Temporally Coherent Video De-Anaglyph

Joan Sol Roo [1,2]

Christian Richardt [1]

Now at Intel VCI, MPI Informatik

1 Inria

2 UNICEN
Universidad Nacional del Centro de la Provincia de Buenos Aires

Anaglyph Images

Right view

F

Right view (G+B)

+

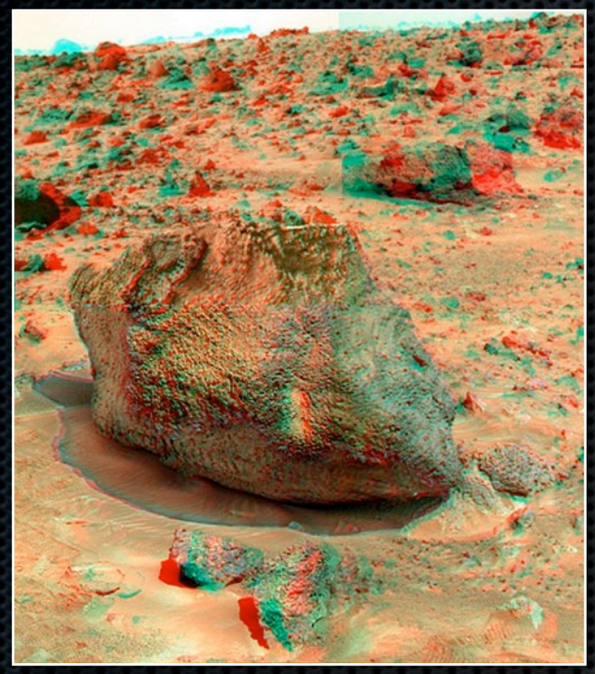
Anaglyph image

Left view

F

Left view (R)

Lots of Legacy Imagery



Mars photos

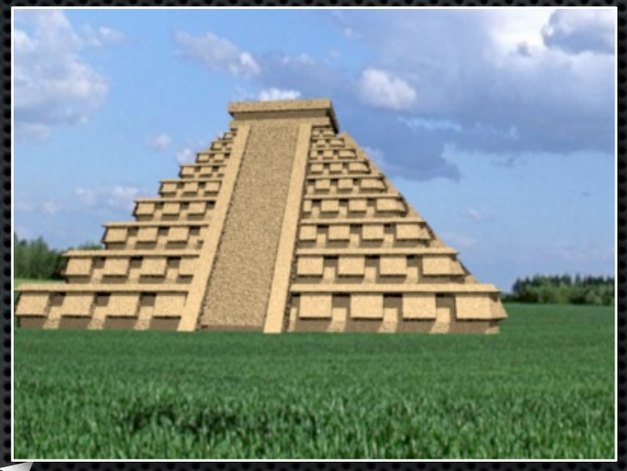
Old 3D movies
(Dial M for Murder)

User content

Video De-Anaglyph

How can we reconstruct the full colors from anaglyph input?

Right view (GB)



Right image

?

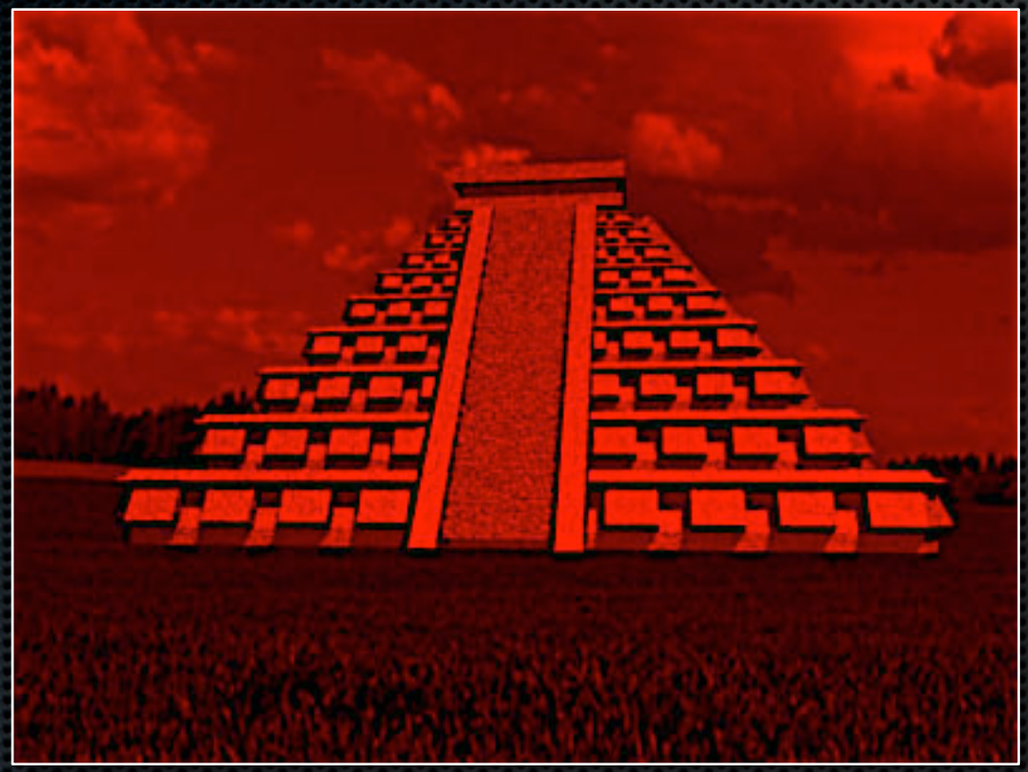
Left view (R)

Left image

Challenges:

- Multimodal Input
- Channel Alignment
- Occlusions
- Temporal Consistency

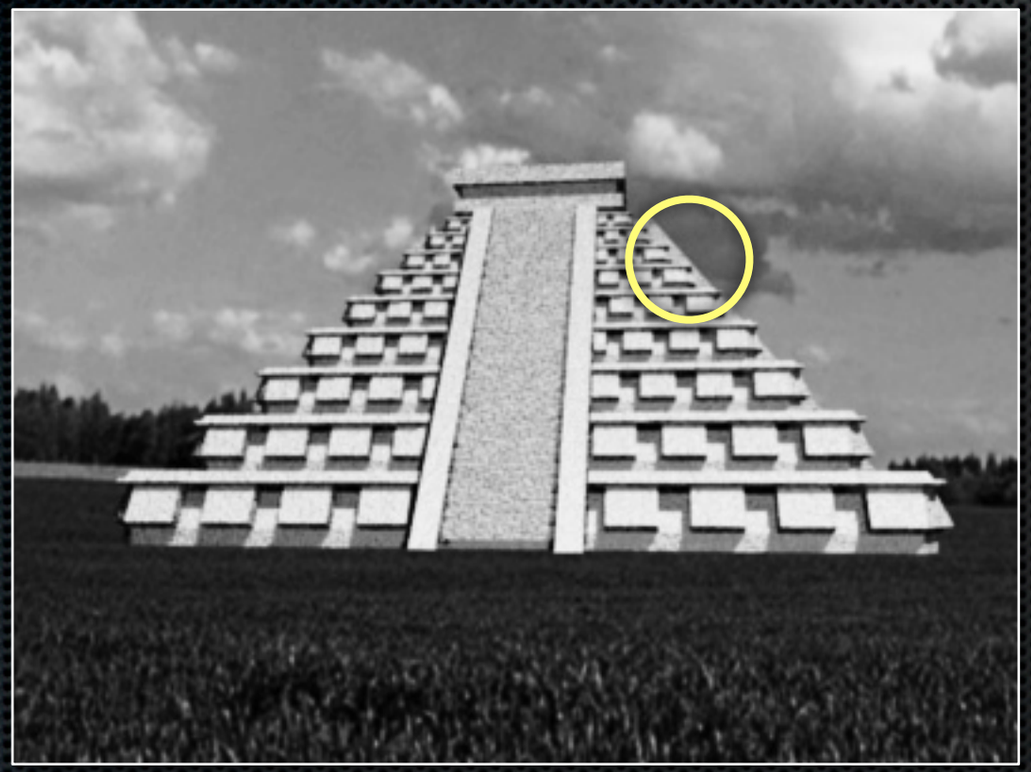
Challenge 1:
Multimodal Input



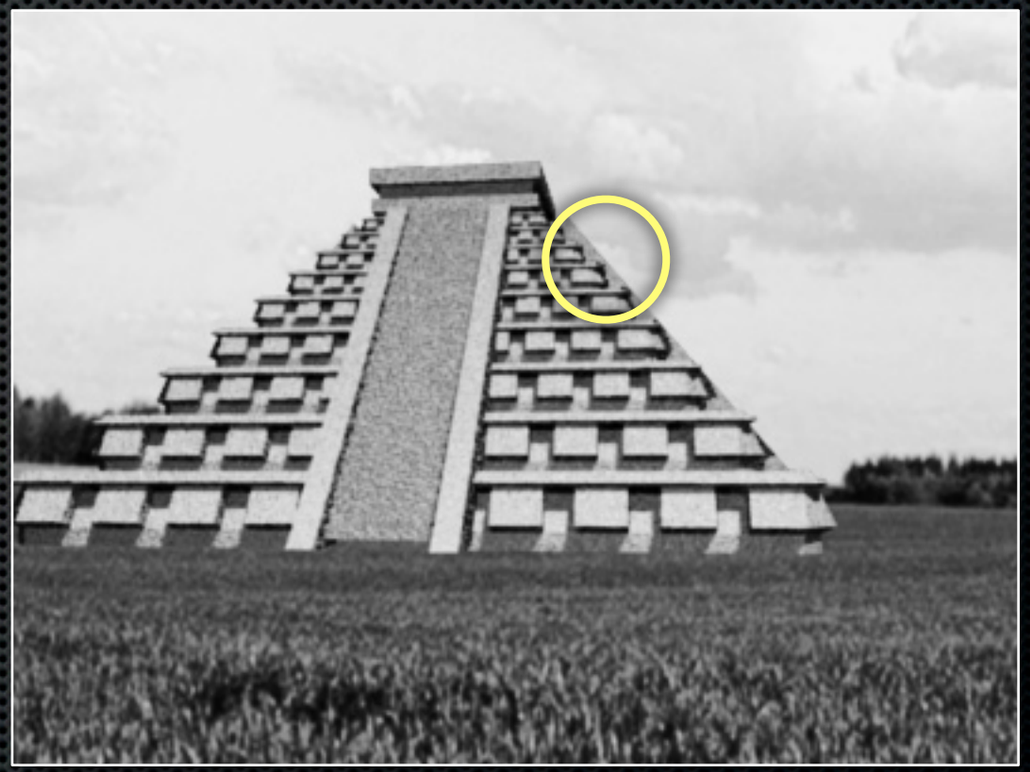
Left view (R)

Right view (G+B)

Challenge 1: Multimodal Input



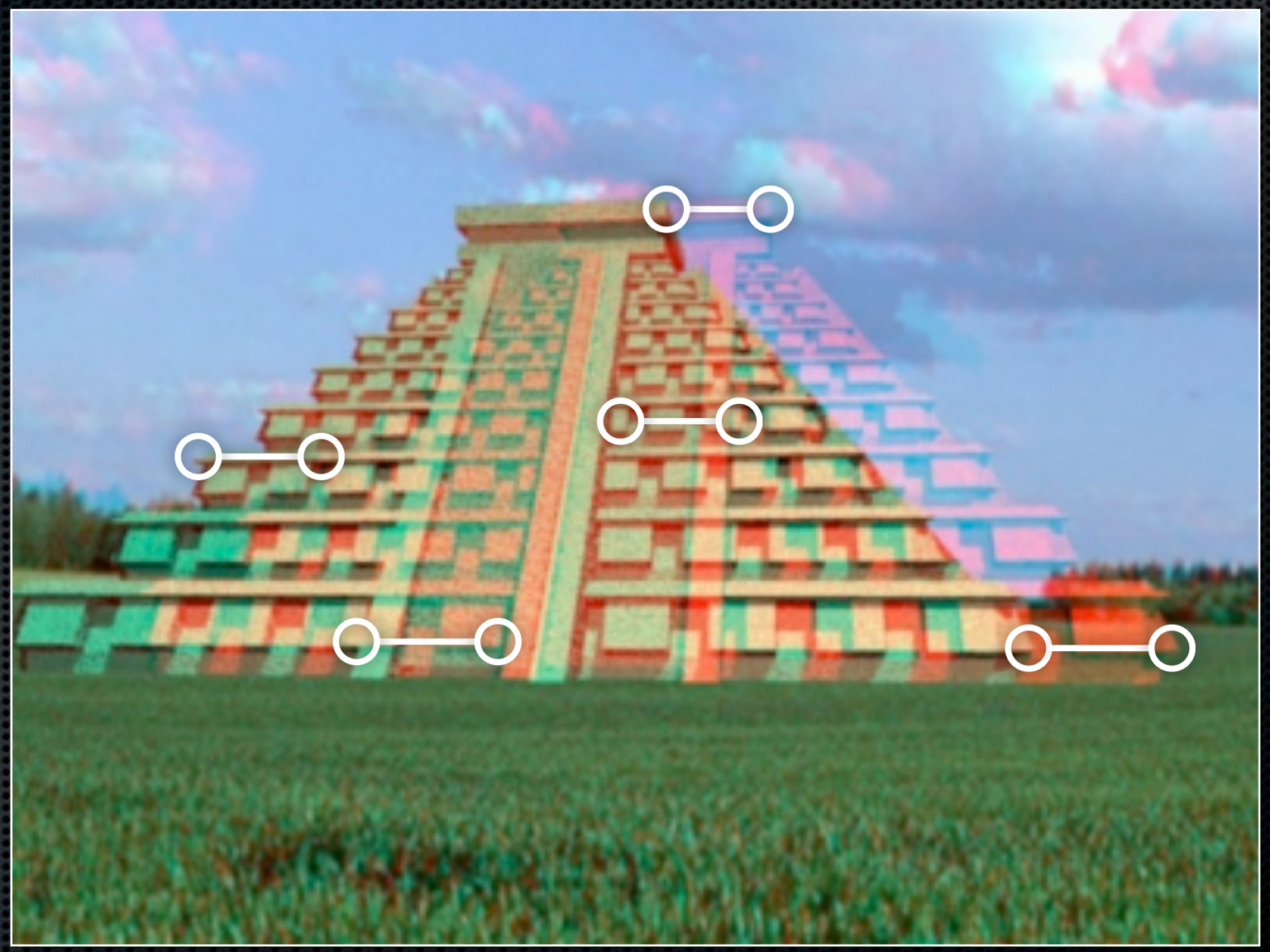
Left view (R to grayscale)



Right view (B+G to grayscale)

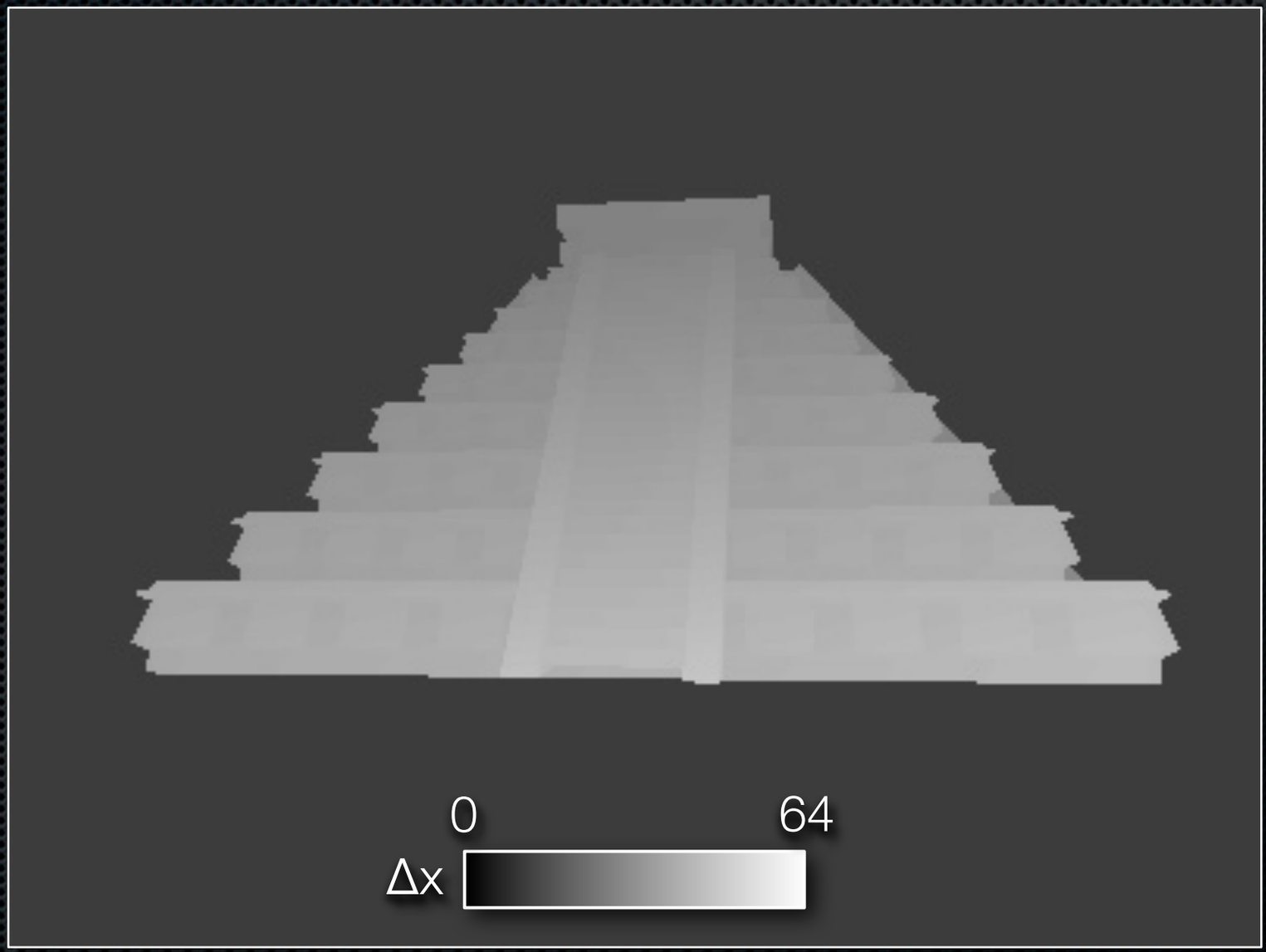
(Increased brightness and contrast for visualisation)

Challenge 2:
Channel Alignment



Anaglyph image

Challenge 2:
Channel Alignment



Disparity map

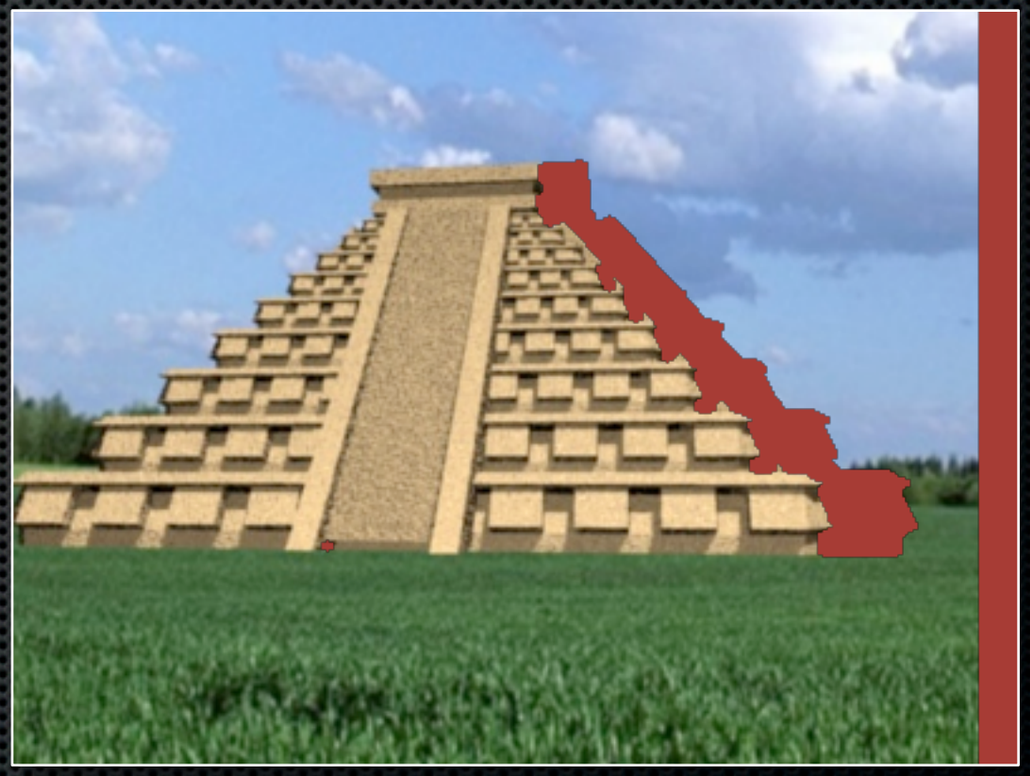
Challenge 3: Occlusions

Left image

Right image

Challenge 3: Occlusions

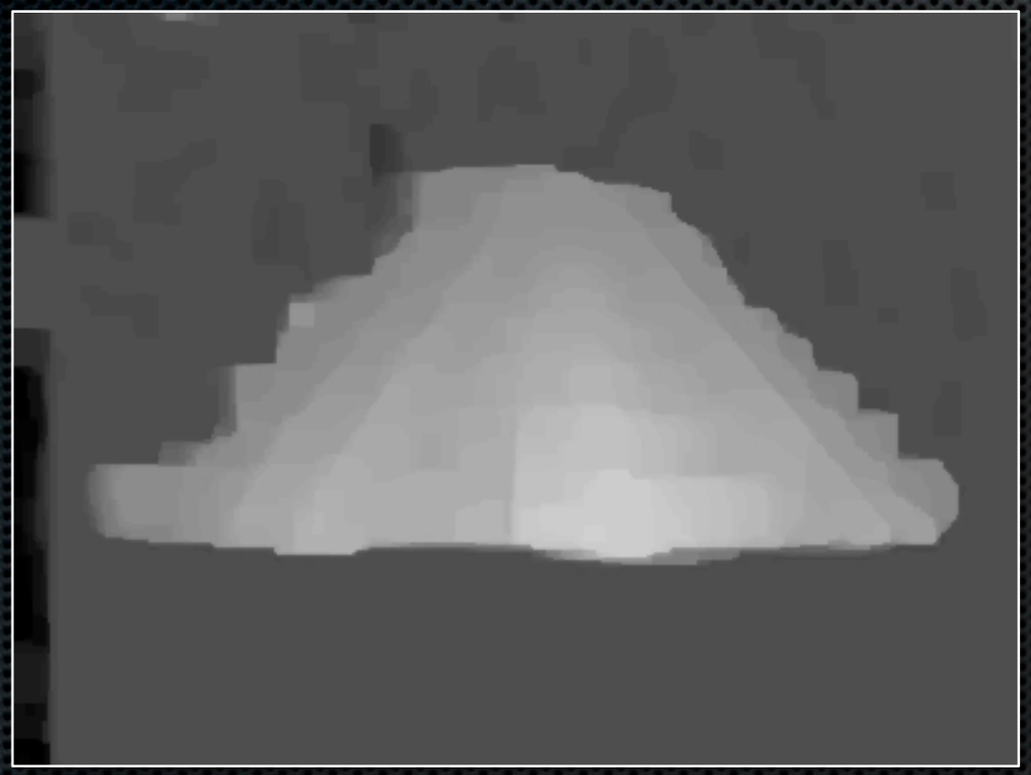
Left image



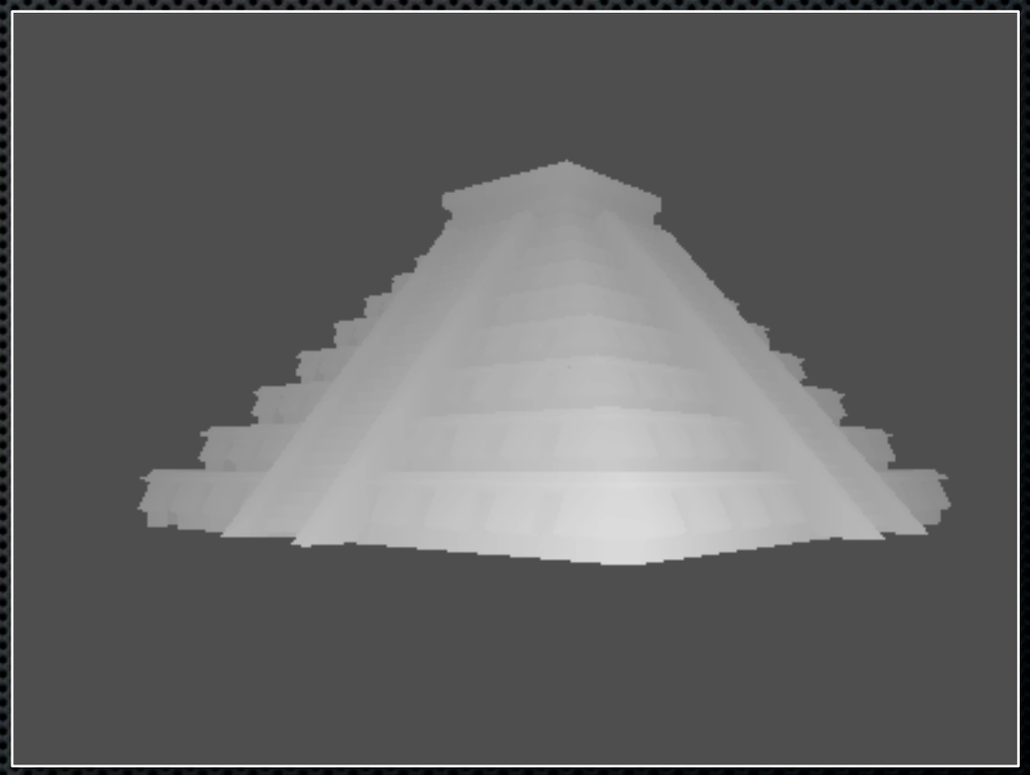
Right image

Occluded areas

Challenge 4:
Temporal Consistency



Disparity using SIFT flow
[Liu et al. 2011]



Ground-truth disparity

Related Work

[http://www.3dtv.at/Knowhow/DeAnaglyph_en.aspx]

Anaglyph image

Right image

Reconstructed left image

Related Work

[Joulin & Kang 2013]

Right view

Compute Correspondences

Propagate Colors

Right view

Left view

Left view

Our Approach

Left view

Right view

Matching

SIFT Flow
[Liu et al. 2011]

→

Temporal Coherence

[Lang et al. 2012]

→

Colorization

Domain Transform
[Gastal & Oliveira 2011]

Left view

Right view

Correspondence: SIFT Flow

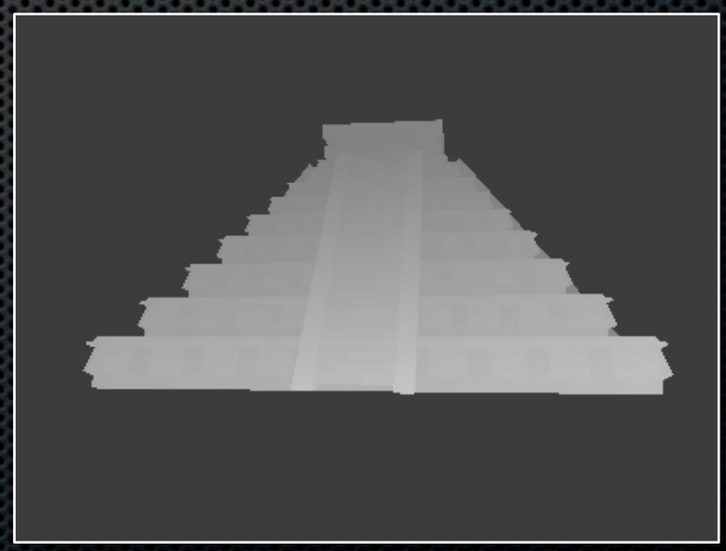
[Liu et al. 2011]

Anaglyph views

Left

Right

Disparity maps



SIFT flow

Ground truth

Correspondence: SIFT Flow

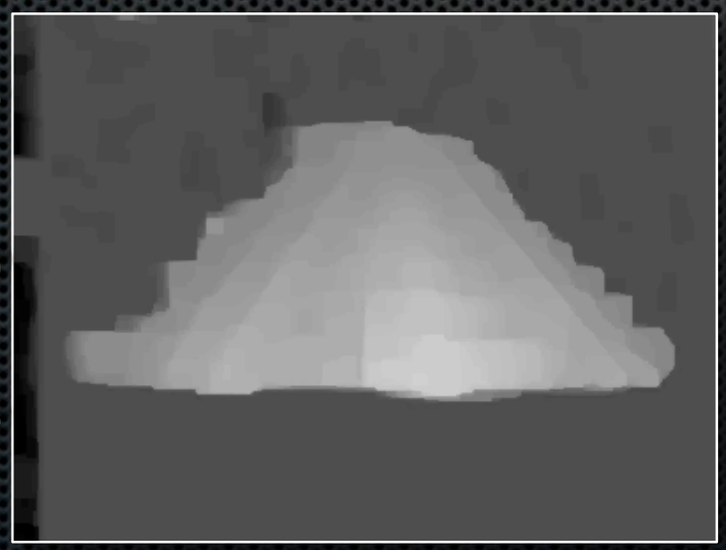
[Liu et al. 2011]

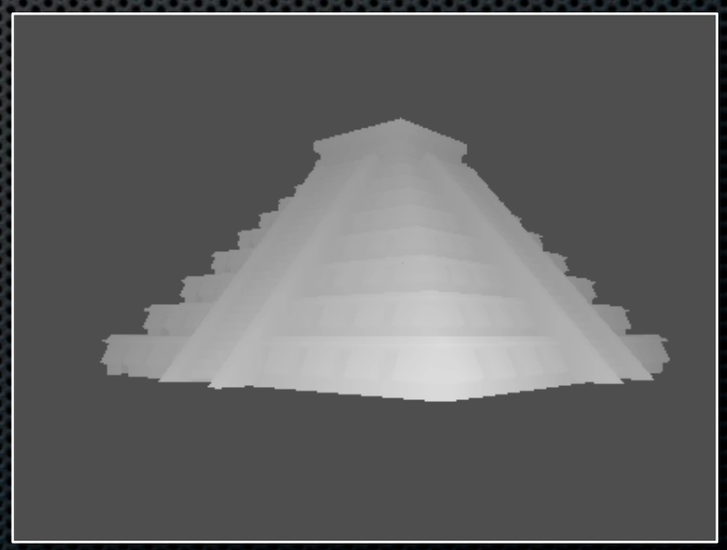
Anaglyph views

Left

Right

Disparity maps



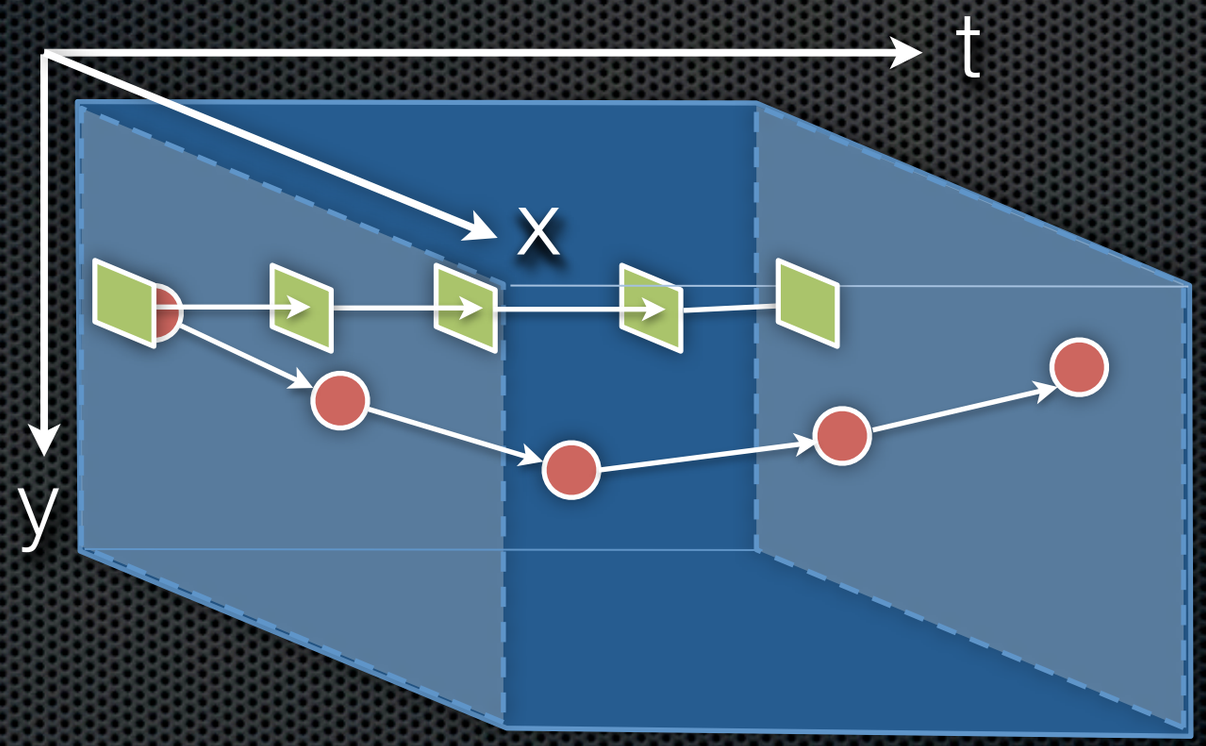


SIFT flow

Ground truth

Temporal Coherence

[Lang et al. 2012]



Temporal propagation

Temporal Coherence

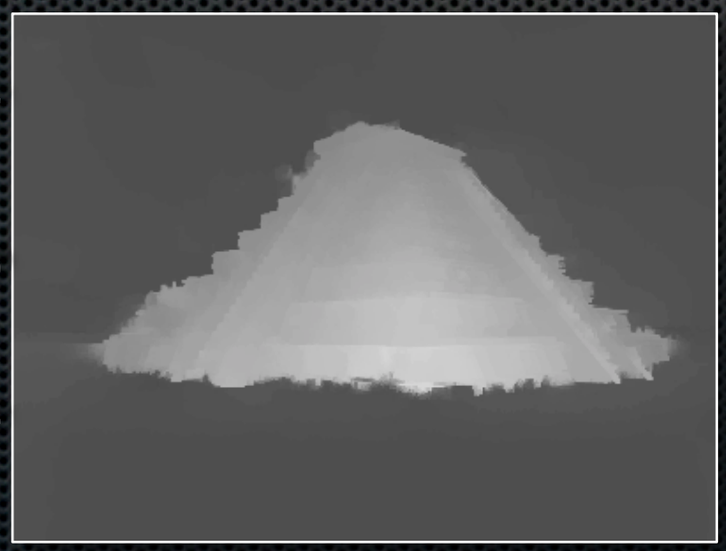
[Lang et al. 2012]

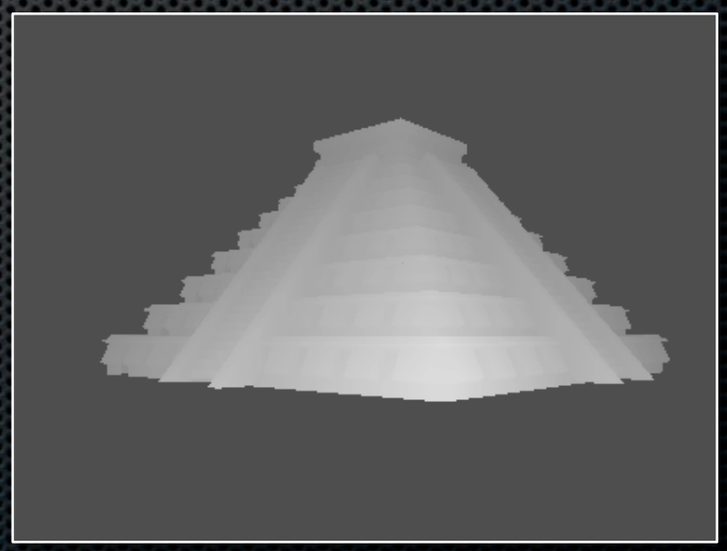
Anaglyph views

Left

Right

Disparity maps





SIFT flow

Ground truth

Colorization

Red

Left view

Cyan

Right view

Combined RGB

(=input anaglyph)

Colorization

Red

Left view

Cyan

Right view warped using disparity

Combined RGB

Left view reconstruction

Colorization

Red

Left view

Cyan

Discard occlusions

Combined RGB

Left image reconstruction

Colorization Example

Reference image

Colorization Example

Scribbles

Colorization Example

Scribbles

Colorized image

Colorization

Red

Left view

Cyan

Discard occlusions

Combined RGB

Left image reconstruction

Colorization

Red

Left view

Cyan

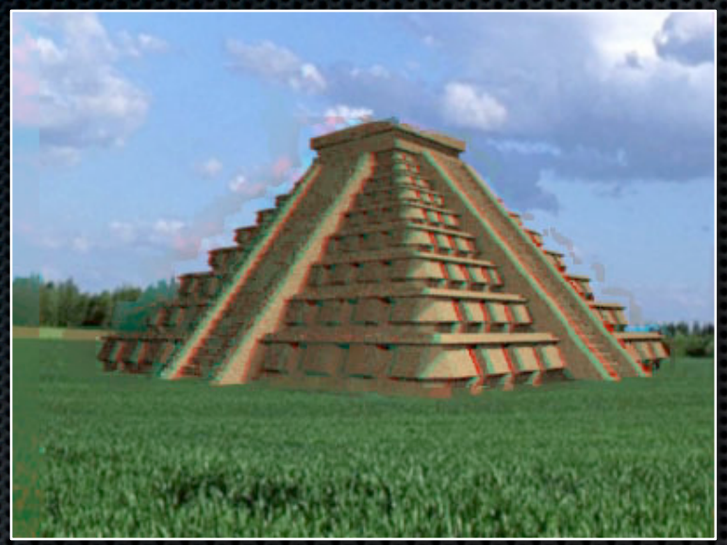
With colorized occlusions

[Gastal & Oliveira 2011]

Combined RGB

Left image reconstruction

Reconstruction Results



Per-frame SIFT flow

Filtered SIFT flow

GT disparities

Original left view

Summary of Solutions

Challenges	Our Solution
Multimodal Input	SIFT Flow [Liu et al. 2011]
Channel Alignment	
Occlusions	Domain Transform [Gastal & Oliveira 2011]
Temporal Consistency	Practical Consistency [Lang et al 2012]

More Results

Input anaglyph video

© Eric Deren, Dzignlight Studios

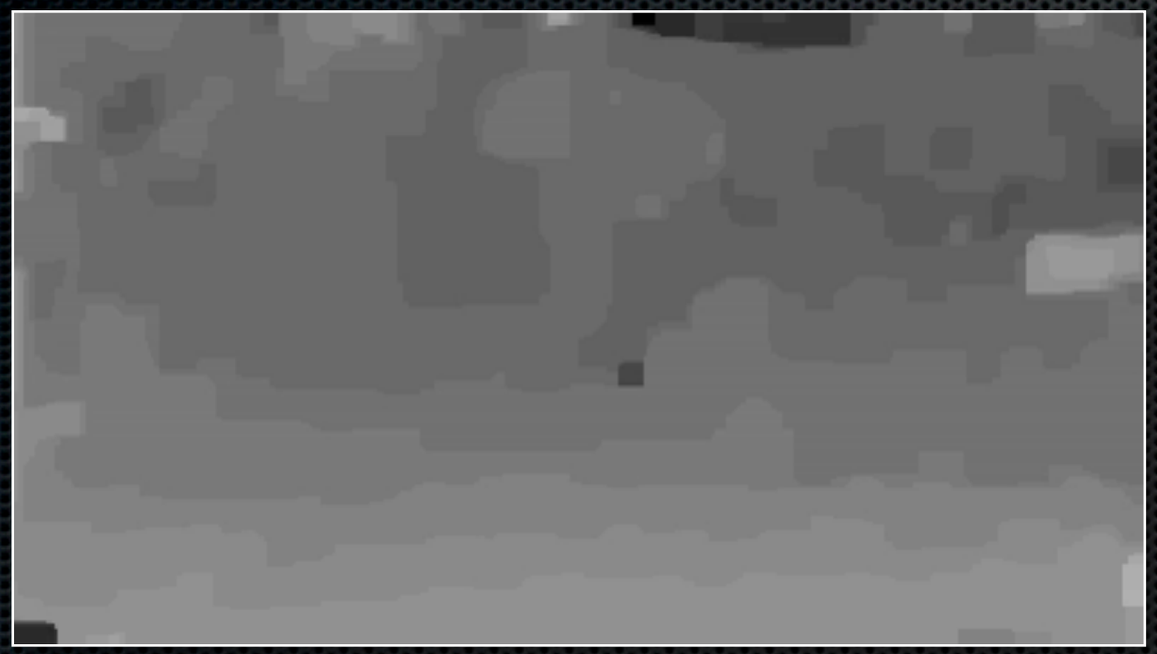
Input Anaglyph Views

Left view

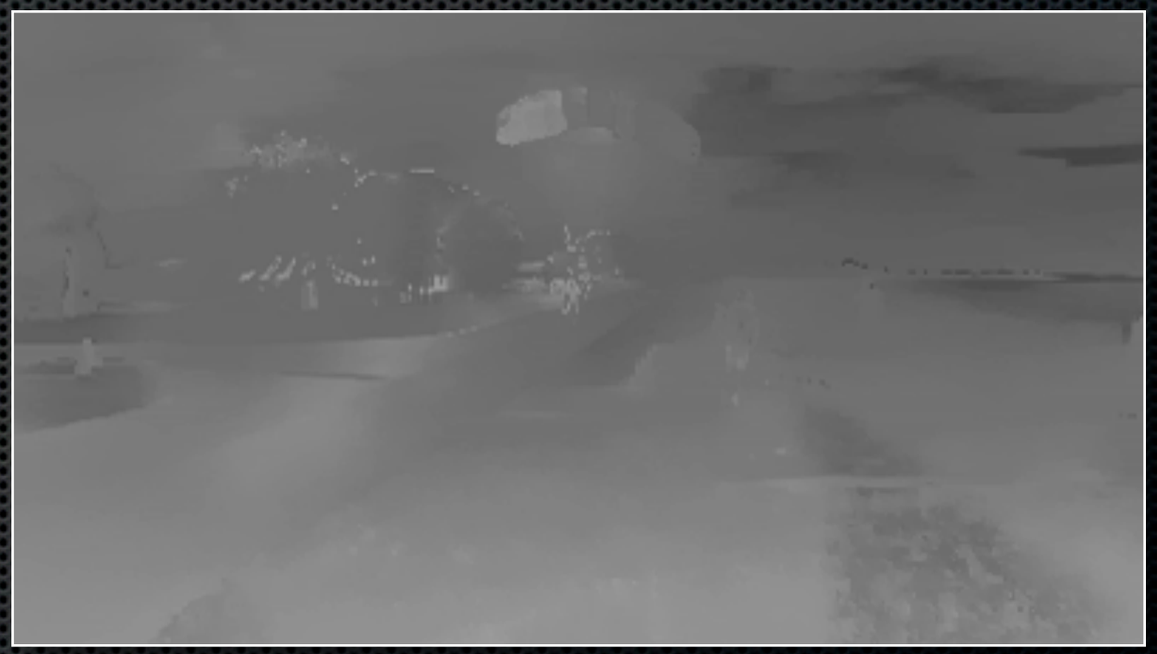
Right view

© Eric Deren, Dzignlight Studios

Disparity Maps



Per-frame SIFT flow disparity
[Liu et al. 2011]



Temporally coherent disparity
[Lang et al. 2012]

© Eric Deren, Dzignlight Studios

Optical Flow

Per-frame Farnebäck flow

[Farnebäck 2003]

Temporally coherent flow

[Lang et al. 2012]

© Eric Deren, Dzignlight Studios

Reconstructed Views

Left view

Right view

© Eric Deren, Dzignlight Studios

More Results

Input anaglyph video

© Eric Deren, Dzignlight Studios

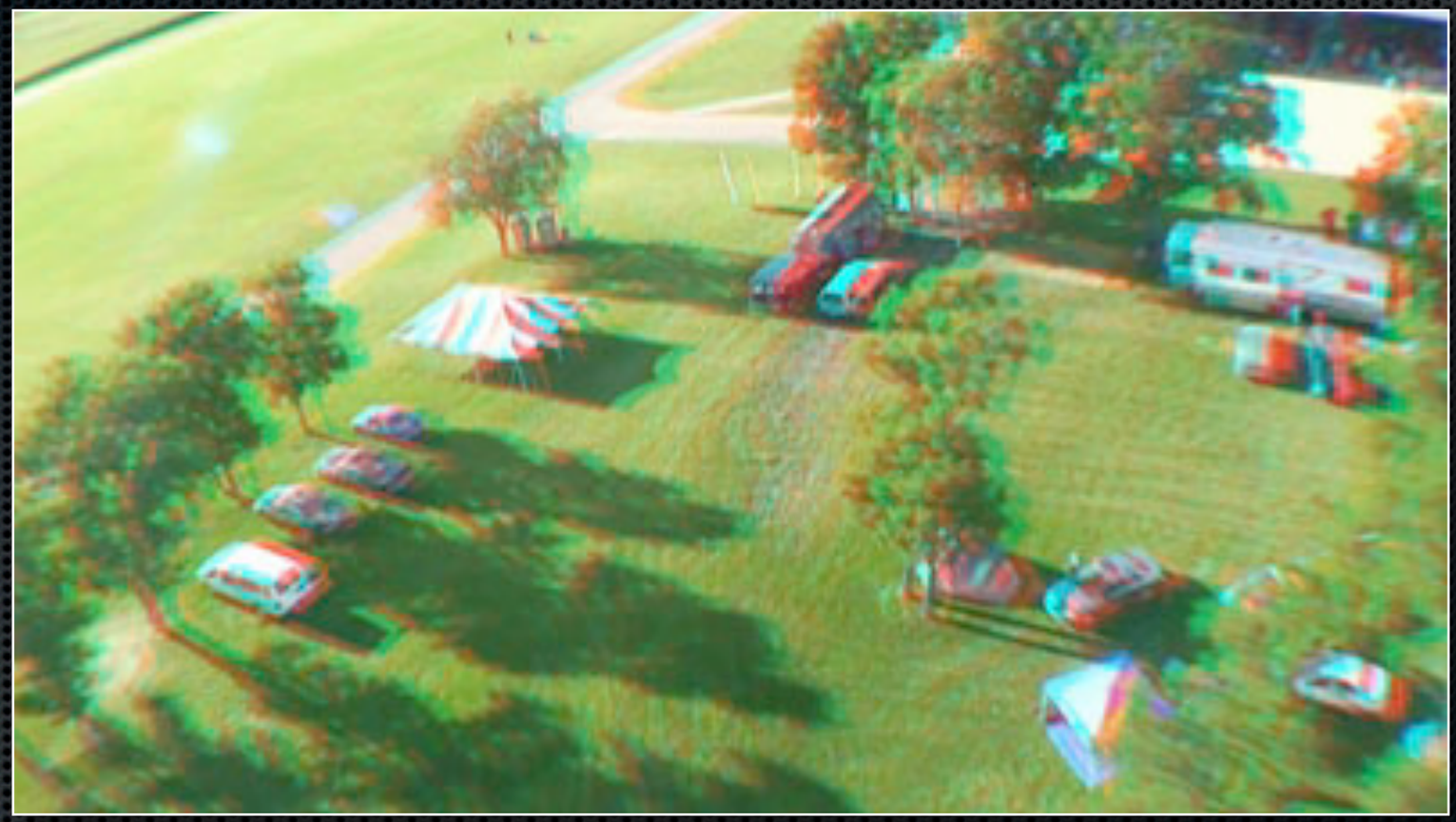
Reconstructed Views

Left view

Right view

© Eric Deren, Dzignlight Studios

More Results



Input anaglyph video

© Eric Deren, Dzignlight Studios

Reconstructed Views

Left view

Right view

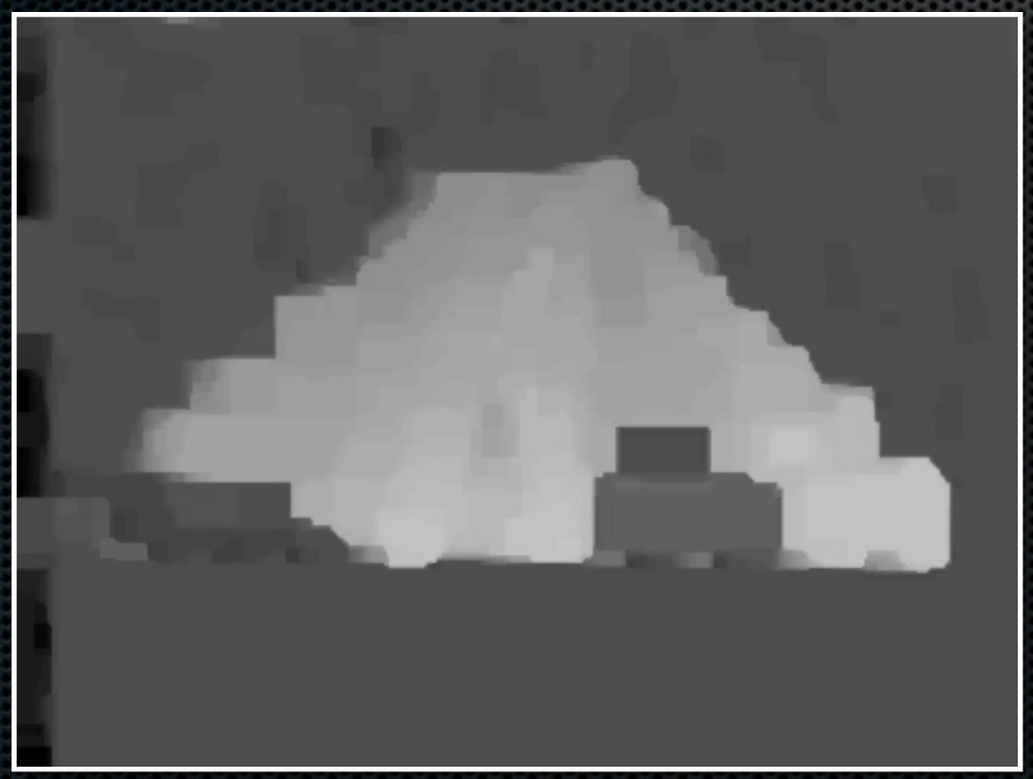
© Eric Deren, Dzignlight Studios

Source Code

- all C++ code available under BSD-like license
- including efficient implementations of:
  - SIFT Flow [Liu et al. 2011]
  - Domain Transform [Gastal & Oliveira 2011]
  - Temporal Consistency [Lang et al. 2012]
- plus our De-Anaglyph tool and example projects
- Project website: richardt.name/video-deanaglyph

Limitations

unreliable disparity maps
may produce poor results



large occlusions are difficult
to fill without inpainting

Conclusion

- achieve good reconstruction of full-color stereo views from anaglyph 3D videos:
  - focusing on temporal coherence
  - using state-of-the-art techniques
- also compute temporally coherent flows + disparities
  - can be used for post-processing tasks

richardt.name/video-deanaglyph