

**INTERNATIONAL ORGANISATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC 1/SC 29/WG 4
MPEG VIDEO CODING**

ISO/IEC JTC 1/SC 29/WG 4 m71410
January 2025, Geneva

Title: [VCM][CE6.1] Automatic quality control for ROI-based tools
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Abstract

This documents presents a description of the new encoder-side control mechanism for RoI-based coding tools in VCM. The new proposal allows for gradual disabling/enabling of ROI-based tools, instead of binary on/off scheme. The document also contains the results of the proposed mechanism, which has been tested under CE6 [1].

1. Introduction

In the current implementation of ROI-based tools in VCM-RS, namely ROI-based pre-processing (greying-out) and ROI-based retargeting, it is only possible to binarily turn those tools on or off. There is no possibility to fluently select operational point of the encoder in between of those two modes.

Therefore we propose a new control parameter for VCM-RS encoder, `RoIInflation`, that allows to select operation point gradually between turning RoI-based tools on (`RoIInflation=0percent`) and turning RoI-based tools off (`RoIInflation=100percent`), as well as setting the automatic calculation of RoI inflation. The simpler version of the mechanism has been already introduced in [2].

2. The idea of the control mechanism

The proposed new command-line parameter, `RoIInflation`, allows for “inflation” of the RoI regions. The higher the value of `RoIInflation`, the effect of RoIs is more “inflated”, i.e. the area of each RoI is extended, and the scaling factor for retargeting is diluted. So, more area of less crucial content becomes encoded and the information density within RoIs becomes lower.

In particular, two mechanisms are used:

- **Extension of the RoI areas**

The higher the value of `RoIInflation`, the greater the extension of RoI areas. Asymptotically RoIs extends to cover the whole picture area as a single region.

$$\text{roi_extension [pixels]} = \text{RoIInflation [\%]} \cdot \text{PictureSize [pixels]}$$

where: $\text{PictureSize} = \max(\text{PictureWidth}, \text{PictureHeight})$

For $\text{RoIInflation}=0\text{percent}$, the value of roi_extension is 0 and RoI regions are not changed, effectively turning RoI-based tools entirely on.

For $\text{RoIInflation}=100\text{percent}$, the value of roi_extension is equal to PictureSize ., and each RoI effectively extends to the whole picture area, effectively turning RoI-based tools entirely off.

It is worth noting, that the roi_extension mentioned above is considered beyond any other RoI extension mechanisms already present in the RoI based tools, which remains unchanged.

- **Dilution of scaling_factors for retargeting**

The higher the value of RoIInflation , the more the effective scaling factor (for RoI-based retargeting) of a given RoI becomes closer to 100% (no change of resolution of RoI area).

Asymptotically, scaling factor becomes 100% and effectively retargeting is disabled,

The scaling factor indices are integer numbers from 0 (100%) to 15 (0%), therefore the scaling factor index is processed as follows:

$$\text{dilluted_scaling_factor_index} = \text{scaling_factor_index} \cdot (100\% - \text{RoIInflation} [\%])$$

For $\text{RoIInflation}=0\text{percent}$, the value of $\text{dilluted_scaling_factor_index}$ remains the same as $\text{scaling_factor_index}$, effectively turning RoI-based retargeting entirely on.

For $\text{RoIInflation}=100\text{percent}$, the value of $\text{scaling_factor_index}$ becomes zero, which correspond to scaling factor 100%, effectively turning RoI-based retargeting entirely off.

3. Automatic control of RoI Inflation

The RoIInflation encoder parameter can be also set to “auto” value. If so, the RoI percentage of RoI extension is calculated automatically based on the quality parameter (QP) supplied to the encoder.

For the QP values greater than 20, the RoI inflation value is set to 0. For the QP values below 20, the effective value of RoI inflation is calculated based on the following formula, and rounded to the nearest half:

$$\text{RoIInflation} [\%] = 38.3 - 3.5 \cdot \text{QP} + 0.08 \cdot \text{QP} \cdot \text{QP}$$

So the example effective values of RoIInflation for different QPs are as follows.

Table 1. Example effective values of RoI inflation for different quality settings

QP	14	15	16	17	18	19	20	21	22	23	24
RoI Inflation [%]	5.0	4.0	3.0	2.0	1.0	0.5	0.5	0.0	0.0	0.0	0.0

4. Experimental results

The simpler version of the proposed tool (without “auto” option) has been already described and extensively tested in [2] (for many different constant RoIInflation values). The experiment of to evaluate the operation of the proposed control mechanism in “auto” mode has been performed under CE6 [1].

The results of the proposal with reference to the current anchor [3] are presented in Tables 2. and 3. It can be observed, that the application of the tool in “auto” mode results in more coding gains, than losses.

Because the CE6 has been performed in accordance to the actual CTC [3], the potential of the tool for lower QPs is not tested, nor shown.

Table 2. Results for the object detection task

Object Detection		End-to-End BD-Rate [%]					
		Inner			E2E		
		RA	LD	AI	RA	LD	AI
SFU-HW	Class A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Class B	0.11%	0.10%	0.01%	-0.15%	0.33%	-1.52%
	Class C	-0.05%	-0.04%	0.33%	-0.20%	-0.38%	-0.76%
	Class D	-1.10%	-0.24%	-0.45%	-1.13%	-2.09%	0.53%
	Average	-0.36%	-0.07%	-0.04%	-0.48%	-0.74%	-0.46%
	Class O	0.00%	0.00%	2.10%	0.00%	-0.01%	1.07%

Table 3. Results for the object tracking task

Object Tracking		End-to-End BD-Rate [%]					
		Inner			E2E		
		RA	LD	AI	RA	LD	AI
TVD	TVD-01-1	0.04%	-1.00%	-1.30%	3.51%	2.79%	-6.25%
	TVD-01-2	-9.02%	-4.20%	1.78%	-1.47%	0.19%	-8.95%
	TVD-01-3	0.00%	0.00%	0.00%	0.10%	-0.19%	-12.73%
	TVD-02-1	0.39%	0.96%	0.10%	0.24%	-1.54%	0.00%
	TVD-03-1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	TVD-03-2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	TVD-03-3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Average	-1.23%	-0.61%	0.08%	0.34%	0.18%	-3.99%

5. Recommendations

- Adopt the proposed control parameter in the software VCM-RS
- Enable the RoI inflation mechanism in CTC in automatic mode (`RoIInflation=auto`).

6. Acknowledgement

Thanks to Min Hyuk Jeong (Myongji University) for performing cross-check.

Patent rights declaration(s)

Poznan University of Technology may have patent claims relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms for such patent claims required to implement the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

References

- [1] ISO/IEC JTC 1/SC 29/WG 4, “VCM-CE 6: quality optimization for RoI-based tools”, doc. N0596, November 2024, Kemer.
- [2] Olgierd Stankiewicz, Sławomir Rózek, Sławomir Maćkowiak, Tomasz Grajek, Maciej Wawrzyniak, Jakub Stankowski, Mateusz Lorkiewicz, Marek Domański, “[VCM] Quality control for ROI-based tools”, ISO/IEC JTC 1/SC 29/WG 4 doc. m70248, November 2024, Kemer.
- [3] ISO/IEC JTC 1/SC 29/WG 4, “Common test conditions for video coding for machines”, doc. N0592, November 2024, Kemer.