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Reconstruction and Motion Estimation from Apparent Contours under Circular Motion

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Introduction

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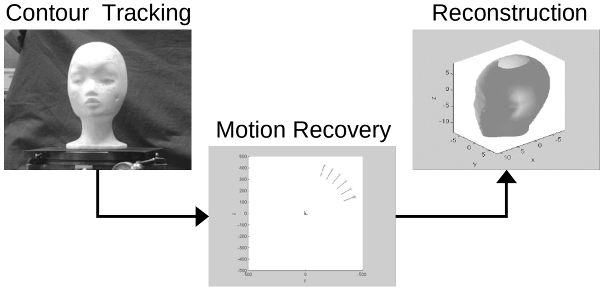
- What's new?



Apparent Contours

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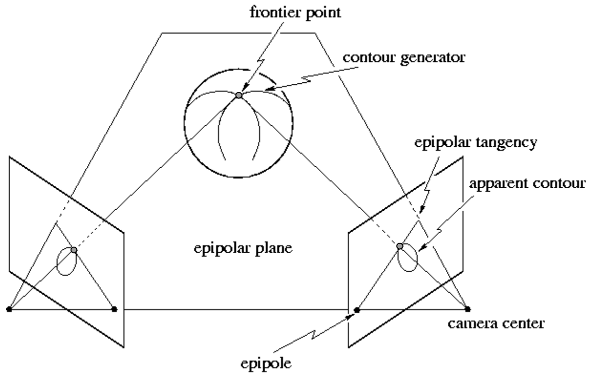

Epipolar Parameterisation

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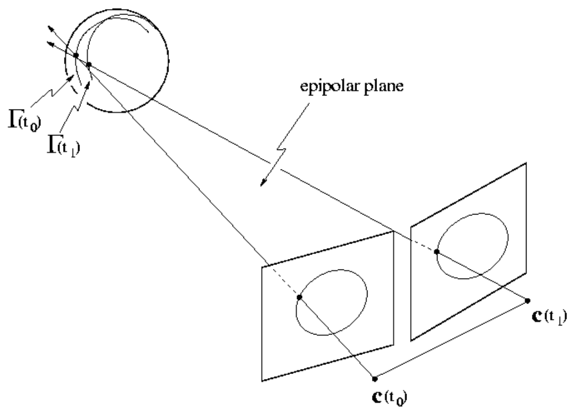

Reconstruction

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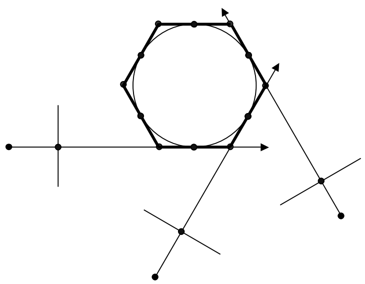
- Volume intersection.



Reconstruction Error

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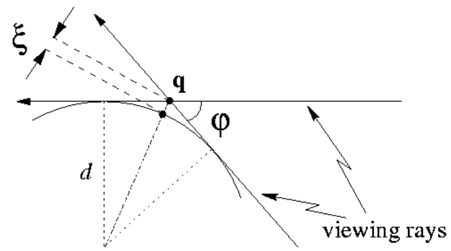

- $\xi = (\sec(\varphi/2) - 1)d \approx d\ \varphi^2/8$
- for $\varphi = 10^o$, $\xi \approx 0.4\%$ of radius d

Motion Recovery: Method 1

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- Capture images of a calibration grid at multiple positions of the turntable

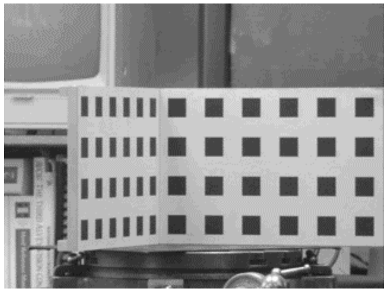

Image Capture

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- Replace grid with object and capture corresponding views

Calibration

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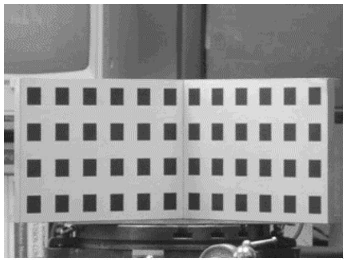
- For each camera position, solve for the 3x4 camera projection matrix



Calibration

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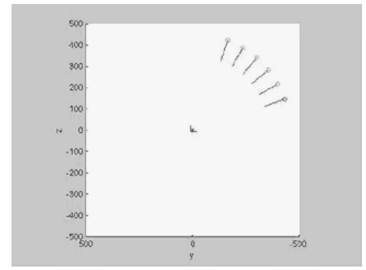
- Track corner points in grid, fit circles to the 3D points, and solve for axis of rotation



Track Apparent Contours

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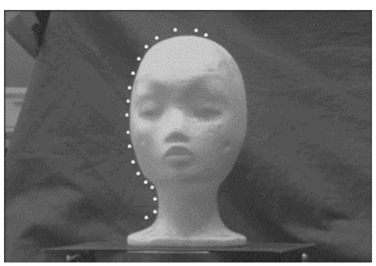
- B-spline snake used to track object contour



Epipolar Parameterization

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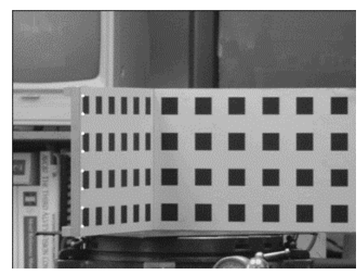
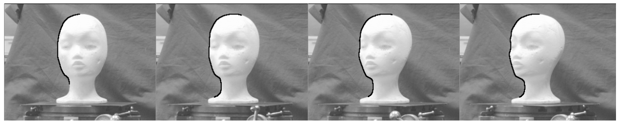
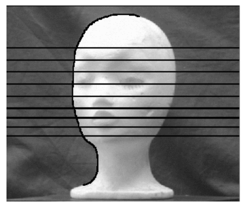
- Find correspondences between apparent contours using epipolar parameterization



Experiment

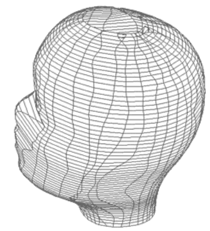


- profiles tracked by B-Spline snakes
- correspondences found by intersections of B-Splines with epipolar lines

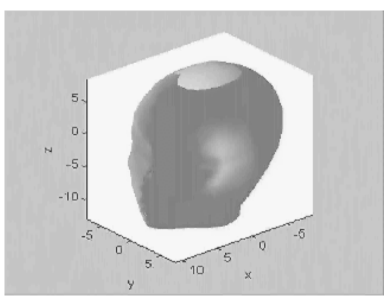


Wire Frame Triangulation

- Points computed by triangulation using pairs of point correspondences

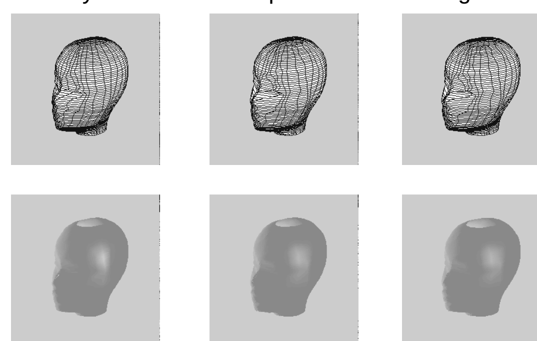


Shaded Model



Results

Boyer Cipolla Triangulation



Experimental Results

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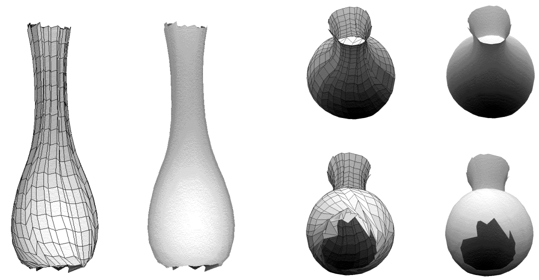
Reconstruction of vase: **DEMO 1**



Experimental Results

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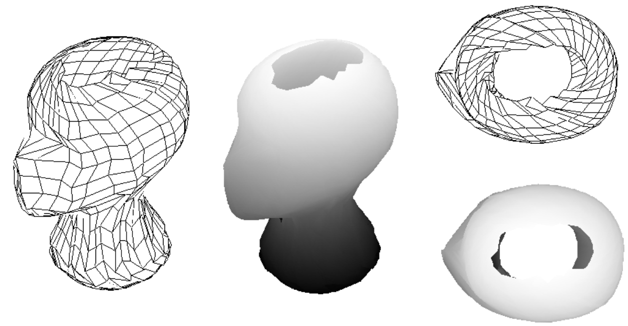
Reconstruction of head model:



Motion Recovery: Method 2

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- Epipolar Geometry - **F**:
  - General Motion (7 d.o.f):
    - ≥ 7 epipolar tangencies.
  - Affine Approximation (4 d.o.f):
    - ≥ 4 epipolar tangencies.
  - Circular Motion (6 d.o.f.):
    - ≥ 2 epipolar tangencies.
    - symmetry properties of surface of revolution (4 d.o.f.).

Symmetry Properties

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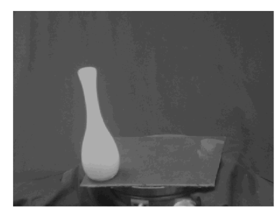
- Image of surface of revolution:
  - symmetric about image of screw axis.



Harmonic Homology

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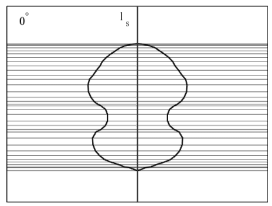
- Pointing towards screw axis:
  - bilateral symmetry.
- Otherwise:
  - harmonic homology.

$$\mathbf{W} = \mathbf{I} - 2\frac{\mathbf{v}_x \mathbf{l}_s^T}{\mathbf{v}_x^T \mathbf{l}_s}$$



Epipolar Geometry

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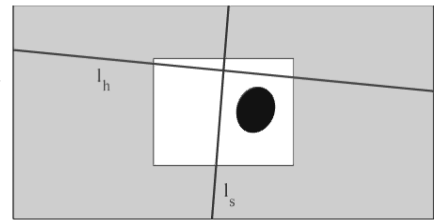
- For circular motion:
  - fixed entities:
    - image of screw axis, horizon, $\mathbf{v}_x$: 5 d.o.f.
  - epipoles and epipolar lines related by **W**.

$$\mathbf{F} = \mathbf{e}_\times \mathbf{W}$$



Epipolar Geometry

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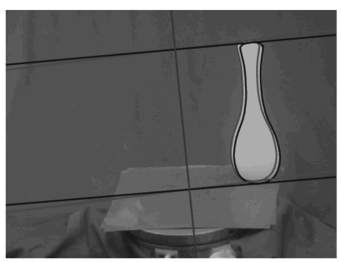
- Correspondent epipolar tangents:
  - related by **W**, intersect at image of screw axis.
- Epipolar tangents in same image:
  - intersect at the epipole.



Preliminary Results

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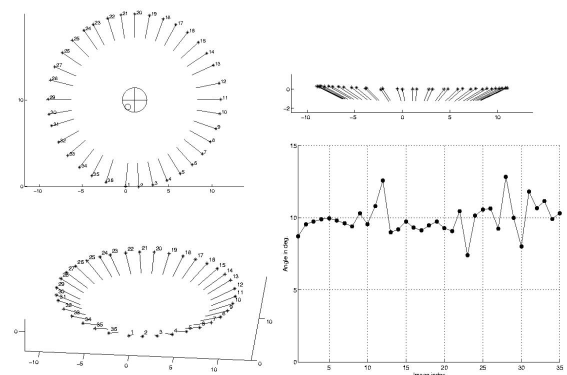

Conclusions

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- Simple Triangulation
  - computationally simple
  - can cope with planar surfaces
- Motion Estimation
  - requires only two epipolar tangencies
  - divide and conquer
  - trivial initializations for all the optimizations
  - low-dimension search space