Constant Threshold

Constant threshold methods typically segment a structure by including all voxels within a user defined region that are within a fixed percentage of the maximum count level in that region, Erdi[1]. Constant threshold methods assume that count levels are consistent within the structure of interest. The actual threshold used for structure segmentation is typically determined empirically with phantoms and accounts for imaging characteristics of the scanner. This assumption is valid for most structures in anatomic imaging modalities such as CT and MR where structures are identified by physical properties inherent to the structure/tissue. However PET and SPECT are functional modalities and image count levels are proportional to physiological properties such as glucose metabolism or tissue blood flow. In large tumors, for example, glucose metabolism may vary significantly from the fastest growing area to a necrotic region.

## SUV (Standard Uptake Value) Threshold

Tissue segmentation based on SUV levels is a constant threshold method based on absolute rather than relative count levels. SUV is designed to show tissue levels relative to expected levels assuming the isotope was uniformly distributed within the body. SUV measurements account for injected dose of the isotope and physical decay of the isotope from isotope injection to image acquisition. The purpose of SUV measures is to show structure avidity for the radio-pharmaceutical. SUV measurements for FDG in PET can be used to define tissue as tumor and monitor therapy response. SUV levels are not intended to identify tumor borders but the existence of a tumor.

Spatial Derivatives - MIMvista Auto Contour

Spatial derivatives are the change in image count levels as a function of location in the image. Assuming the object has different intensity than the background, there is a change in count level at the edge of the object. A point inside the object of interest and six points near the edge of the object are defined by the operator by doing a left click near the center of the object and dragging to a point near the edge of the object. Five additional edge points are automatically determined at equal angular increments from the operator defined edge point. The software uses this initial edge definition to define a contiguous 3D set of edge points.

The constant threshold and spatial derivative methods were evaluated using phantoms that had spheres filled with FDG. The phantoms were obtained on different cameras with various ratios of activity in the sphere to activity in the background and are shown in the following tables.

## Different Cameras, Similar Source to Background Ratio
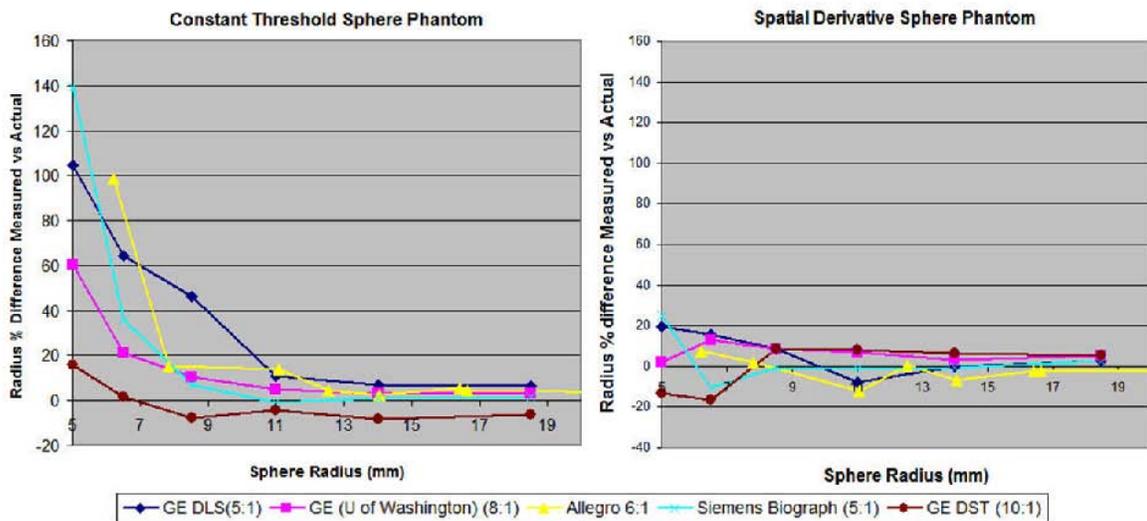
Same Camera, Varied Source to Background Ratio
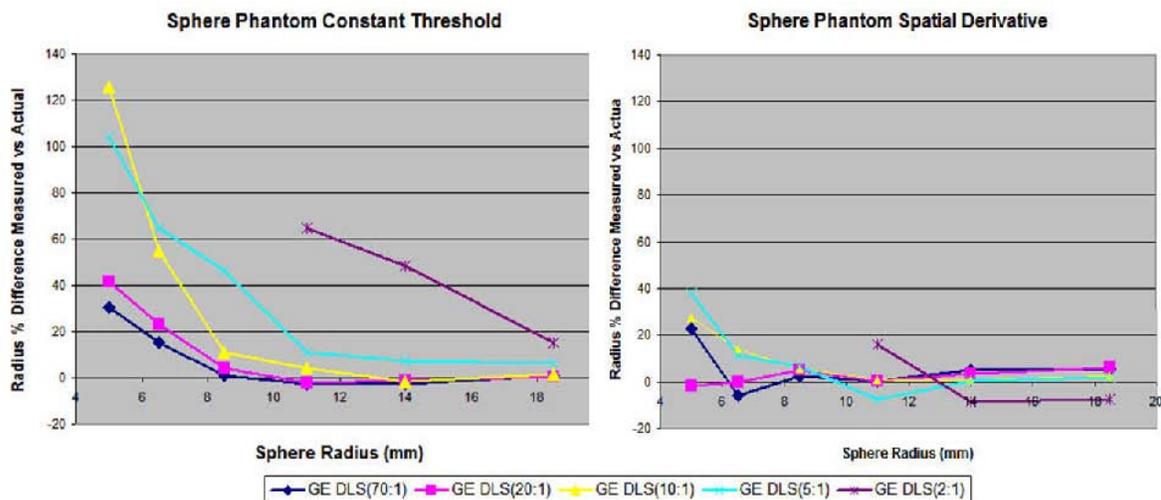
The constant threshold and spatial derivative methods were evaluated using lung tumors in patient image volumes where the lung tumor was easily identified in the CT image volume. In each of the following images the bottom row is the fusion of the PET and CT image volumes.
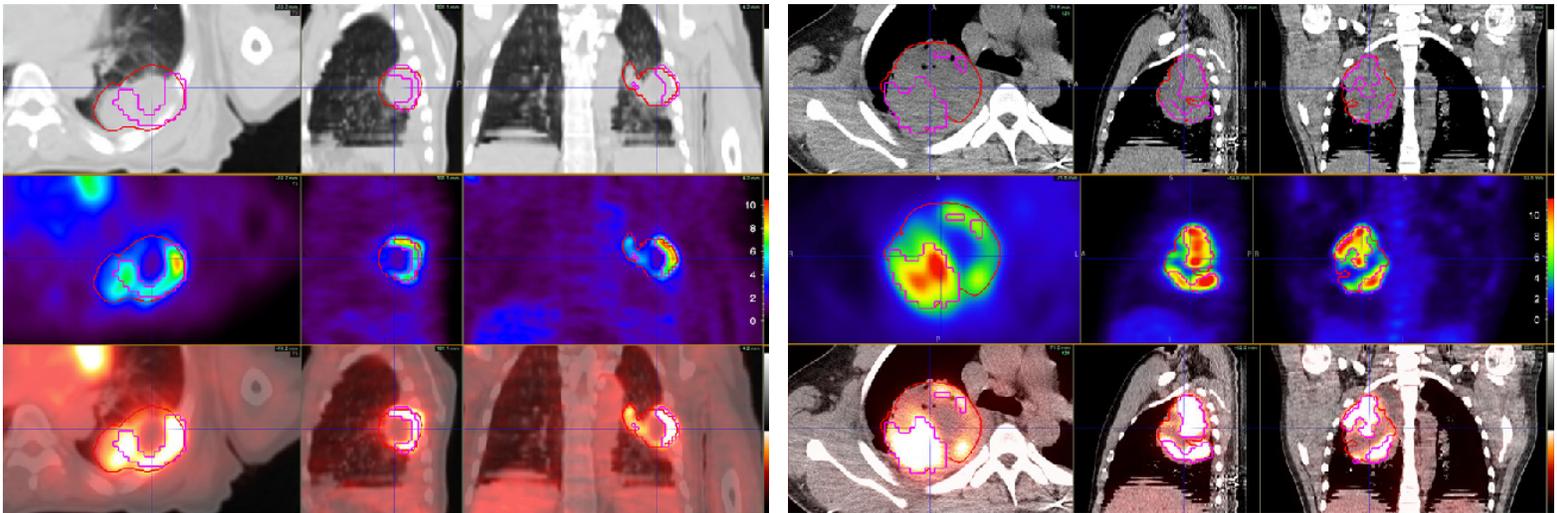
In the above image volumes, there is a large difference in FDG levels in the tumor which causes the constant threshold method, purple, to underestimate tumor volume. The red contour is generated by the spatial derivative method.
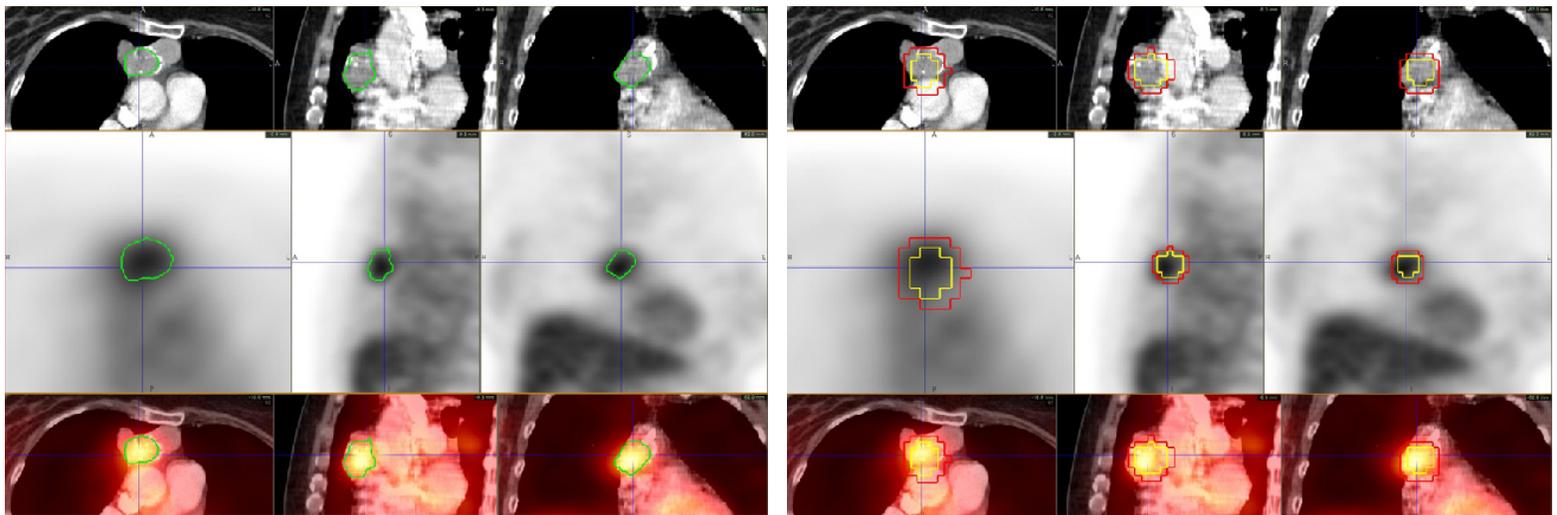
The image on the left shows the result of using the spatial derivative method to define a lung tumor in green. The image on the right displays the contours defined using the constant threshold method, red and yellow contours. Since the tumor is surrounded by a background with relatively high counts, the constant threshold contours are a function of the size of the operator defined region to include the tumor.

References

1. Erdi Y, Mawlawi O, Larson S, et al. "Segmentation of Lung Lesion Volume by Adaptive Positron Emission Tomography Image Thresholding." Cancer, vol. 80, pp. 2505-9., 1997.