It's All Done with Mirrors

Correspondence-and-Calibration-Free 3D Reconstruction

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Multiple-view reconstruction

Need calibrated images of the object

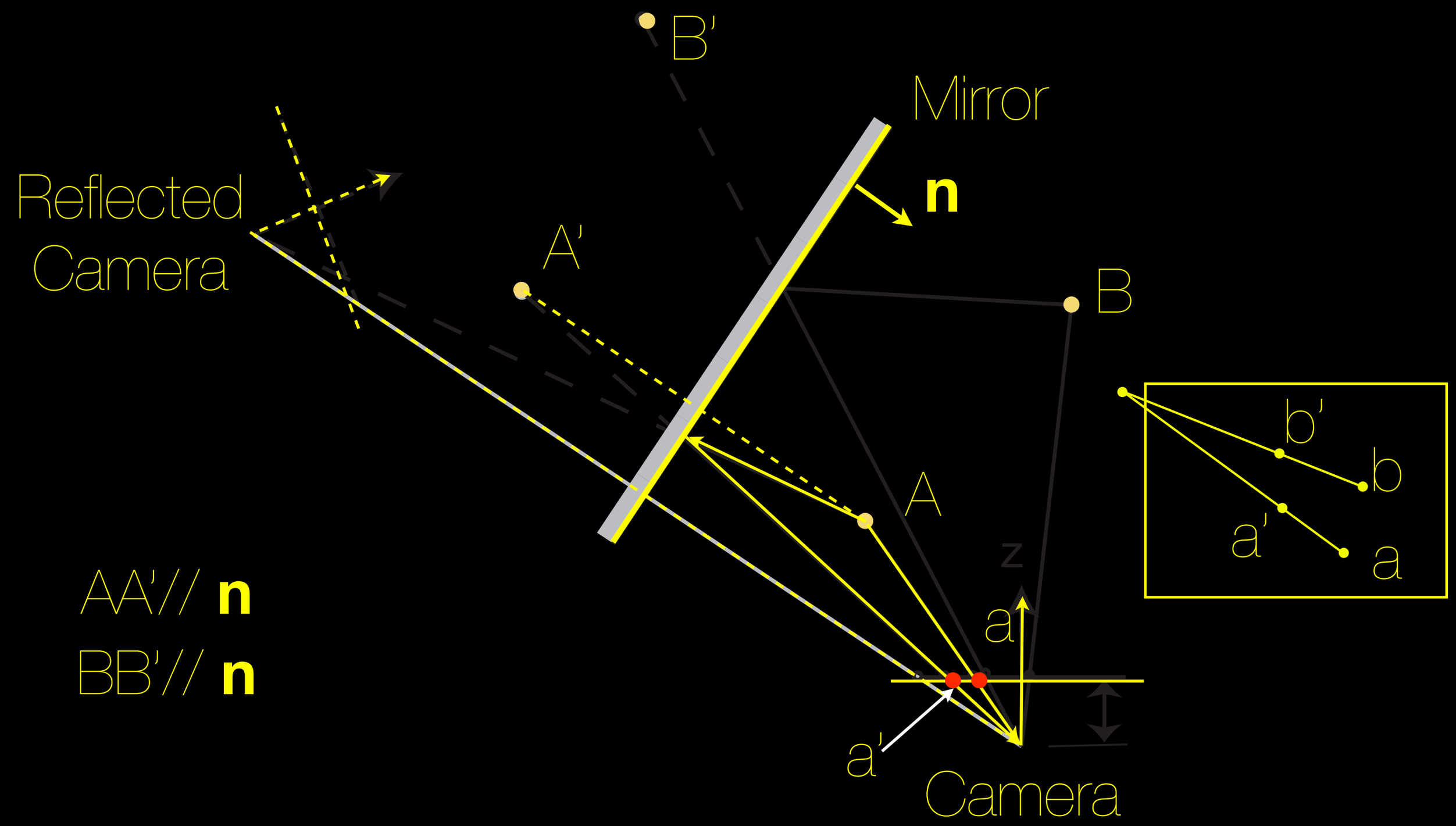
How to get the images

- Turn table with single static camera
- Fixed array of static cameras
- Moving camera(s)

Here comes the mirror

- Automatic multiple-view silhouette based reconstruction
- More flexible than camera arrays
  - freely place the extra views (with slight constraints)
  - Identical intrinsic parameters
- Easier to calibrate than a moving camera

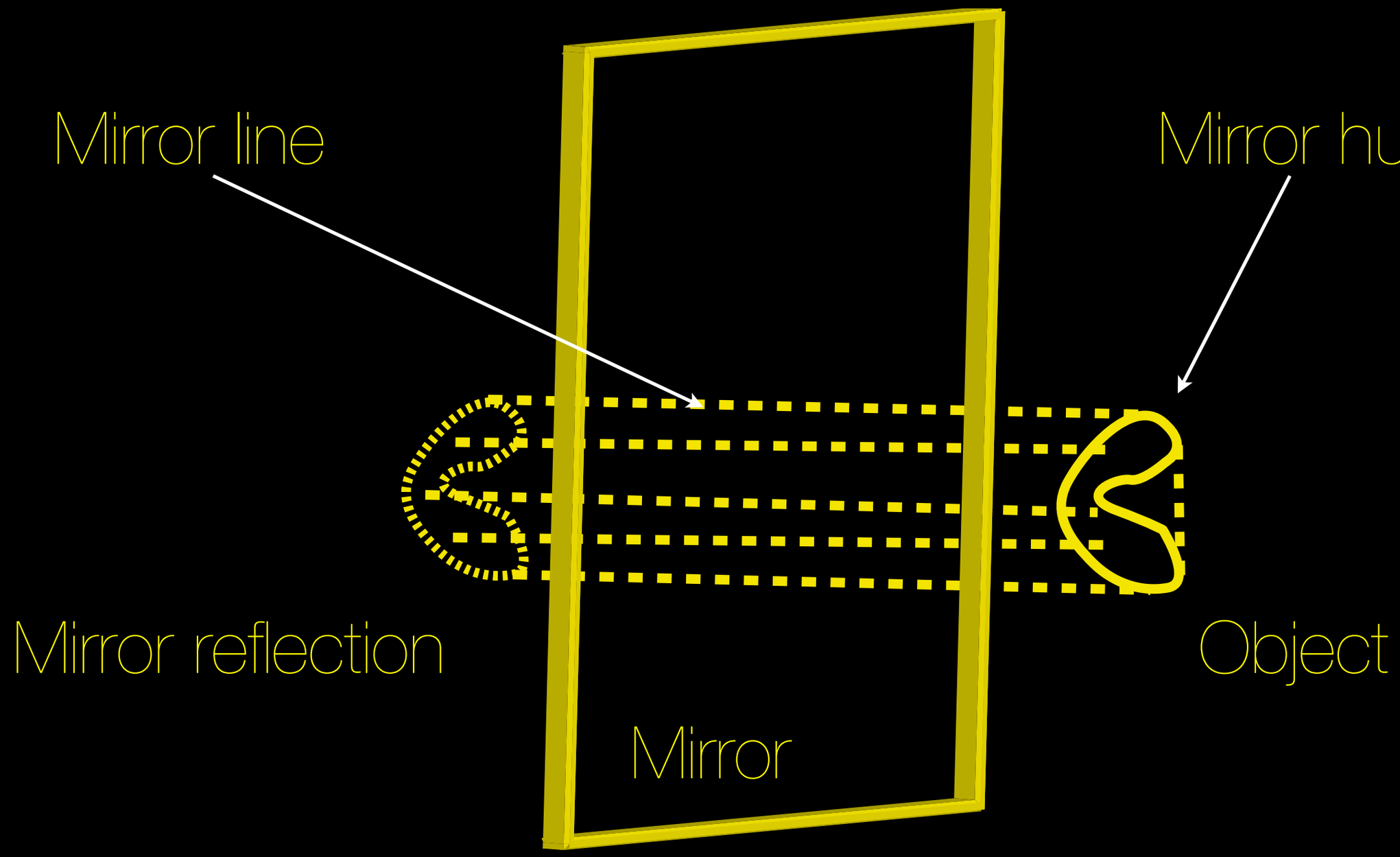
Mirror induced camera



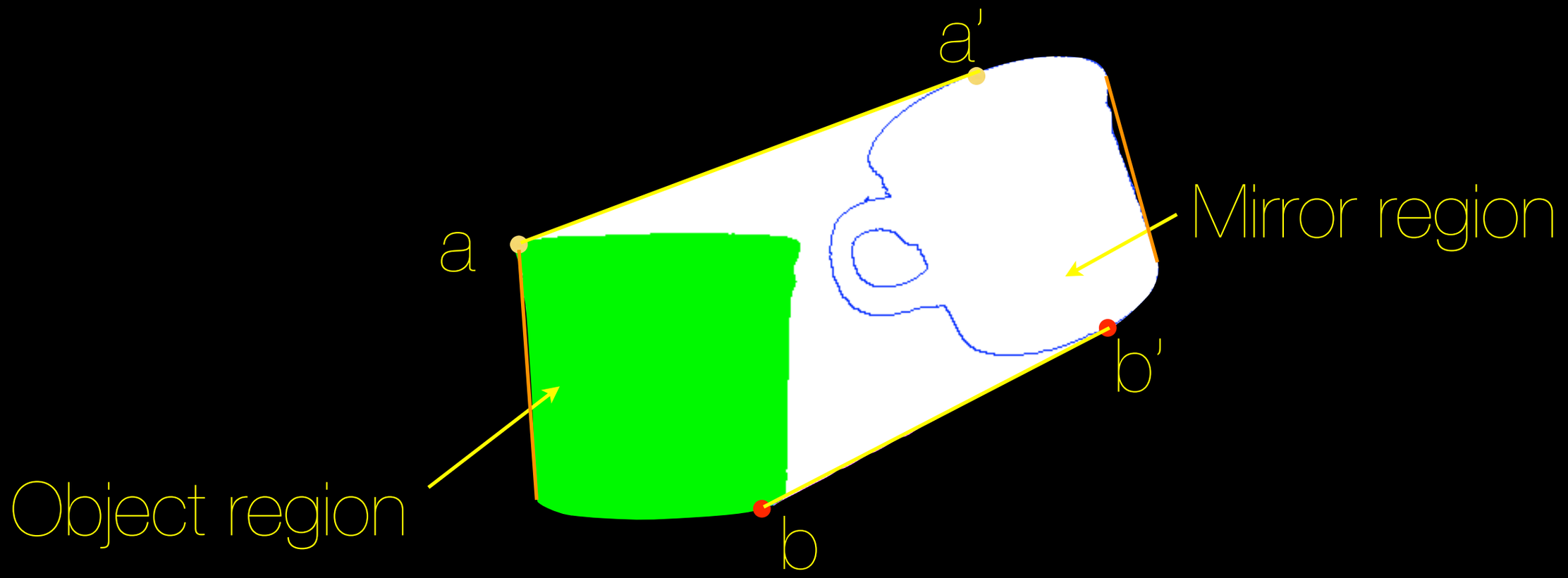
Locating the mirror

- Equation $\mathbf{n} \cdot \mathbf{x} + d = 0$
- Orientation (plane normal) first
- Distance second

Mirror hull and mirror line



Supporting lines



Definition of supporting line

- part of the convex hull
- end points belong to two different regions

Finding supporting lines

- Segment and label object and mirror regions
- Compute the convex hull of object and mirror regions
- The edges that connects the regions are the supporting lines
- At most two can be found

Visibility requirement

Correspondence-free

Claim:

Each supporting line provides a correspondence of an object point and its mirror image.

Proof:

A supporting line is the projection of a mirror line if the visibility requirement is met.

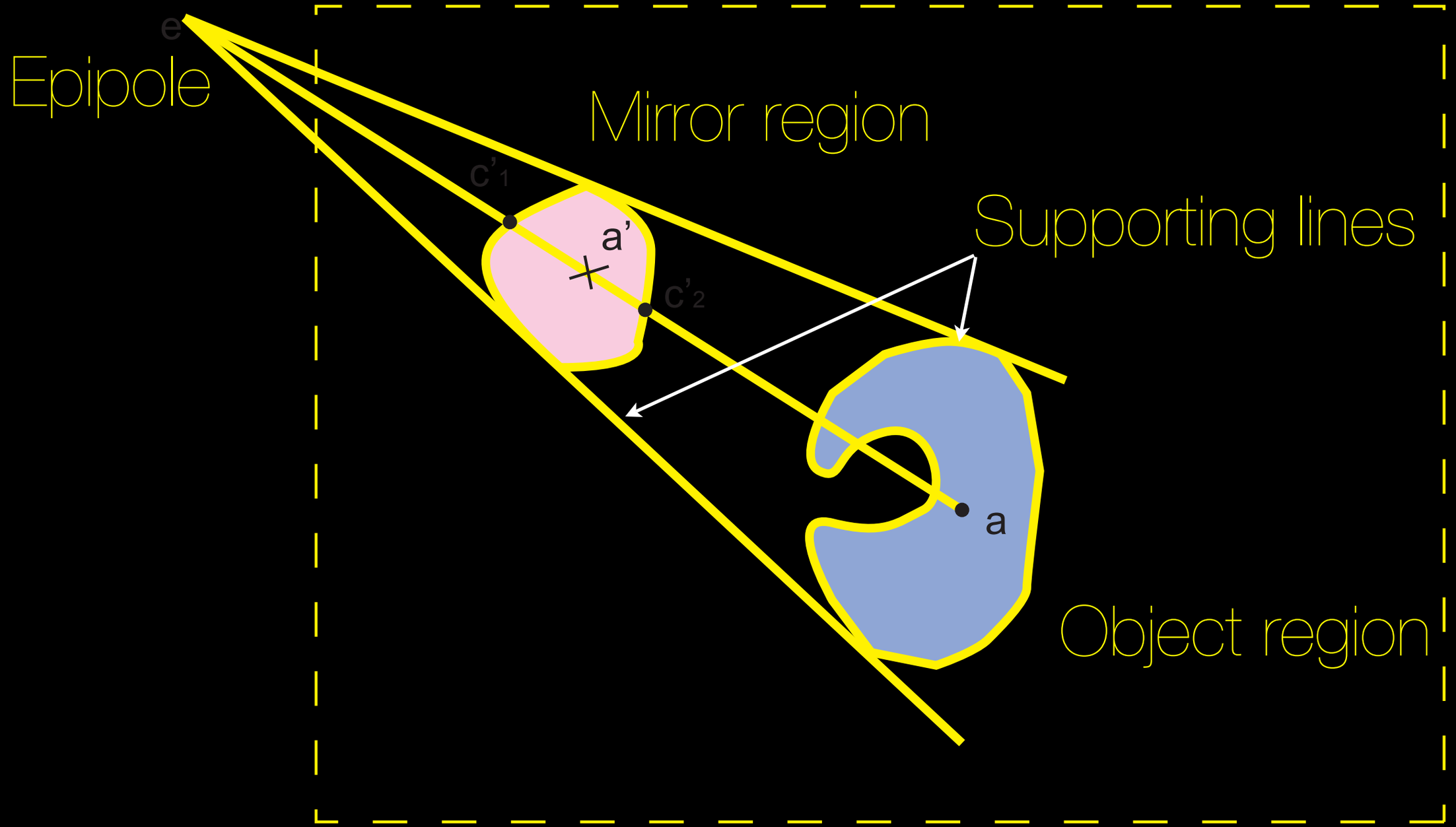
Distance of the mirror

- Tracking a single scene point
- Tracking two points on the mirror

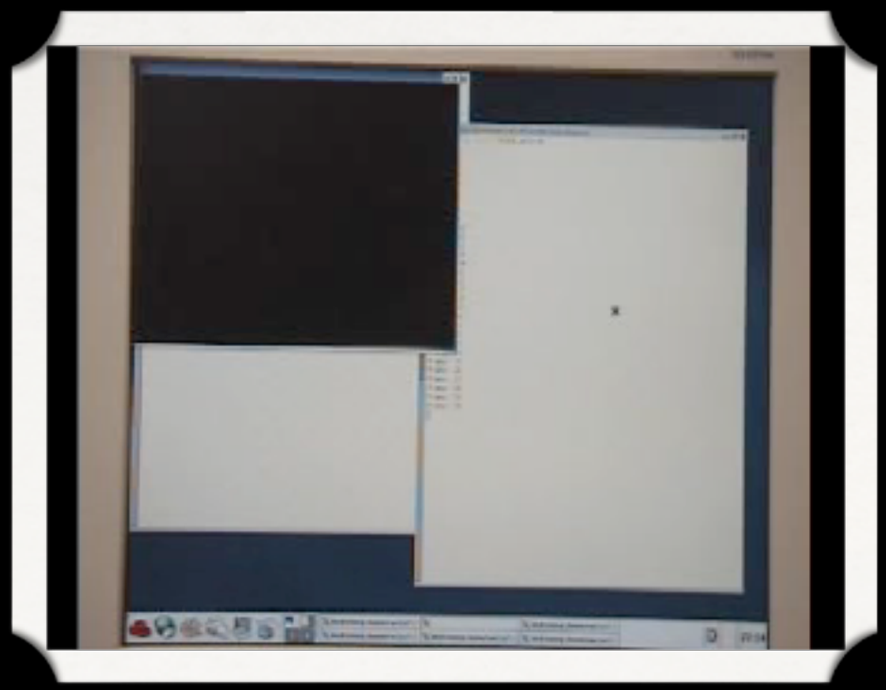
That's it

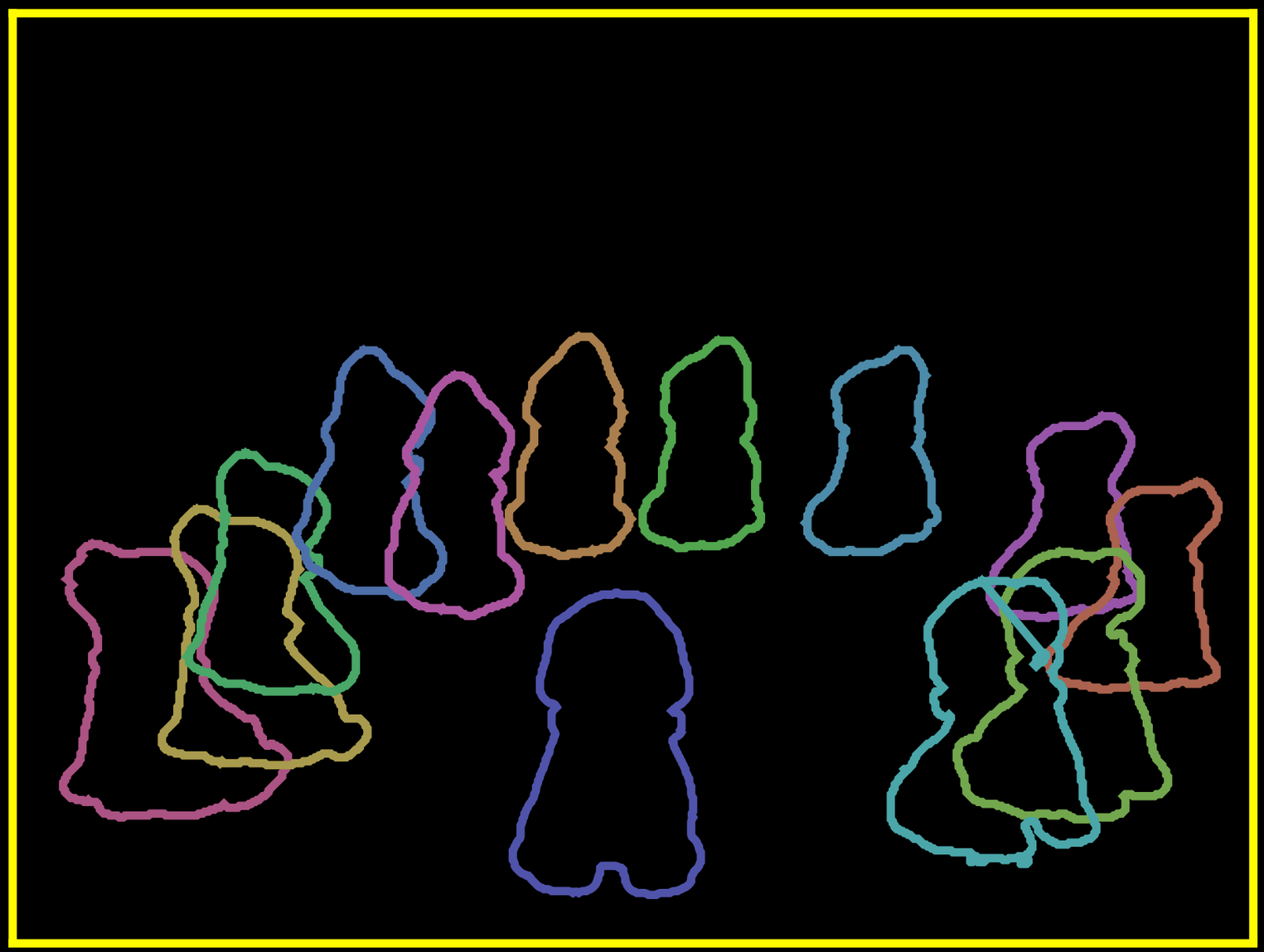
We now have multiple calibrated views of an object

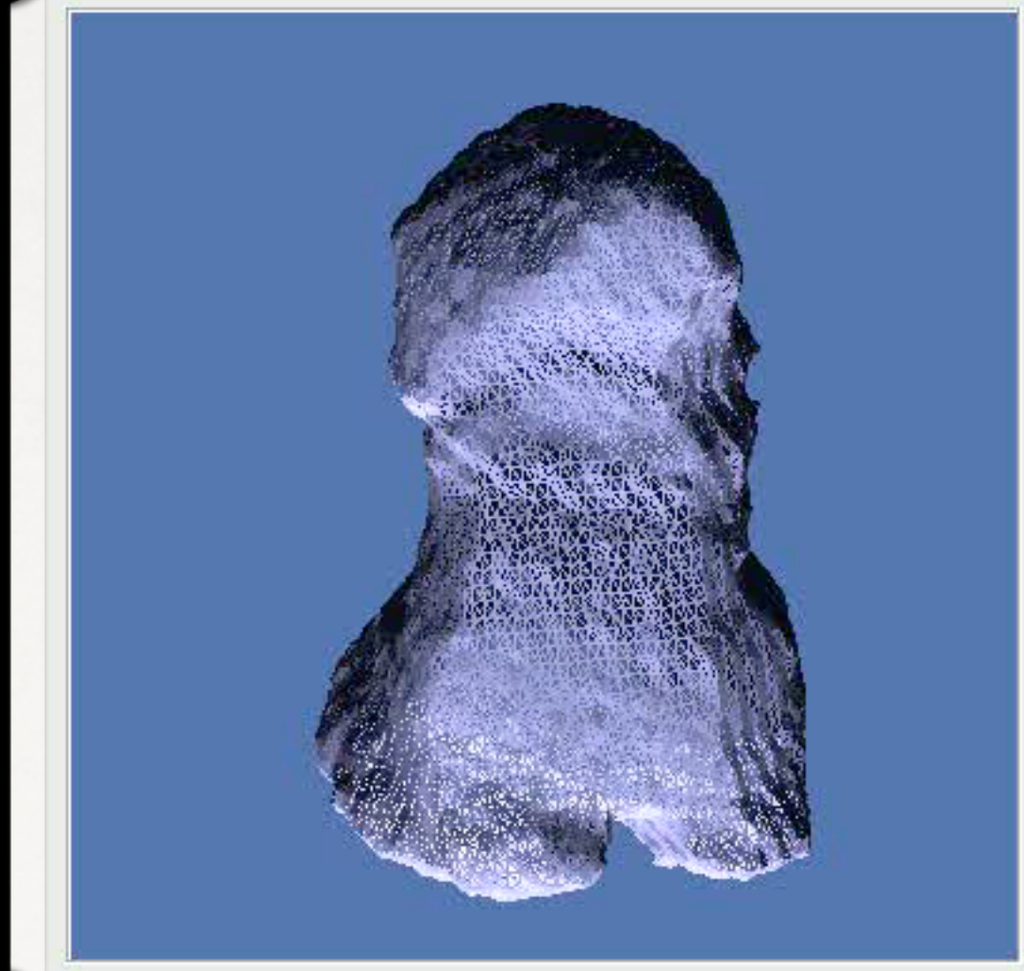
Volumetric representation



In action







Limitations

- Requiring internally calibrated camera
- Segmentation
- Static and extra views sharing a single image
- Partial coverage of the view hemisphere

What we have shown

- Simple setup; no special devices
- Fully automatic
- Fast; reconstruction in real-time

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