Spatio-Temporal Activity based Tiling for Panorama Streaming

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Outline

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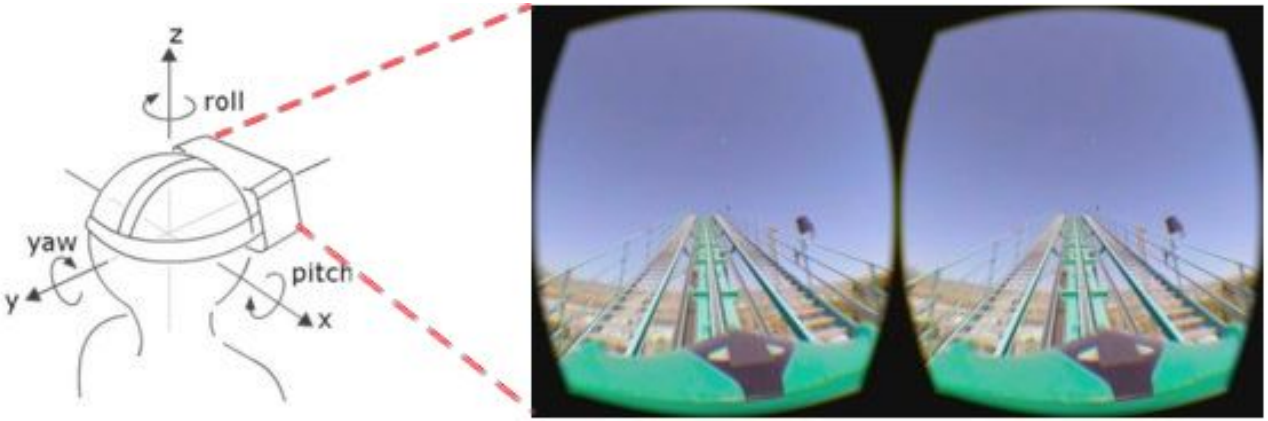
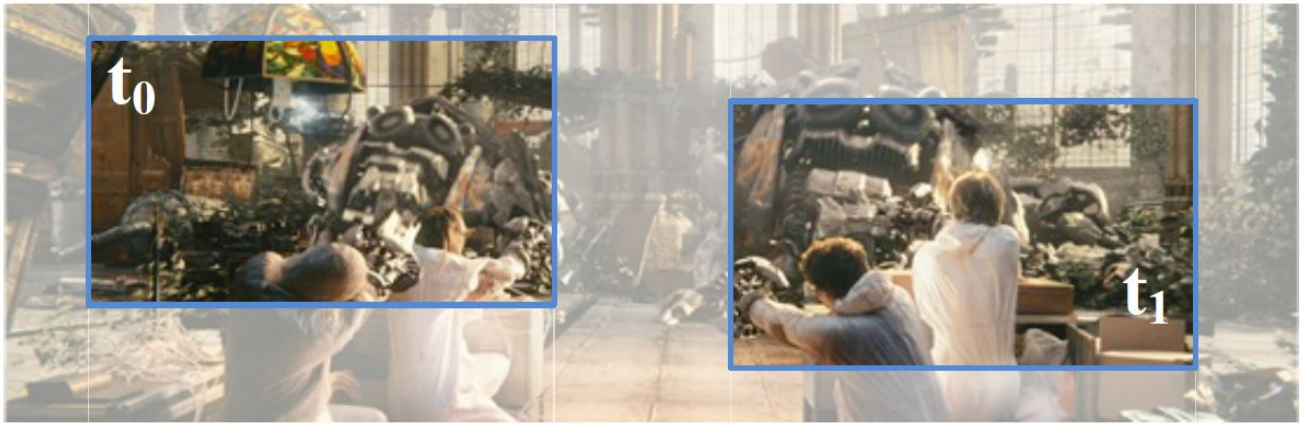
Motivation

- In panorama streaming, users can navigate the high-resolution videos with an arbitrary Region-of-Interest (RoI)
- Transmitting the whole video is unfeasible
- Tile-based panoramic streaming overcomes the mentioned drawbacks



To be solved...

- Tile based panoramic streaming allows users to receive a set of tiles that match their RoI instead of the whole video
- How to derive from the video content the optimal tile size in a low complexity manner



Related work

- Brute force approach [1]
- High computational complexity
- Pixel overhead & bitrate per pixel (bpp)

$$BR(t_w, t_h) = RoI_{size} * \eta(t_w, t_h) * \varphi(t_w, t_h) \qquad (1)$$

with η being:

$$\eta(t_w, t_h) = \frac{(r_w + t_w - 1) * (r_h + t_h - 1)}{RoI_{size}} \qquad (2)$$

[1] A. Mavlankar, B. Girod, “Spatial-Random-Access-Enabled Video Coding for Interactive Virtual Pan/Tilt/Zoom Functionality”, IEEE Transactions on Circuits and Systems for Video Technology (CSVT), Vol.21, No. 5, May 2011.

Spatial-temporal activity metrics

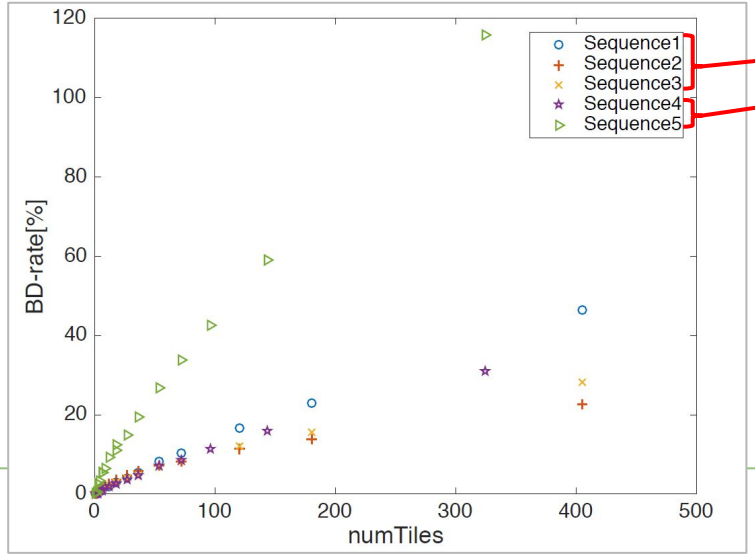
- Based on aforementioned method,

$$\left(t_w^{opt}, t_h^{opt}\right) = \arg \min_{(t_w, t_h)} \eta(t_w, t_h) * \left(1 + BD(t_w, t_h)\right) \quad (5)$$

- Pixel overhead is easy to be computed and does not depend on the content
- Bjøntegaard-Delta bitrate (BD-rate) measurement method
  - For the same PSNR, and
  - Negative values tell how much lower the bitrate is reduced (coding efficiency is increased), and positive values tell how much the bitrate is increased (coding efficiency is reduced)

Spatial-temporal activity metrics (cont.)

- For a high number of tiles the BD-rate can vary from around 20% to around 120%
- The test conditions used by JCT-VC during standardization



Num. tiles	Tile sizes for 6912x1920	Tile sizes for 6912x1532
2	3456x1920	3456x1536
4	3456x960	3456x768
3	2304x1920	2304x1536
6	2304x960	2304x768
9	2304x640	2304x512
6	1152x1920	1152x1536
12	1152x960	1152x768
18	1152x640	1152x512
18	768x960	768x768
27	768x640	768x512
54	768x320	768x256
36	576x640	576x512
72	576x320	576x256
120/96*	576x192	576x192
180/144*	384x192	384x192
405/314*	256x128	256x128

*different number of tiles for the different resolution videos

Spatial-temporal activity metrics (cont.)

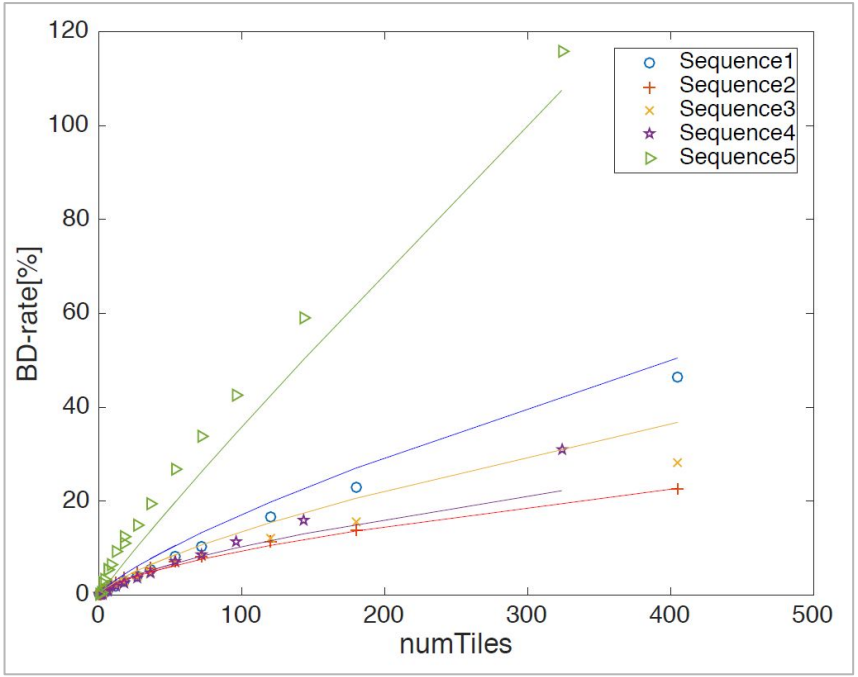
- Based on [2] and [3], it can derive the equation below,

$$BD_{model}(t_w, t_h) = \frac{1}{0.82+1.5*SA^{-0.05}*TA^{-0.04}} * (N_{tiles}(t_w, t_h) - 1)^{\frac{1}{0.32*SA^{0.33}*TA^{0.11}}} \quad (10)$$

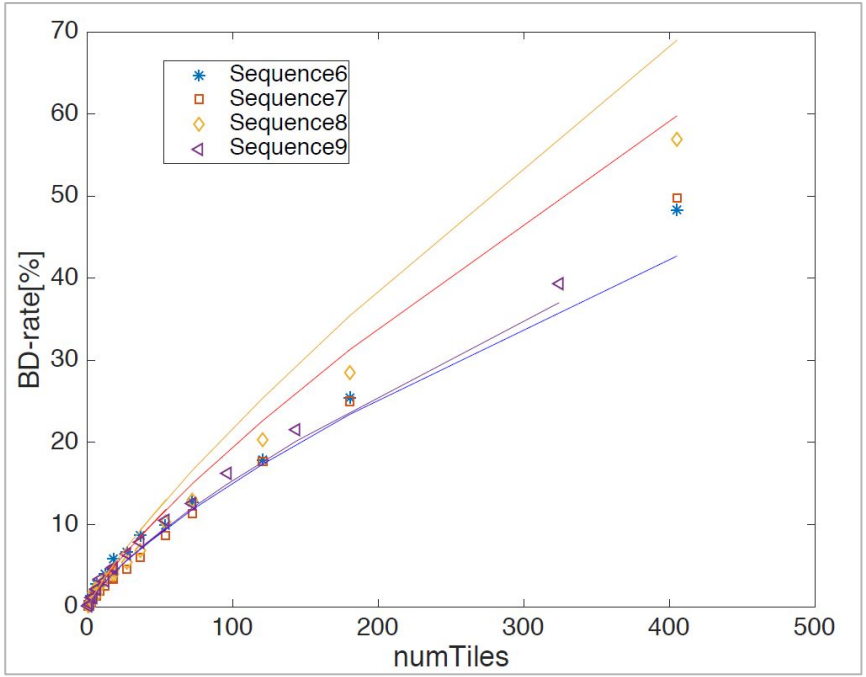
$$BD_{model}(t_w, t_h) = \quad (10)$$
$$= \frac{1}{0.82+1.5*SA^{-0.05}*TA^{-0.04}} * (N_{tiles}(t_w, t_h) - 1)^{\frac{1}{0.32*SA^{0.33}*TA^{0.11}}}$$

Spatial-temporal activity metrics (cont.)

- The presented model for each sequence as well as the actual BD-rate values



Training sequences



Testing sequences

Validations

- Real -> the actual BD-rate values measured for tiled encodings
- Model -> the predict values measured by the proposed model

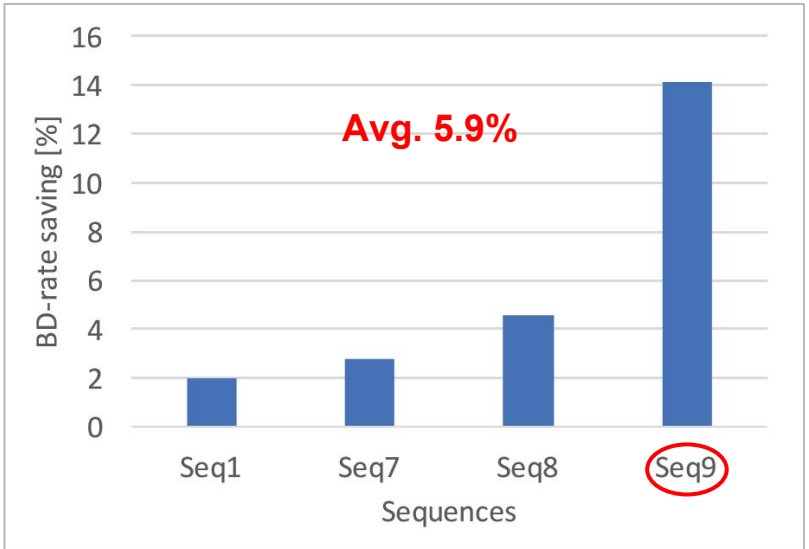
Table 4: Optimal size using the real BD-rate and the model in Eq. 10

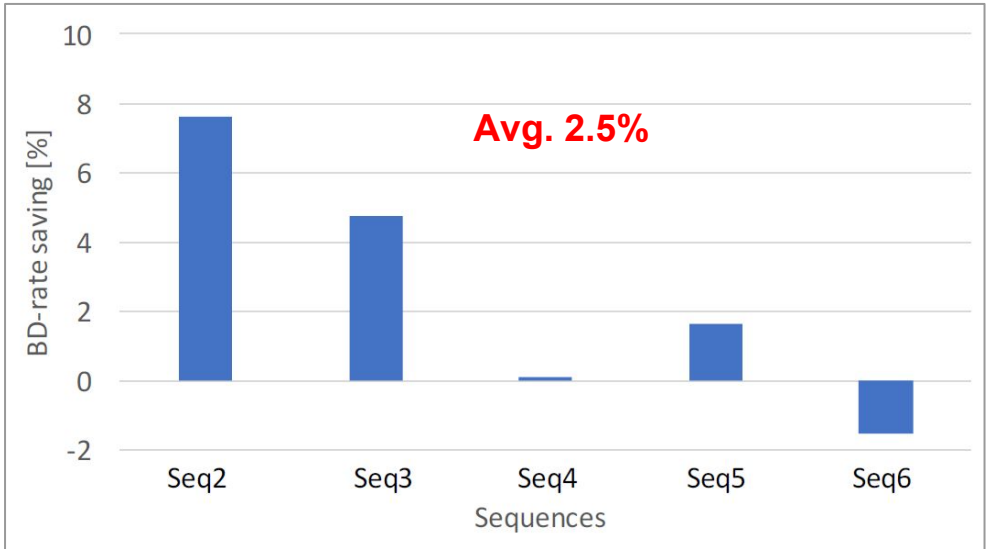
	Real	Model
Seq1	384x192	384x192
Seq2	256x128	256x128
Seq3	256x128	256x128
Seq4	256x128	256x128
Seq5	576x192	576x192
Seq6	384x192	256x128*
Seq7	384x192	384x192
Seq8	384x192	384x192
Seq9	256x128	256x128

*different result when using the model

Validations (cont.)

- The most occurring tile sizes among the 9 sequences is 384x192 and 256x128
- It computes the BD-rate savings in comparison to having a static configuration





Conclusion

- On average gains of 5.9% are achieved as tile size is 256x128
- On average gains of 2.5% are achieved as tile size is 384x192

- They proposed an optimization process, which has a low complexity compared to performing encodings for each tiling variant, in order to minimize the transmitted bitrate of the RoI content

Q & A