)
Code file : VM01
Bitrate : (in 1000 bit) 64.00
Frame-frequency 10.00
Scene cut : 0
Block size : 8
Output frames : 50
Different output frames : 49

Item	Mean	1	2	3	4	5	15
R.M.S. for luminance	3.2	4.0	4.0	3.6	3.4	3.2	3.0
SNR for luminance	38.1	36.1	36.0	36.9	37.6	38.2	38.7
Mean value of the step size	14.6	20.8	30.2	21.2	15.6	13.6	11.6
Mean value of non-zero coeff.	2.0	1.2	1.7	1.7	2.1	2.2	2.1
Mean value of zero coeff.	3.1	0.9	1.9	2.4	3.2	3.1	3.0
Block type of Y							
Intra	0	1584	0	0	0	0	0
Fixed (Inter/No MC/no coded)	1094	0	984	1216	1254	1160	1141
Inter (Inter/No MC/coded)	56	0	28	140	106	96	75
Fixed MC (Inter/MC/no coded)	309	0	509	195	139	193	209
Inter MC (Inter/MC/coded)	126	0	63	33	85	135	159
filtered	435	0	572	228	224	328	368
Block type of C							
Intra	0	792	0	0	0	0	0
Fixed (Inter/No MC/no coded)	643	0	740	710	694	680	643
Inter (Inter/No MC/coded)	149	0	52	82	98	112	149
filtered	0	0	0	0	0	0	0
Number of bits							
Block attributes Y	1063	1188	1019	1059	1042	1144	1084
total	1675	1782	1397	1542	1600	1707	1722
Classification indexes	0	0	0	0	0	0	0
EOB words	991	3996	429	765	867	1029	1149
Motion Vectors	435	0	636	219	182	283	338
Coefficients Y	2134	11104	680	1387	2186	2727	2744
total	3141	16181	1029	1863	2700	3332	3593
Total	6243	21959	3491	4389	5349	6351	6802

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Appendix : Modifications

In the case of the 64 kbit/s simulations the following cases where compared:

- Including different scanning classes CASE 1
- Applying a discrimination of critical scene parts CASE 2
- Post processing CASE 3

STATISTICS REFERENCE MODEL :

DATE : 8 - 10 - 1987

SEQUENCE : CLAIR 64 KBIT/S 10 HZ

COMPARISON : MACRO BLOCKS

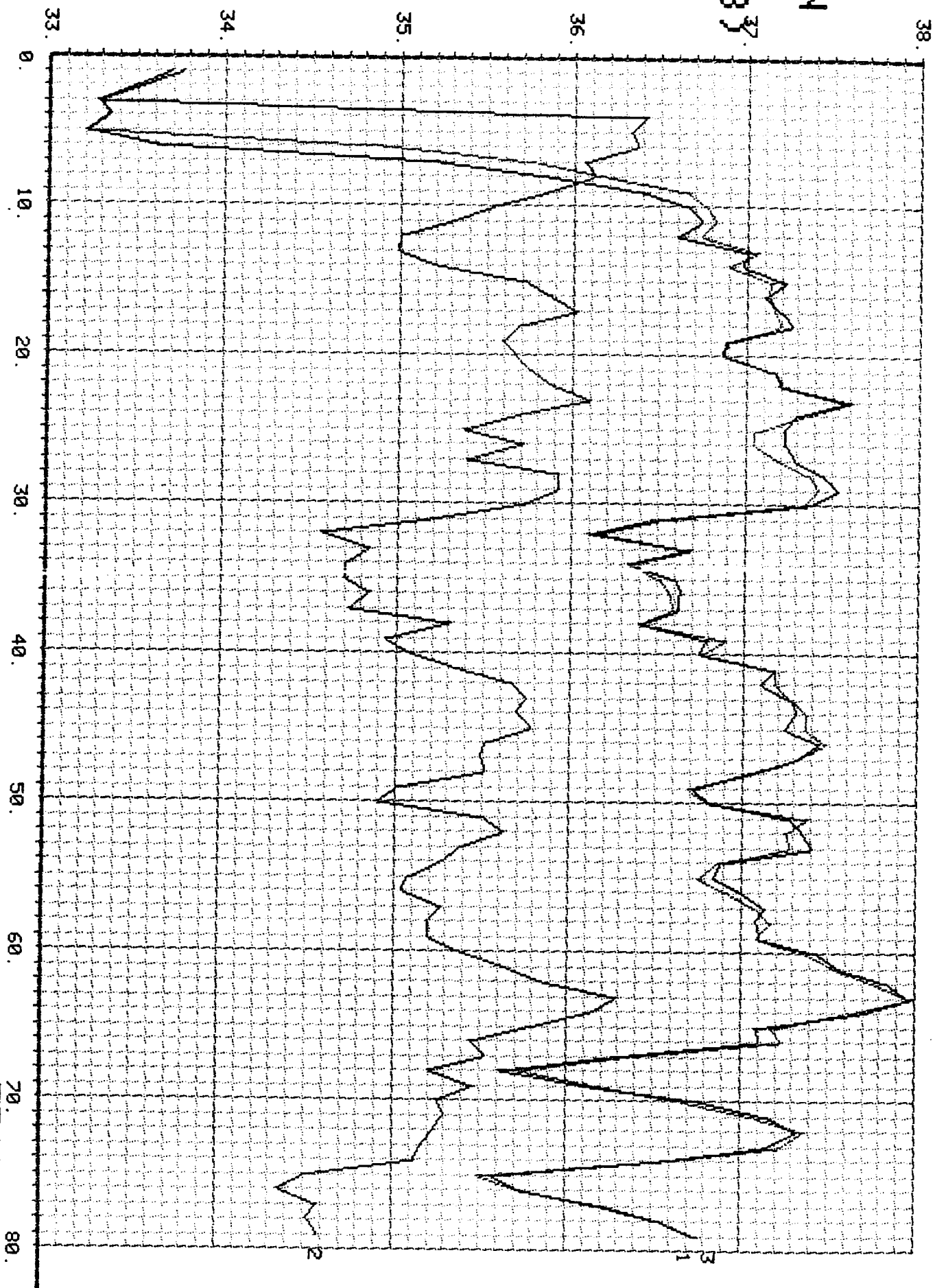
		CRITICAL BLOCKS		SCANNING CLASSES	
ITEM	15th pict Mean seq	15th pict	Mean seq	15th pict	Mean seq
1. RMS for luminance	3.549 3.751	4.103	4.352	3.559	3.768
2. SNR	37.128 36.647	35.868	35.356	37.104	36.608
3. Mean value of step size	22.947 27.918	41.579	53.075	23.579	28.250
4. Mean value of the no. of non-zero coefficients	2.616 2.687	3.963	3.453	2.448	2.659
5. Mean value of the no. of zeroes before the last NZ-coef.	8.235 7.239	10.967	9.042	4.590	4.314
6. Block type MACRO	FIXED	265	285	274	285
	CODED MC	36	48	36	48
	FIXED MC	1	3	1	3
	CODED	94	58	85	58
7. Block type of Y	FIXED	1290	1281	1288	1281
	CODED MC	112	128	109	127
	FIXED MC	36	78	39	79
	CODED	146	95	148	95
8. Block type of UV	FIXED	769	746	761	747
	CODED	23	45	31	44
9. Number of bits	Macro attributes	657	613	639	613
	Classification indexes	0	0	514	445
	End of block	1560	1284	1452	1283
	Motion vectors	296	414	296	414
	Coefficients				
	Y	3830	3573	3155	3097
	U	123	221	158	217
	V	68	107	96	106
	Total	4021	3902	3409	3421
	Total	6534	6214	6310	6178

1 : MACRO BLOCKS
2 : CRITICAL BLOCKS
3 : SCANNING CLASSES

8-10-87

S/N

(DB)



STATISTICS REFERENCE MODEL :

DATE : 9 - 10 - 1987

SEQUENCE : MISS AMERICA 64 KBIT/S 10 HZ

COMPARISON : MACRO BLOCKS

COMPARISON :		MACRO BLOCKS		CRITICAL BLOCKS		SCANNING CLASSES		
ITEM		15th pict	Mean seq	15th pict	Mean seq	15th pict	Mean seq	
1. RMS for luminance		3.322	3.603	3.748	4.044	3.339	3.651	
2. SNR		37.702	36.998	36.654	35.995	37.657	36.882	
3. Mean value of step size		23.579	28.500	38.737	46.283	24.526	29.493	
4. Mean value of the no. of non-zero coefficients		2.088	1.846	3.194	2.493	2.034	1.814	
5. Mean value of the no. of zeroes before the last NZ-coeff.		4.389	3.544	6.410	5.220	2.855	2.269	
6. Block type MACRO	FIXED	247	221	273	241	250	223	
	CODED MC	81	102	54	80	78	100	
	FIXED MC	22	30	49	52	25	32	
	CODED	46	41	20	21	43	39	
7. Block type of Y	FIXED	1114	1003	1147	1021	1115	1004	
	CODED MC	166	167	134	150	162	162	
	FIXED MC	246	365	278	382	250	369	
	CODED	58	48	25	29	57	47	
8. Block type of UV	FIXED	720	691	734	700	715	696	
	CODED	72	100	58	91	77	95	
9. Number of bits	Macro attributes		672	715	593	652	663	709
	Classification indexes		0	0	0	0	438	419
	End of block		1524	1730	888	1223	1452	1685
	Motion vectors		824	1064	824	1064	824	1064
	Coefficients		Y U V Total	2792 208 201 3201	2170 223 418 2812	2701 353 375 3431	2417 232 245 2894	1837 204 393 2435
Total		6221	6322	6117	6372	6271	6314	

MISS AMERICA 64 KBIT/S 10 HZ

- 1 : MACRO BLOCKS
- 2 : CRITICAL BLOCKS
- 3 : SCANNING CLASSES

9-10-87

