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

Document #504
June 1989

Source : JAPAN
Title : Simulation Results of Reference Model 8

1 Introduction

In this document, simulation results of Reference Model 8 are presented and compared with those of previous Reference Models at higher bit rate.

2 Simulation Results

Table 2 shows the comparison with RM4, RM6 and RM7 at q = 5. The statistics tables at q = 1, 5 and 23 are shown in the Table 3, 4 and 5. And the characteristics of SNR versus bit rate are shown in the Figure 1, 2 and 3.

Figure 4 ~ 13 shows the SNR for luminance and the stability of step sizes for RM7 and RM8 at q=5.

In this simulation, a step size for the first scene is according to Table 1 if not defined in the table 9 of Doc#446(RM7). A buffer size is equal to q × 6.4 kbit refered to p27 of Doc#446(RM7) but if q is not integer (ex. *bit rate = 44 kbps*) then a buffer size is intended as the following formula.

$$\text{buffer size} = \frac{\text{bit rate(kbps)}}{59.4} \times 6.4\text{kbit}$$

Table 1: Step size for the first scene

Video channels q =	1~4	5~17	23
Stepsize	32	16	12

3 Observation

SNR for RM8 is slightly better than SNR for RM7. And a step size for RM8 is stable compared with RM7 in any sequence, since a step size is updated in each group of 11 macro blocks.

Table 2: Comparison with RM4, RM6 and RM7 at q=5

Sequence	MISS AMERICA				SALESMAN			
Frame rate	15 Hz				15 Hz			
Transmission rate	q=5				q=5			
Reference Model	RM4	RM6	RM7	RM8	RM4	RM6	RM7	RM8
RMS of luminance	2.5	2.45	2.46	2.43	3.7	3.40	3.30	3.29
SNR of luminance (dB)	40.2	40.36	40.32	40.41	36.8	37.50	37.76	37.79
Mean value of step size	–	8.34	8.64	8.21	–	8.57	8.94	8.22

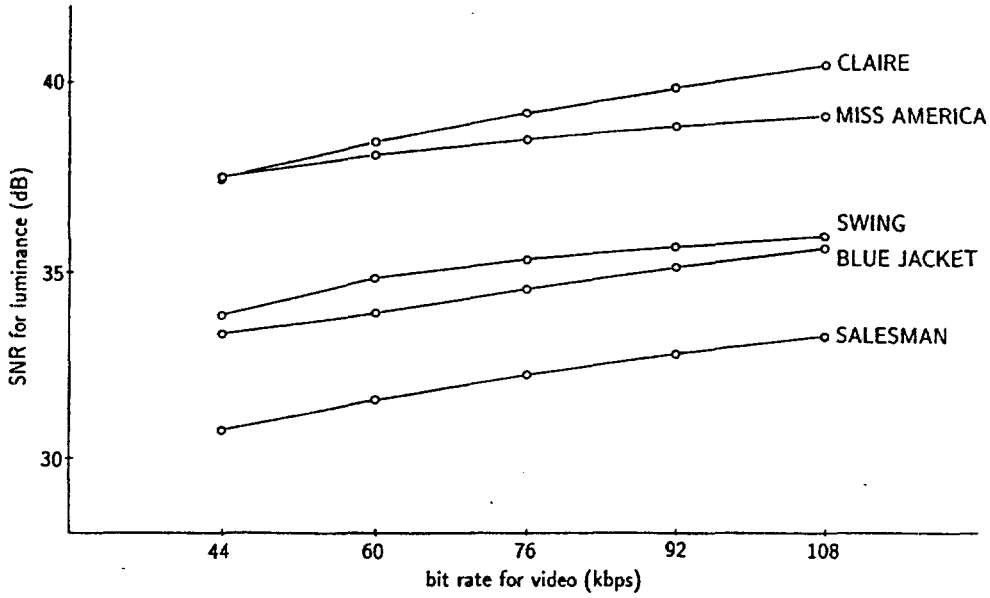

Figure 1: SNR for luminance vs. bit rate, frame rate 10 Hz

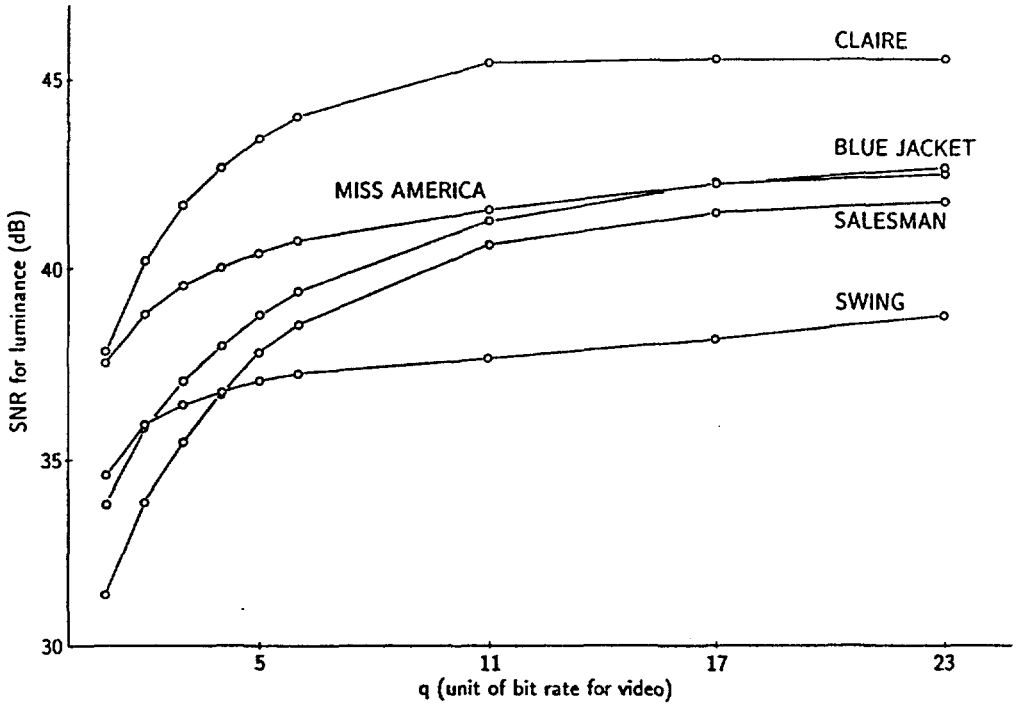

Figure 2: SNR for luminance vs. bit rate, frame rate 15 Hz

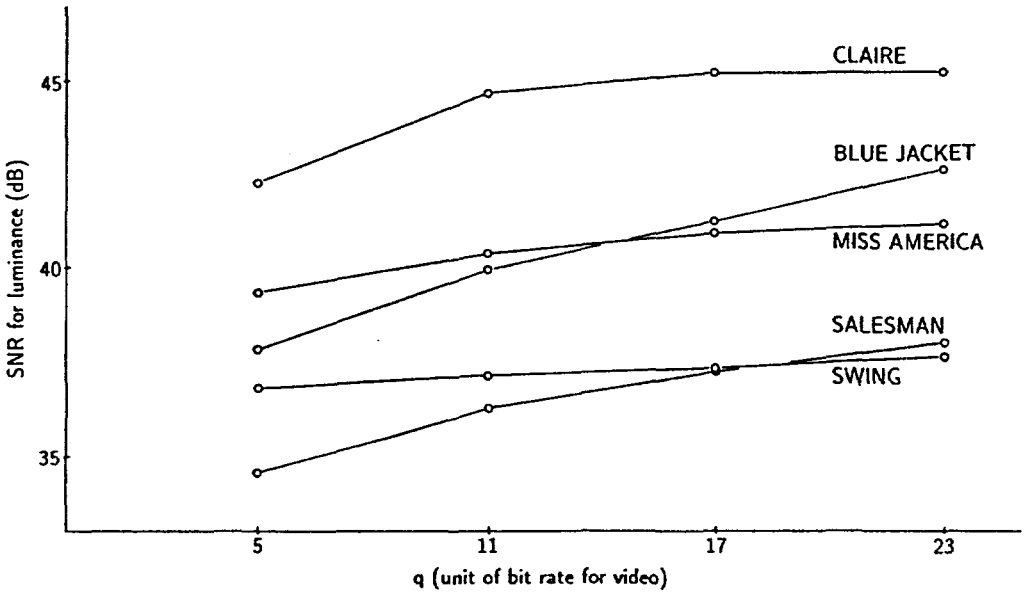

Figure 3: SNR for luminance vs. bit rate, frame rate 30 Hz

Table 3: Simulation Results of RM8 at q=1

Statistics : RM8
Modification :
Bit-rate : q = 1
Institute : G.C.T.
Date : May 12, 1989
Frame-rate : 10 Hz

ITEM		claire	swing	miss	sales	blue
SNR for luminance	Y	38.42	34.85	38.07	31.55	33.91
SNR for chrominance	U	39.03	36.35	37.85	38.60	38.87
	V	42.11	36.91	38.81	39.45	37.64
RMS for luminance	Y	3.06	4.61	3.19	6.75	5.14
RMS for chrominance	U	2.85	3.88	3.27	2.99	2.90
	V	2.00	3.64	2.92	2.72	3.35
Mean value of step size		17.95	15.23	18.10	25.24	21.77
Mean value of number of	Y	3.09	2.22	2.36	2.85	3.84
non-zero coefficients	C	1.56	2.16	1.37	1.22	1.62
	Y and C	2.88	2.23	2.01	2.76	3.33
Mean value of number of	Y	5.73	20.67	3.83	8.87	9.48
zeroes before the last	C	2.57	13.97	2.45	1.59	3.85
non-zero coefficients	Y and C	5.29	19.71	3.33	8.49	8.20
Block type of MACRO	Intra	0	1	0	2	1
	Fixed	276	266	210	270	287
	Fixed MC	6	1	23	6	3
	Coded	67	123	90	83	84
	Coded MC	46	5	73	36	21
Block type of Y	Fixed	1268	1385	1125	1277	1364
	Fixed MC	85	11	256	76	46
	Coded	106	177	76	142	122
	Coded MC	124	12	127	90	53
Block type of C	Fixed	756	752	678	779	740
	Coded	36	40	114	13	52
Number of bits	Macro attr.	710	714	899	699	584
	EOB	533	461	634	499	455
	MV	330	49	593	268	151
	CBP	560	637	890	544	540
	Coeff. Y	3555	3359	2250	3828	3685
	Coeff. U	165	441	327	54	236
	Coeff. V	72	261	309	37	276
	TOTAL	5929	5924	5906	5932	5931

Table 4: Simulation Results of RM8 at q=5

Statistics	: RM8	Institute	: G.C.T.
Modification	:	Date	: May 12, 1989
Bit-rate	: q = 5	Frame-rate	: 15 Hz

ITEM		claire	swing	miss	sales	blue
SNR for luminance	Y	43.43	37.09	40.41	37.79	38.80
SNR for chrominance	U	43.43	40.04	39.62	42.89	41.76
	V	46.08	40.12	41.92	43.84	40.58
RMS for luminance	Y	1.72	3.56	2.43	3.29	2.93
RMS for chrominance	U	1.72	2.54	2.66	1.83	2.08
	V	1.27	2.52	2.04	1.64	2.38
Mean value of step size		6.29	7.79	8.21	8.22	7.96
Mean value of number of	Y	5.05	2.41	3.38	5.31	5.22
non-zero coefficients	C	2.34	2.36	2.32	1.66	1.92
	Y and C	4.40	2.45	2.90	4.79	4.49
Mean value of number of	Y	9.92	35.49	9.84	14.57	12.99
zeroes before the last	C	6.29	13.40	4.69	3.71	6.25
non-zero coefficients	Y and C	9.06	34.17	7.50	13.04	11.49
Block type of MACRO	Intra	0	0	0	1	0
	Fixed	170	121	74	186	169
	Fixed MC	0	1	1	0	0
	Coded	188	267	251	178	209
	Coded MC	38	7	70	31	17
Block type of Y	Fixed	1101	982	1009	1104	1157
	Fixed MC	18	13	95	16	12
	Coded	329	570	289	356	358
	Coded MC	136	18	190	108	57
Block type of C	Fixed	648	747	391	716	674
	Coded	144	45	401	76	118
Number of bits	Macro attr.	1115	1258	1401	1022	1080
	EOB	1217	1267	1759	1081	1067
	MV	203	67	367	176	92
	CBP	1243	1306	2060	1034	1221
	Coeff. Y	13694	14880	9323	15247	12927
	Coeff. U	1205	603	3372	432	409
	Coeff. V	496	346	1345	180	752
	TOTAL	19175	19730	19631	19175	17551

Table 5: Simulation Results of RM8 at q=23

Statistics	RM8	Institute	: G.C.T.
Modification	:	Date	: May 12, 1989
Bit-rate	: q = 23	Frame-rate	: 30 Hz

ITEM		claire	swing	miss	sales	blue
SNR for luminance	Y	45.23	37.63	41.19	38.00	42.63
SNR for chrominance	U	45.21	41.76	40.18	42.80	43.68
	V	47.24	41.85	42.80	43.71	43.10
RMS for luminance	Y	1.40	3.35	2.22	3.21	1.88
RMS for chrominance	U	1.40	2.08	2.50	1.85	1.67
	V	1.11	2.06	1.85	1.66	1.78
Mean value of step size		4.05	5.99	5.88	7.19	4.09
Mean value of number of	Y	5.06	3.57	4.21	5.18	7.22
non-zero coefficients	C	2.23	2.47	3.56	2.30	2.47
	Y and C	4.29	3.55	3.94	4.95	5.91
Mean value of number of	Y	11.06	42.04	31.24	38.48	19.34
zeroes before the last	C	7.39	11.96	8.08	5.48	11.27
non-zero coefficients	Y and C	10.05	40.73	21.84	35.85	17.13
Block type of MACRO	Intra	0	0	0	0	0
	Fixed	103	18	17	82	54
	Fixed MC	0	0	0	0	0
	Coded	272	366	295	271	325
	Coded MC	21	11	84	43	16
Block type of Y	Fixed	1009	456	734	725	853
	Fixed MC	4	13	28	11	3
	Coded	491	1083	512	685	665
	Coded MC	80	32	310	162	63
Block type of C	Fixed	575	736	230	718	517
	Coded	217	55	561	74	274
Number of bits	Macro attr.	1353	1573	1532	1377	1484
	EOB	1575	2340	2766	1843	2005
	MV	92	96	558	214	87
	CBP	1691	1680	2526	1449	1997
	Coeff. Y	17076	38528	26481	39572	35380
	Coeff. U	1733	733	8625	712	1495
	Coeff. V	759	416	2639	233	2709
	TOTAL	24283	45370	45130	45403	45160

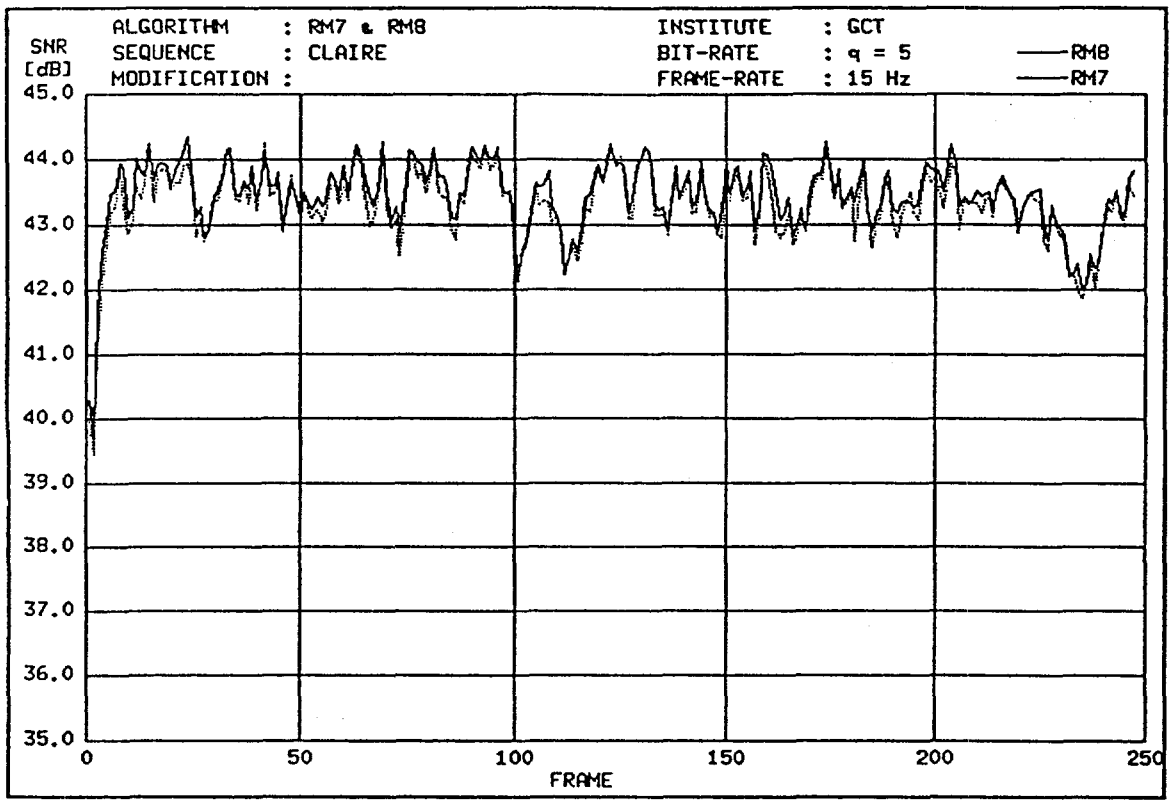

Figure 4: SNR for luminance "CLAIRE at q=5"

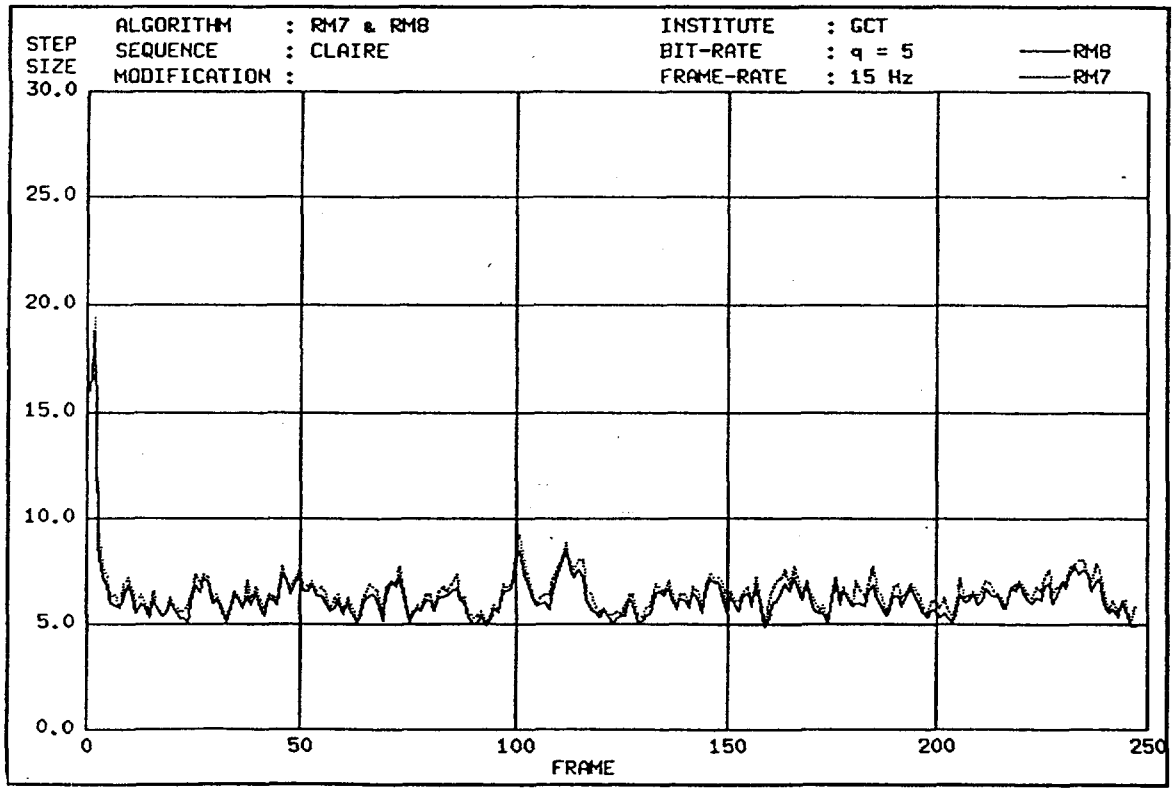

Figure 5: Ups and downs for stepsize "CLAIRE at q=5"

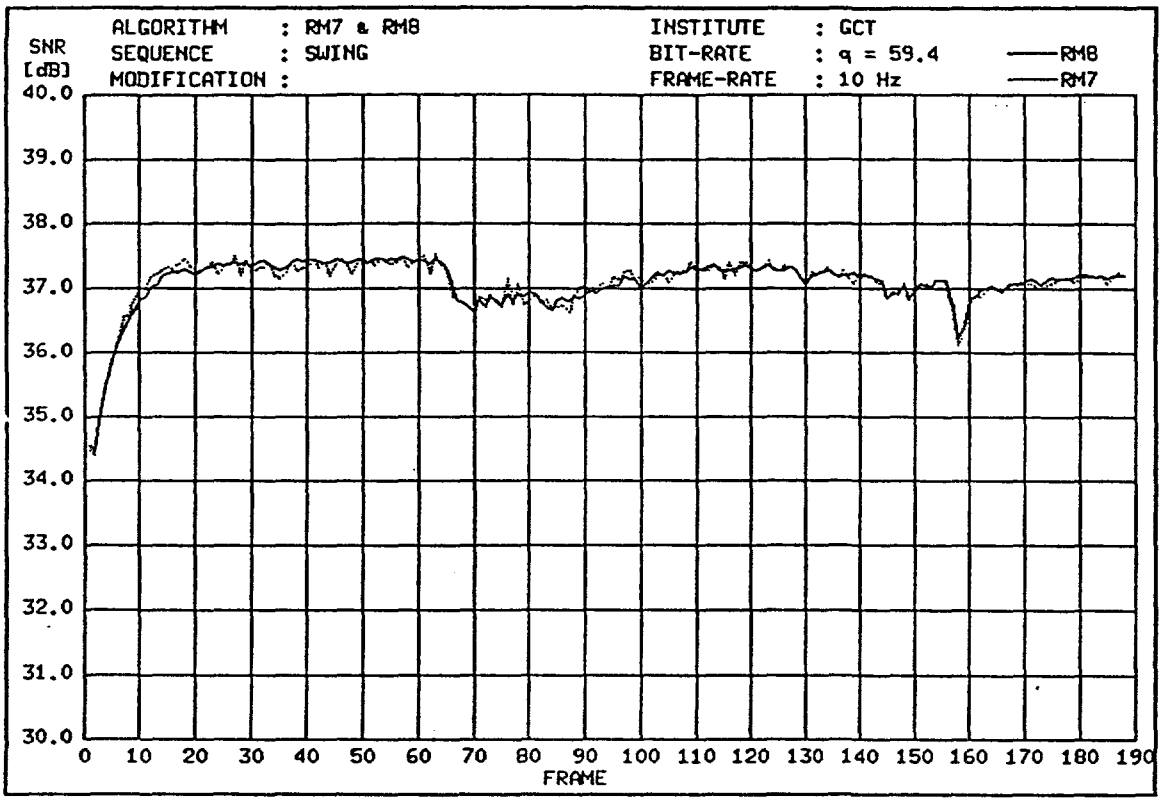

Figure 6: SNR for luminance "SWING at q=5"

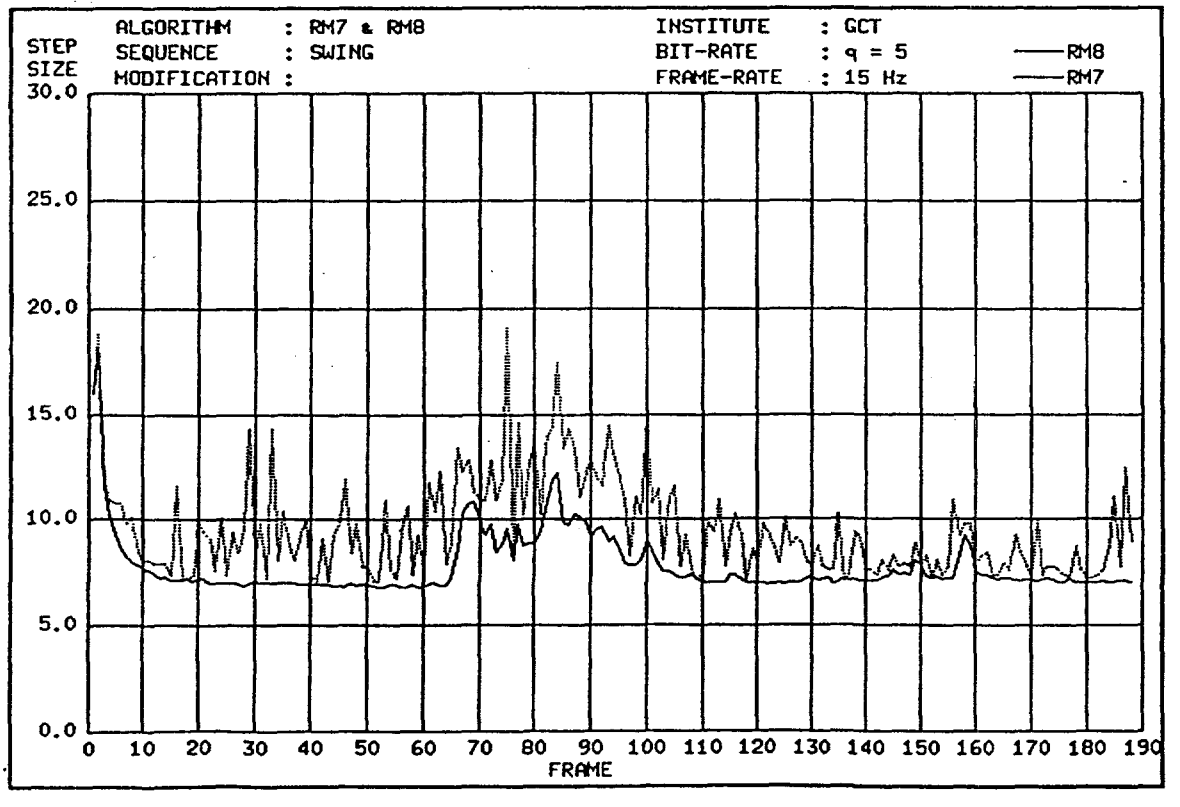

Figure 7: Ups and downs for stepsize "SWING at q=5"

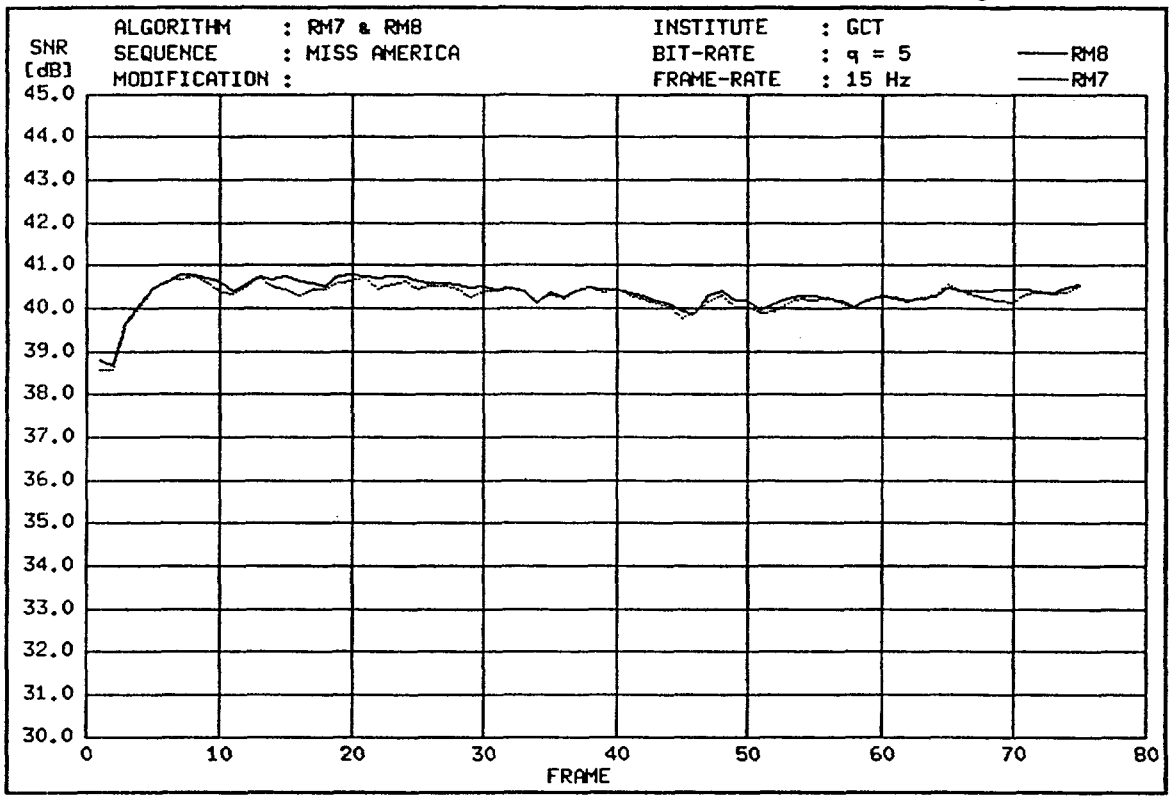

Figure 8: SNR for luminance "MISS AMERICA at q=5"

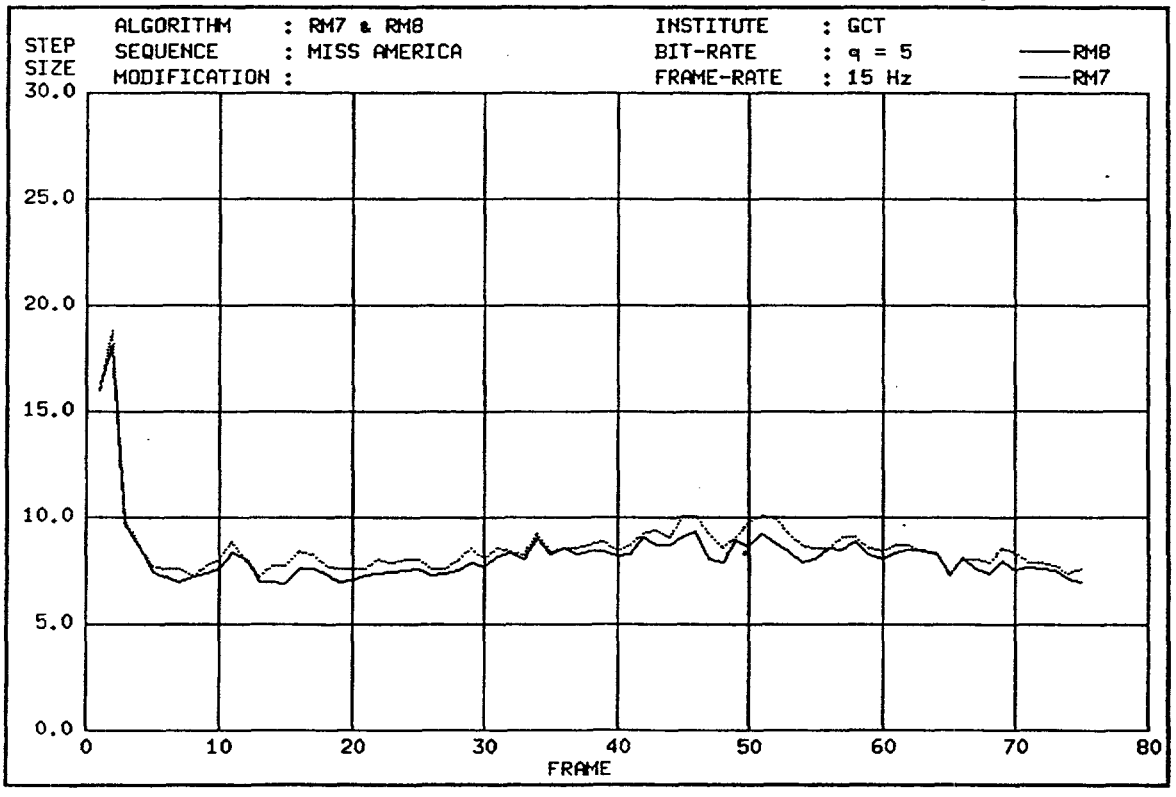

Figure 9: Ups and downs for stepsize "MISS AMERICA at q=5"

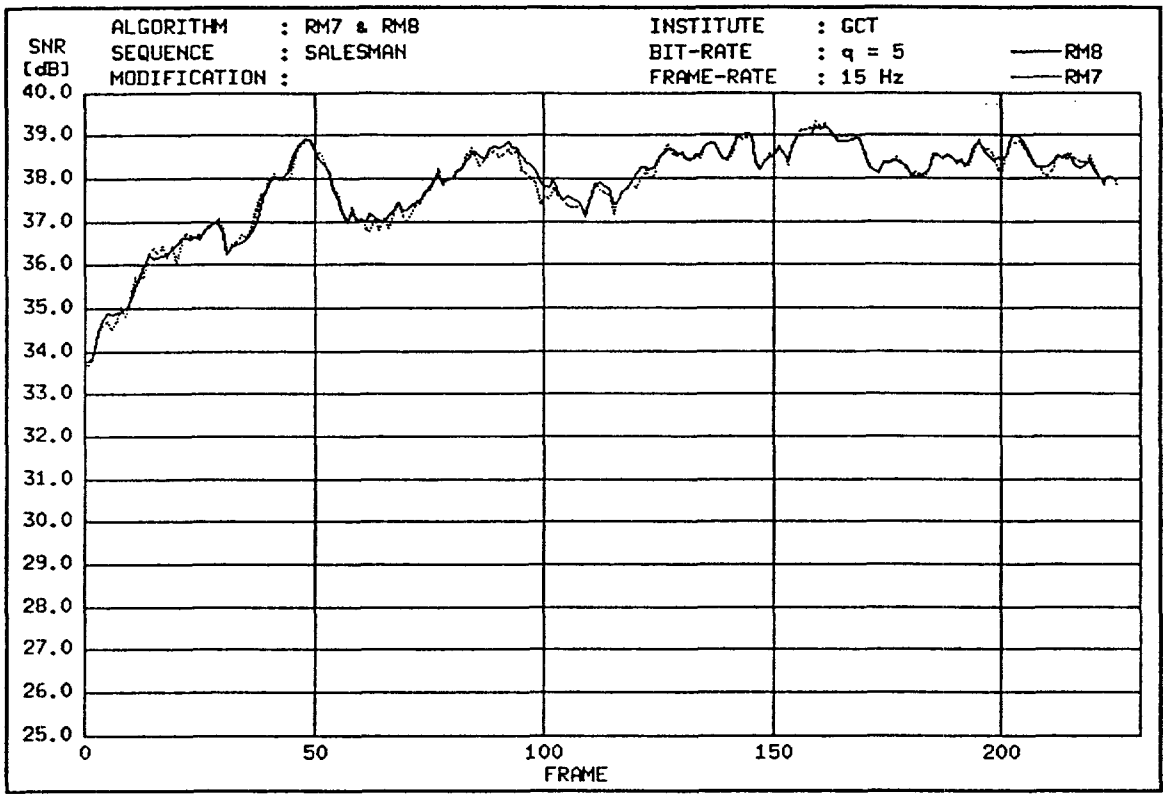

Figure 10: SNR for luminance "SALESMAN at q=5"

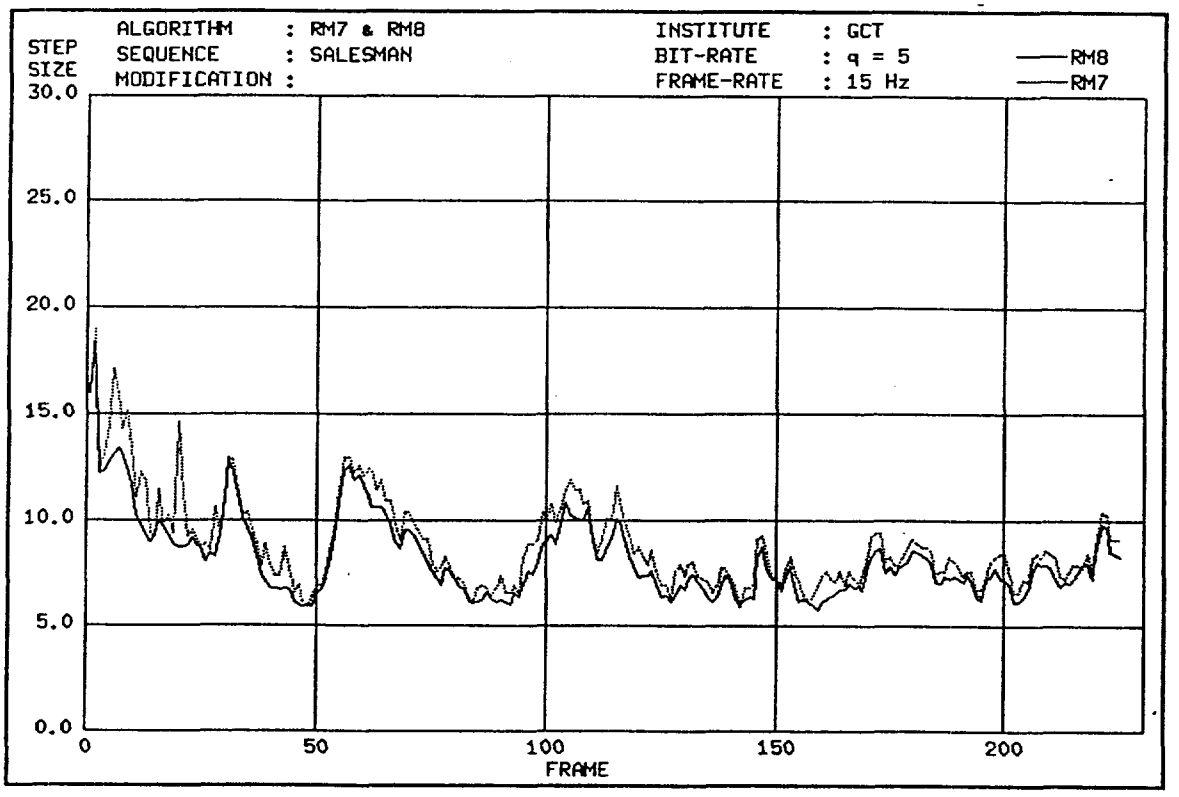

Figure 11: Ups and downs for stepsize "SALESMAN at q=5"

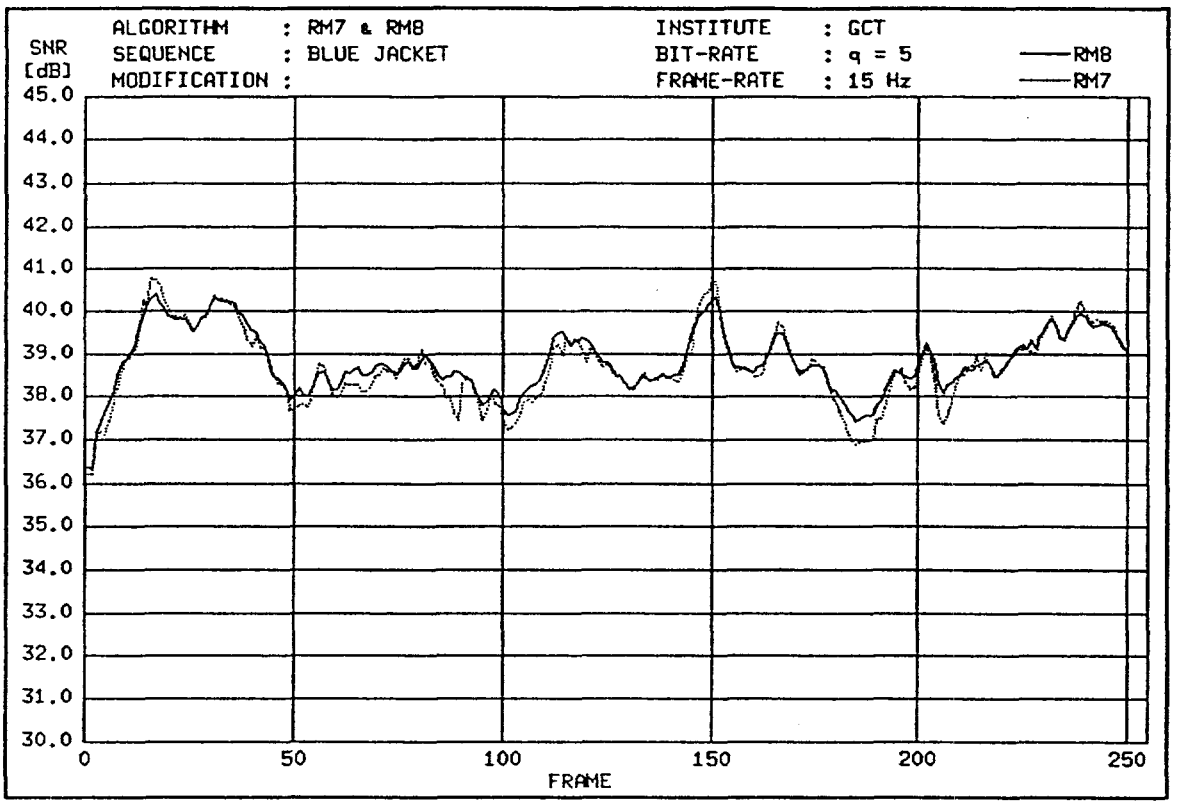

Figure 12: SNR for luminance "BLUE JACKET at q=5"

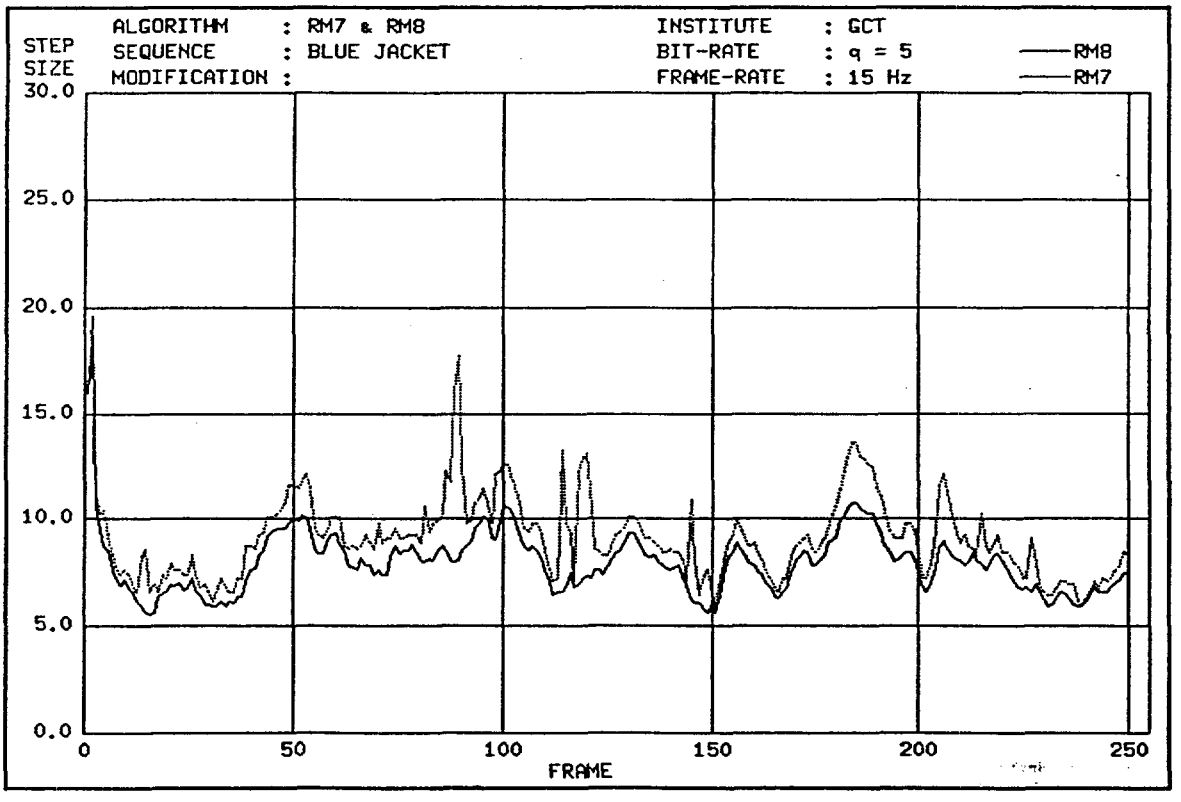

Figure 13: Ups and downs for stepsize "BLUE JACKET at q=5"