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Abstract

This document reports the behaviour of using an L1 distance metric during the nearest neighbour search during LoD generation as part of core experiment 13.30 [**?**, N18937].

Introduction

The mandate of the core experiment is to evaluate proposed optimisations to —

- examine the coding efficiency of each proposed method,
- examine the complexity of each proposed method,
- examine the combined effects of all proposed methods.

The purpose of CE13.30 is to track various minor optimisations and to understand their aggregate effect before making a decision on adoption.

The proposed method

The proposed optimisation [1] uses the L1 (Manhattan) distance between points for the purpose of level-of-detail construction in attribute coding. This contrasts to the current G-PCC design that uses L2-squared (Euclidean) distances. The optimisation in effect replaces a per searched point difference multiplication with an absolute value operation.

An implementation has been provided in the `mpeg128/ce13.30/nn-l1-opt` branch of the CE repository. The implementation consists of two parts. First the nearest neighbour search code is refactored to enable separate (local) storage of the metric used for searching and the L2 distances used for weight computation. The second part updates the search metric to L1 from L2-squared.

Results

The performance of the proposed method is assessed according to the common test conditions [2] and compared to the TMC13v8.0 anchor [3] in Table 1.

The increase in runtime can be associated with the refactoring step as shown in Tables 2 and 3. The original input contribution proposed the L1 change based upon changes that are being tested in CE13.6 [4]. It is suggested to re-review the performance the CE13.6 tested proposal is adopted.

Table 1 – Performance of L1 nearest neighbour search compared to TMC13v8.0

		BPP Ratio [%]			BD-Rate [Δ%]						Avg. of ratio maxrssk [%]		Ratio of avg. runtime [%]	
Condition	Class	Geometry	Colour	Refl	D1	D2	Y	Cb	Cr	R	Encoder	Decoder	Encoder	Decoder
C1_ai	cat1-A						1.2	1.0	1.2		100	100	162	174
C1_ai	cat3-fused						−0.2	−0.2	−0.2	−0.3	100	100	125	135
C1_ai	cat3-frame									−0.4	100	100	147	154
C1_ai	overall						1.0	0.9	1.1	−0.4	100	100	155	166
C2_ai	cat1-A				0.0	0.0	0.7	0.6	0.4		100	100	112	163
C2_ai	cat1-B				0.0	0.0					100	100	96	98
C2_ai	cat3-fused				0.0	0.0	0.4	0.1	−0.3	0.0	100	100	110	173
C2_ai	cat3-frame				0.0	0.0				−0.4	100	100	113	154
C2_ai	overall				0.0	0.0	0.7!	0.6!	0.3!	−0.3	100	100	105	131
CW_ai	cat1-A	100.0	100.1								100	100	170	186
CW_ai	cat1-B	100.0									100	100	100	102
CW_ai	cat3-fused	100.0	100.0	100.0							100	100	114	128
CW_ai	cat3-frame	100.0		100.0							100	100	106	110
CW_ai	overall	100.0	100.1!	100.0							100	100	125	132
CY_ai	cat1-A						0.3	0.3	0.3		100	100	174	188
CY_ai	cat3-fused						0.1	0.1	0.1	0.0	100	100	105	107
CY_ai	cat3-frame									−0.1	100	100	126	128
CY_ai	overall						0.3	0.3	0.3	−0.1	100	100	154	164

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 2 – Performance of refactoring compared to TMC13v8.0

		BPP Ratio [%]			BD-Rate [Δ%]						Avg. of ratio maxrssk [%]		Ratio of avg. runtime [%]	
Condition	Class	Geometry	Colour	Refl	D1	D2	Y	Cb	Cr	R	Encoder	Decoder	Encoder	Decoder
C1_ai	cat1-A						0.0	0.0	0.0		100	100	160	170
C1_ai	cat3-fused						0.0	0.0	0.0	0.0	100	100	121	127
C1_ai	cat3-frame									0.0	100	100	144	153
C1_ai	overall						0.0	0.0	0.0	0.0	100	100	152	162
C2_ai	cat1-A				0.0	0.0	0.0	0.0	0.0		100	100	112	163
C2_ai	cat1-B				0.0	0.0					100	100	99	
C2_ai	cat3-fused				0.0	0.0	0.0	0.0	0.0	0.0	100	100	114	164
C2_ai	cat3-frame				0.0	0.0				0.0	100	100	112	151
C2_ai	overall				0.0	0.0	0.0!	0.0!	0.0!	0.0	100	100	106	
CW_ai	cat1-A	100.0	100.0								100	100	167	195
CW_ai	cat1-B	100.0									100	100	97	97
CW_ai	cat3-fused	100.0	100.0	100.0							100	100	96	120
CW_ai	cat3-frame	100.0		100.0							100	100	108	111
CW_ai	overall	100.0	100.0!	100.0							100	100	122	131
CY_ai	cat1-A						0.0	0.0	0.0		100	100	172	185
CY_ai	cat3-fused						0.0	0.0	0.0	0.0	100	100	104	108
CY_ai	cat3-frame									0.0	100	100	123	125
CY_ai	overall						0.0	0.0	0.0	0.0	100	100	152	162

NOTE — Condition CY metrics reported using Hausdorff PSNR.

Table 3 – Performance of L1 nearest neighbour search compared to refactoring

		BPP Ratio [%]			BD-Rate [Δ%]						Avg. of ratio maxrssk [%]		Ratio of avg. runtime [%]	
Condition	Class	Geometry	Colour	Refl	D1	D2	Y	Cb	Cr	R	Encoder	Decoder	Encoder	Decoder
C1_ai	cat1-A						1.2	1.0	1.2		100	100	101	102
C1_ai	cat3-fused						−0.2	−0.2	−0.2	−0.3	100	100	104	106
C1_ai	cat3-frame									−0.4	100	100	102	101
C1_ai	overall						1.0	0.9	1.1	−0.4	100	100	102	102
C2_ai	cat1-A				0.0	0.0	0.7	0.6	0.4		100	100	100	100
C2_ai	cat1-B				0.0	0.0					100	100	97	
C2_ai	cat3-fused				0.0	0.0	0.4	0.1	−0.3	0.0	100	100	96	106
C2_ai	cat3-frame				0.0	0.0				−0.4	100	100	100	102
C2_ai	overall				0.0	0.0	0.7!	0.6!	0.3!	−0.3	100	100	99	
CW_ai	cat1-A	100.0	100.1								100	100	102	96
CW_ai	cat1-B	100.0									100	100	103	106
CW_ai	cat3-fused	100.0	100.0	100.0							100	100	119	107
CW_ai	cat3-frame	100.0		100.0							100	100	98	98
CW_ai	overall	100.0	100.1!	100.0							100	100	103	101
CY_ai	cat1-A						0.3	0.3	0.3		100	100	101	101
CY_ai	cat3-fused						0.1	0.1	0.1	0.0	100	100	101	99
CY_ai	cat3-frame									−0.1	100	100	102	102
CY_ai	overall						0.3	0.3	0.3	−0.1	100	100	101	101

NOTE — Condition CY metrics reported using Hausdorff PSNR.

References

[1] Z. Gao, D. Flynn, A. Tourapis, and K. Mammou, "[G-PCC][New proposal] Using L1 norm for nearest neighbour search in Prediction and Lifting schemes," ISO/IEC JTC1/SC29/WG11, 128th meeting,

Geneva, Tech. Rep. m51011, Oct. 2019.

[2] 3DG, “Common Test Conditions for PCC,” ISO/IEC JTC1/SC29/WG11, 128th meeting, Geneva, Tech. Rep. w18883, Oct. 2019.

[3] ——, “G-PCC performance evaluation and anchor results,” ISO/IEC JTC1/SC29/WG11, 128th meeting, Geneva, Tech. Rep. w18885, Oct. 2019.

[4] ——, “CE4FE 13.6 Attribute LOD generation,” ISO/IEC JTC1/SC29/WG11, 128th meeting, Geneva, Tech. Rep. w18905, Oct. 2019.