How-To Create a Symmetric Ellipsoid Image Using itkEllipsoidInteriorExteriorSpatialFunction

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Abstract

This example demonstrates how to create a geometrical shape within an *itkImage* using Spatial Functions. Specifically, this example will use *itkSymmetricEllipsoidInteriorExteriorSpatialFunction* to create an itkImage consisting of a symmetric ellipsoid along an orientation vector. An n-dimensional symmetric ellipsoid is one, which has m axes of equal length and $(n-m)$ unique axes lengths. Specifically, itkSymmetricEllipsoidInteriorExteriorSpatialFunction creates a symmetric ellipsoid for the case where $(n-m) = 1$ and the ellipsoid's major axis is oriented along a single orientation vector. itkSymmetricEllipsoidInteriorExteriorSpatialFunction creates a symmetric ellipsoid for the can be found in the `functions` module.

Contents

1 Example Description

First, an *itkImage* $\big($dimension of 3, size of $50x50x50$, spacing of $(1,1,1)$, and origin $(0,0,0)$ $\big)$ is created and completely filled with pixels of intensity value 128. Then, *itkFloodFilledSpatialFunctionConditionalIterator* is used to iterate through the image and set pixels to 256 if *itkSymmetricEllipsoidInteriorExteriorSpatialFunction* returns 1, meaning that it is within the interior of the ellipsoid. The ellipsoid is defined by its axes lengths (from edge-to-edge of the ellipsoid) as well as the orientations of its unique axes. This example is restricted to 3D to allow for the visualization of the resulting image, which is done via a *VTK* image. The volume of the ellipsoid is measured by counting the number of interior pixels of the ellipsoid. This measure can be used to verify the resulting ellipsoid by comparing it against the calculated volume (percent difference) of the ellipsoid given by:

$$V = \frac{4}{3}\pi\left(\frac{a}{2}\right)\left(\frac{b}{2}\right)\left(\frac{c}{2}\right), \qquad (1)$$

where a, b, and c are the lengths of the ellipsoid axes.

The ellipsoid is also validated by checking that the center of the ellipsoid has been labeled as an interior pixel (a function value of 1) by evaluating the spatial function at the origin of the ellipsoid.

Note: Orientation vector must be normalized!

2 What is Needed to Run This Example?

Build and run itkSymmetricEllipsoidInteriorExteriorSpatialFunctionExample.cxx from the workspace generated from CMake. The resulting VTK image file is stored as:

”Insight/Examples/SymmetricEllipsoidInteriorExteriorSpatialFunction/symmetricEllipsoid.vtk”

Default settings should result in an image of an ellipsoid with its axis Default settings should result in an image of an ellipsoid with its unique axis of length 45 oriented along the (1,1,0) direction and symmetric axes of length 30. The origin of the ellipsoid is sampled and evaluated by the spatial function and returns *function value*, which is 1 since the origin of the ellipsoid is within the ellipsoid.

Results of the example (with defaults):

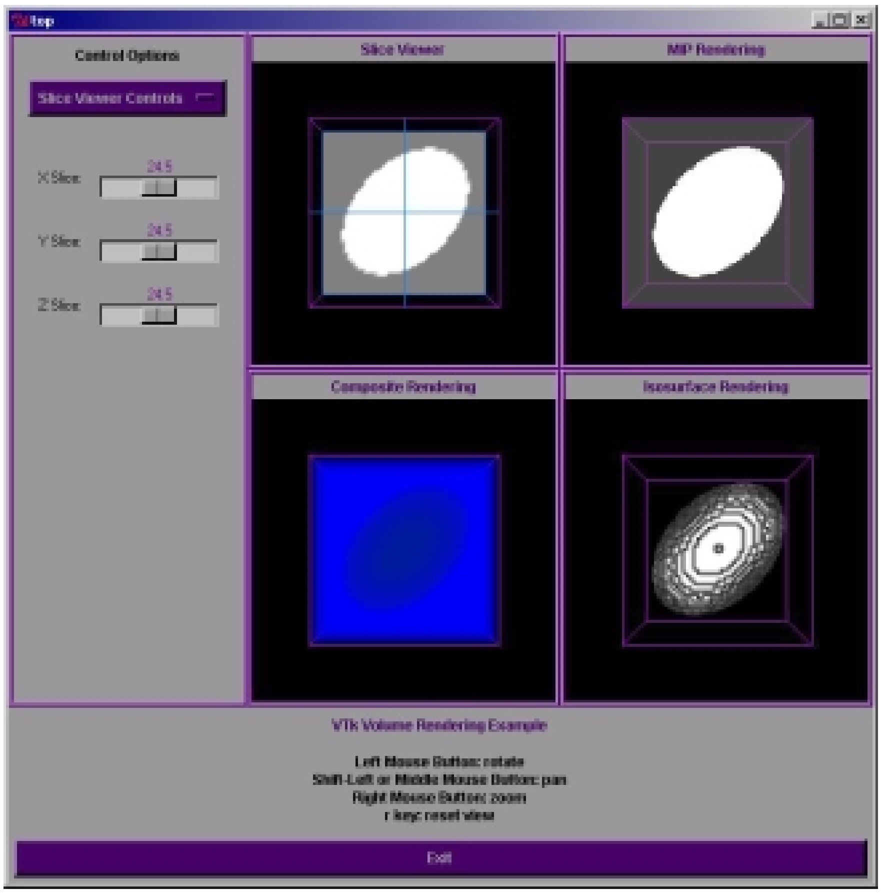
calculated ellipsoid volume	12566.4 pixels
measured ellipsoid volume	12428 pixels
volume error	1.10907 %
function value	1

*See Fig. 1 below or ”Insight/Examples/SymmetricEllipsoidInteriorExteriorSpatialFunction/symmetricEllipsoid.jpg” for snapshot of resulting image.

3 Insight Classes Used

These are the Insight classes used for this example with a brief description. They appear in order of first use:

- itkImage.h: generates a physical image.
- itkImageRegionIterator.h: iterates through the pixels in the physical image and sets them to 128.
- itkSymmetricEllipsoidInteriorExteriorSpatialFunction.h: evaluates pixels in the image and determines whether they are within the symmetric ellipsoid or not.
- itkFloodFilledSpatialFunctionConditionalIterator.h: iterates the image and sets them to 256 if they are within the ellipsoid.



Left Mouse Button: rotate
Shift-Left or Middle Mouse Button: pan
Right Mouse Button: zoom
r key: reset view

Figure 1: Resulting Image Containing an Ellipsoid From This Example

4 Possible Uses Of Ellipsoids

The ellipsoid images created by SymmetricEllipsoidInteriorExteriorSpatialFunction are useful for testing imaging algorithms, pixel sampling routines, establishing geometric domains of influence, etc. Symmetric ellipsoids are useful where only one orientation vector is known and minor axes of equal lengths are tolerable.

5 Non-ITK Requirements

A VTK image viewer is needed to visualize the output file symmetricEllipsoid.vtk.

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