CCITT SG XV
Specialists Group on Coding for Visual Telephony

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Title: An optimization of quantizer

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1. Introduction

This document describes the relationship between quantizer thresholds and represented values. Since the level distribution of cosine transform coefficients can be approximated to Laplacian distribution, we know that the represented value which is equal distance from upper and lower thresholds is not optimum. It is suggested that the represented value for the first non zero level have a lower value than the one which is specified for RM4 and the first flexible hardware compatibility check.

2. Method description and simulation results

Figure 1 shows the quantizing characteristics of RM4. As to the first quantizing level, whose input thresholds are represented as point A and point B in the figure, the distribution of input coefficient value is shown in Figure 2. The frequency of small levels is much higher than large levels. Therefore, the represented value which has equal distance from upper and lower thresholds is not optimum.

The following two modified methods are investigated.

(1) Modification 1 (Figure 3):

This has higher threshold for the first quantizing level and has the same represented values. In the simulation,
$A' = A + 0.25g$, where g is step size.

(2) Modification 2 (Figure 4):

This has the same thresholds and has lower represented value for the first represented value. In the simulation three parameters are tested.

Mod 2-1	$R' = R - 0.25g$
Mod 2-2	$R' = R - 0.20g$
Mod 2-3	$R' = R - 0.18g$

The results are summarized in Table 1. Compared with RM4, modification 1 shows no improvement in coding efficiency since coded data increase in the process of coding. Modification 2, on the other hand, displays noticeable improvement. Although Mode 2-3 is calculated as optimum from the distribution itself shown in Figure 2, the lower R' such as Mod 2-1 shows better quality. This may be because that the lower R' has noise reduction effect.

3. Conclusion

It is shown that the lower represented value for the first quantizer level displays better quality than the one which will be used for the first compatibility check. Further optimizations should be sought through hardware experiments.

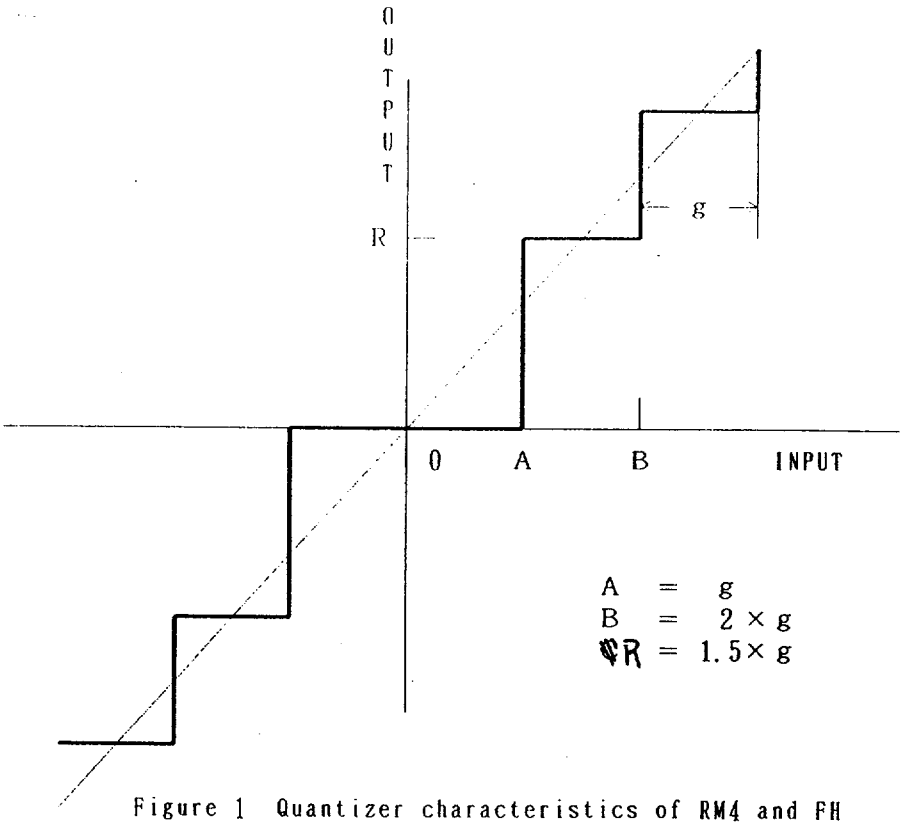

Figure 1 Quantizer characteristics of RM4 and FH for the first compatibility check

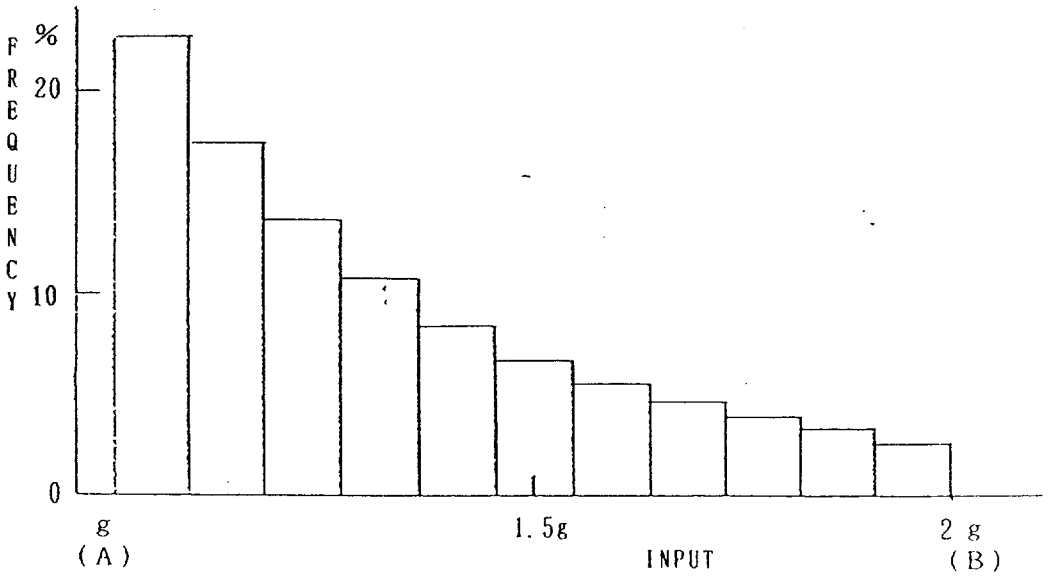

Figure 2 Frequency in the first quantizer level

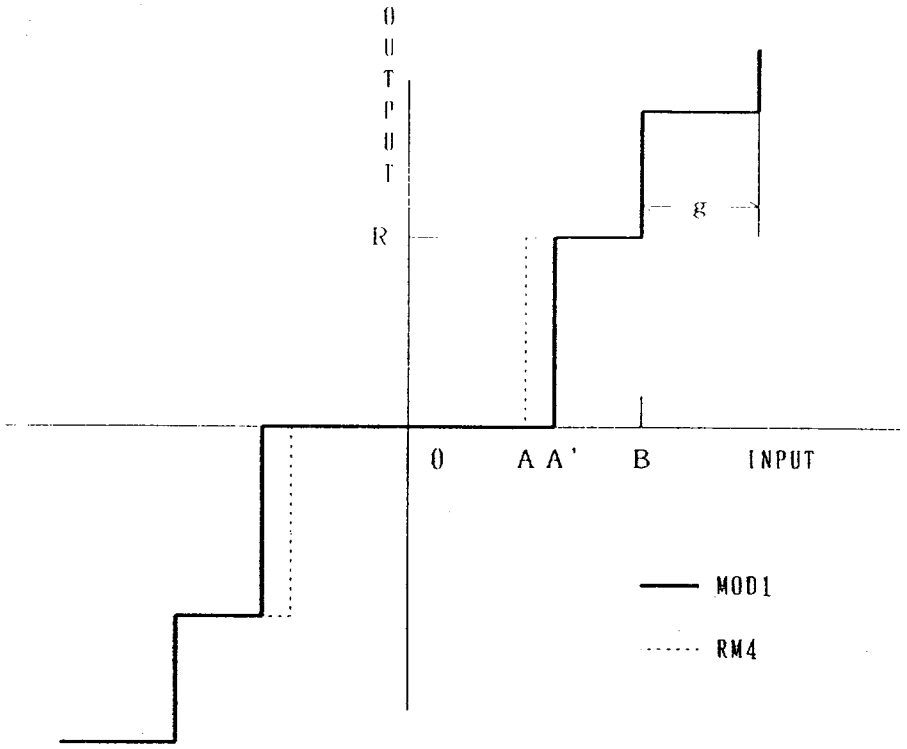

Figure 3 Quantizer characteristics of MOD1 (Modified version 1)

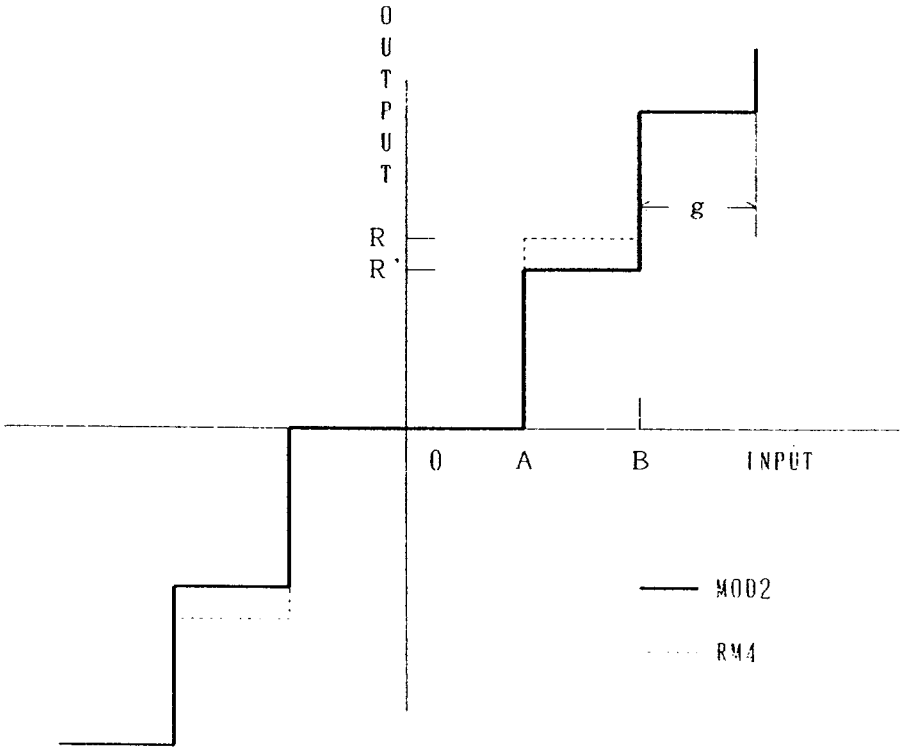

Figure 4 Quantizer characteristics of MOD2 (Modified version 2)

Table 1(a). Simulation results for Sequence: Miss America

Item			RM4	MOD1	MOD2-1	MOD2-2	MOD2-3	
1)R.M.S. for luminance			2.48	2.46	2.44	2.44	2.45	
2)SNR for luminance			40.24	40.32	40.39	40.37	40.35	
3)Mean value of the step size			11.15	9.04	10.90	10.93	10.97	
4)Mean value of the number of non-zero coefficients			2.59	2.60	2.63	2.64	2.63	
5)Mean value of the number of zeroes before the last non-zero coefficient			6.93	6.79	7.02	7.00	7.00	
6) Block type of Y	Fixed		995	1015	1001	1001	1001	
	Intra		1	0	0	0	1	
	Filtered Fixed		81	76	75	77	78	
	Non-filt Fixed MC		55	62	58	57	56	
	Filtered Fixed MC		58	54	51	52	53	
	Non-filt Inter		148	145	156	153	152	
	Filtered Inter		70	61	66	67	67	
	Non-filt Inter MC		85	91	95	94	92	
	Filtered Inter MC		87	75	77	79	81	
	Filtered Block of Luminance		297	268	271	277	280	
7) Block type of C	Fixed		330	359	343	342	338	
	Intra		0	0	0	0	0	
	Filtered Fixed		81	82	79	79	81	
	Non-filt Inter		164	164	172	170	170	
	Filtered Inter		214	184	195	197	200	
	Filtered Block of Chrominance		295	266	274	277	281	
8) Number of bits	Attributes	Y	3029	2959	2998	3000	3001	
		Cr	731	688	707	713	715	
		Cb	1016	991	1000	1000	1009	
		Total	4777	4639	4706	4713	4726	
	Classification indexes		784	750	793	790	788	
	EOB		1544	1451	1531	1530	1531	
	Motion Vectors		2293	2271	2267	2271	2267	
	Coefficients	Y	6337	6629	6499	6469	6458	
		Cr	1466	1503	1463	1472	1461	
		Cb	2685	2634	2616	2631	2645	
		Total	10489	10767	10579	10573	10565	
	Total		19888	19880	19877	19878	19878	
9)Number of coded blocks			772	726	766	765	766	
10)Number of coded coefficients			7384	6856	7429	7409	7413	

Table 1(b). Simulation results for Sequence: Checked Jacket

Item			RM4	MOD1	MOD2-1	MOD2-2	MOD2-3	
1)R.M.S. for luminance			3.10	3.10	2.98	3.01	3.01	
2)SNR for luminance			38.31	38.30	38.64	38.57	38.55	
3)Mean value of the step size			11.63	9.46	11.30	11.33	11.36	
4)Mean value of the number of non-zero coefficients			3.34	3.16	3.40	3.40	3.39	
5)Mean value of the number of zeroes before the last non-zero coefficient			9.08	8.27	8.94	8.98	8.96	
6) Block type of Y	Fixed		953	966	970	968	966	
	Intra		1	1	1	1	1	
	Filtered Fixed		73	57	58	61	61	
	Non-filt Fixed MC		17	20	15	15	15	
	Filtered Fixed MC		14	13	11	12	12	
	Non-filt Inter		331	352	349	344	344	
	Filtered Inter		77	60	61	64	67	
	Non-filt Inter MC		63	66	71	70	68	
	Filtered Inter MC		51	43	43	44	45	
	Filtered Block of Luminance		217	176	175	183	187	
7) Block type of C	Fixed		582	592	587	588	587	
	Intra		0	0	0	0	0	
	Filtered Fixed		38	29	31	33	33	
	Non-filt Inter		136	142	142	138	139	
	Filtered Inter		33	27	29	31	31	
	Filtered Block of Chrominance		72	56	61	65	65	
8) Number of bits	Attributes	Y	3020	2925	2908	2927	2944	
		Cr	475	436	449	458	455	
		Cb	484	444	465	469	466	
		Total	3980	3806	3822	3855	3866	
	Classification indexes		1050	1052	1053	1052	1054	
	EOB		1391	1392	1399	1392	1396	
	Motion Vectors		1171	1155	1141	1139	1142	
	Coefficients	Y	10973	11054	11095	11096	11070	
		Cr	545	590	564	557	564	
		Cb	385	430	399	396	392	
		Total	11905	12074	12059	12050	12027	
	Total		19499	19481	19477	19490	19488	
9)Number of coded blocks			696	696	700	696	698	
10)Number of coded coefficients			8524	7789	8469	8467	8476	

Table 1(c) Simulation results for Sequence: Split-Trevor

Item			RM4	MOD1	MOD2-1	MOD2-2	MOD2-3	
1)R.M.S. for luminance			3.36	3.41	3.30	3.30	3.31	
2)SNR for luminance			37.60	37.47	37.75	37.75	37.73	
3)Mean value of the step size			13.83	11.78	13.66	13.69	13.73	
4)Mean value of the number of non-zero coefficients			4.18	4.00	4.23	4.22	4.22	
5)Mean value of the number of zeroes before the last non-zero coefficient			6.83	6.55	6.80	6.81	6.83	
6) Block type of Y	Fixed		772	798	790	788	785	
	Intra		43	43	43	43	43	
	Filtered Fixed		65	54	52	54	56	
	Non-filt Fixed MC		27	37	30	29	31	
	Filtered Fixed MC		62	66	57	58	57	
	Non-filt Inter		137	134	146	143	143	
	Filtered Inter		52	41	42	45	45	
	Non-filt Inter MC		170	178	186	184	183	
	Filtered Inter MC		251	228	234	235	237	
	Filtered Block of Luminance		433	392	387	394	397	
7) Block type of C	Fixed		567	585	575	574	573	
	Intra		10	10	10	10	10	
	Filtered Fixed		58	51	50	51	52	
	Non-filt Inter		75	79	83	81	81	
	Filtered Inter		80	65	73	74	74	
	Filtered Block of Chrominance		138	116	123	126	127	
8) Number of bits	Attributes	Y	3627	3547	3548	3564	3577	
		Cr	541	516	525	527	529	
		Cb	586	549	568	566	570	
		Total	4756	4614	4643	4658	4677	
	Classification indexes		1311	1254	1305	1304	1305	
	EOB		1644	1564	1637	1637	1637	
	Motion Vectors		4096	4088	4067	4066	4077	
	Coefficients	Y	16200	16506	16334	16322	16292	
		Cr	830	815	832	834	828	
		Cb	873	861	880	877	876	
		Total	17903	18184	18047	18034	17996	
	Total		29711	29705	29701	29702	29694	
9)Number of coded blocks			822	782	819	819	819	
10)Number of coded coefficients			8961	8168	8946	8945	8948	