

How to measure the relevance of a retargeting approach?

ECCV'10, Greece, 10 September 2010



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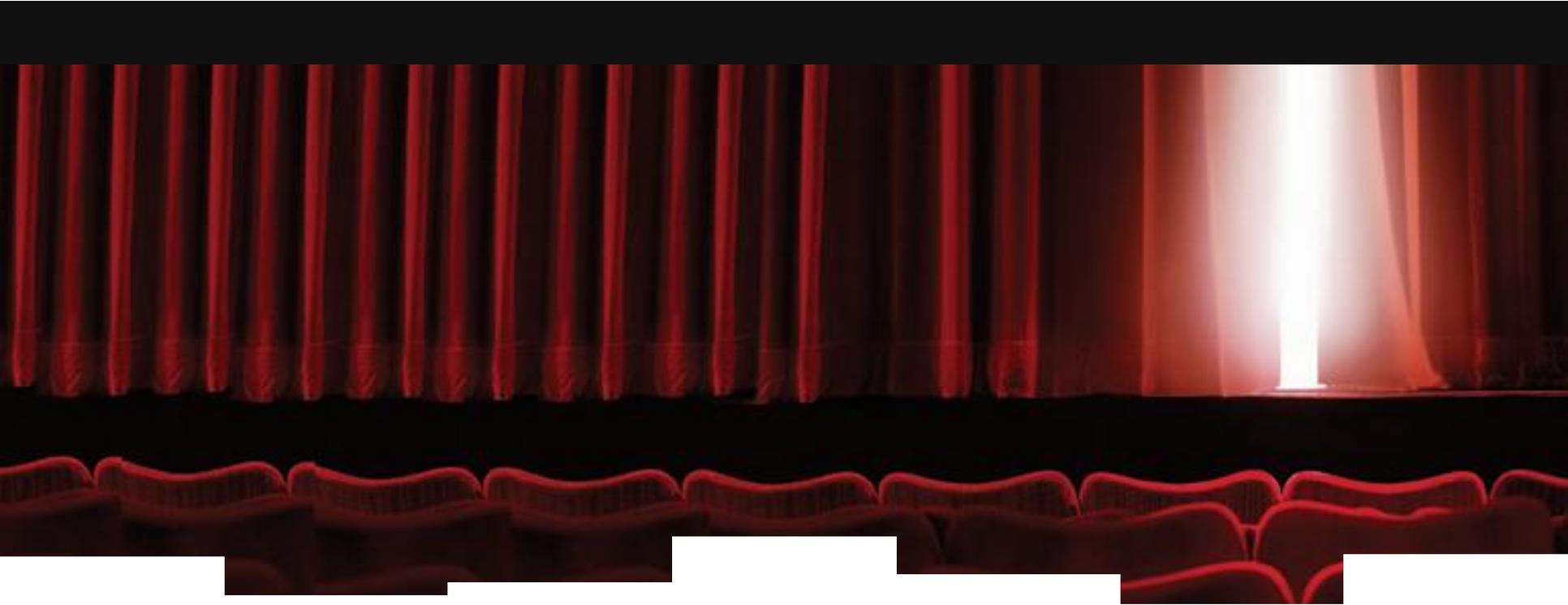
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Content

- Introduction
- Retargeting relevant factors
- Proposed metric
- Validation
- Conclusion & Perspectives

Introduction



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Context

Retargeting for small screen devices in mobile/broadcast applications

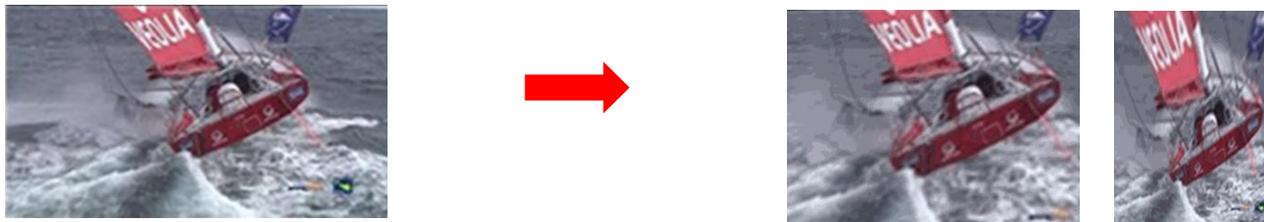


State of the Art: Uniform Transform

Linear transform: Sub-sampling, pillar-box, letter-box

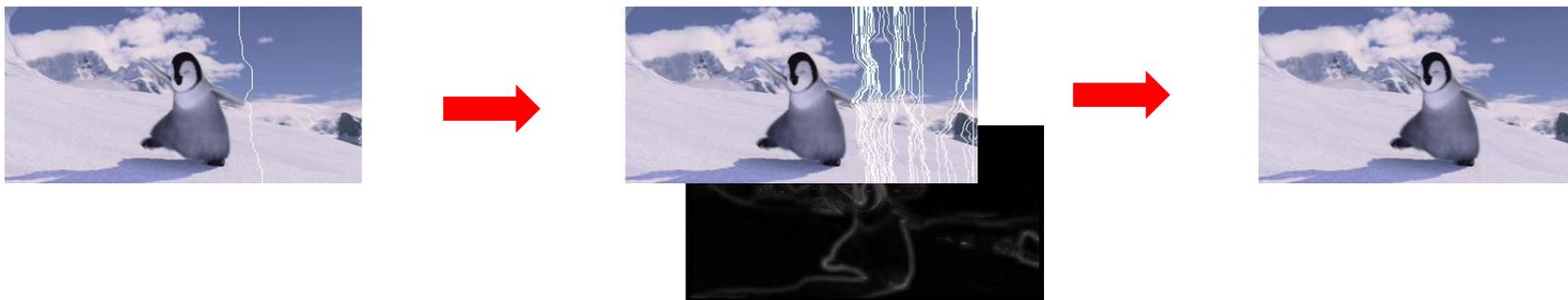


Non-linear transform: Scaling, Warping, Anamorphic

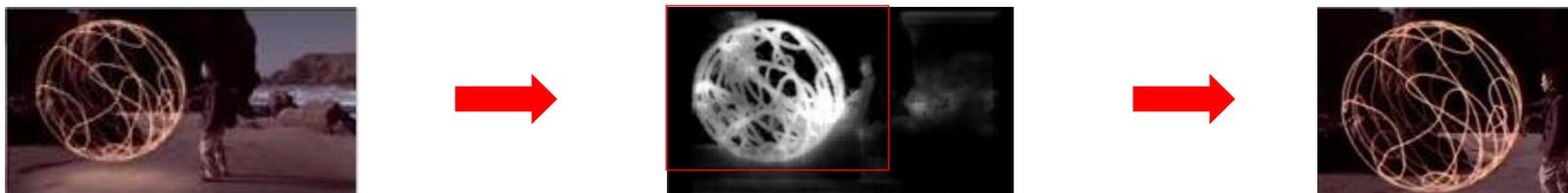


State of the Art: Content Aware Reframing

Seam Carving



Adaptive Cropping



Constrained Approaches

- Shape/Structure preserving approaches
- Energy based deformations
- Region-based adaptive warping/sampling

Mixed

- Crop, scaling and warp/seam carving approaches

Some examples (Images)

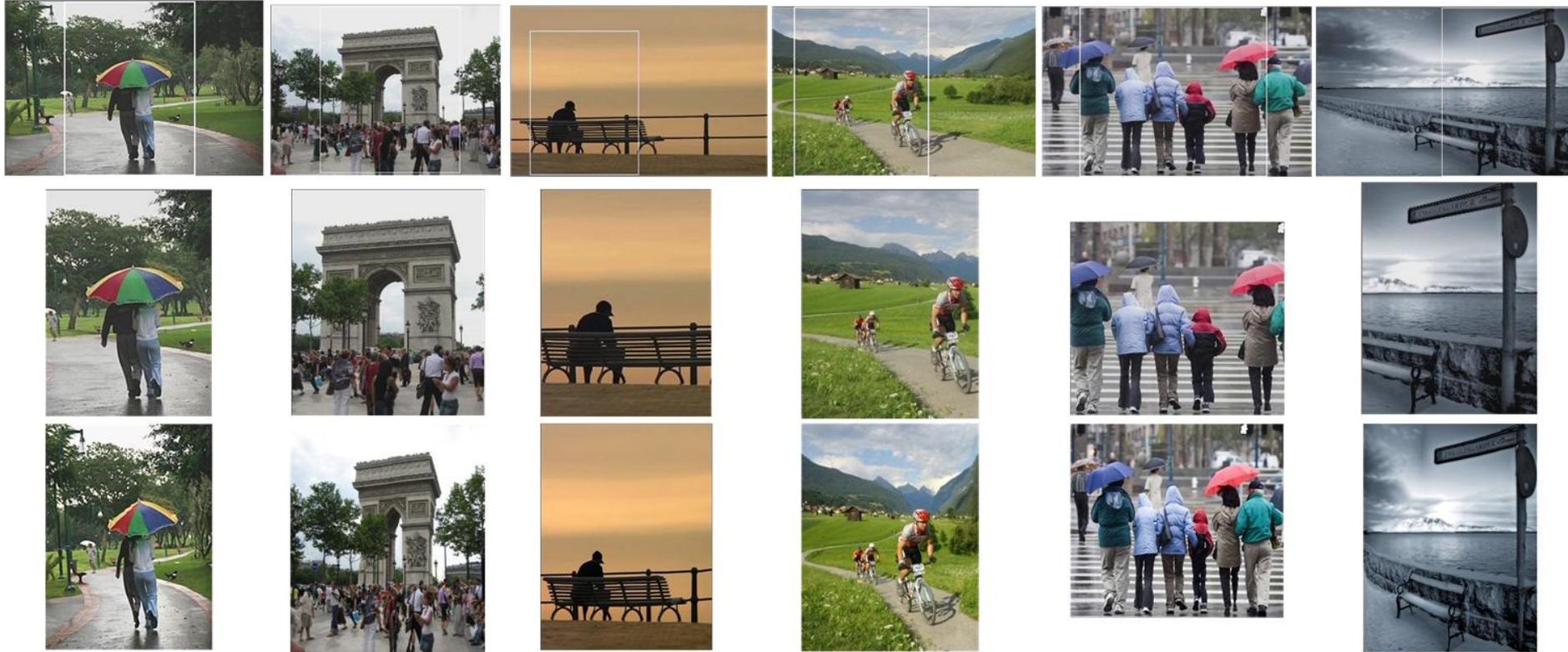
Original + window

Adaptive
Cropping

Seam
Carving

Adaptive Cropping (Chamaret C., Le Meur O., ICPR 2008)

Seam Carving (Avidan S., Shamir A., SIGGRAPH 2007)



Some examples (Video)

Original + window

Down-sampling

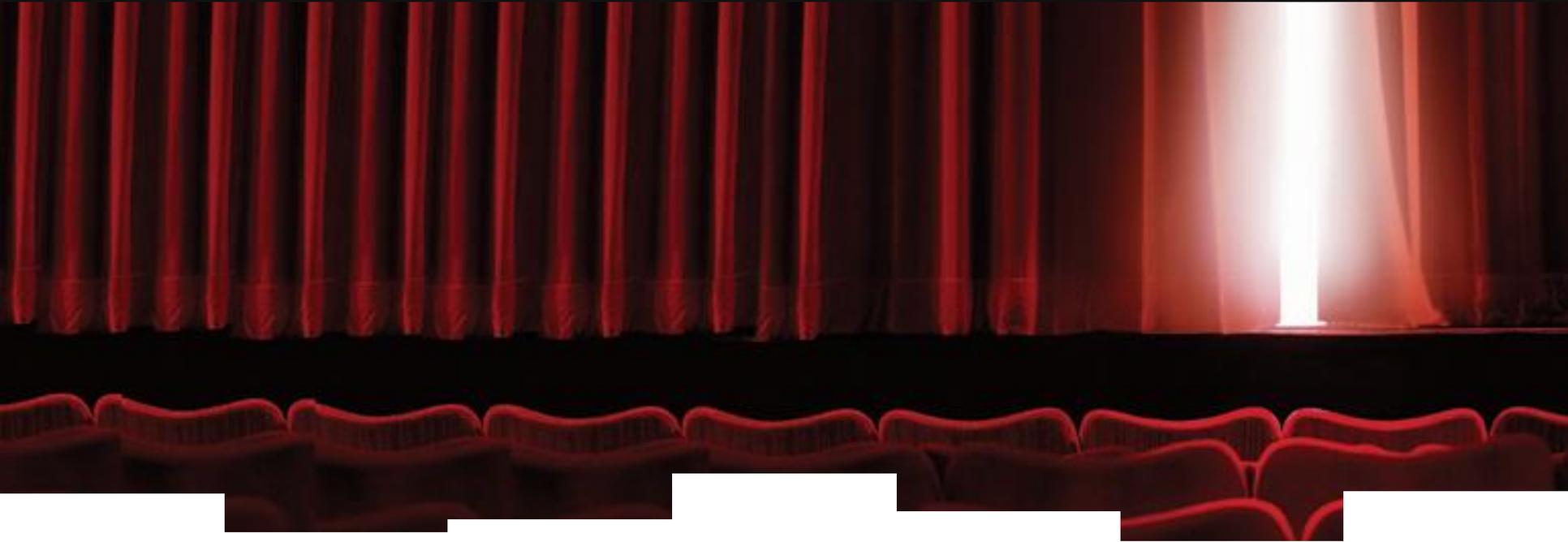
Reframing

Linear Transform (Sub-sampling)

Adaptive Cropping (Chamaret C., Le Meur O., ICPR 2008)



Factors Impacting the Reframing Efficiency

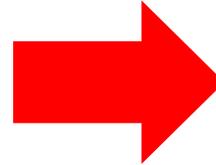


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Scene consistency

- Objects shape
- Distance between objects
- Aspect ratio
- Image Distortion



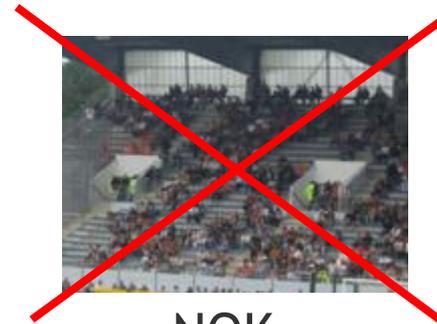
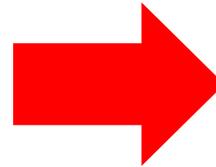
NOK



OK

Spatial consistency

- Keep relevant information in the final image
- But zooming for improved comfort



NOK



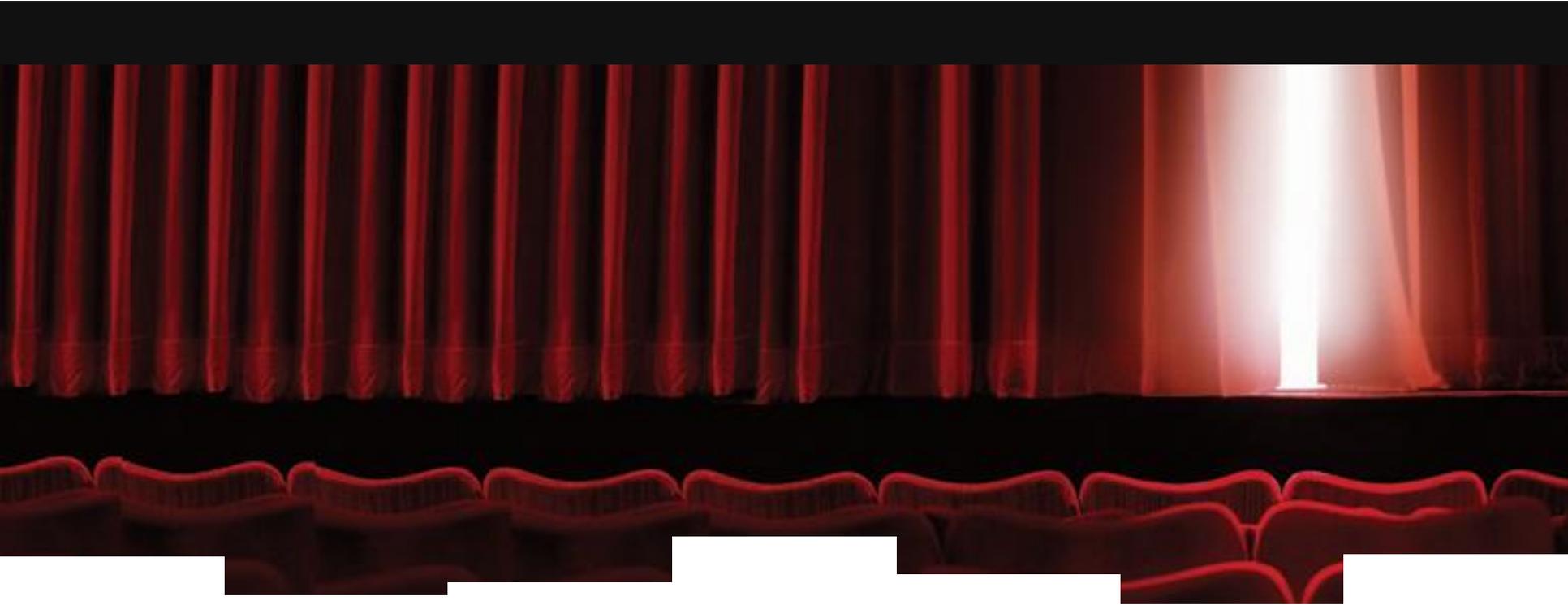
OK

Temporal consistency & stability

- Temporal consistency between frames to prevent visual annoyances
 - Consistent for frame to frame
 - Simulate shooting & camera motion
 - Manage scene cuts



Proposed Assessment Metric



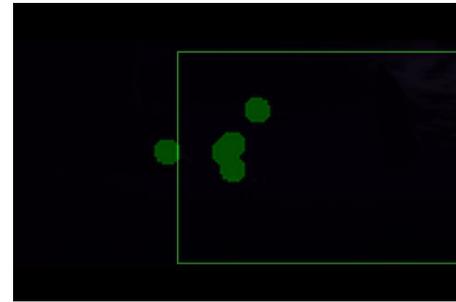
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Definition

Based on the use of eye-tracking data

- Real users, content dependent
- Compare computed cropping window (CW or BB) to observers fixation points (FP)



Taking into account...

- Scene consistency
- Spatial consistency
- Temporal consistency and stability (natural motion)
- Comfort (Zoom)

Definition

Quality computation

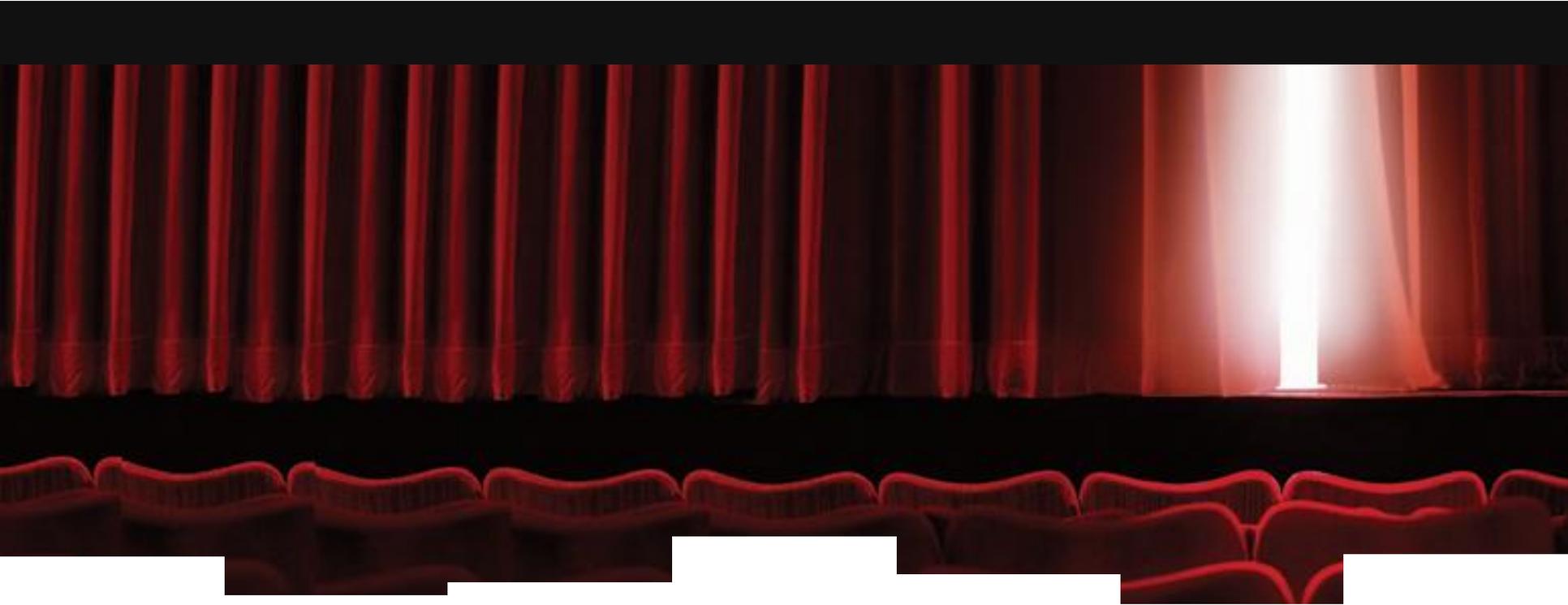
$$Q = f \left(p_f(t) \times \frac{100}{100 + coh_c(t)^\gamma} \times \frac{100}{100 + coh_z(t)^\beta} \times \frac{100}{100 + g(z(t), z_{opt}(t))^\alpha} \right)$$

- P_f : preservation of visually important areas (% of FP inside BB)
- Coh_c : temporal variations of the reframing (bounding box)
- Coh_z : temporal variations of the coverage ratio (zoom)
- g .: distance between current coverage (z) and optimal coverage ratio (z_{opt})
- f .: pooling function
- a, B, γ : coefficients

Limitations

- Image distortions are not taken into account
 - *could be done through P_f*
- The position of the window compared to the scene content is not taken into account
- Z_{opt} is fixed
- The different factors functions are probably too simple

Validation



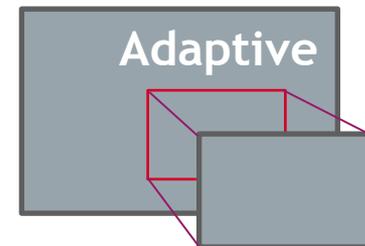
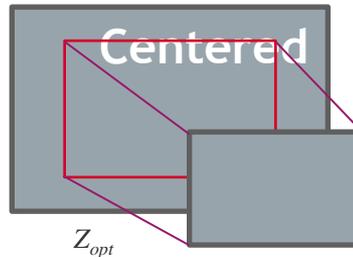
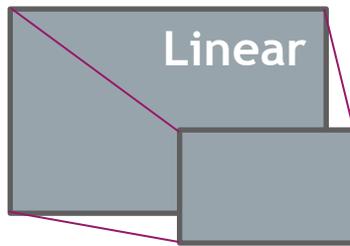
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Context (1/3)

Retargeting Algorithms

- Linear distortion
- Centered cropping
- Adaptive reframing based on RoI (Chamaret C., Le Meur O., ICPR 2008)
 - *With and without temporal stability processing*



with and w/o temporal filtering

Context (2/3)

Video Sequences

- Format: IN: 720x480 OUT: 360x240
- 4 sequences: Movie, Cartoon1, Cartoon2, Sports



Clip	Number of observers	Spatial resolution	Length (frames)	Type
Movie	16	720 × 480	1000	Trailer (action)
Cartoon1	16	720 × 480	1200	Trailer (cartoon)
Cartoon2	16	720 × 480	2000	Trailer (cartoon)
Sports	16	720 × 480	2000	basketball, soccer, cycling...

Context (3/3)

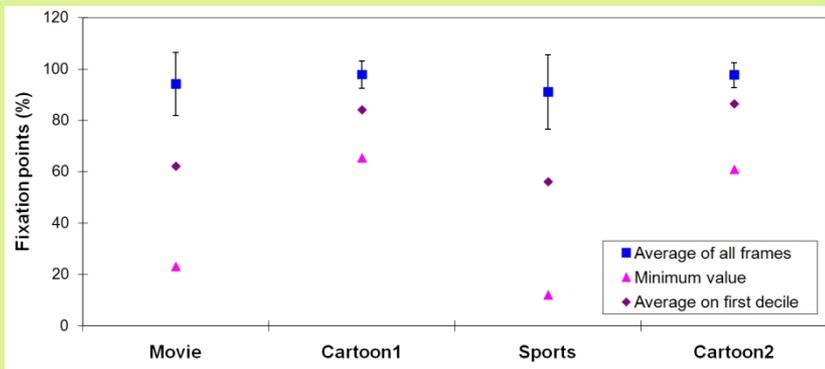
Metric

<i>Algo</i>	<i>Pf</i>	coh_c	coh_z	$Z-Z_{opt}$
Linear	Distortion factor (1)	0	0	0.5/0.35
Centered	FP in BB	0	0	0
Adaptive	FP in BB	$\frac{\partial}{\partial t}$ BB position	$\frac{\partial}{\partial t}$ zoom	f(zoom)

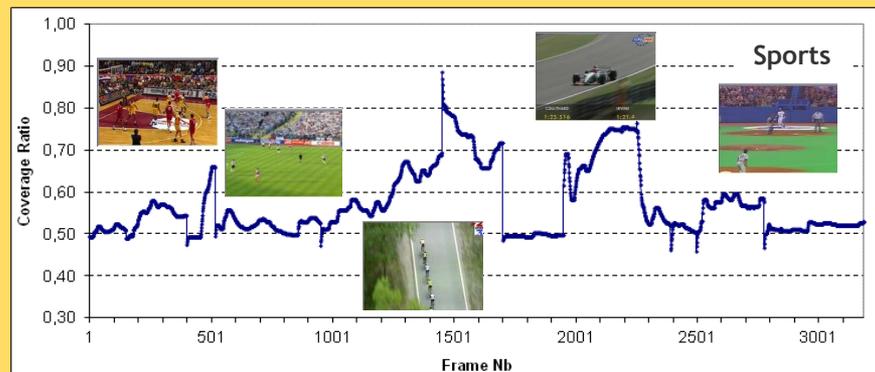
$Z_{opt} = 0.5$ or 0.65 (16:9 movie)

Results on the individual functions

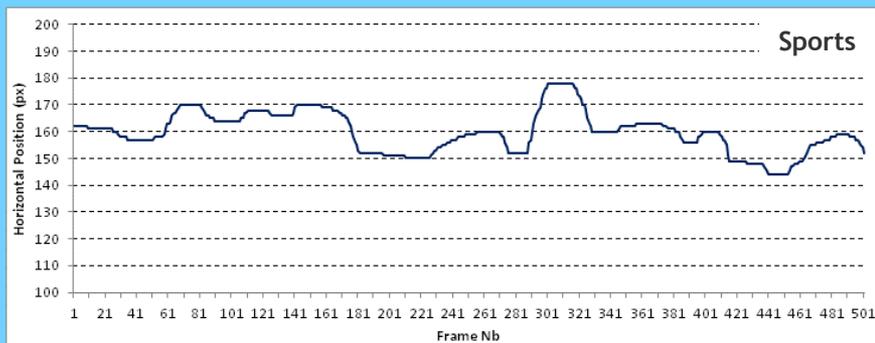
P_f: preservation of visually important areas



Coh_z: temporal variations of the coverage ratio (zoom)



Coh_c: temporal variations of the cropping window center



Quality Metrics: Global Results

Global Results Q [**x100**]

- $Z_{opt}=0.5/0.65$ (Movie); f .: average; $a=\beta=1$, $\gamma=3$

$$Q = f \left(p_f(t) \times \frac{100}{100 + coh_c(t)^\gamma} \times \frac{100}{100 + coh_z(t)^\beta} \times \frac{100}{100 + g(z(t), z_{opt}(t))^\alpha} \right)$$

<i>Algo</i>	<i>Min</i>	<i>Max</i>	<i>average</i>
Linear	66.67	74.1	72.84
Centered	56.78	100.00	96.92
Adaptive (w/o temp)	33.22	100.00	51.08
Adaptive (with temp)	35.49	99.77	86.47

Quality Metrics: Results per sequences

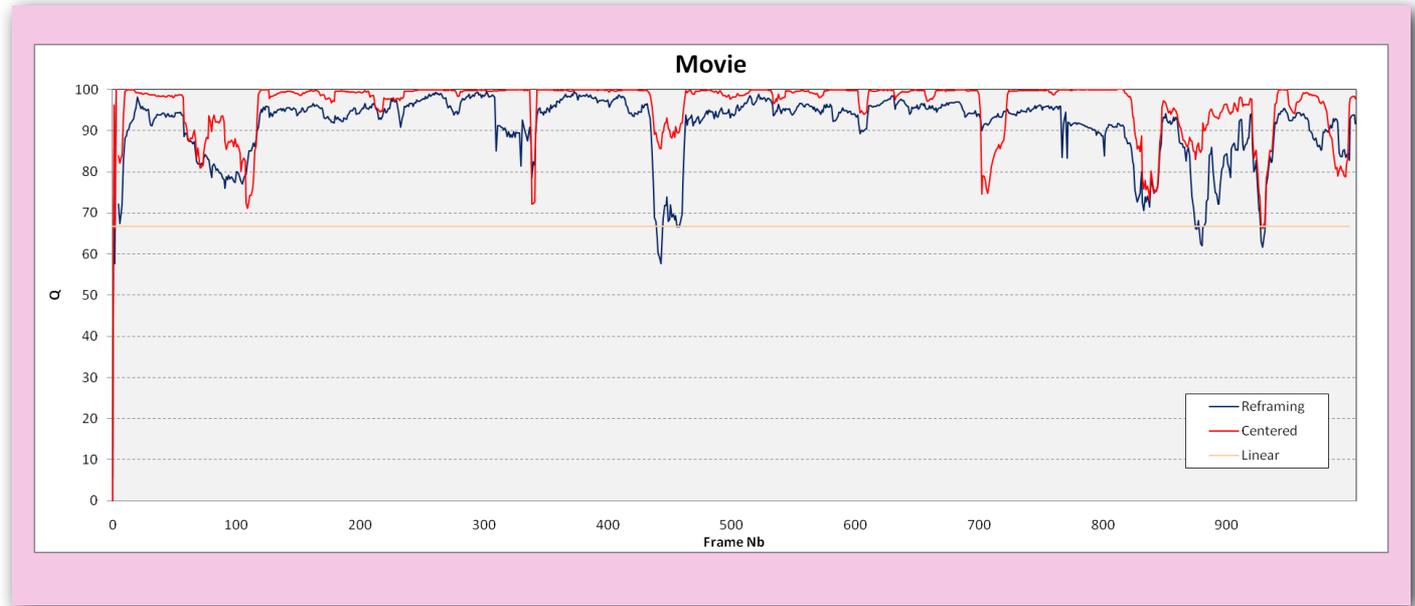
Results Q [x100]

- $Z_{opt}=0.5/0.65$ (Movie); $f.$: average; $a=\beta=1$, $\gamma=3$

$$Q = f \left(p_f(t) \times \frac{100}{100 + coh_c(t)^\gamma} \times \frac{100}{100 + coh_z(t)^\beta} \times \frac{100}{100 + g(z(t), z_{opt}(t))^\alpha} \right)$$

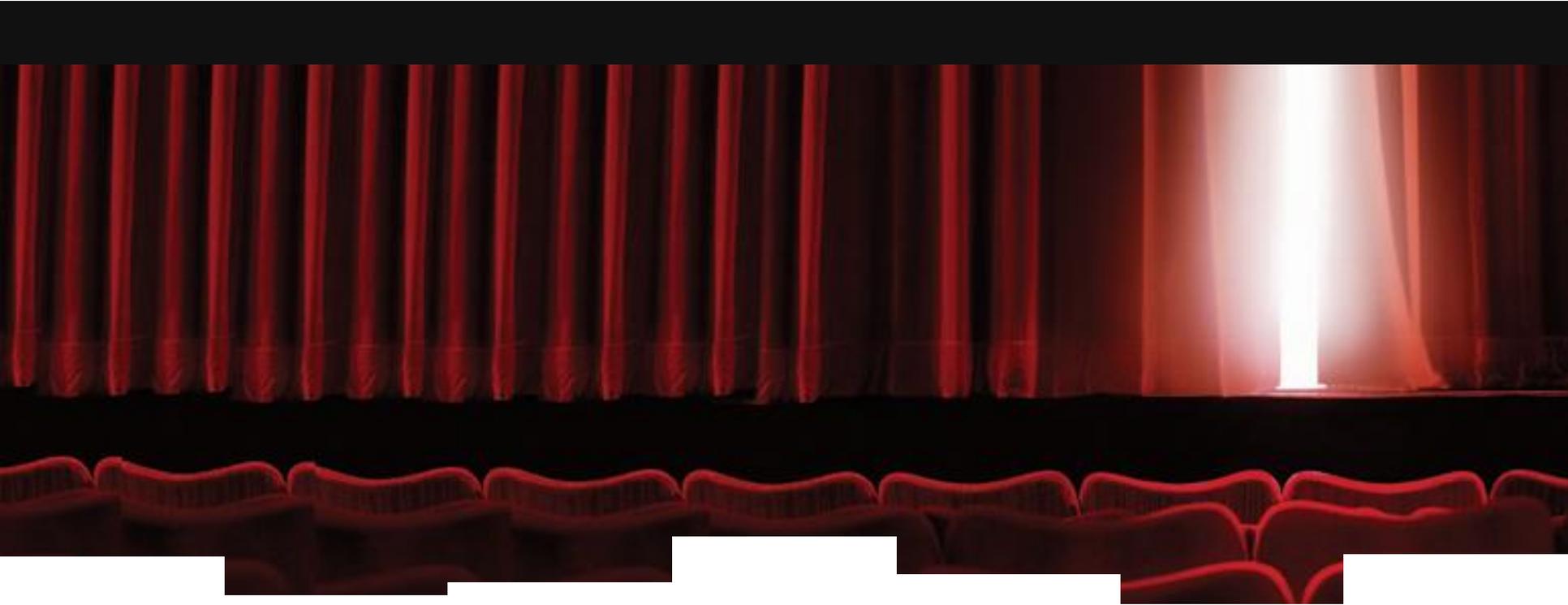
<i>Algo</i>	<i>Movie</i>	<i>Cartoon1</i>	<i>Cartoon2</i>	<i>Sports</i>
Linear	66.67	74.07	74.07	74.07
Centered	96.16	98.98	98.90	94.24
Adaptive (w/o temp)	60.31	66.99	66.34	64.69
Adaptive (with temp)	91.22	91.34	99.77	98.65

Quality Metric: Results for *Movie*



Movie	Q	P_f	coh_c	coh_z	$z-z_{opt}$
Linear	66.67	100.00	0	0	50
Centered	96.16	96.16	0	0	0
Adaptive	91.22	95.49	[0-4]	[0-7]	[0-12]

Conclusion



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Conclusions & Perspectives

Metric

- Takes into account accuracy and stability in both spatial and temporal dimensions
- Includes “Comfort” metric (zoom)
- Applied to different reframing schemes

Improvements

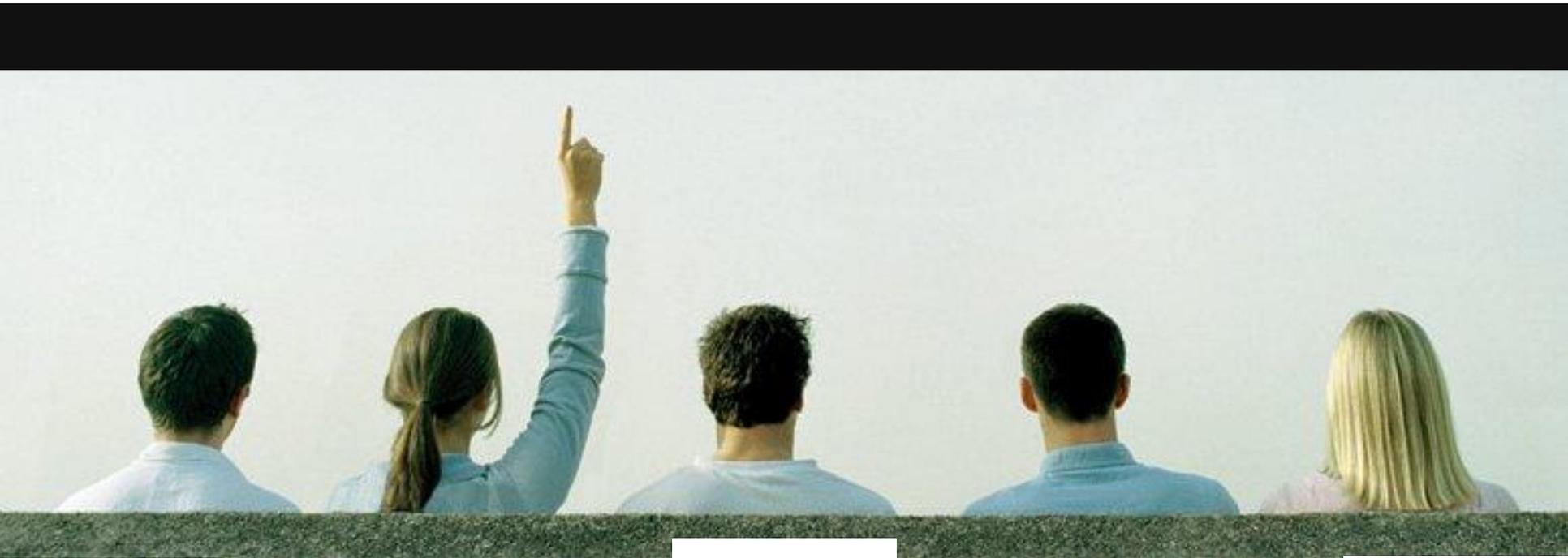
- Inc. Specific distortion factor
- Inc. Quality factor for the positioning of the window
- Take into account scenes cuts for the two *coh* factors
- Compute metric on other reframing schemes to complete validation
- Perform subjective tests to validate the metric

Supplemental materials

- Video: <http://www.thlab.net/~guillotelp/publications/ECCV10-Reframing.avi>

Thank you

Special thanks to Fabrice Urban for the computation of the results



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Annex

