Lecture 11 Part B - Math 143
Extended Gaussian Images (EGI) and Their Applications

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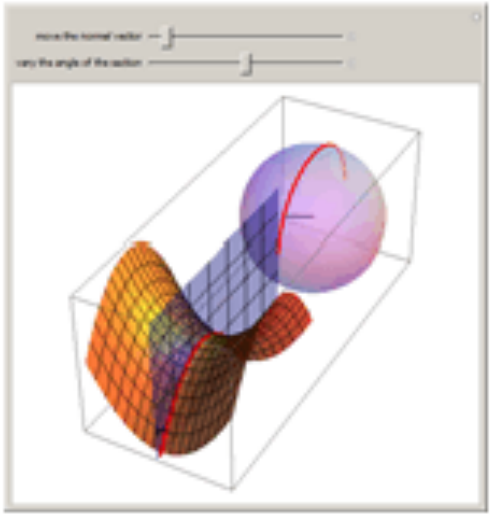
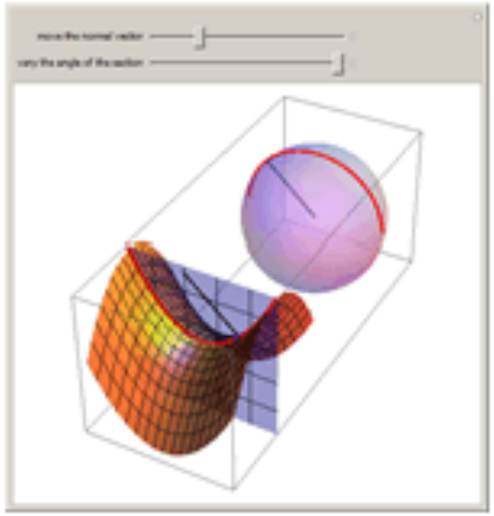
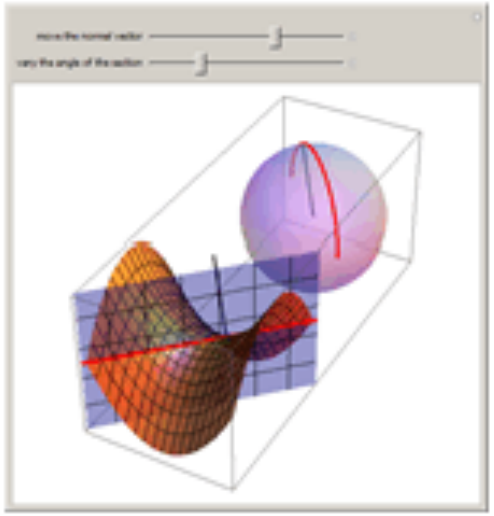
Normal Section and Gauss Map

- Les S be regular surface (or a differentiable manifold of dim=2).
- Let **n** be a normal vector of S at a point p on S.
- Let v be a tangent vector in the tangent space T_pS.
- As the direction of the vector **v** changes, each time (**v**, **n**) determines a plane, cut through the surface to get the red curve on the surface S.
- This obtained red curve is called the **normal section** associated to the direction **v**.
- The curvature of the normal section at p is called the **normal curvature** at p.
- The red curve on the sphere is the Gauss image of the red curve on S under the Gauss Map.

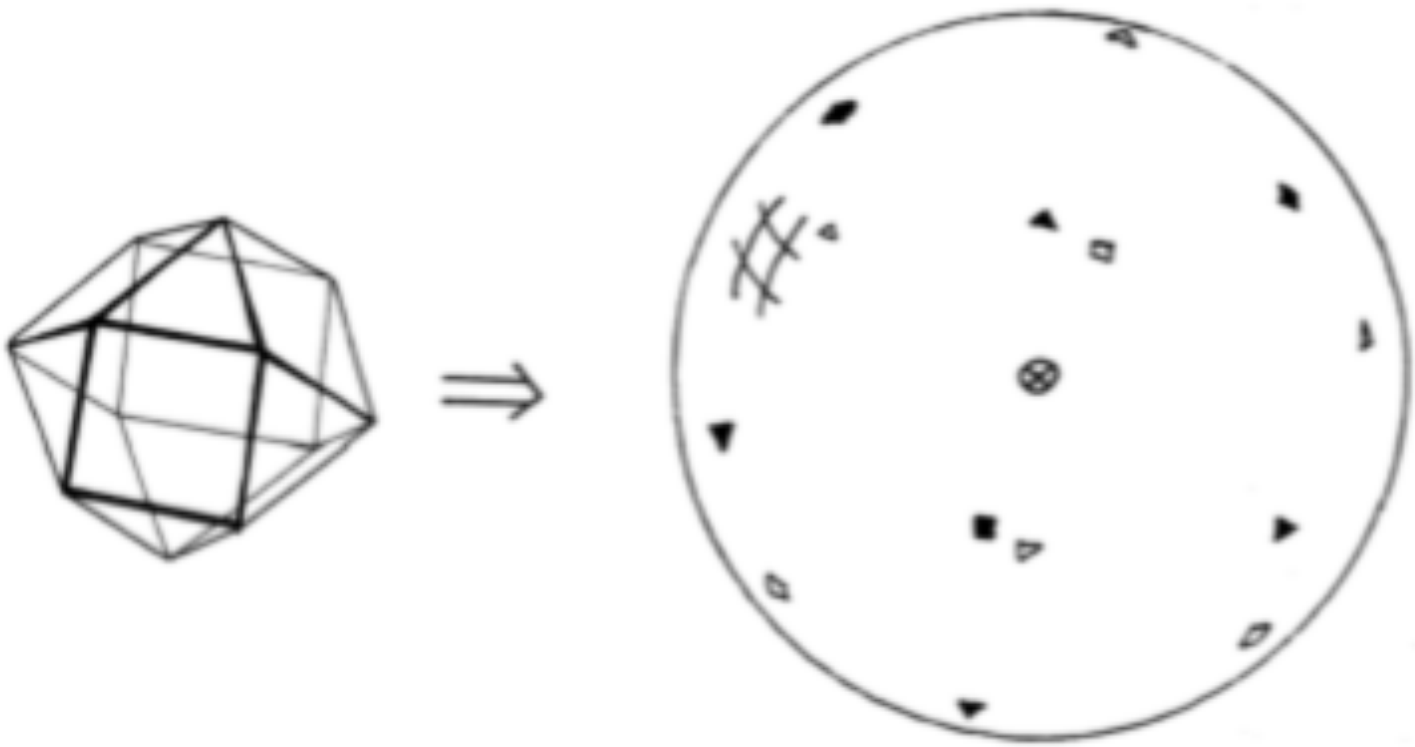






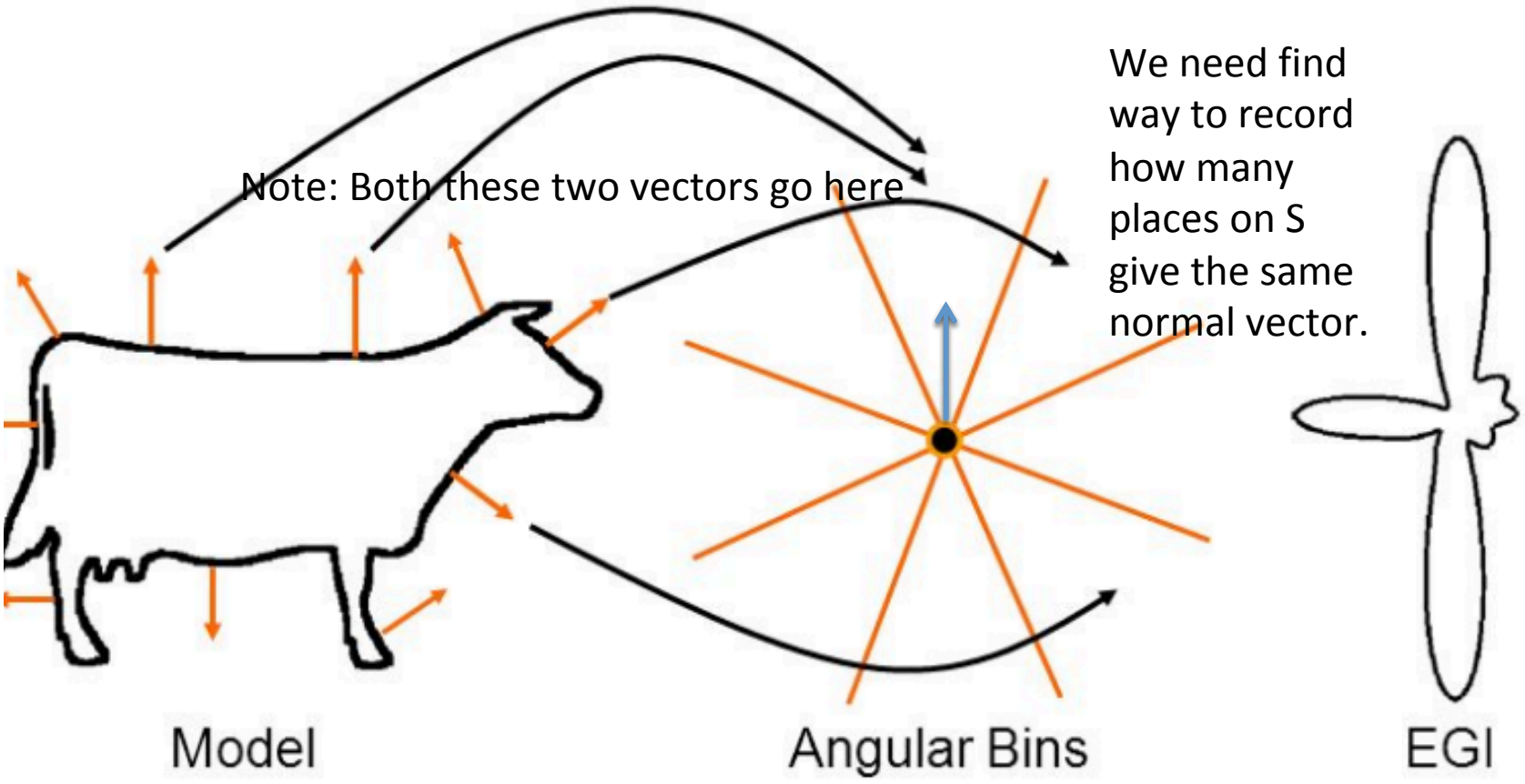
https://www.youtube.com/watch?v=JRKJ2q7UCA8

How to Extend the Gauss Map to Discrete Case?



Note all the points on the front square face have the same normal vector, therefore go to the same point on the sphere under the Gauss Map.

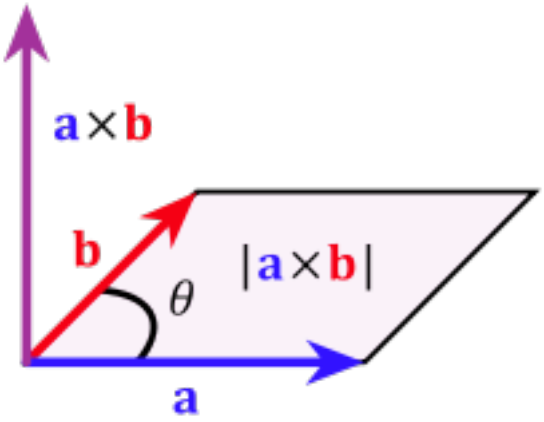
Idea of Extend Gaussian Images (EGI)

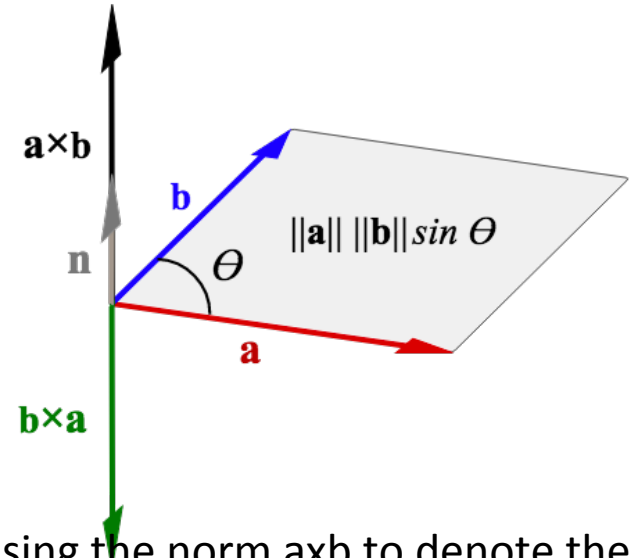


https://www.google.com/search?q=extended+Gaussian+images&source

Extend Gaussian Images (EGI)

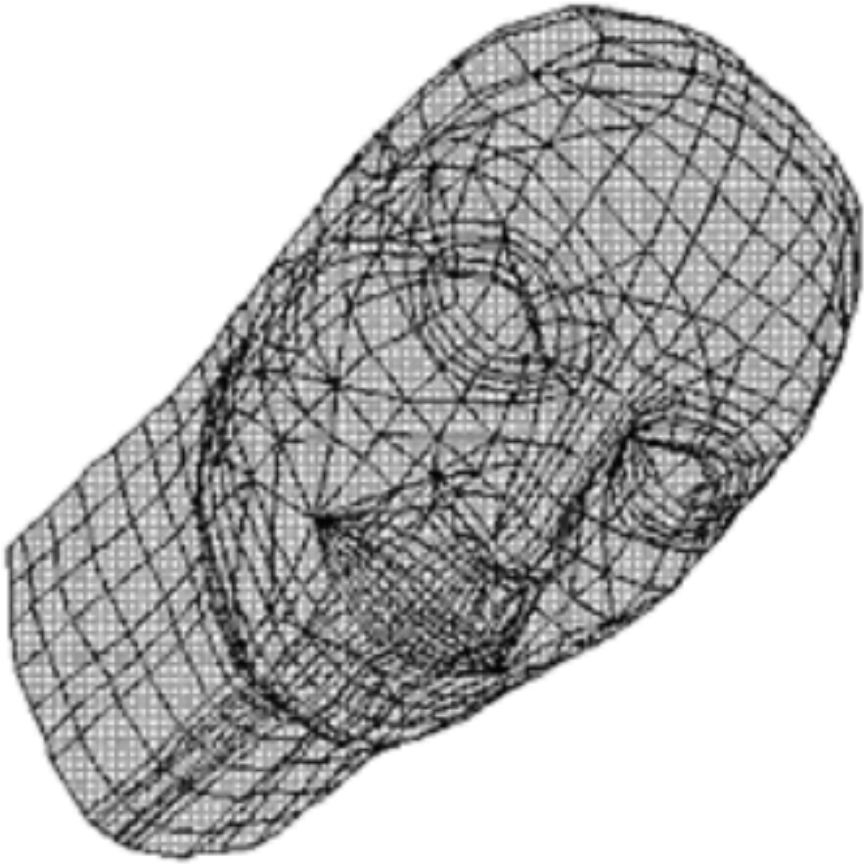
- Extended to include area of each face.
  - Place point mass on the sphere surface equal to area of face at the head of each normal.
  - Alternate representation: Scale the normal proportional to area.

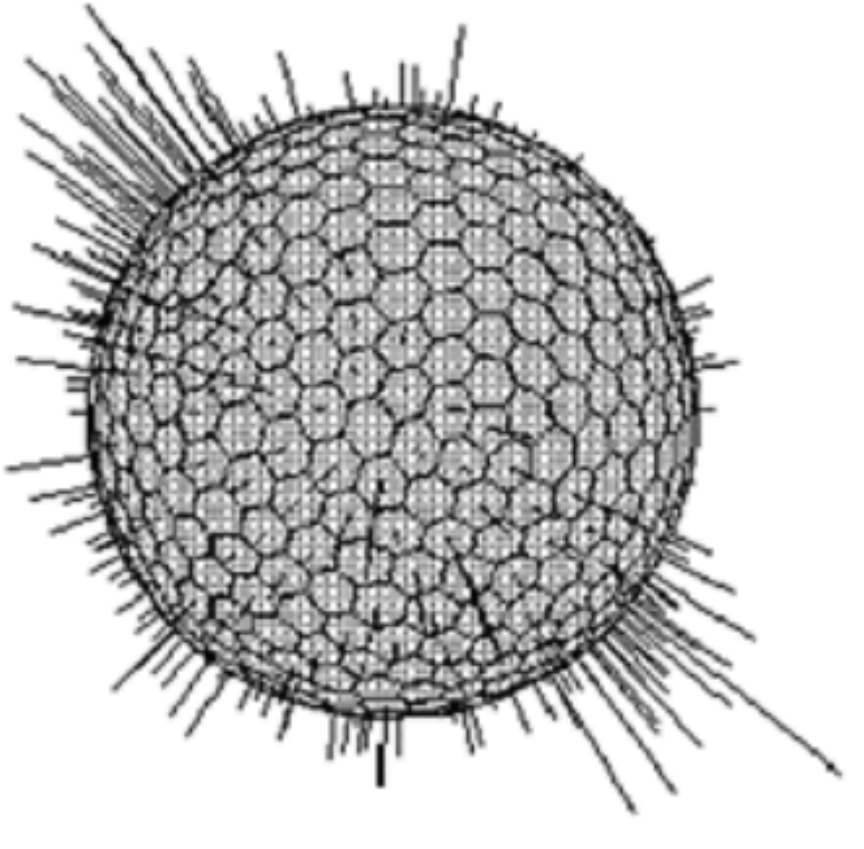




Recall the norm of a x b has two meanings! We are using the norm axb to denote the area.
Note: This kind of idea can be extended to wedge product.

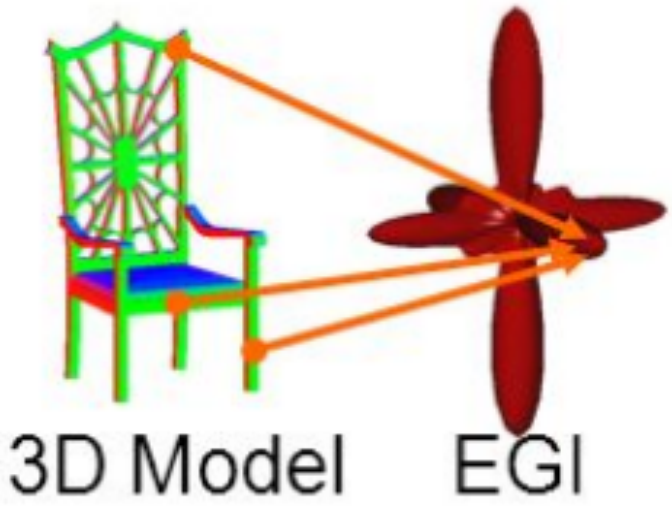
Example: EGI of a human face

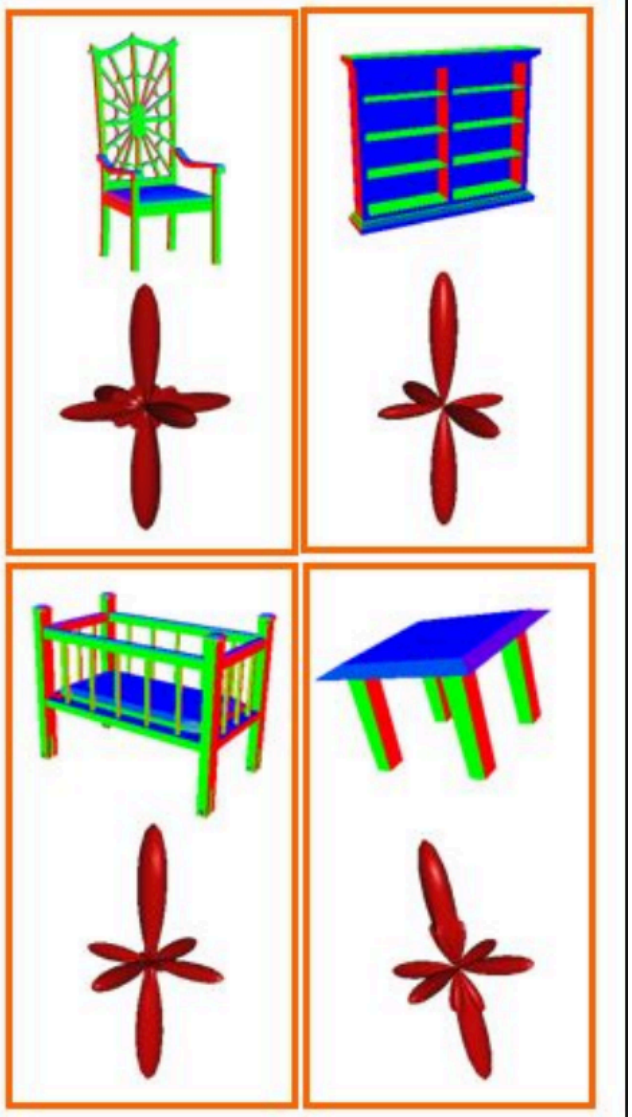




https://www.computer.org/csdl/trans/tp/1997/02/i0164.html

EGI as a characteristic to distinguish objects or for pattern recognition





Key Properties of Extended Gaussian Images (EGI)

- Be able to center the mass at the origin.
- Total mass of the extended Gaussian Images equals the surface area of the object.
- EGI is Invariant under translation.
- Rotation of the object causes an equal rotation of the extended Gaussian image.

There are many other applications, especially in computer vision.

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3D Symmetry Detection Using The Extended Gaussian Image

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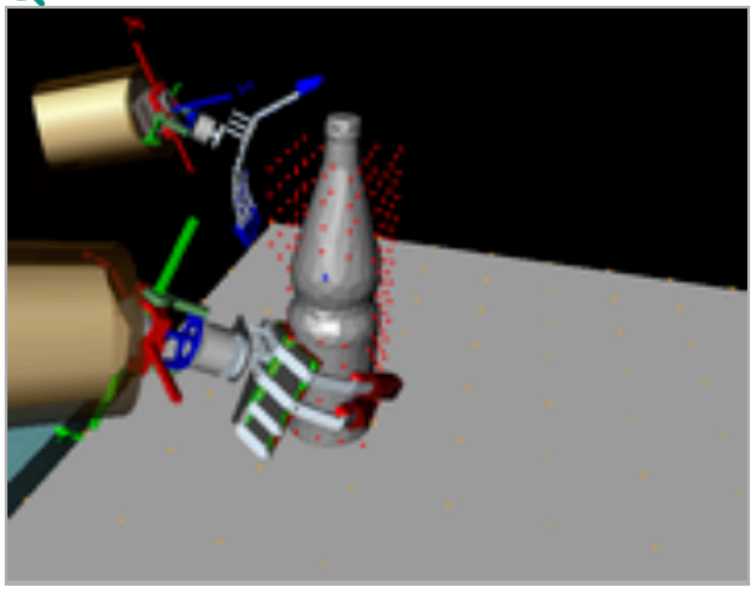
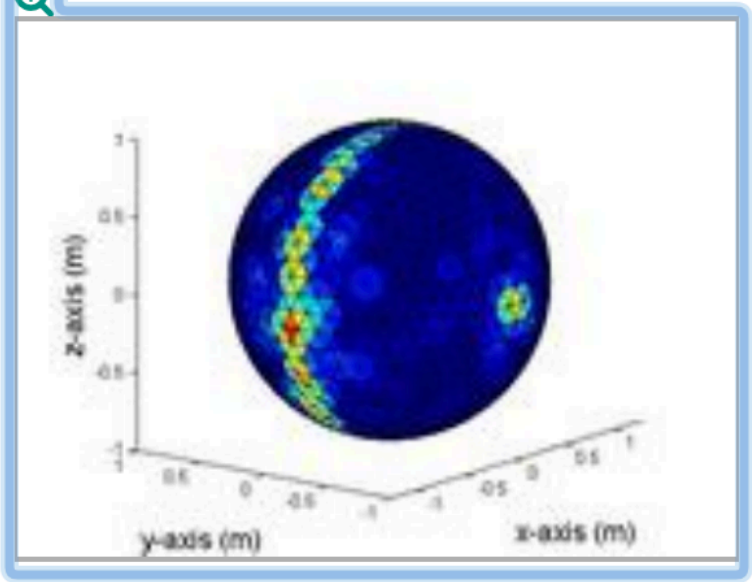
ABSTRACT

Abstract—Symmetry detection is important in the area of computer vision. A 3D symmetry detection algorithm is presented in this correspondence. The symmetry detection problem is converted to the correlation of the Gaussian image. Once the Gaussian image of the object has been obtained, the algorithm is independent of the input format. The algorithm can handle different kinds of images or objects. Simulated and real images have been tested in a variety of formats, and the results show that the symmetry can be determined using the Gaussian image.

More Applications of EGI: e.g. Auto monitoring product quality



Tactile exploration



Extended Gaussian Image (EGI) of a cylinder-shaped object.

References

- https://www.google.com/search?ei=EcyRWrbvIY_ajwP7oLKYCg&q=properties+of+extended+Gaussian+images&oq=properties+of+extended+Gaussian+images&gs_l=psy-ab.3...5465.9209.0.9561.14.14.0.0.0.0.95.1174.14.14.0....0...1c.1.64.psy-ab..0.2.170...0i13k1.0.hpsNSY1LZqw

Back up slides

More examples

- Efficient and Robust 3D Line Drawings Using Difference-of-Gaussian
- https://www.youtube.com/watch?v=q8ezF4Lq_KQ&t=3s