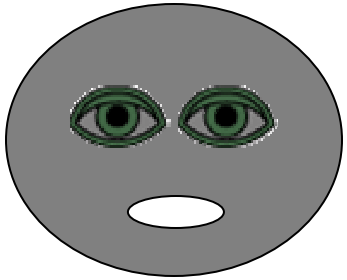
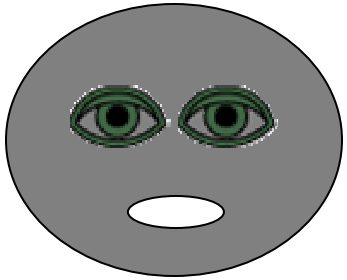


Robot Vision: A Holistic View

Instrumental Vision



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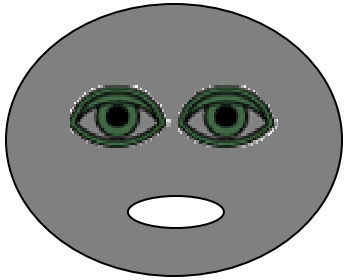
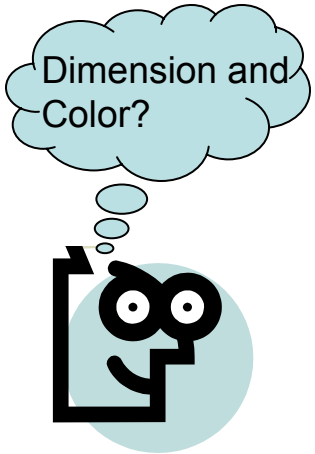
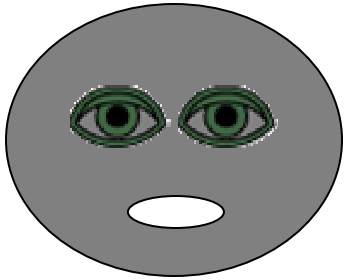


Introduction

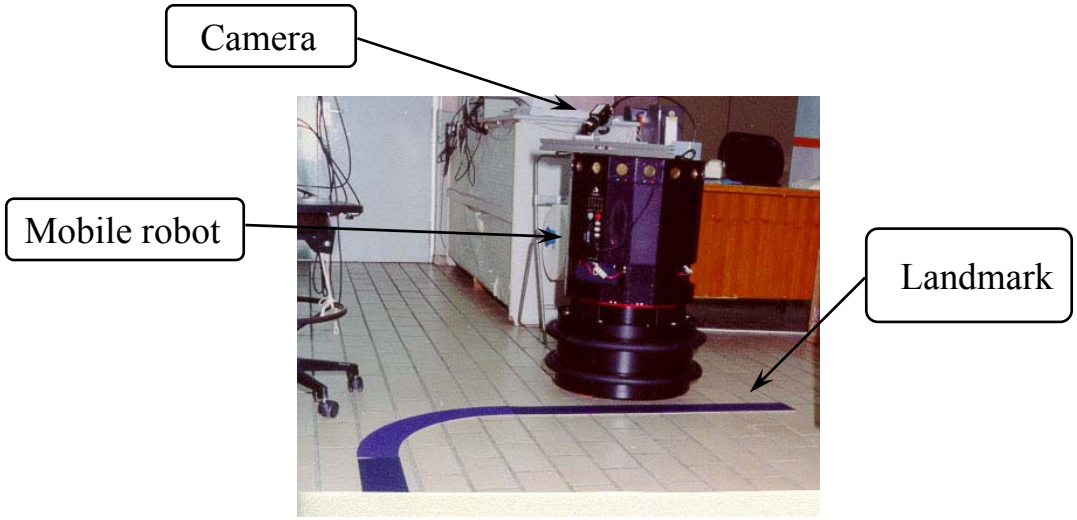
Human vision is not quantitative.

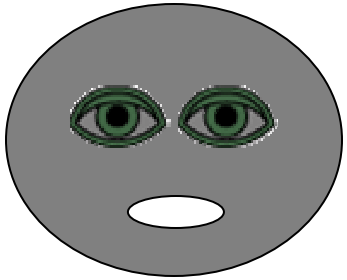




Introduction

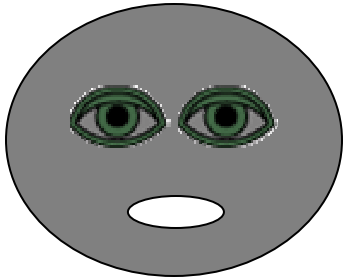
Robot vision could be quantitative.





Introduction

- Therefore, instrumental vision studies the aspect of using images to do measurement.
- In other words, instrumental vision aims at quantitatively measuring the geometric (and chromatic) parameters of a scene or object from its images.
- In general, we can use robot vision to measure 2-D geometry.
- In particular, we can also use robot vision to measure 3-D geometry.



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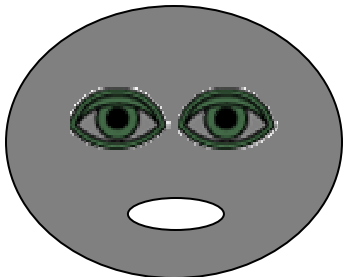
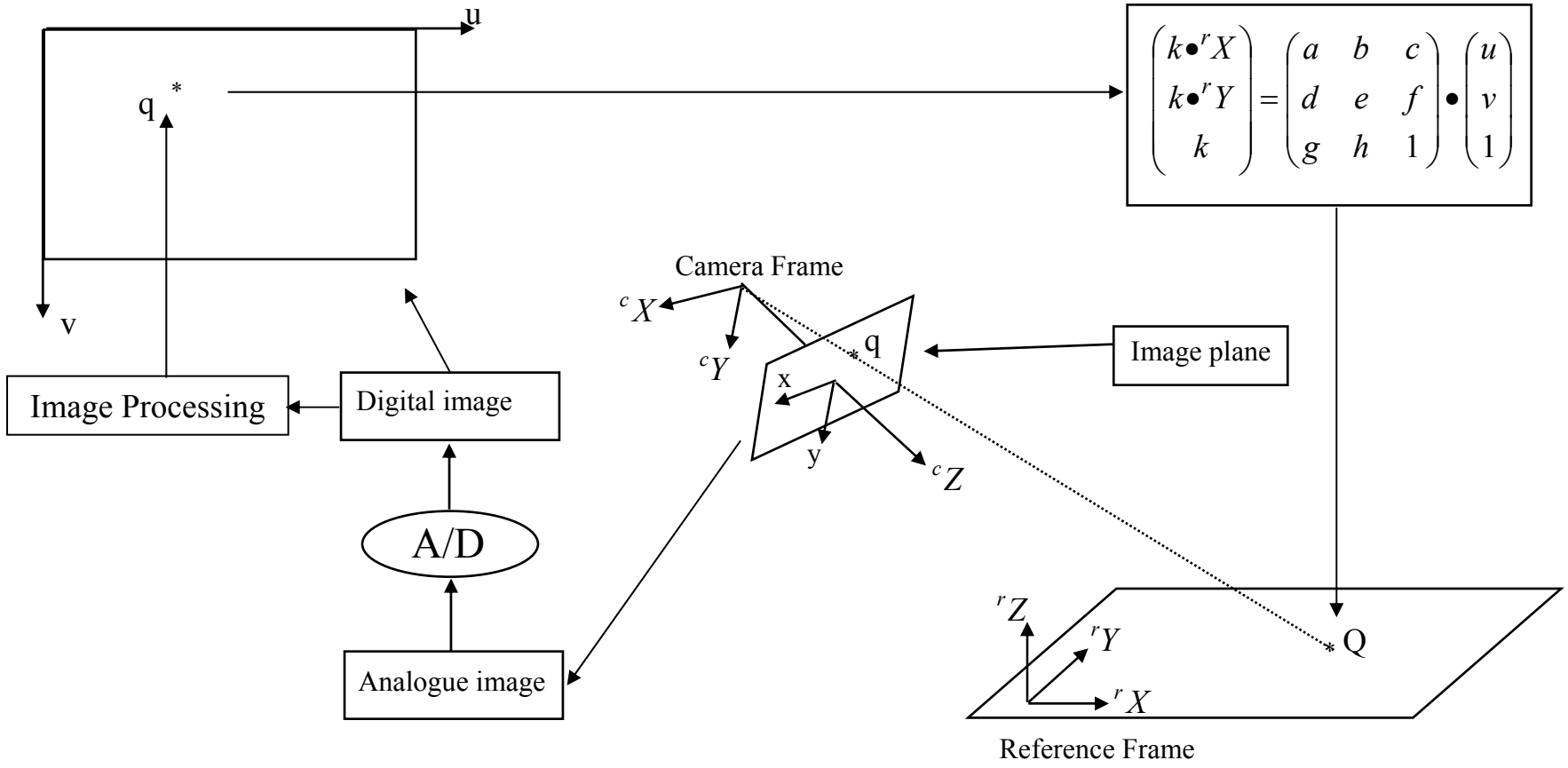
Measurement of 2D geometry

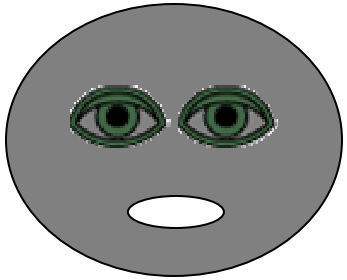
- The basics of using robot vision to measure 2-D geometry is as follows:
- Robot vision must have at least one camera, which outputs images.
- By default, we consider that a camera outputs 2-D arrays of pixels.
- Hence, an image represents a 2-D space.
- If the geometric features of interest are contained in a 2-D plane, the 2-D geometry of these features could be precisely computed from one image.
- The geometric transformation underlying this process is called Homography Transform.



Measurement of 2D Geometry

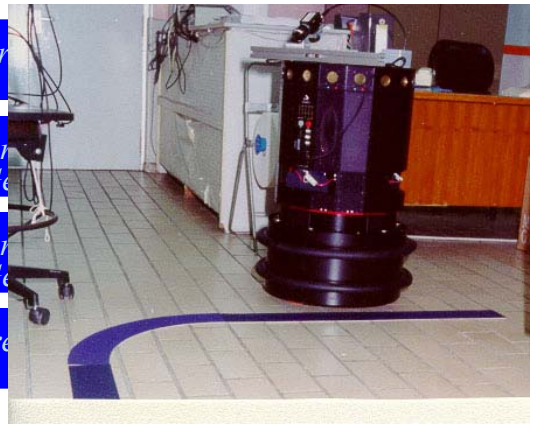
Homography Transform





Measurement of 2D Geometry

Example



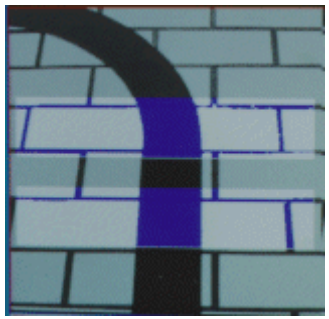
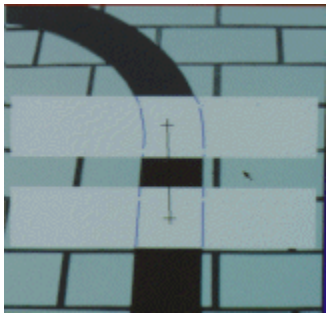


Image taken at Time T1 with two binarized sub regions.



Detected central line of road mark from the two sub regions.

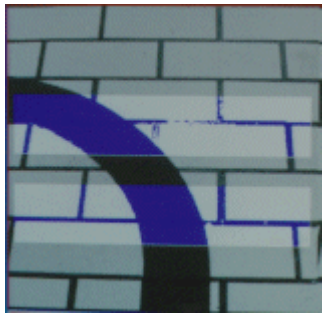
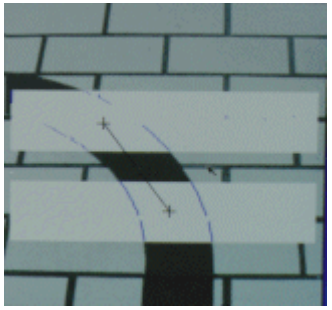
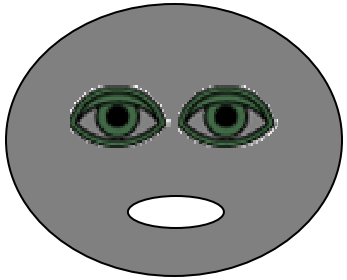


Image taken at Time T2 with two binarized sub regions.

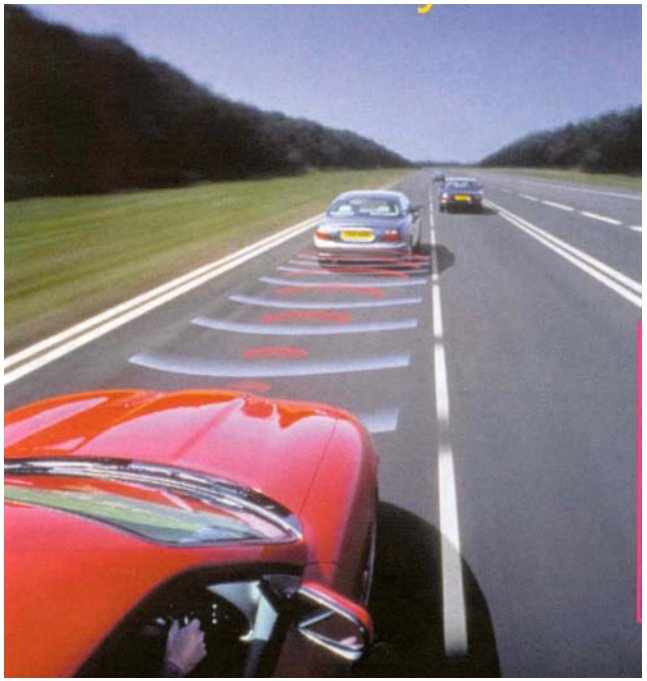


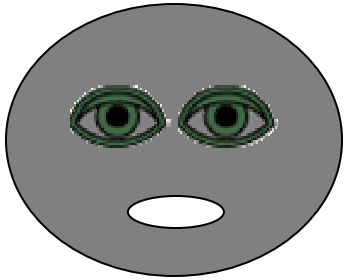
Detected central line of road mark from the two sub regions.



Measurement of 2D geometry

Example

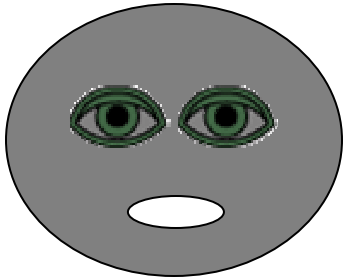




Measurement of 2D Geometry

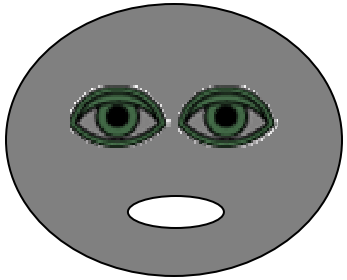
Example

(Run Demo)



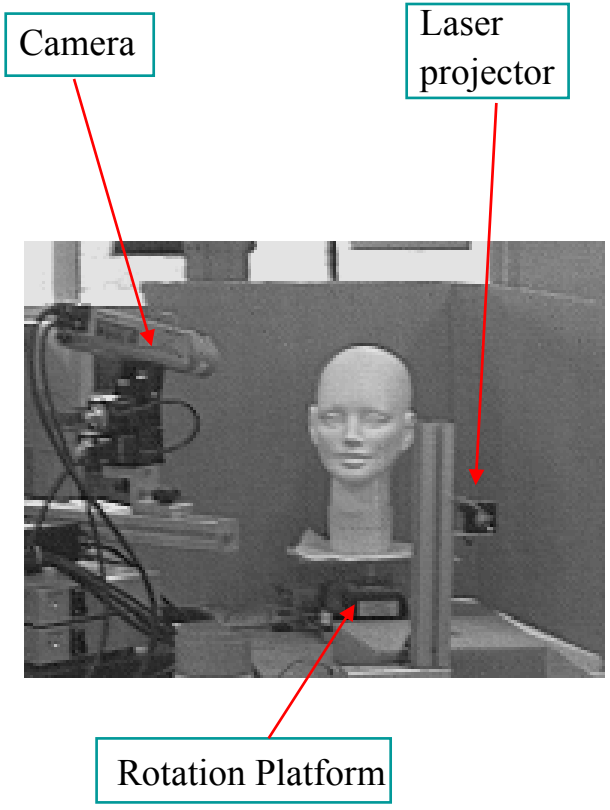
Measurement of 3D Geometry

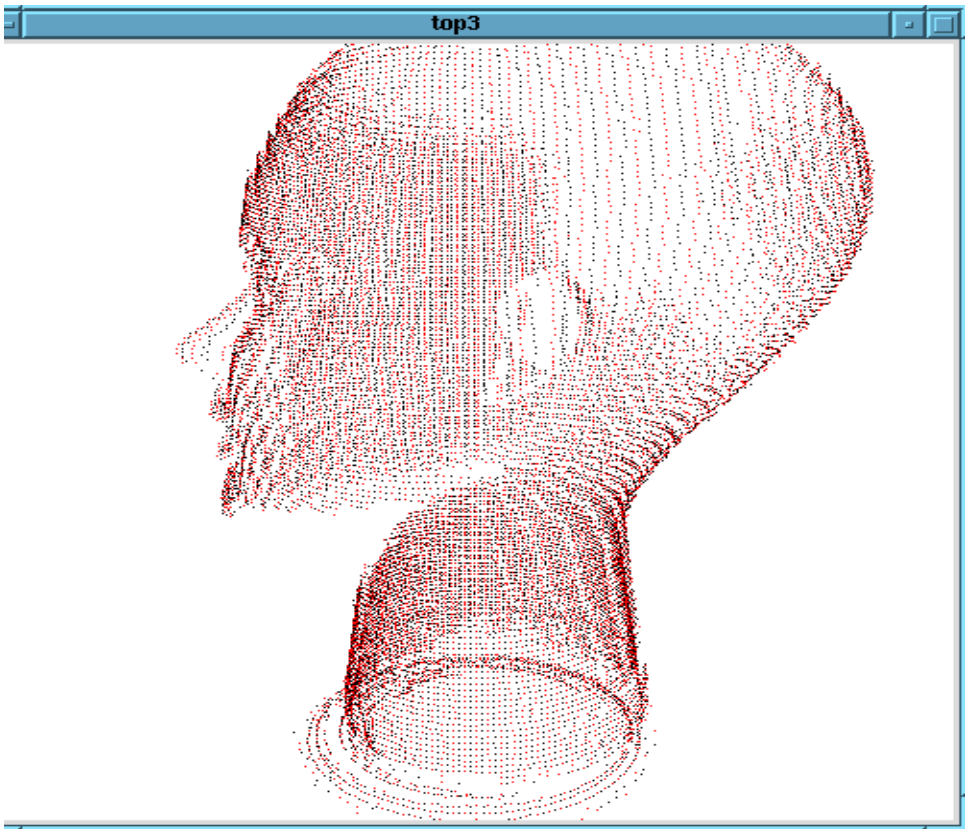
- The basics of using robot vision to measure 3-D geometry is as follows:
- With one camera, it is straightforward to determine the geometry on a 2-D plane, using the homography transform.
- But, in a 3-D space, we could create an artificial plane using a light projector. In this way, one eye and one projector could form an active vision system to sense the geometry of a 3-D object.
- On the other hand, if a robot's vision system makes use of two (or more) cameras, it is possible to compute the geometry of a 3-D object (or scene) in some particular ways.

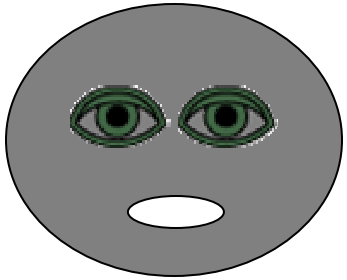


Measurement of 3D geometry

One Eye + One Projector

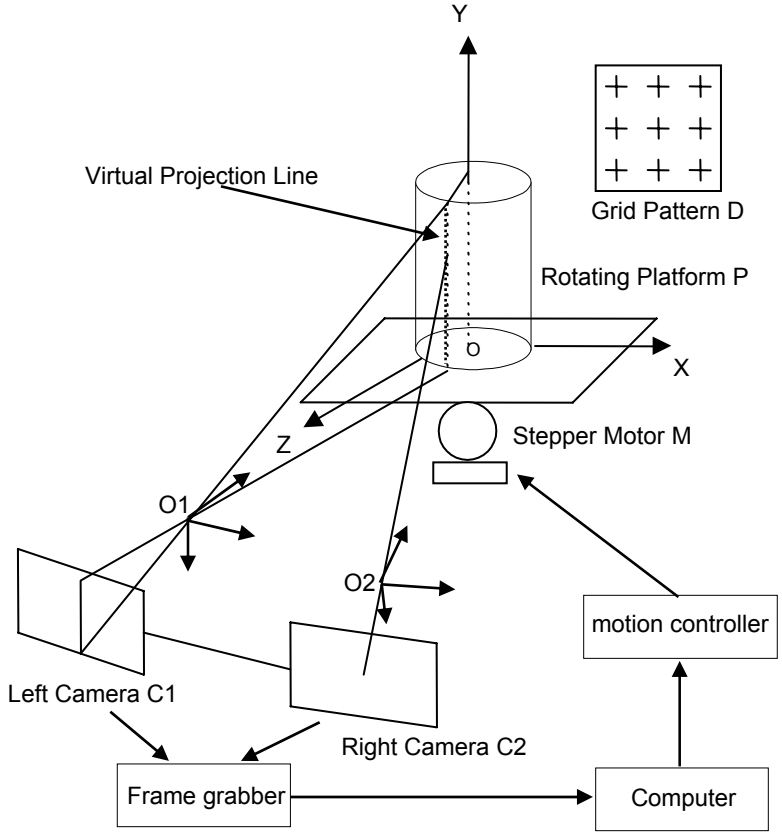


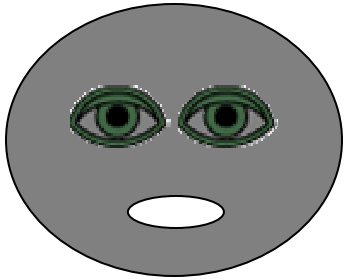




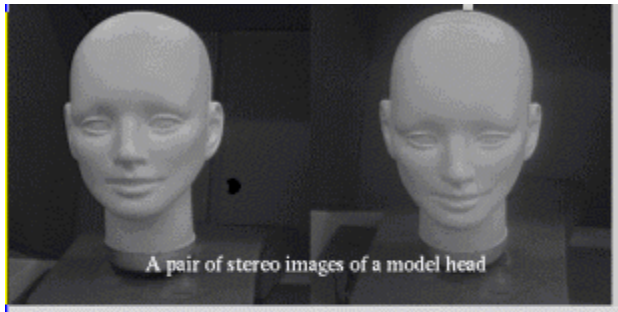
Measurement of 3D geometry

Binocular Vision in a Special Setting





Measurement of 3D Geometry



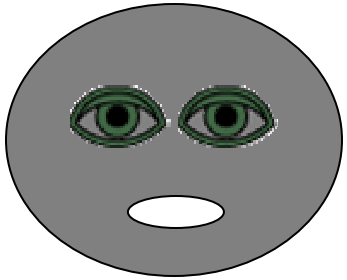
The final reconstructed 3D head

Horizontally and vertically interpolated 3D head

The final reconstructed 3D cup

Horizontally and vertically interpolated 3D cup

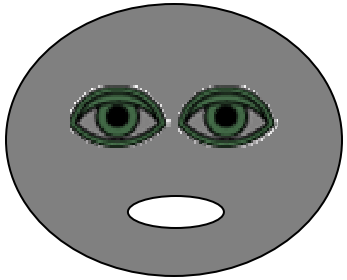
The reconstructed 3D feature points of cup



Future Challenge

- One remaining challenge to instrumental vision is how to quantitatively acquire the 3-D geometry of a scene or object in real-time, from a general setting of binocular vision.

- It seems that the answer is “Reconstructive Vision”.



End of Instrumental Vision