Source: UK
Title: TM1 Compatibility Experiments
Purpose: Information

Introduction

A layered coding approach has been taken to achieve compatible coding, each layer providing a specific picture resolution. A two-layer encoder and decoder are shown in figures 1 and 2. The base layer is MPEG-1 coding SIF resolution pictures. The top layer is MPEG-2 coding 601 resolution pictures.

In the experiments the coding has been restricted to two layers and the base layer is an MPEG-1 coder. However the coding scheme is flexible. There are several options:

1. The base layer could be MPEG-2 coding TV interlaced pictures. The second layer could then be HDTV interlace. Thus providing TV/HDTV compatibility.

2. Further layers can be added if required eg SIF, 601 HDTV.

3. The coding in the base layer could be H.261.

Furthermore a layered coding algorithm provides cell loss resilience in an ATM enviroment (the base layer can be sent as high priority and the second or subsequent layers can be sent with lower priority).

Similarly a layered coding scheme can provide graceful degradation.

Compatible Experiment

This section describes an initial experiment to compare the performance of two-layered compatible coding and simulcast using TM1.

The compatible coding scheme is a two-layered coding scheme. The base layer codes SIF resolution pictures using MPEG-1 at a bit rate of 1.5Mbits/s. The second layer codes the CCIR601 pictures with the remaining bit rate of 2.5Mbits/s and selects the compatible prediction whenever it is best to do so.

The simulcast method codes the CCIR601 pictures with 2.5Mbits/s (assuming 1.5Mbits/s is used to code SIF pictures) with no compatible prediction.

T Transform
Q Quantizer
Sw Switch
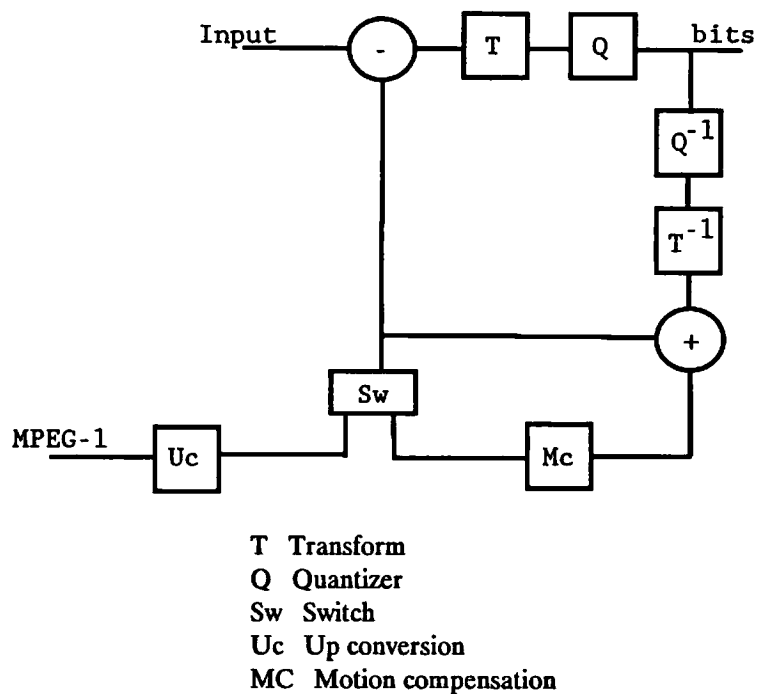Uc Up conversion
MC Motion compensation

Figure 1: MPEG-2 Encoder with prediction from a lower layer.

T Transform
Q Quantizer
Sw Switch
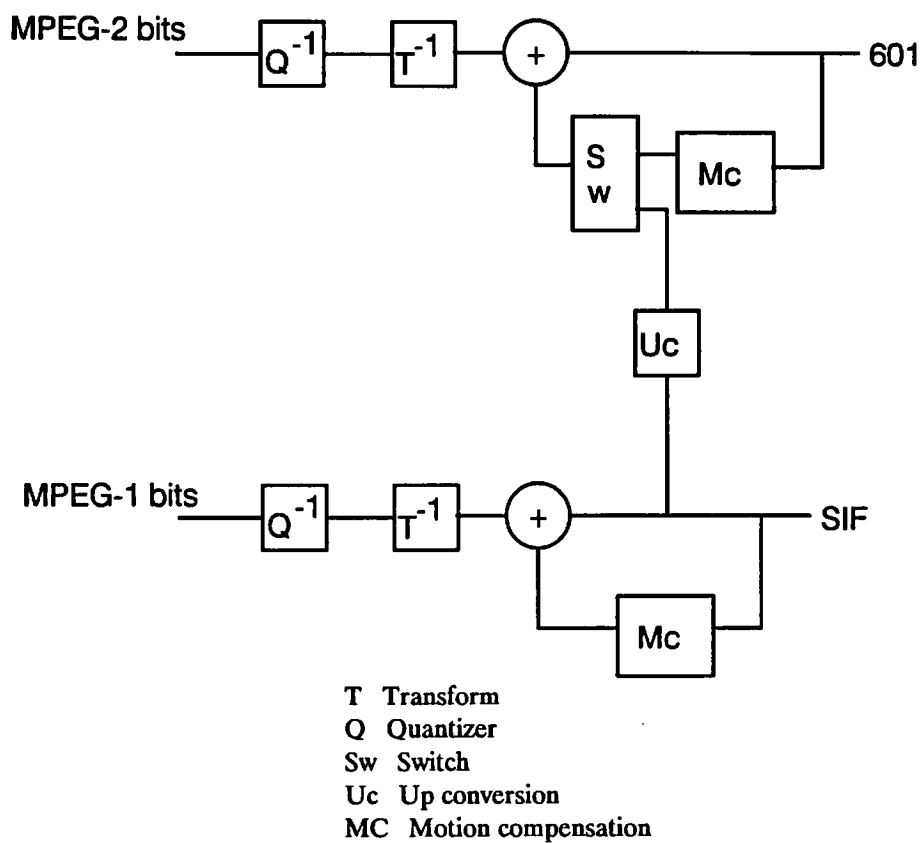Uc Up conversion
MC Motion compensation

Figure 2: MPEG-2 Decoder with prediction from a lower layer.

Encoder Description

The encoder is TM1 with the following prediction modes only:
- Frame/Field adaptive
- Compatible prediction from the MPEG-1 locally decoded pictures.

For the compatible prediction the decision basis is on a 16*8 block as described in appendix G.1 of the TM. There is a two bit code at the end of the macroblock type to indicate whether field 1 or field 2 or both or none have been coded compatibly (in the statistics this is Top, Bottom, All and None).

Results

Three simulations each have been performed on Mobile and Calendar and Flower Garden:
- 4Mbits/s Incompatible coding
- 4Mbits/s Compatible coding (1.5Mbits SIF + 2.5Mbits CCIR601).
- 2.5Mbits/s Simulcast coding.

Calendar

The average luminance SNR for the test model TM at 4Mbits/s was 29.65dB (with the compatible prediction switched off). The detailed statistics are shown in table 1.

The average luminance SNR for the two-layered compatible scheme was 28.06dB. The average luminance SNR for simulcast was 27.33dB. The gain of two-layered compatible coding over simulcast was 0.73dB. The detailed statistics are shown in tables 2 and 3.

Flower Garden

The average luminance SNR for the test model TM at 4Mbits/s was 29.44dB (with the compatible prediction switched off). The detailed statistics are shown in table 4.

The average luminance SNR for the two-layered compatible scheme was 28.44dB. The average luminance SNR for simulcast was 27.09dB. The gain of two-layered compatible coding over simulcast was 1.35dB. The detailed statistics are shown in tables 5 and 6.

Conclusion

A layered coding scheme provides more flexibilty to meet the varied requirements of MPEG-2.

It has been shown that the use of a base layer prediction in a two-layer coding scheme can improve the SNR picture quality over the simulcast approach.

Item	All	Intra	Predicted	Interpolated
Number of pictures	124	11	31	82
RMS for luminance	8.44	7.71	8.25	8.61
SNR for Y	29.65	30.41	29.83	29.47
SNR for U	34.44	34.77	34.05	34.55
SNR for V	35.48	35.9	35.08	35.57
Mean value of QP	11.9	9.82	9.13	13.23
Macroblock type				
Intra	145	1584	18	0
Forward with coefficients	391	0	1343	84
Forward without coefficients	100	0	222	68
Backward with coefficients	67	0	0	102
Backward without coefficients	61	0	0	93
Interpolated with coefficients	329	0	0	498
Interpolated without coefficients	248	0	0	375
None Compatible	1345	1584	1583	1223
Top Compatible	0	0	0	0
Bottom Compatible	0	0	0	0
All Compatible	0	0	0	0
Frame based transform	514	1079	829	318
Field based transform	420	504	532	366
Frame based prediction	1045	0	1423	1042
Field based prediction	154	0	141	179
Number of bits				
MBA	1622	1584	1584	1641
MTYPE	7494	6371	8339	7325
Pattern	3818	0	7026	3117
Quantizer index	84	179	177	36
Vectors	12194	0	10776	14366
Coefficients	136172	677954	199939	39387
Total	162975	687747	229422	67459

Table 1. TM1 coding statistics for Calendar. Average bit rate 4.07Mbit/s.

Item	All	Intra	Predicted	Interpolated
Number of pictures	124	11	31	82
RMS for luminance	10.12	9.49	10.15	10.2
SNR for Y	28.06	28.59	28.03	28
SNR for U	33.25	33.56	32.75	33.4
SNR for V	34.26	34.68	33.75	34.39
Mean value of QP	15.95	12.94	12.17	17.78
Macroblock type				
Intra	141	1584	3	0
Forward with coefficients	366	0	1268	74
Forward without coefficients	129	0	312	77
Backward with coefficients	51	0	0	77
Backward without coefficients	72	0	0	109
Interpolated with coefficients	212	0	0	321
Interpolated without coefficients	319	0	0	483
None Compatible	946	51	1110	1005
Top Compatible	144	0	293	108
Bottom Compatible	17	0	34	13
All Compatible	184	1532	145	17
Frame based transform	396	937	712	204
Field based transform	375	646	559	269
Frame based prediction	996	0	1443	961
Field based prediction	154	0	137	182
Number of bits				
MBA	1611	1584	1584	1626
MTYPE	7086	6376	8359	6700
Pattern	3135	0	6733	2196
Quantizer index	73	204	145	28
Vectors	12419	0	11063	14598
Coefficients	75672	387600	116464	18406
Total	101589	397430	145929	45140

Table 2. Compatible coding statistics for Calendar. Average bit rate 2.55Mbit/s.

Item	All	Intra	Predicted	Interpolated
Number of pictures	124	11	31	82
RMS for luminance	11	10.47	11.12	11.03
SNR for Y	27.33	27.75	27.24	27.31
SNR for U	32.78	32.95	32.33	32.92
SNR for V	33.76	34.05	33.33	33.89
Mean value of QP	18.68	15.56	14.21	20.79
Macroblock type				
Intra	147	1584	23	1
Forward with coefficients	324	0	1165	50
Forward without coefficients	171	0	394	110
Backward with coefficients	41	0	0	62
Backward without coefficients	96	0	0	146
Interpolated with coefficients	177	0	0	267
Interpolated without coefficients	322	0	0	488
None Compatible	1281	1584	1584	1126
Top Compatible	0	0	0	0
Bottom Compatible	0	0	0	0
All Compatible	0	0	0	0
Frame based transform	380	1079	692	168
Field based transform	309	504	496	212
Frame based prediction	980	0	1409	950
Field based prediction	153	0	150	175
Number of bits				
MBA	1612	1584	1584	1627
MTYPE	7028	6372	8498	6560
Pattern	2597	0	5851	1715
Quantizer index	65	183	144	20
Vectors	11987	0	10850	14026
Coefficients	77166	468161	105008	14191
Total	102045	477960	133516	39720

Table 3. Simulcast coding statistics for Calendar. Average bit rate 2.55Mbit/s.

Item	All	Intra	Predicted	Interpolated
Number of pictures	124	11	31	82
RMS for luminance	8.7	7.31	8.42	8.99
SNR for Y	29.44	30.88	29.67	29.16
SNR for U	32.89	33.17	32.56	32.97
SNR for V	34.92	35.19	34.66	34.98
Mean value of QP	13.83	11.13	10.5	15.45
Macroblock type				
Intra	147	1584	24	0
Forward with coefficients	371	0	1187	113
Forward without coefficients	194	0	371	154
Backward with coefficients	98	0	0	149
Backward without coefficients	93	0	0	140
Interpolated with coefficients	333	0	0	504
Interpolated without coefficients	244	0	0	370
None Compatible	1483	1584	1584	1432
Top Compatible	0	0	0	0
Bottom Compatible	0	0	0	0
All Compatible	0	0	0	0
Frame based transform	465	801	541	391
Field based transform	485	783	670	375
Frame based prediction	1186	0	1375	1274
Field based prediction	150	0	183	157
Number of bits				
MBA	1628	1584	1584	1651
MTYPE	8478	6365	8451	8772
Pattern	3612	0	5341	3443
Quantizer index	57	145	109	26
Vectors	17565	0	15848	20571
Coefficients	129863	584766	206395	39907
Total	162795	594522	239314	75953

Table 4. TM1 coding statistics for Flower Garden. Average bit rate 4.07Mbit/s.

Item	All	Intra	Predicted	Interpolated
Number of pictures	124	11	31	82
RMS for luminance	9.73	8.38	9.63	9.95
SNR for Y	28.44	29.7	28.49	28.25
SNR for U	31.85	32.5	31.62	31.84
SNR for V	33.9	34.6	33.58	33.94
Mean value of QP	17.67	14	13.34	19.8
Macroblock type				
Intra	141	1584	2	0
Forward with coefficients	346	0	1140	93
Forward without coefficients	195	0	441	128
Backward with coefficients	72	0	0	110
Backward without coefficients	97	0	0	147
Interpolated with coefficients	227	0	0	343
Interpolated without coefficients	366	0	0	554
None Compatible	736	42	511	914
Top Compatible	518	0	928	432
Bottom Compatible	18	0	34	15
All Compatible	174	1541	109	15
Frame based transform	345	583	446	275
Field based transform	442	1000	695	271
Frame based prediction	1142	0	1396	1199
Field based prediction	163	0	185	177
Number of bits				
MBA	1638	1584	1584	1666
MTYPE	8065	6364	8443	8150
Pattern	3417	0	6431	2736
Quantizer index	52	141	93	24
Vectors	18846	0	16603	22222
Coefficients	68014	341268	107260	16522
Total	101621	351015	141995	52903

Table 5. Compatible coding statistics for Flower Garden. Average bit rate 2.54Mbit/s.

Item	All	Intra	Predicted	Interpolated
Number of pictures	124	11	31	82
RMS for luminance	11.36	10.03	11.45	11.5
SNR for Y	27.09	28.14	26.99	26.98
SNR for U	31.37	31.55	31.03	31.48
SNR for V	33.85	33.95	33.59	33.93
Mean value of QP	22.09	18.08	16.84	24.61
Macroblock type				
Intra	148	1584	28	0
Forward with coefficients	304	0	1058	59
Forward without coefficients	246	0	496	185
Backward with coefficients	55	0	0	84
Backward without coefficients	123	0	0	186
Interpolated with coefficients	199	0	0	301
Interpolated without coefficients	357	0	0	540
None Compatible	1435	1584	1584	1358
Top Compatible	0	0	0	0
Bottom Compatible	0	0	0	0
All Compatible	0	0	0	0
Frame based transform	332	801	463	219
Field based transform	375	783	624	226
Frame based prediction	1136	0	1363	1202
Field based prediction	150	0	192	155
Number of bits				
MBA	1641	1584	1584	1670
MTYPE	8005	6369	8569	8011
Pattern	2486	0	4645	2004
Quantizer index	46	166	86	14
Vectors	17690	0	15958	20718
Coefficients	70529	397292	105371	13523
Total	101988	407062	137794	47528

Table 6. Simulcast coding statistics for Flower Garden. Average bit rate 2.55Mbit/s.