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Title: [VCM] [CE5.1] Background compression using RoI-based retargeting
Source: Poznan University of Technology
**Olgierd Stankiewicz, Sławomir Rózek, Mateusz Lorkiewicz, Tomasz Grajek,
Sławomir Maćkowiak, Hubert Żabiński, Maciej Wawrzyniak, Jakub Stankowski,
Marek Domański**

Abstract

This documents presents results for CE5.1 experiment, and is a demonstrational evidence that the currently adopted RoI-based retargeting technology can be used for transmission of the background. In the current software model VCM-RS v0.11.1, the background is removed (grayed-out) during RoI-preprocessing step. The tested technology hasn been originally contributed in m70542 [3]

1. The currently adapted strategy

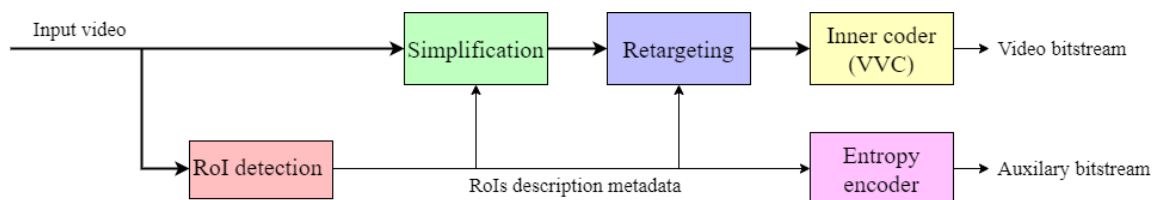


Fig. 1. RoI-based preprocessing and retargeting tool adopted to VCM.

The currently adapted RoI processing framework includes two steps:

- RoI-based preprocessing
 - o The background is blurred
 - o The deep background is grayed out
- RoI-based retargeting
 - o Particular RoI regions are stretched
 - o By default, remaining regions are stretched to zero (RoI scale factor=15)

Table 1. RoI scaling factor meaning.

RoI scaling factor	Downsampling nominator	Downsampling denominator	Approx size [%]
0	1	1	100%
1	31	32	96%
2	15	16	93%
3	7	8	87%
4	6	7	85%
5	5	6	83%
6	4	5	80%
7	3	4	75%
8	2	3	67%
9	1	2	50%
10	2	5	40%
11	1	3	33%
12	1	4	25%
13	1	5	20%
14	1	10	10%
15	0	1	0%

The currently used strategy assumes that the background area (outside of RoI regions specified in the input RoI descriptors) is grayed out and not transmitted. This results in decoded image like presented in Fig.1

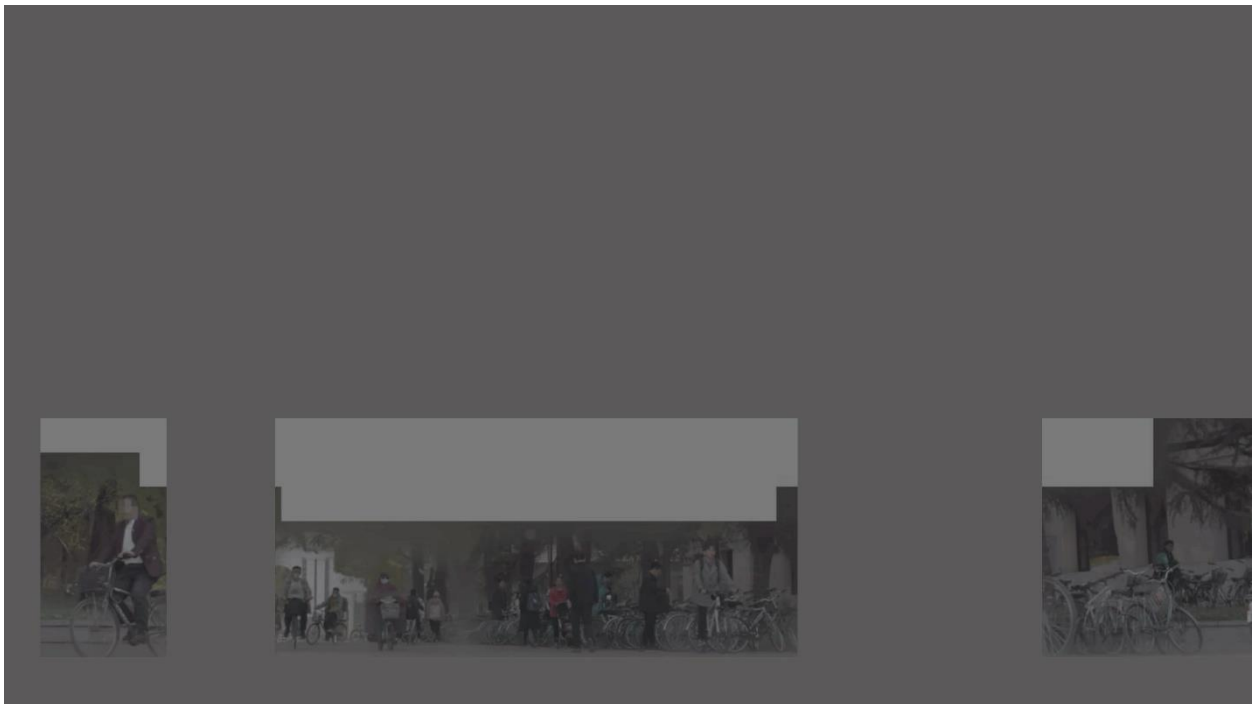


Fig. 1. Example of RoI-preprocessing which grays out the background (light gray - transmitted), and RoI retargeting which stretched the background to zero (dark gray – filled at the decoder).

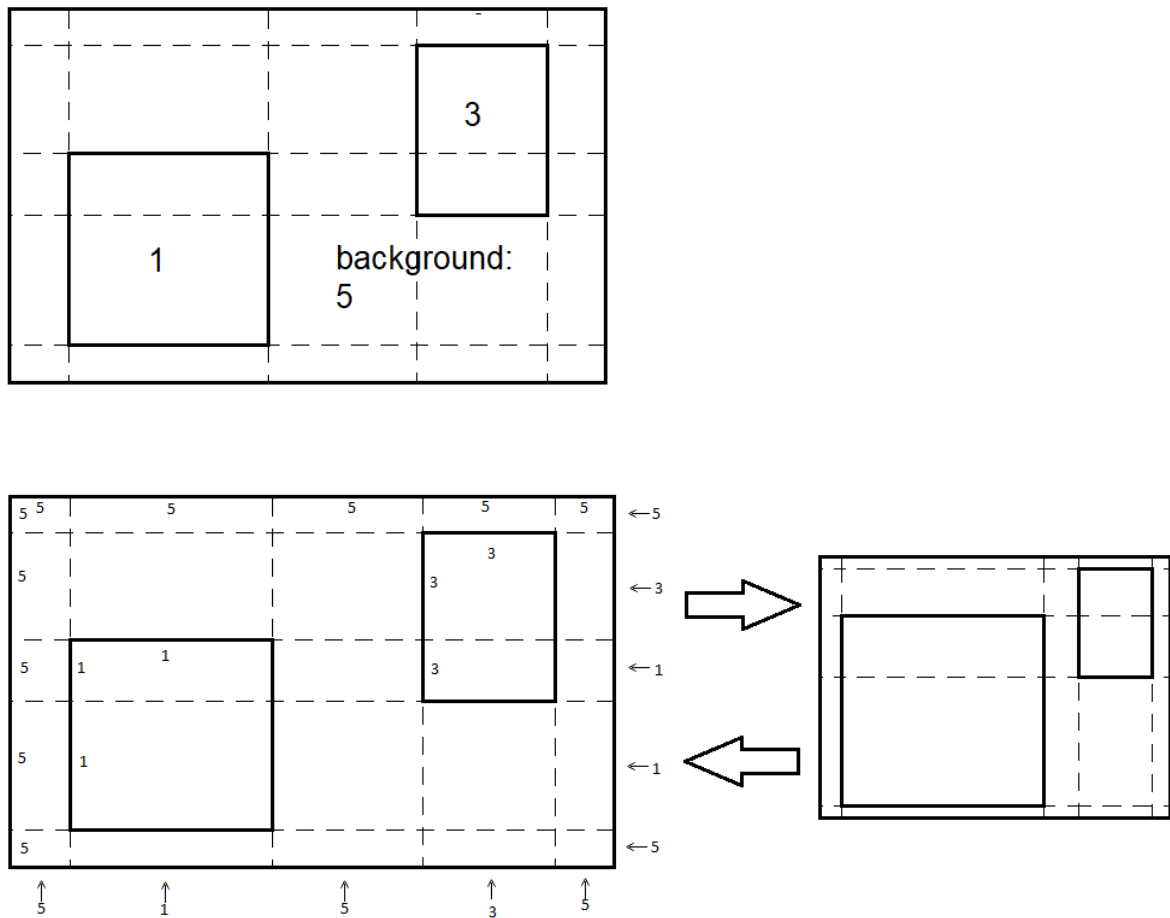
2. Background transmission strategy

The transmission of the background can be done easily without modification of the already existing syntax / without changing of the decoder specification.

The required steps in the encoder are:

- Not employing graying out of the background
- Adding additional RoI to RoI list, which would cover the whole area of Picture, with selected RoI scale factor (different than 15)

The scheme (as an idea) has been already presented in the original contributions [1] and [2], (Fig. 2), where background is assigned e.g. RoI scale factor 5, instead of 15.



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Fig. 2. Assignment of RoI scale 5 to the background, thanks to which the background is not stretched to zero.

To allow the abovementioned functionality we made the following simple modifications to the encoder in VCM-RS software (encode software only):

- Additional command-line parameter –RoIBackgroundBandwidth
 - o Bandwidth of background to remain after preprocessing step, normalized to range 0...1
 - o Default in VCMRS v0.11.1: RoIBackgroundBandwidth=0.001
 - o Setting RoIBackgroundBandwidth=0 ideally would mean transmitting only DC component. Practically, all values below 0.0001 are interpreted as DC-only.
 - o Setting RoIBackgroundBandwidth=1 means no filtration at all.
- Modification of background filter code, to avoid aliasing
 - o Previously filtered background was practically non-existent in the encoded image, because either it was:
 - Grayed out
 - Covered with actual RoIs

Therefore a simple scheme for reduction of computational complexity was used, where the background was first decimated without filtering (aliasing!) and then low-pass filtered
In the improved version, the background is filtered with full resolution.
- Additional command-line parameter –RoIRetargetingBackgroundScale
 - o Scale factor index to be assigned to background area (see Table 1)
 - o Default in VCMRS v0.11.1: RoIRetargetingBackgroundScale=15, meaning that the background is stretched to zero. Note: no additional RoI region coordinates are transmitted in that case.
 - o RoIRetargetingBackgroundScale<15: Additional RoI region is inserted that covers the entire picture. The background areas are stretched accordingly



Fig. 3. Example of background transmission - PartyScene



Fig. 4. Example of background transmission – Traffic

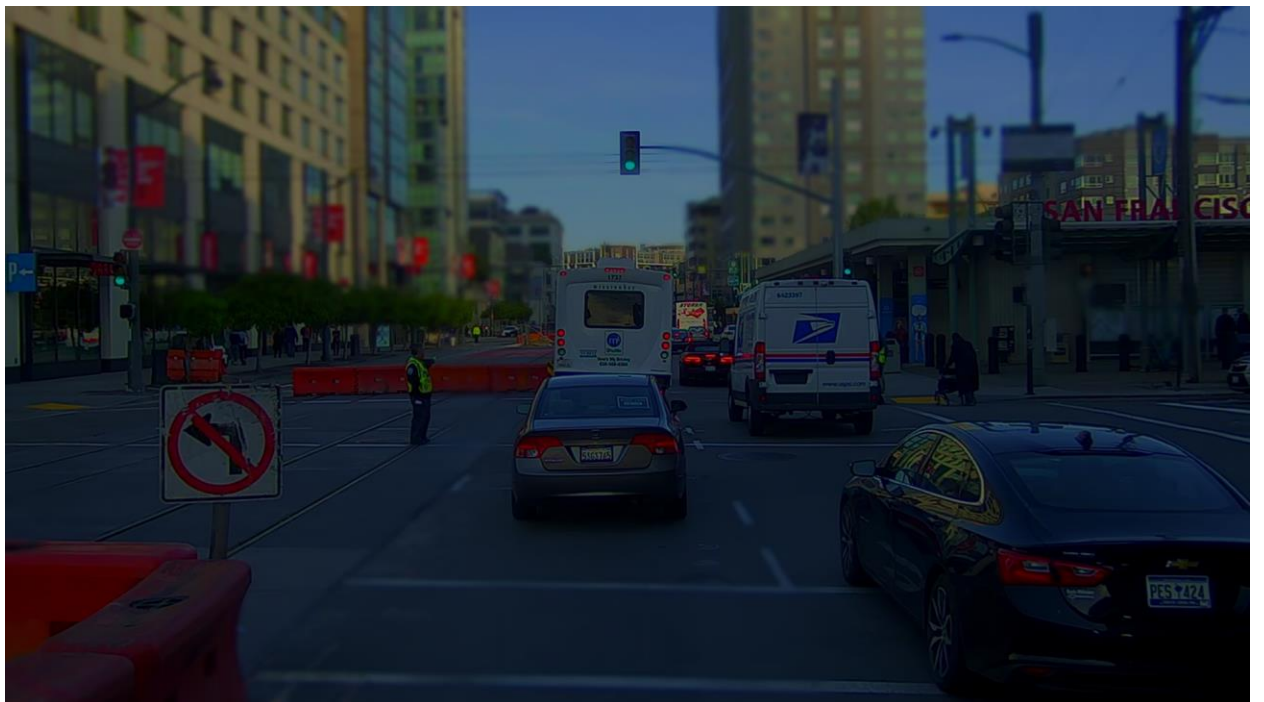


Fig. 5. Example of background transmission – Panda 005

3. Experiments

The experiments have been performed in accordance to CTC.

We have internally tested various pairs of RoIBackgroundBandwidth and RoIRetargetingBackgroundScale:

- RoIBackgroundBandwidth = 0.001, RoIRetargetingBackgroundScale=15
- RoIBackgroundBandwidth = 0.05, RoIRetargetingBackgroundScale=14
- RoIBackgroundBandwidth = 0.10, RoIRetargetingBackgroundScale=13
- RoIBackgroundBandwidth = 0.20, RoIRetargetingBackgroundScale=12
- RoIBackgroundBandwidth = 0.25, RoIRetargetingBackgroundScale=11

Basing on the results, we have selected the best performing scenario which is:

- RoIBackgroundBandwidth=0.10, corresponding to low-pass filtering at 10% of bandwidth for Background
- RoIRetargetingBackgroundScale=13, corresponding to 20% of retargeted bandwidth for Background

Such setting satisfied anti-aliasing requirements coming from the sampling theorem.

The results are provided in XLS file, It can be noted that:

- There are significant gains up to 50% in the case of Panda dataset, and even higher.
- In most of the cases, comparison through BD-Rates is not possible due to lack of overlapping
- In the case of TVD and SFU there are losses, due to redundant transmission of background which is not needed for evaluation.

4. Summary and recommendations

Summary:

- Background transmission can be done without need for normative changes
- Addition of command-line parameters is needed in the encoder in VCM-RS software

Recommendations:

- Adopt the additional command-line parameters to VCM-RS software
- Discuss understanding of VCM requirements, and whether CTC should include:
 - graying out of the background (beneficial for bandwidth) or
 - preserving the background (beneficial for quality).
- Employ the proposed settings to Panda dataset in CTC

6. References

[1] Sławomir Rózek, Olgierd Stankiewicz, Sławomir Maćkowiak, Tomasz Grajek, Maciej Wawrzyniak, Jakub Stankowski, Mateusz Lorkiewicz, Dominik Cywiński, Jakub Szekielda, Marek Domański "[VCM] Improved RoI preprocessing and retargeting for VCM" ISO/IEC JTC 1/SC 29/WG 4 m66523

Online – January 2024

[2] Sławomir Rózek, Olgierd Stankiewicz, Sławomir Maćkowiak, Tomasz Grajek, Maciej Wawrzyniak, Jakub Stankowski, Mateusz Lorkiewicz, Dominik Cywiński, Jakub Szekielda, Marek Domański "

"[VCM] CE1-related: Improved RoI retargeting for VCM with optimized scaling factors" ISO/IEC JTC 1/SC 29/WG 4 m66988 Rennes – April 2024

[3] Olgierd Stankiewicz, Sławomir Rózek, Mateusz Lorkiewicz, Tomasz Grajek, Sławomir Maćkowiak, Maciej Wawrzyniak, Jakub Stankowski, Marek Domański "[VCM] Background transmission using RoI-based retargeting", ISO/IEC JTC 1/SC 29/WG 4 m70542, Kemer. October 2024.

Patent rights declaration(s)

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