

# Multiple View Geometry

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Exercises: Julia Diebold & Robert Maier



# Reconstructing the World from Images

Some Recent Developments



# Reconstruction from Aerial Images



One of two input images



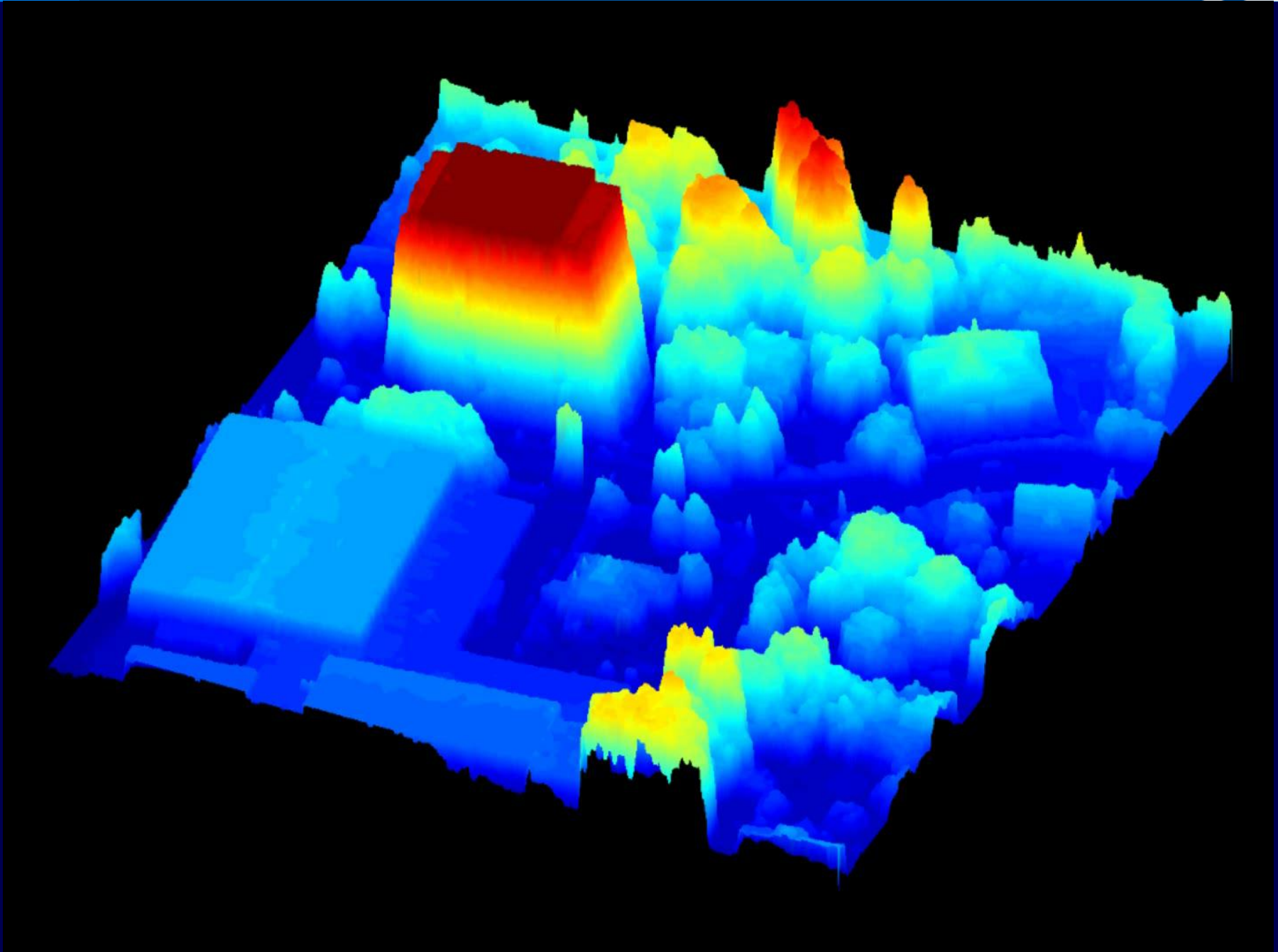
Depth reconstruction

*Pock, Schoenemann, Graber, Bischof, Cremers, ECCV '08*





# Reconstruction from Aerial Images





# Application: Driver Assistance





# Toward Free View-Point Television





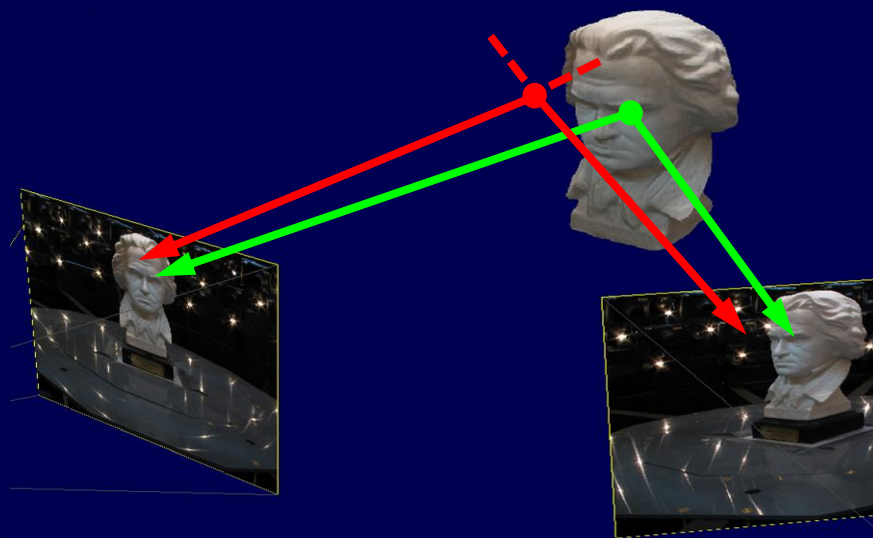
# Multiple View Reconstruction



# Solutions via Energy Minimization

Photoconsistency function:

$$\rho : \mathbb{R}^3 \rightarrow [0, 1]$$



Determine a surface  $S$  of optimal photoconsistency by minimizing

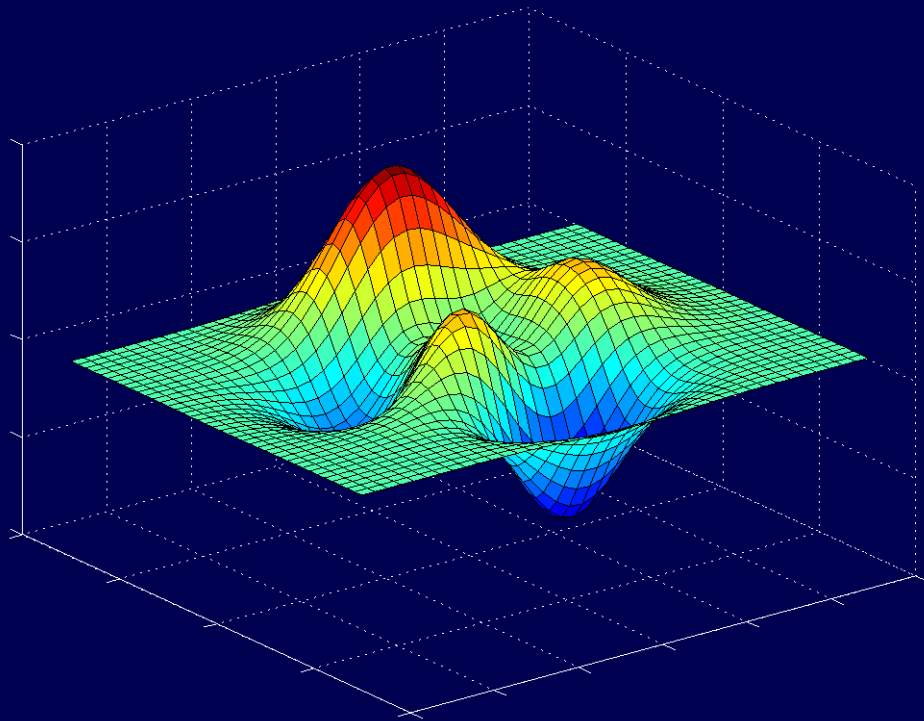
$$E(S) = \int_S \rho \, dA$$

*Kolev, Klodt, Brox, Cremers, Int. J. of Computer Vision '09:*

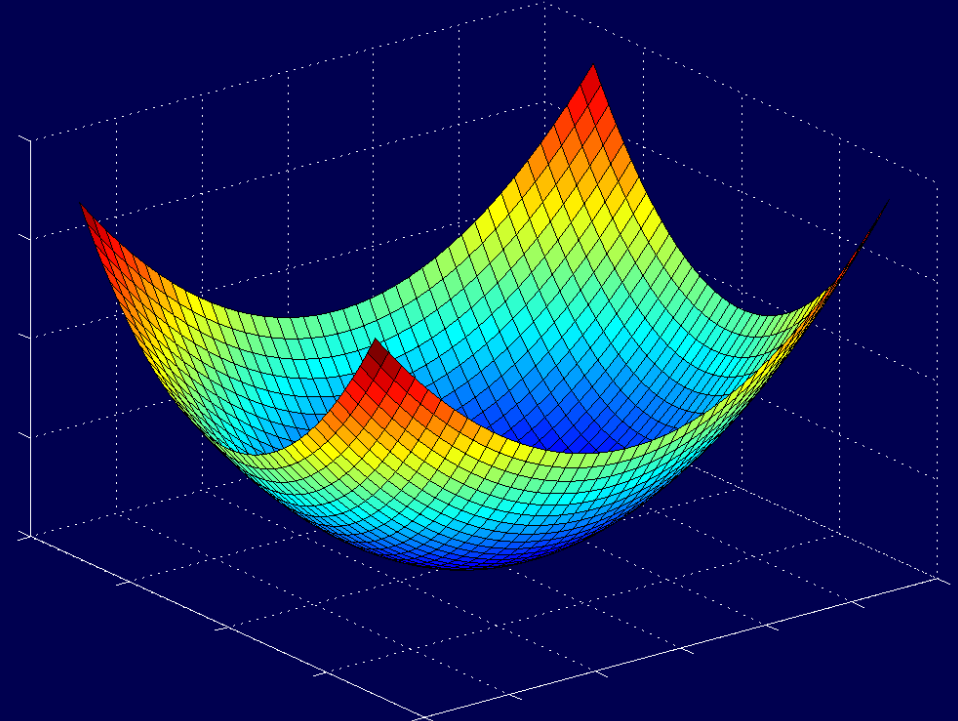
Theorem: Globally optimal surfaces can be computed via convex relaxation.



# Solutions via Energy Minimization

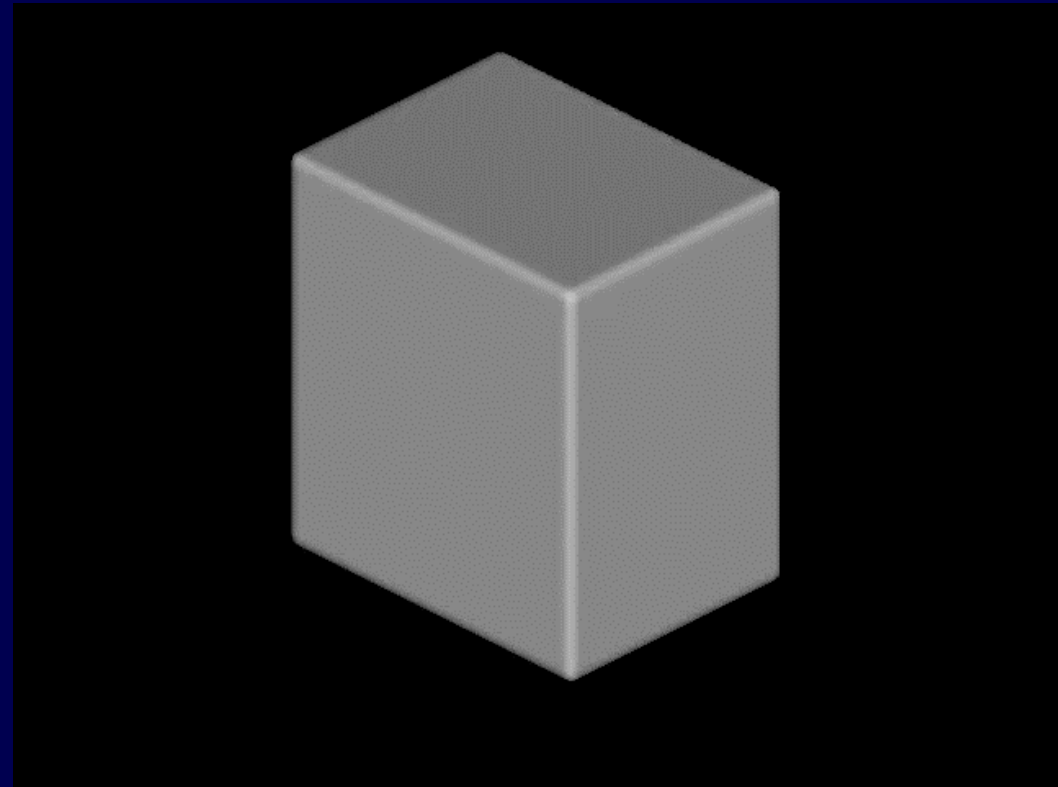
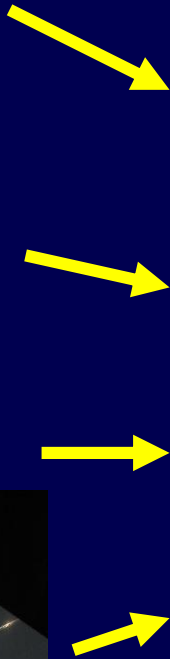


Non-convex energy



Convex energy

# 3D Reconstruction



*Kolev et al., Int. J. of Computer Vision 2009*



# Textured 3D Reconstruction



*Goldlücke, Cremers, ICCV '09, DAGM '09\**

*\* Best Paper Award*

# Silhouette Consistent Reconstruction



*Kolev, Cremers, ECCV '08, PAMI '09:*

Theorem: Provably silhouette-consistent reconstructions can be computed by convex optimization over convex domains.





# Reconstructing the Niobids Statues



*Kolev, Cremers, ECCV '08, PAMI '12*



# Reconstructing the Niobids Statues



*Kolev, Cremers, ECCV '08, PAMI '12*

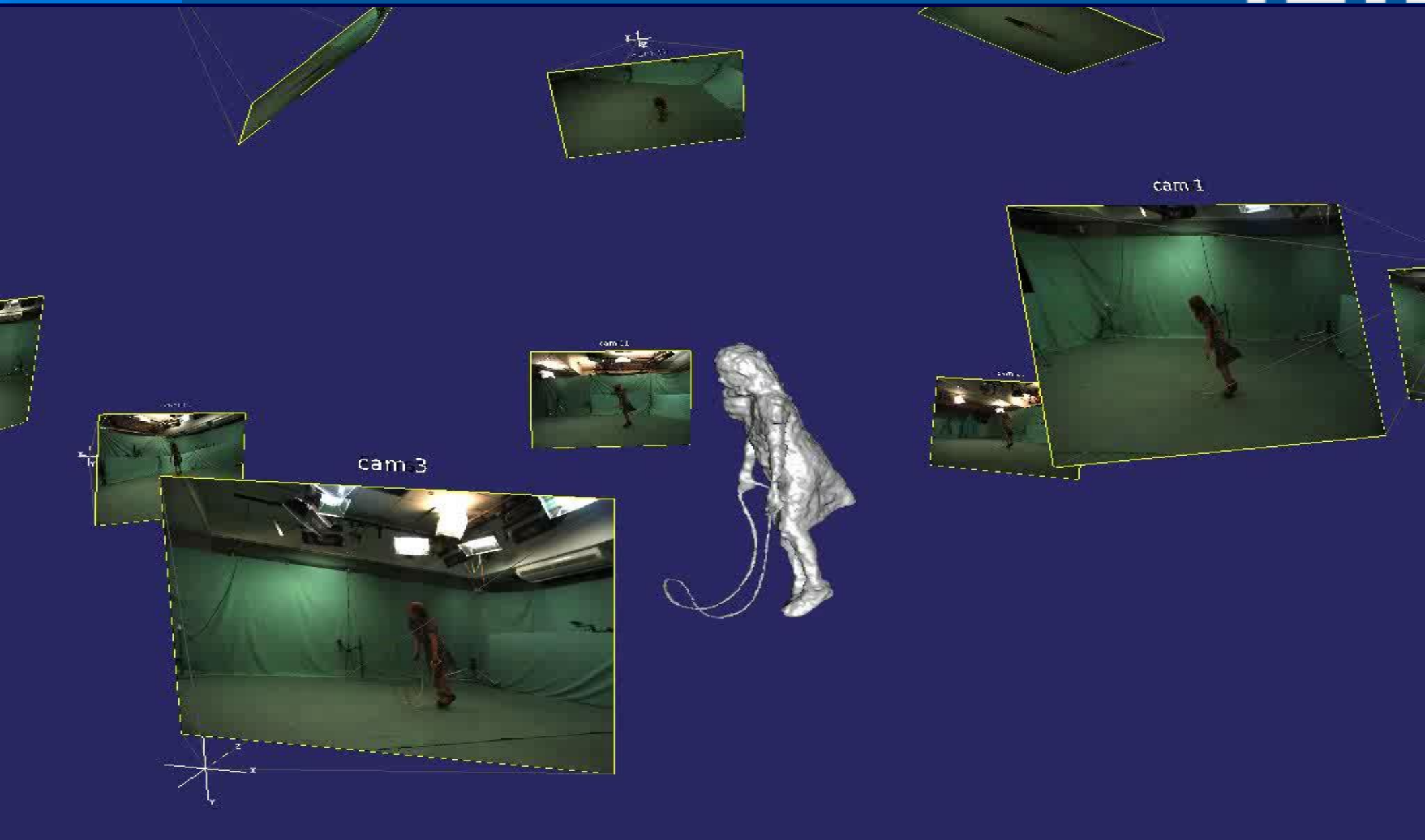


# Reconstructing the Niobids Statues



*Kolev, Cremers, ECCV '08, PAMI '12*

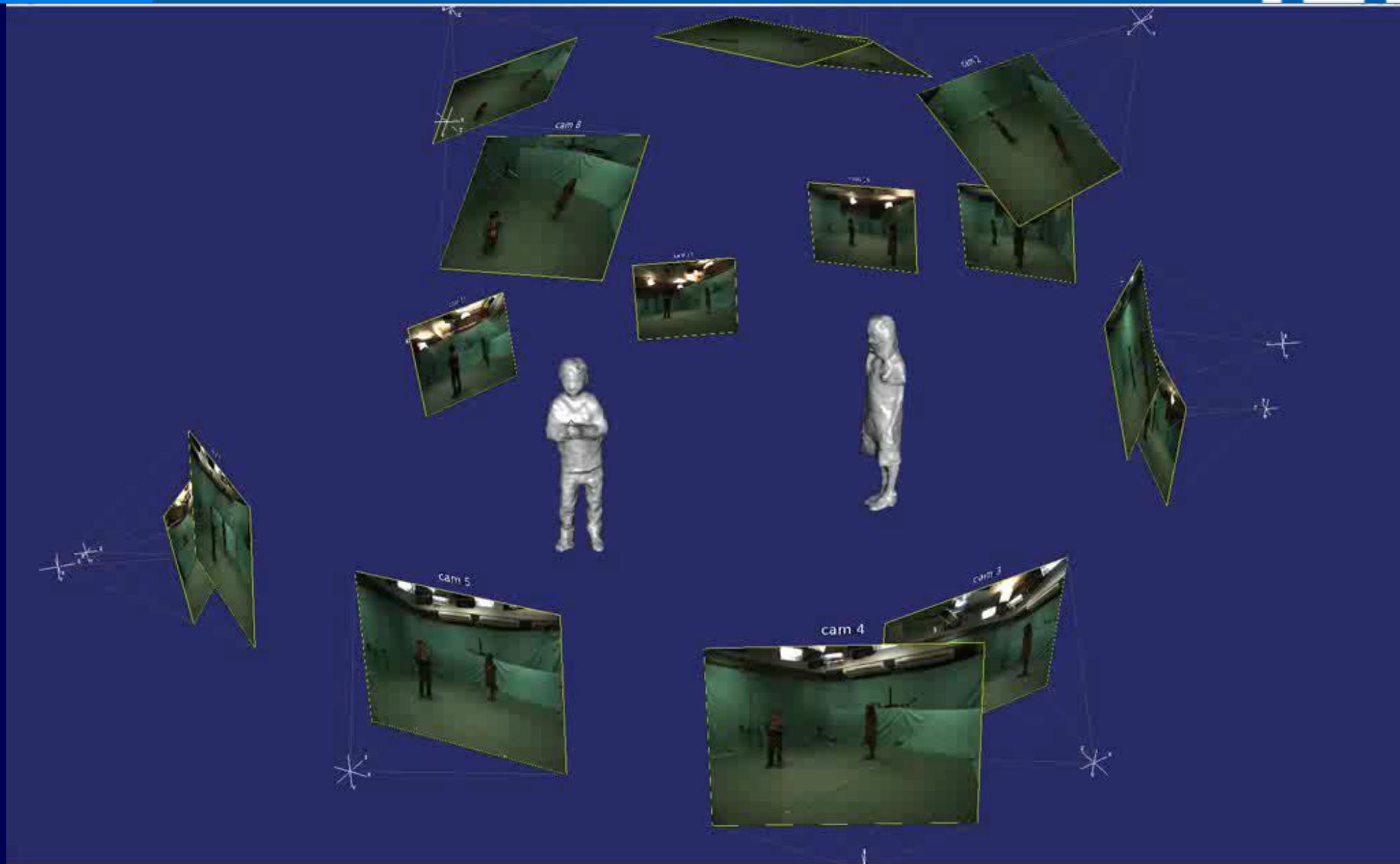
# Reconstructing Dynamic Scenes



*Oswald, Stühmer, Cremers, ECCV '14*



# Action Reconstruction



*Oswald, Cremers, ICCV '13 4DMoD Workshop*

# Action Reconstruction



# Application: Driver Assistance



*Wedel, Cremers, "Scene Flow", Springer 2011*



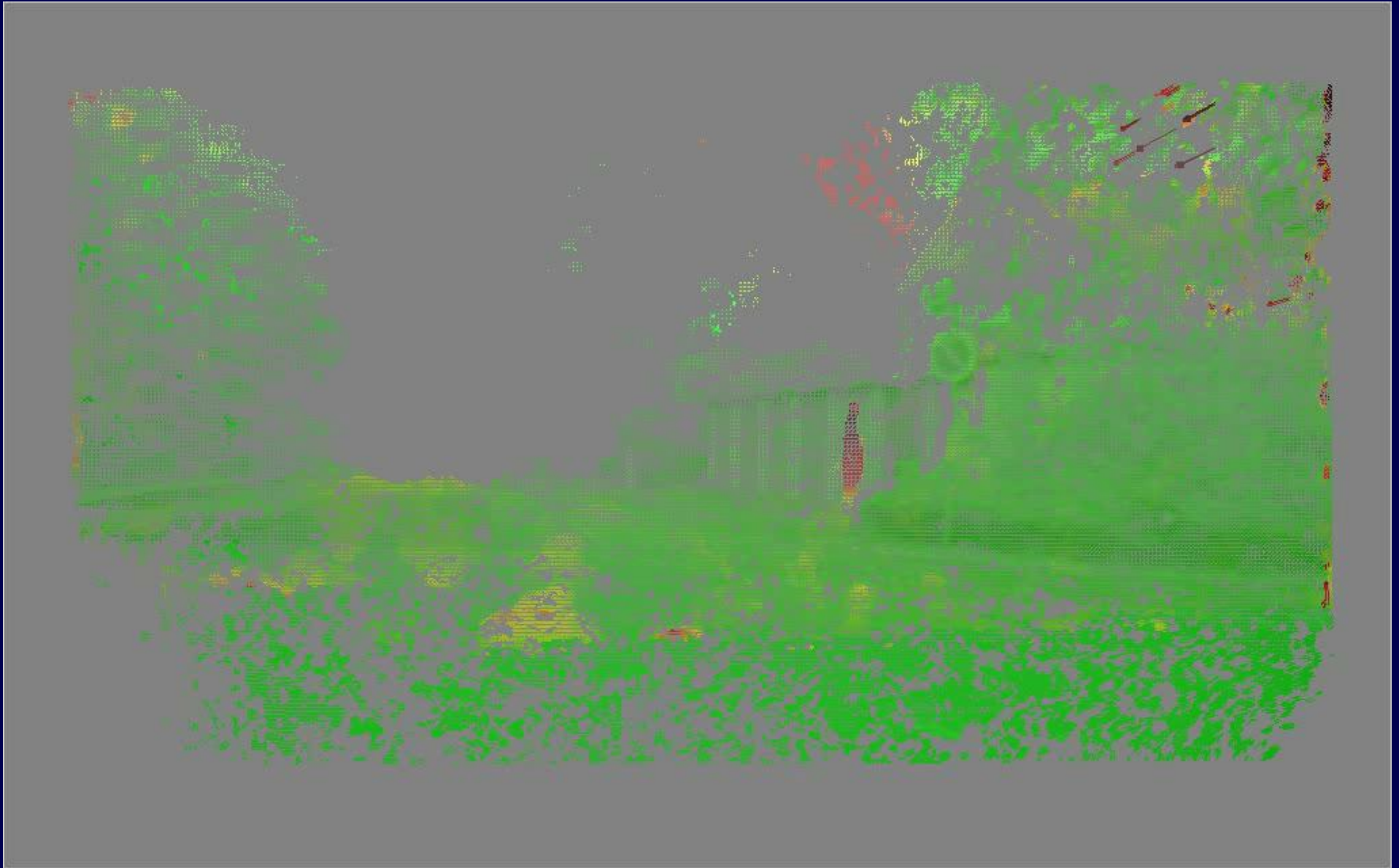


# Application: Driver Assistance

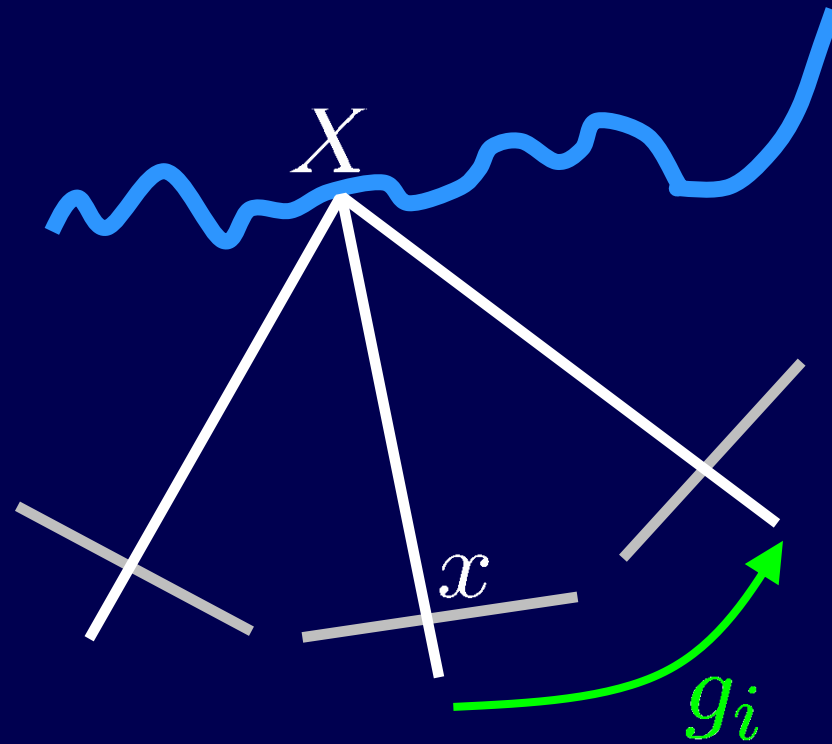


*Wedel, Cremers, "Scene Flow", Springer 2011*





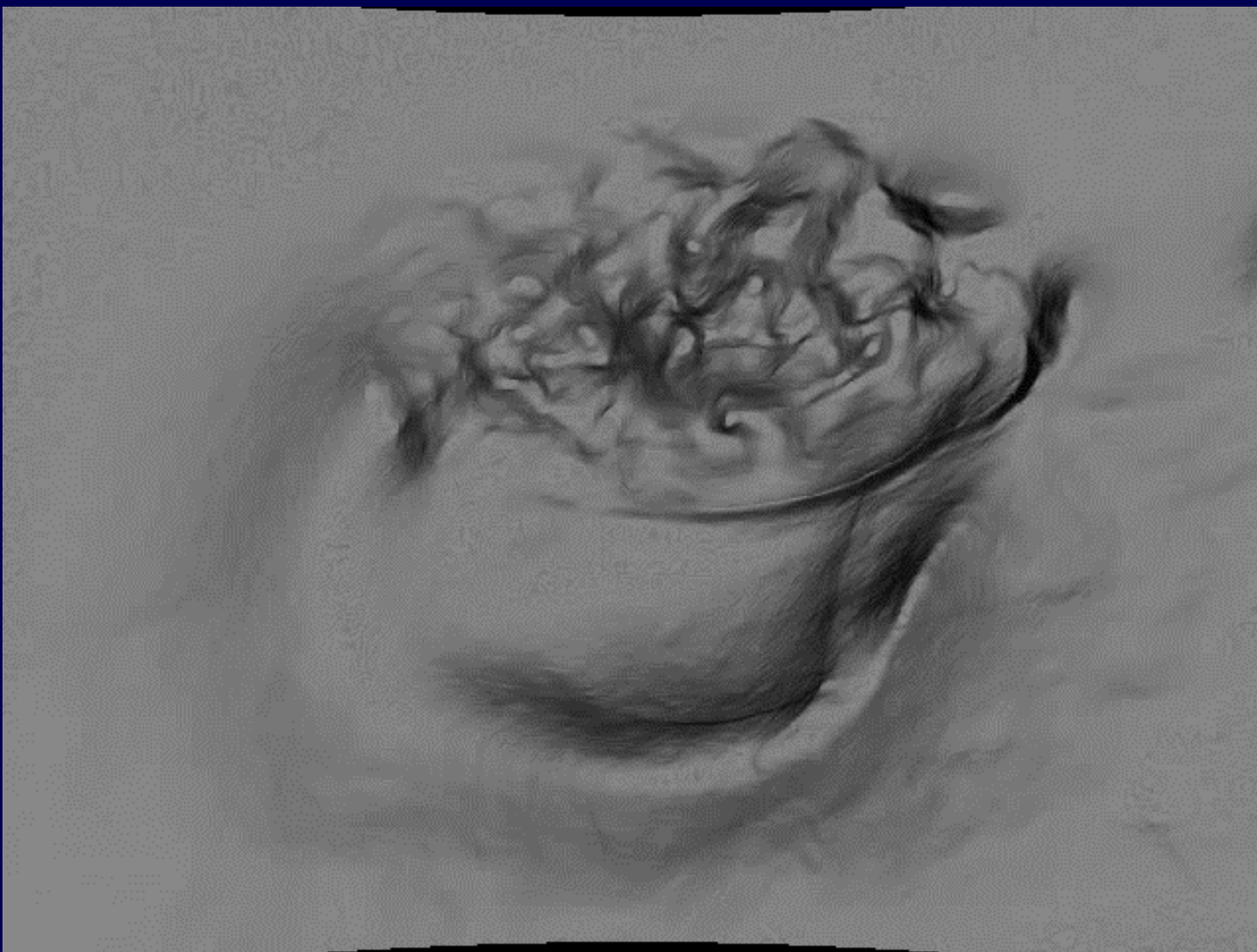
*Wedel, Cremers, "Scene Flow", Springer 2011*



*Stuehmer, Gumhold, Cremers, DAGM '10*



*Stuehmer, Gumhold, Cremers, DAGM '10*

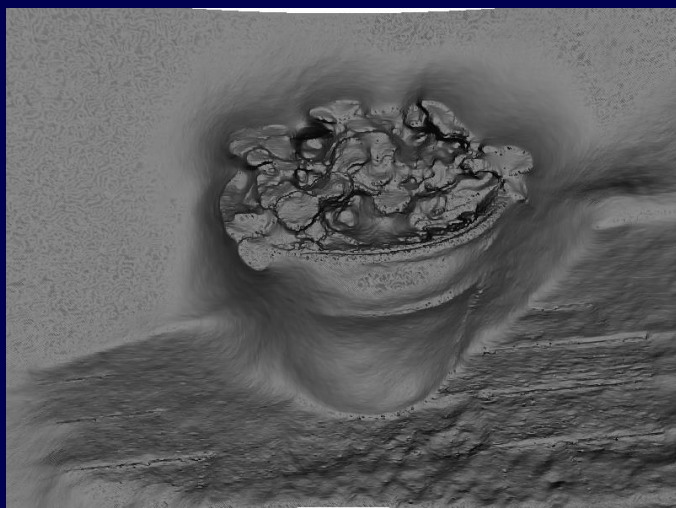


*Stuehmer, Gumhold, Cremers, DAGM '10*

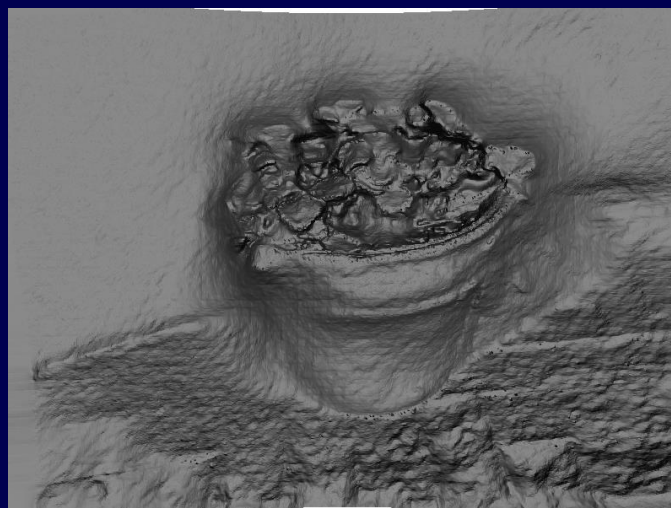




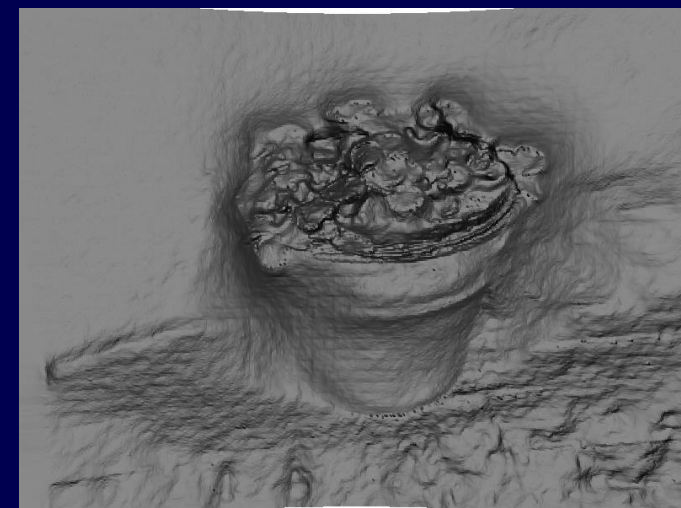
# Realtime 3D Reconstruction



1.8 fps



11.3 fps



24 fps

*Stuehmer, Gumhold, Cremers, DAGM '10*



# LSD SLAM



*Engel, Schöps, Cremers, ECCV 2014: Large-Scale Direct Monocular SLAM*





# Autonomous Quadcopters



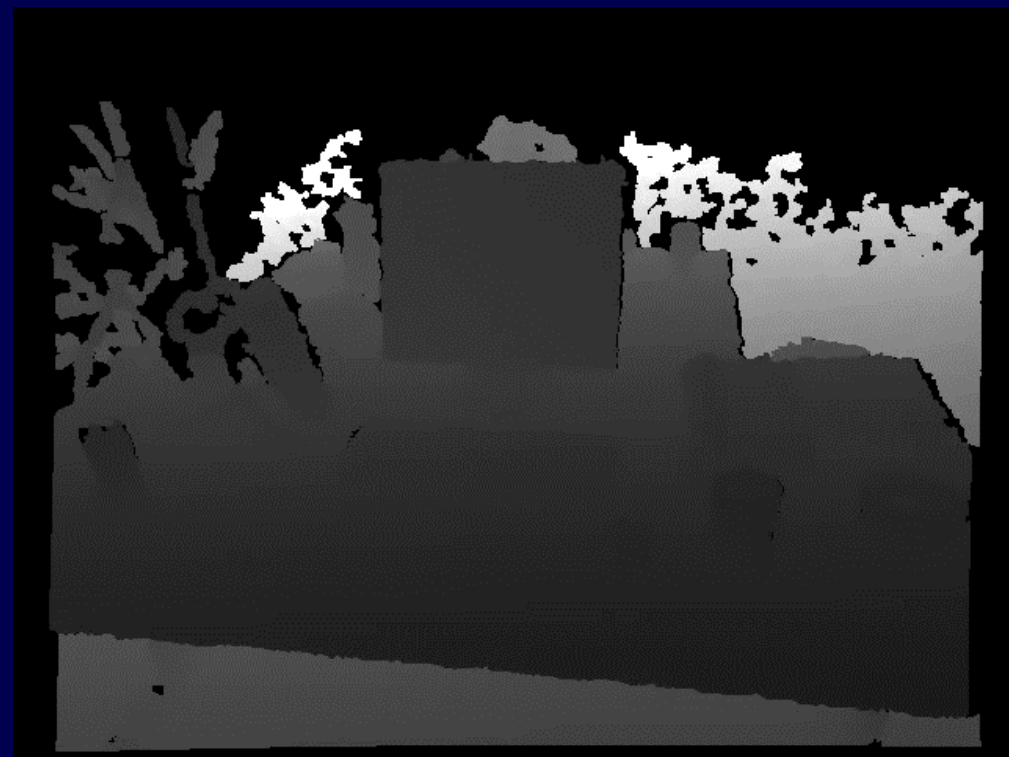
*Engel et al. IROS '11*



# RGB-D Cameras



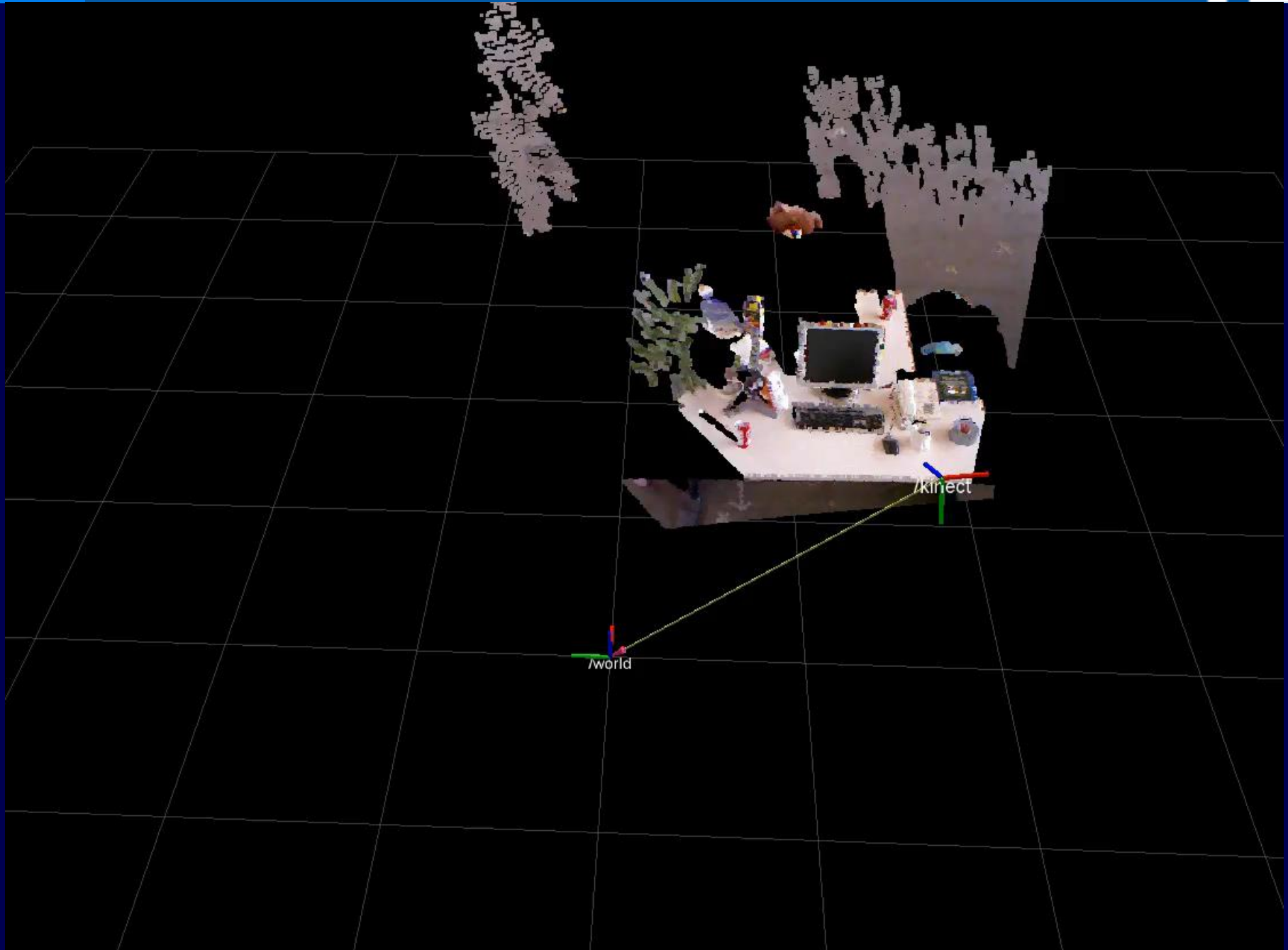
Color input



Depth input



# Accurate Camera Tracking





# Realtime 3D Modeling



Color input



Depth input

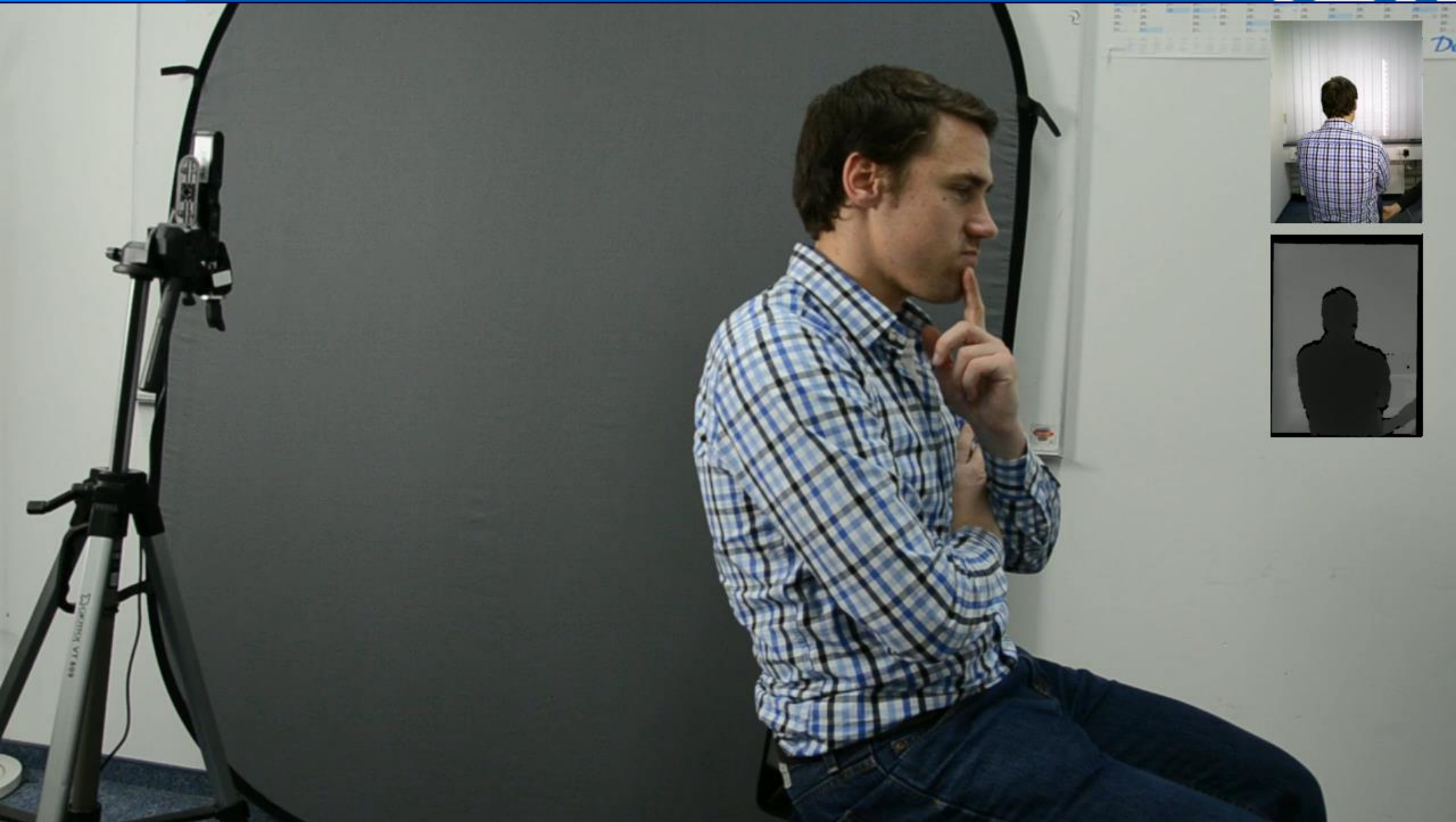


# Realtime 3D Modeling





# Realtime 3D Modeling



Download demo @ <http://www.fablitec.com>





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# Reconstruction on the Fly



*Bylow, Sturm, Kerl, Kahl, Cremers RSS '13*

# Large Scale: Loop Closure

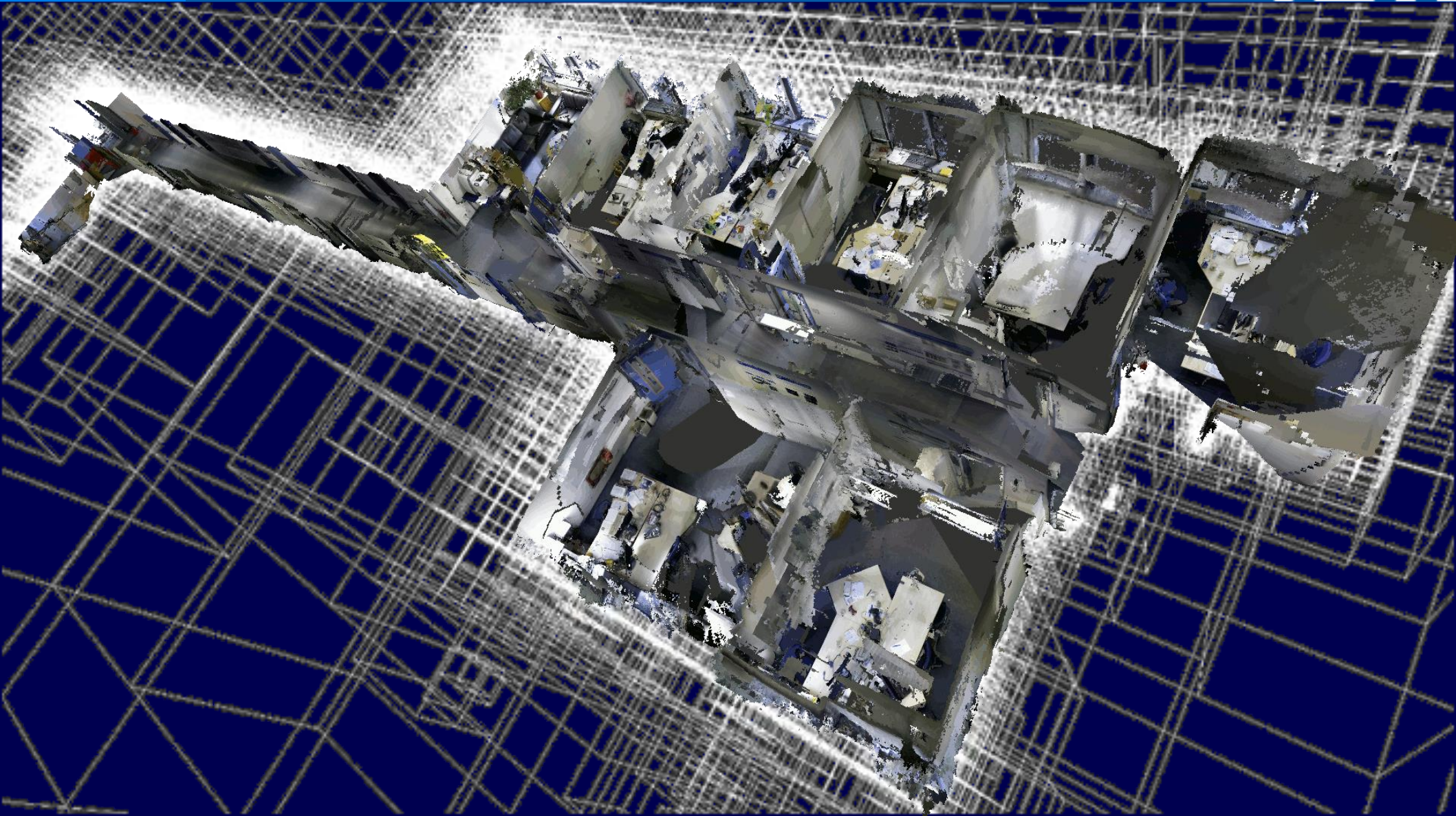
RGB-D dataset 'fr3/office'

*Kerl, Sturm, Cremers ICRA '13*

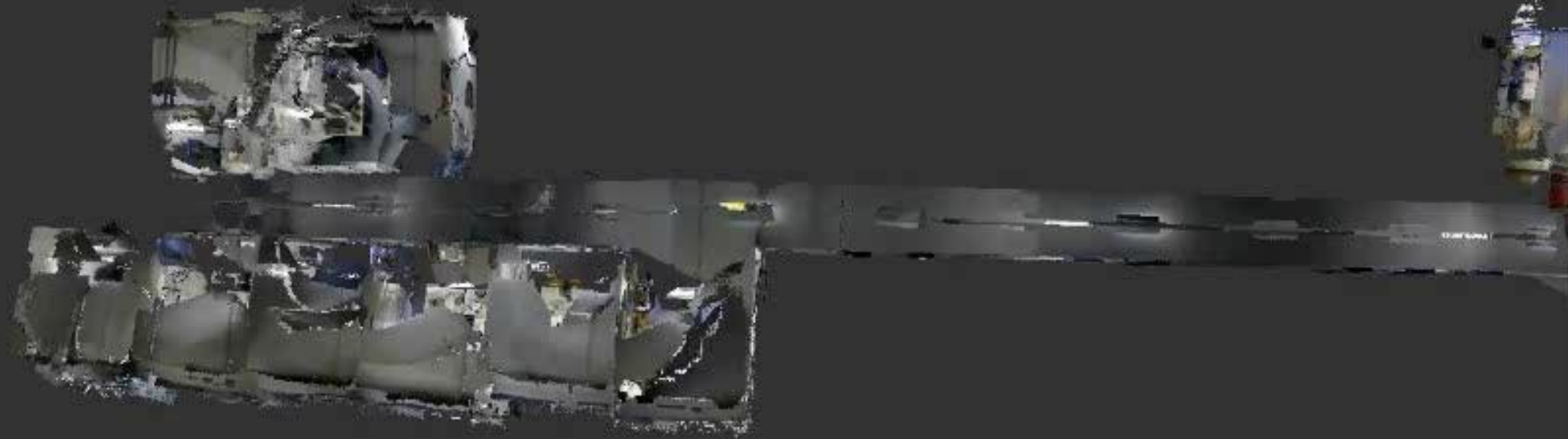




# Large Scale: Octrees



*Steinbrücker, Kerl, Sturm, Cremers ICCV '13*



## Large-Scale Reconstruction

*Steinbrücker, Kerl, Sturm, Cremers ICCV '13, ICRA '14*



# Summary



multiview reconstruction



super-res. textures



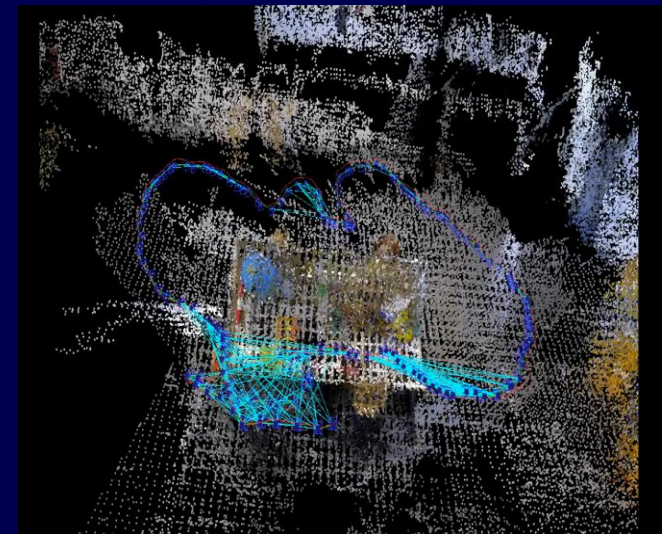
action reconstruction



visual SLAM



RGB-D modeling



large scale reconstruction