

Reconstruction and Motion Estimation from Apparent Contours under Circular Motion

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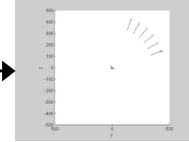
Introduction

- What's new?

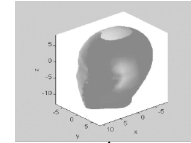
Contour Tracking



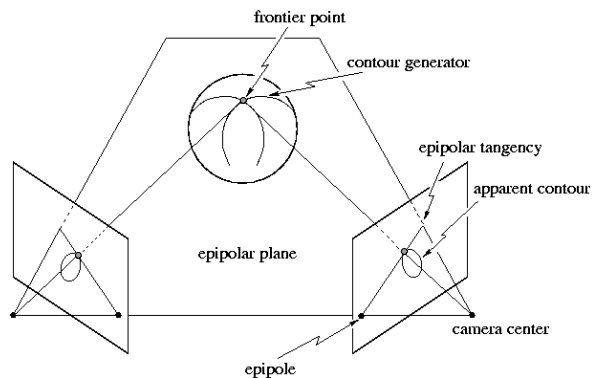
Motion Recovery



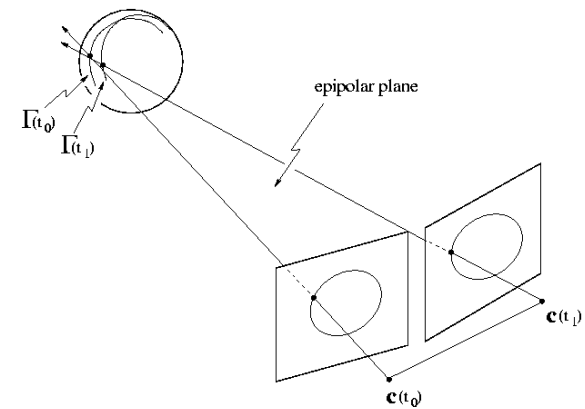
Reconstruction



Apparent Contours

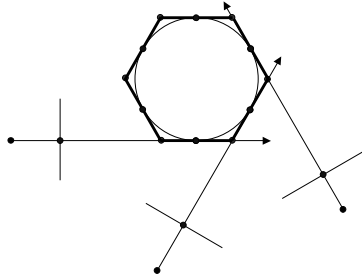


Epipolar Parameterisation

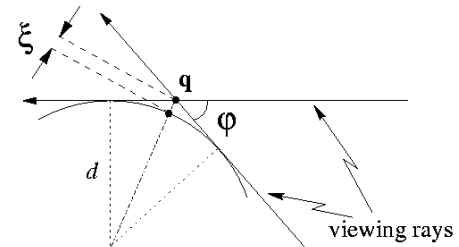


Reconstruction

- Volume intersection.



Reconstruction Error



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

Motion Recovery: Method 1

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

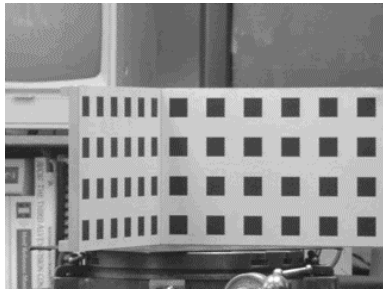


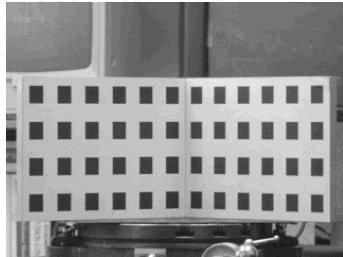
Image Capture

- Replace grid with object and capture corresponding views



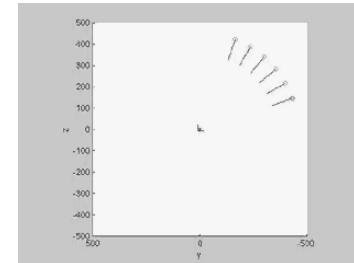
Calibration

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



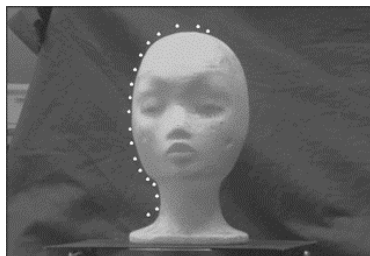
Calibration

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



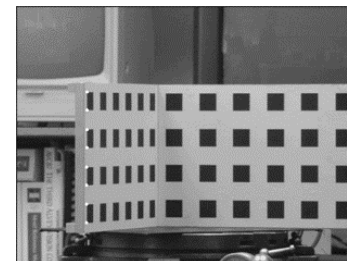
Track Apparent Contours

- B-spline snake used to track object contour

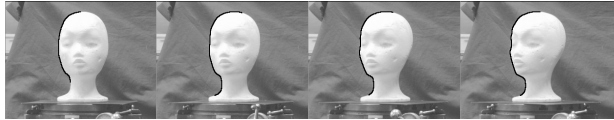


Epipolar Parameterization

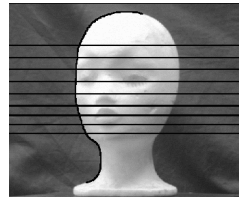
- Find correspondences between apparent contours using epipolar parameterization



Experiment

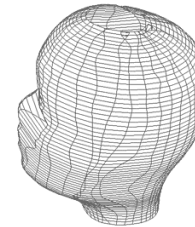


- profiles tracked by B-Spline snakes
- correspondences found by intersections of B-Splines with epipolar lines

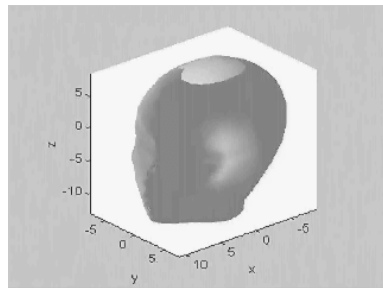


Wire Frame Triangulation

- Points computed by triangulation using pairs of point correspondences

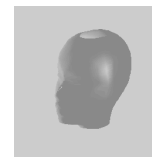
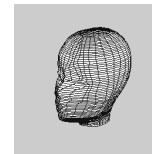


Shaded Model

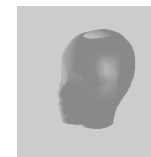
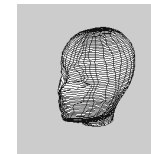


Results

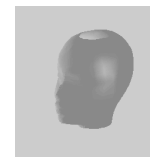
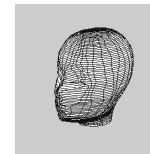
Boyer



Cipolla

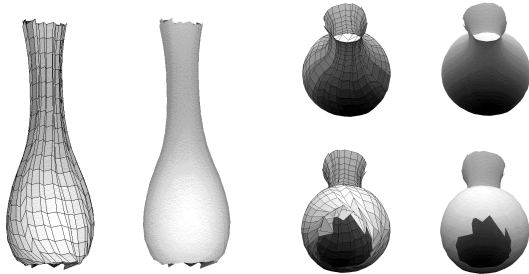


Triangulation



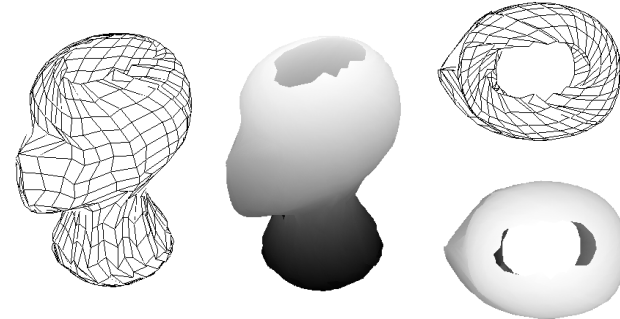
Experimental Results

Reconstruction of vase: **DEMO 1**



Experimental Results

Reconstruction of head model:



Motion Recovery: Method 2

- 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

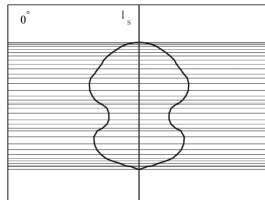
- Image of surface of revolution:
 - symmetric about image of screw axis.



Harmonic Homology

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

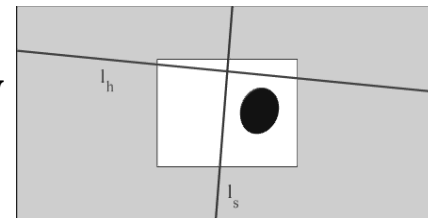
$$\mathbf{W} = \mathbf{I} - 2 \frac{\mathbf{v}_x \mathbf{l}_s^T}{\mathbf{v}_x^T \mathbf{l}_s}$$



Epipolar Geometry

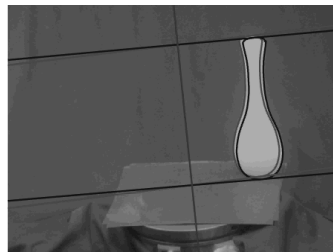
- For circular motion:
 - fixed entities:
 - image of screw axis, horizon, \mathbf{v}_x : 5 d.o.f.
 - epipoles and epipolar lines related by \mathbf{W} .

$$\mathbf{F} = \mathbf{e}_x \mathbf{W}$$

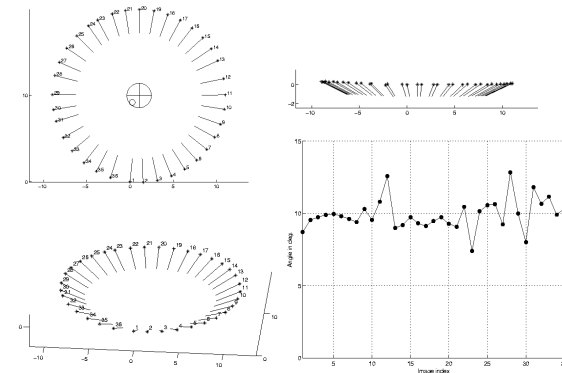


Epipolar Geometry

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



Preliminary Results



Conclusions



- 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