Abdominal segmentation of adipose tissue using Graph Cuts

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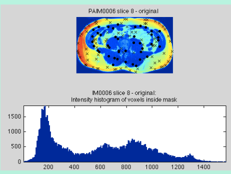
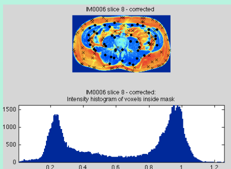
Abstract
It is of high clinical relevance to divide the adipose tissue of the human abdomen into different compartments called superficial and deep subcutaneous adipose tissue and visceral adipose tissue, sSAT, dSAT and VAT. It is the hypothesis that *Graph Cuts* can solve the problem in 3D by locating two boundaries, Interior SAT-boundary and Scarpa's Fascia. This poster gives and introduction to the work.

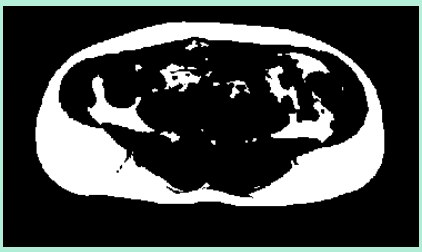
Preprocessing

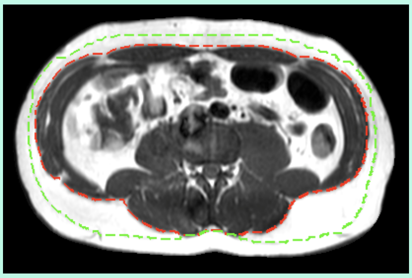
Before the actual segmentation can take place the *Magnetic Resonance Imaging (MRI)* data have to be preprocessed. As there exist a spatial intensity inhomogeneity in the images it is necessary to perform a *Bias Field correction*. The method used to this correction is called *Thin Plate Spline.* Below the two figures show an image and the corresponding intensity histogram before and after the correction is performed.





After the correction a method called *Fuzzy C-means Clustering* is applied to the images to divide the tissue into adipose and nonadipose tissue. The figure below shows the clustering of one slice in a subject. The white areas are adipose tissue and the black areas are nonadipose tissue.

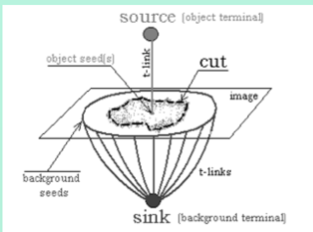




Graph Cut

The first step before Graph Cutting is to construct the graph. The images are considered a volume where all neighboring pixels are connected through n-links. Each pixel, also denoted node, has 4 neighbors in the 2D plane and 2 neighbors in the depth.

Another kind of link exists, the so-called t-links that connects the image to a source and a sink. The sink is an ellipse in the center of the volume and the source is placed on the outer abdomen boundary. This is shown in the figure below.



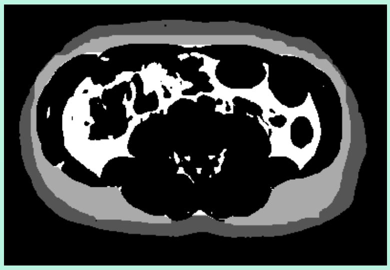
The links between the nodes in the 2D plane are given edge weights that are calculated from the first and second order derivative of the image.

The interior SAT boundary is characterized by a large radial gradient whereas Scarpa's Fascia is characterized by a large radial second order derivative.

The links between the nodes in the depth are given a constant value, experimentally chosen.

After the graph construction the cut is calculated using *the min-cut/ max-flow* algorithm written by Yuri Boykov and Vladimir Kolmogorov. In the figure to the left the interior SAT boundary (red) and Scarpa's Fascia (green) are shown in a slice.

On the figure below the result of the *Graph Cut* and *Fuzzy C-means Clustering* is used to segment the abdomen into sSAT (grey), dSAT (light grey), VAT (white) and nonadipose tissue (black).



Improvement

The use of Graph Cuts has made it possible to segment the relevant boundaries successfully in more slices than earlier methods. This is due to the fact that the segmentation is performed in 3D, where connections between slices exist, which secures that information is transferred to neighbouring slices.

Conclusion

The use of Graph Cuts in segmentation of different types of adipose tissue in the abdomen has shown good results. As the segmentation is performed in 3D it gives very satisfying results in almost an entire volume.

12/5-2011