SIGGRAPH2011

Display Pixel Caching

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Motivation / Problem

- mismatching properties of input video and output display:
  - different resolution (can be solved with upsampling)
  - **different aspect ratio**
- empty (black) borders

4:3 content on 16:9 screen

cinnemascope content on 16:9 screen

low res. 16:9 content on 16:9 screen

Related Techniques

- simple solutions to change aspect ratio:
- cropping
  - lost content
- stretching
  - unnatural proportions

original

clipped

original

stretched

Related Techniques

- video retargeting:
  - content based stretching/cropping
  - good quality with interactive constraint editing
  - fully automatic and real-time methods difficult to realize

original

stretch

retargeting (not real-time)[1]

1 [Rubinstein, M., Shamir, A., Avidan, S.: Multi-operator media retargeting. ACM Trans. Graph. 28 (2009) 1-11]

Related Techniques

- video retargeting:
  - content based stretching/cropping
  - good quality with interactive constraint editing
  - fully automatic and real-time methods difficult to realize

original

stretch

retargeting (real-time)[1]

1 [Chiang, C., Wang, S., Chen, Y., Lai, S.: Fast jnd-based video carving with gpu acceleration for real-time video retargeting. IEEE Trans. Cir. and Sys. for Video Technol. 19 (2009) 1588-1597]

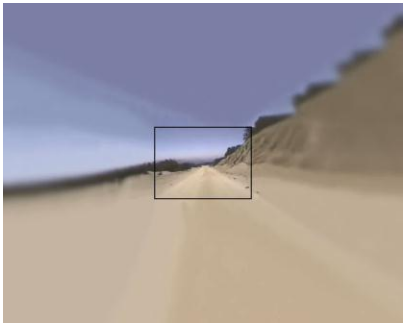
Display Pixel Caching (DPC)

Related Techniques

- video mosaicing - additional challenges:
  - input material complex local and global motion patterns
  - real time with HD video content
  - must not change original video frame

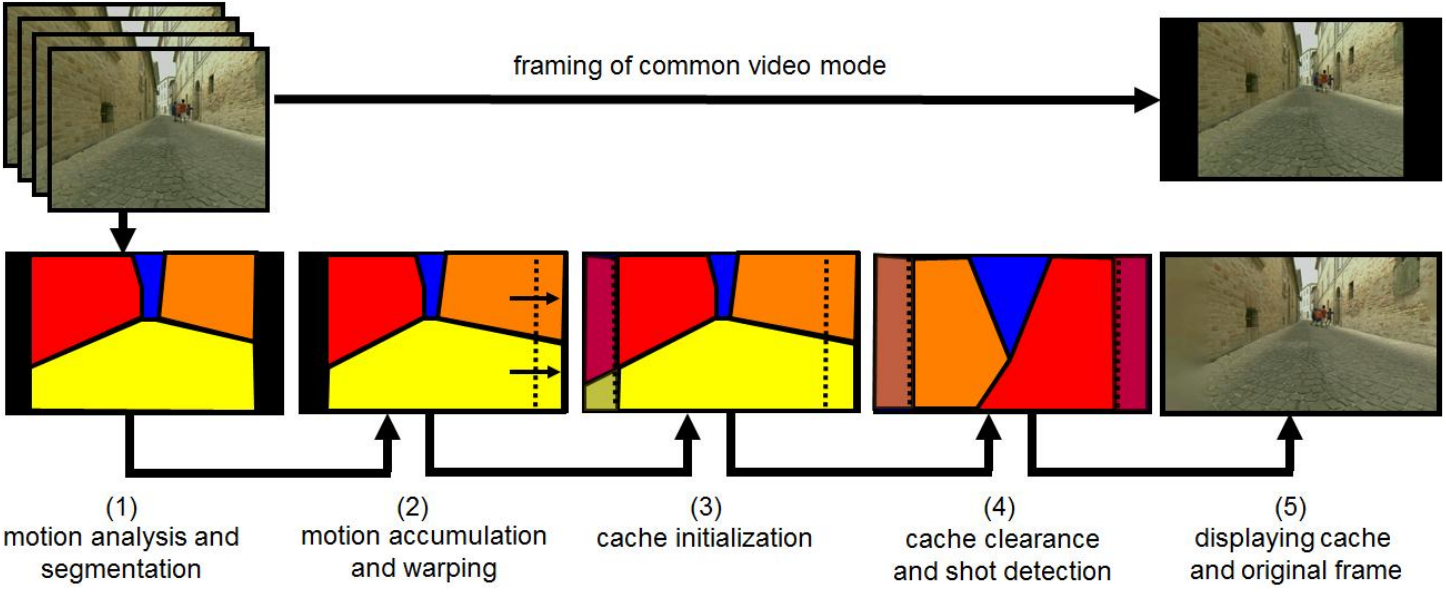
[DiVerdi, S., Wither, J., Höllerer, T.: Envisor: Online environment map construction for mixed reality. In: IEEE Virtual Reality 2008, pp. 19-26 (2008)]

- video extrapolation
  - video completion approach
  - not real time
  - for peripheral vision



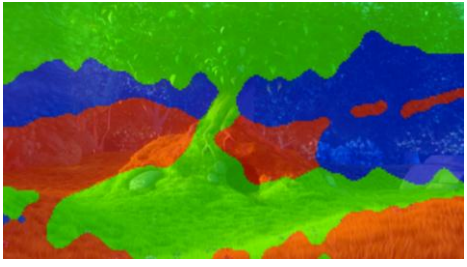
[Avraham, T., Schechner, Y.: Ultrawide foveated video extrapolation. IEEE Selected Topics in Signal Processing 5 (2011)]

DPC Processing Pipeline

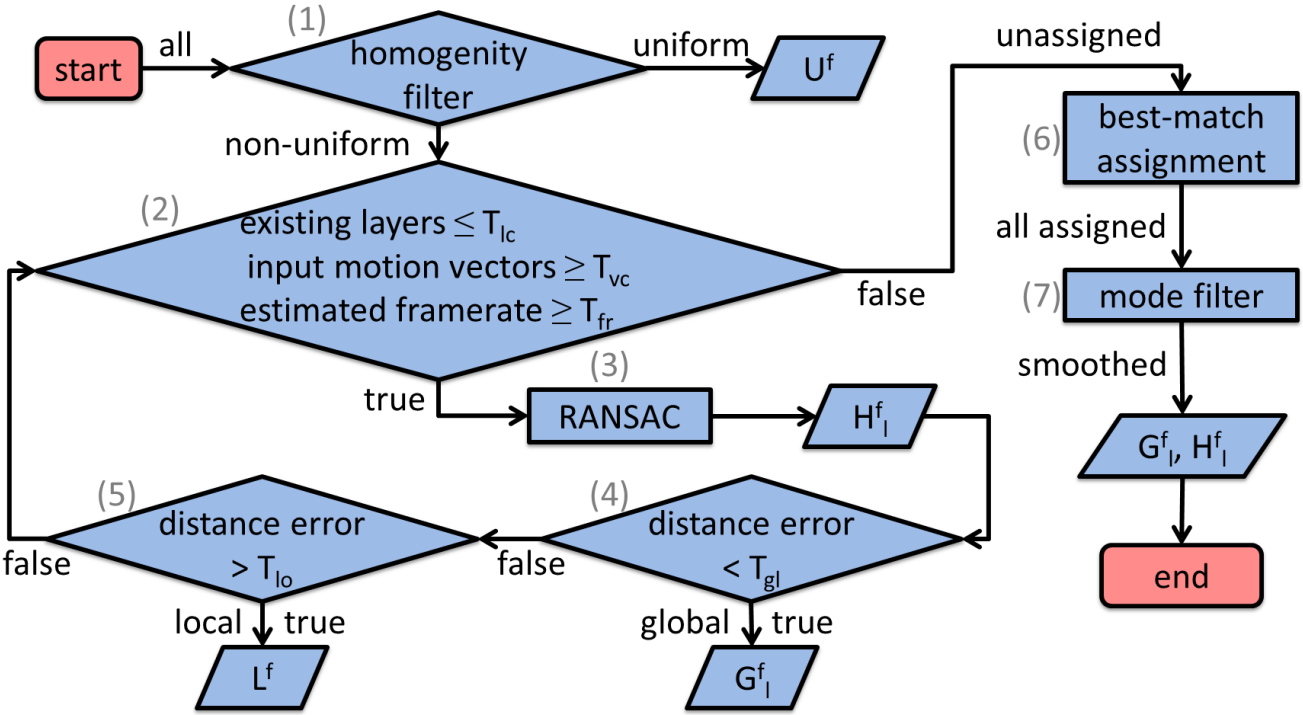


Motion Analysis and Processing

- motion vectors from MPEG video stream
- segmentation of motion flow into different motion layers
- assignment of an individual homography matrix to each layer
- warping of each layer

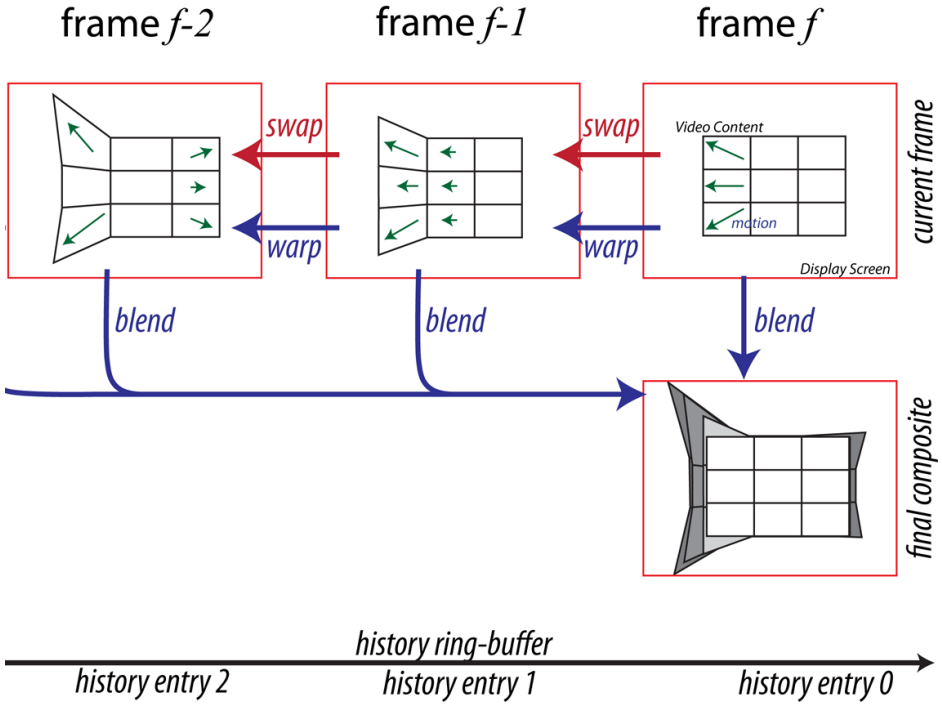


Motion Segmentation

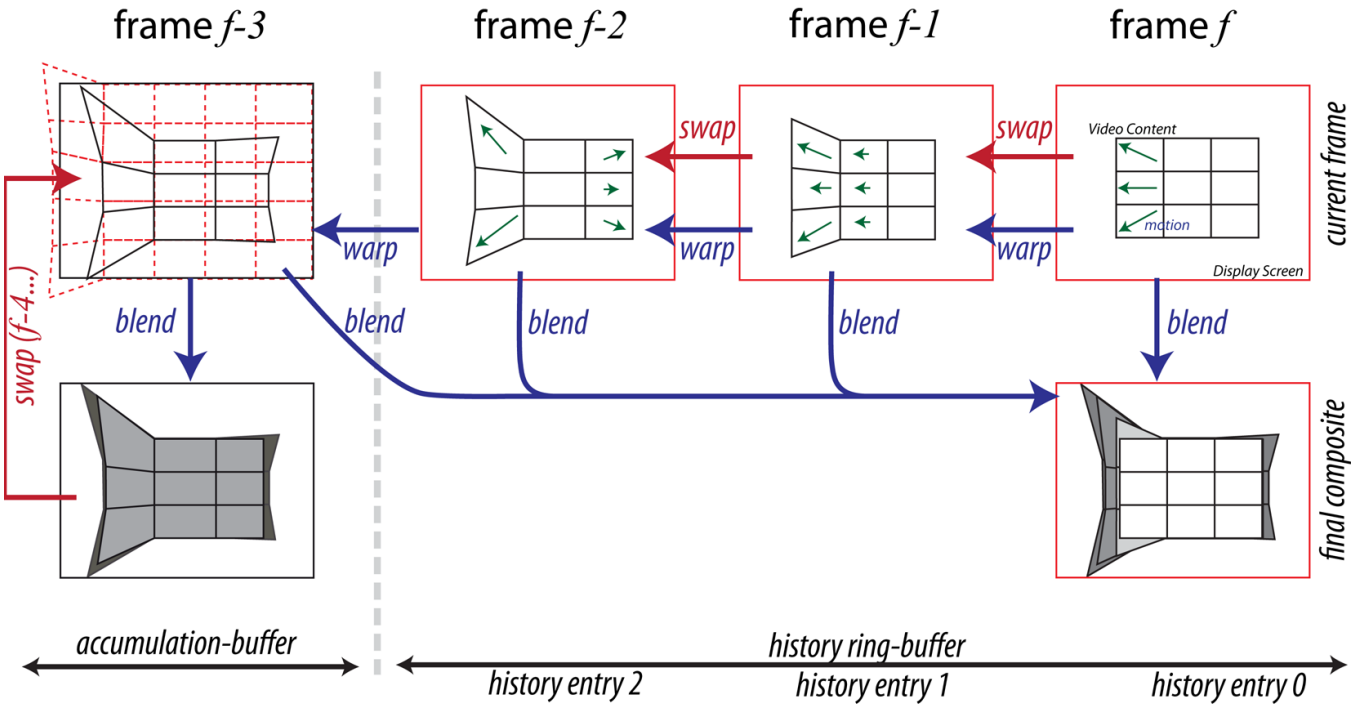


Motion Accumulation and Warping

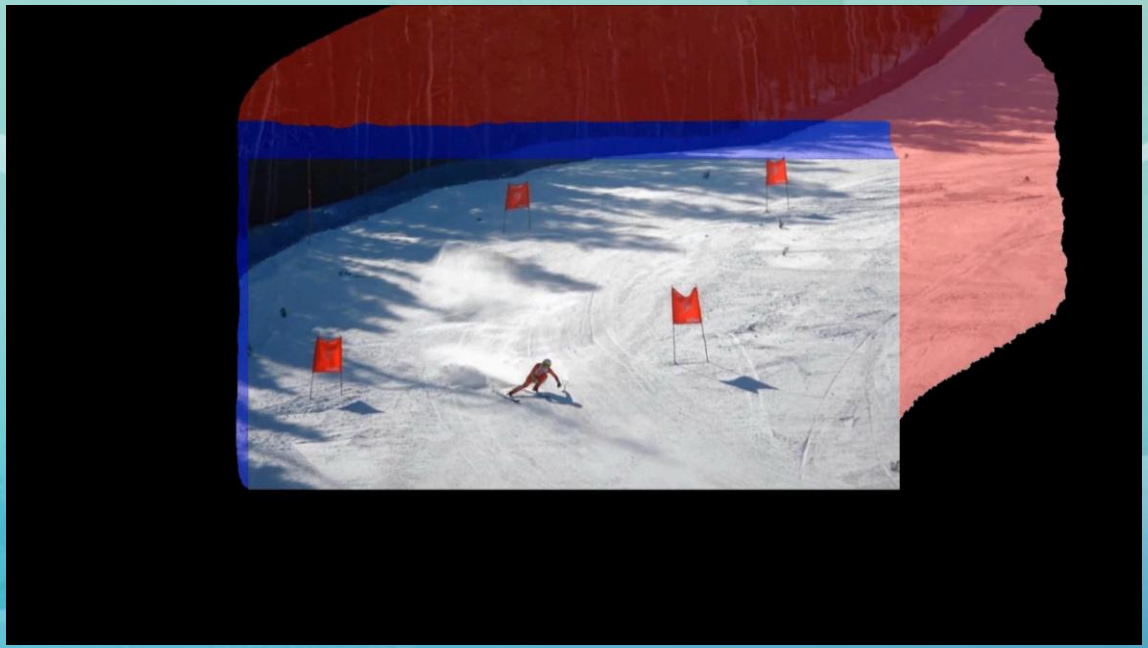
- vertex grid:
  - motion vector
  - vertex
- transformed with homographies



Accumulation Buffer



History Ring-Buffer and Accumulation Buffer



No Initialization

Full Initialization

Progressive Clipping

Conservative Clipping

Cache Clearance and Shot Detection

Cache Clearance and Shot Detection

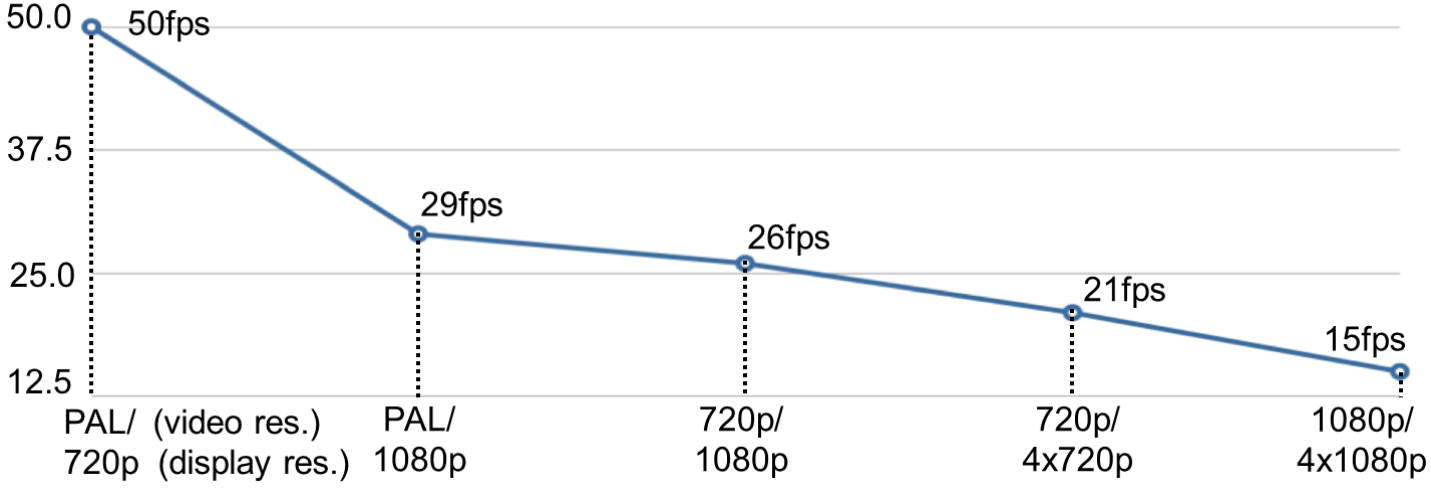
wrong cache

original frame

Cache Clearance and Shot Detection

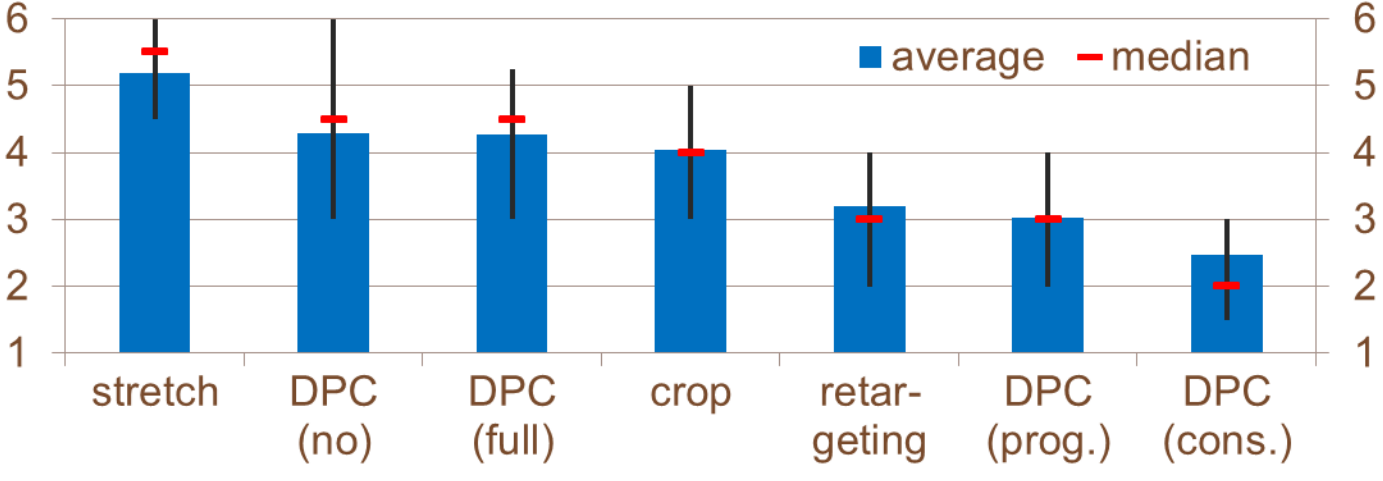
Performance

- using CUDA and OpenGL shader
  - 2.67 GHz QuadCore; 6GB RAM; NVIDIA GTX 285 graphics board



User Evaluation

- each mode compared to the original
  - 1 = mode preferred most; 6 = original preferred most
  - 59 participants, + details



Limitations & Improvements

- undefined or noisy MPEG motion vectors
  - runtime flow computations
- detect and continue local motions
  - motion path extrapolation
  - use depth information
- new objects enter field of view
  - clear cache

undefined motion vectors

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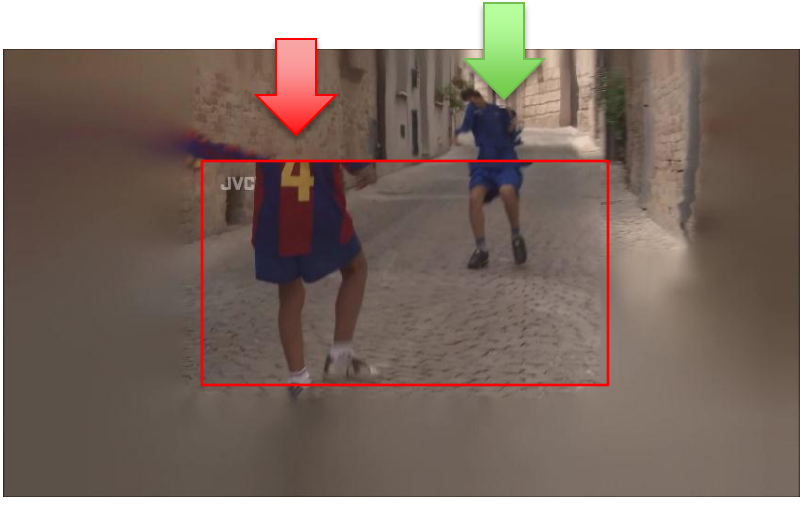

possible inconsistent local motion in cache

display pixel caching (conservative clipping)

Summary

- first prototype:
  - techniques for cache initialization, management and clearance
  - can handle global (inc. parallax) and local motion (with limitations)
  - real-time capable
- user evaluation:
  - evaluated acceptance of different DPC modes
  - promising results for DPC with progressive and conservative clipping

Thank you!

DPC: to appear at ISVC’11 in September

www.jku.at/cg

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