Volume Estimation and Surgery Planning from Lung CT Images

ANA ELISA FERREIRA SCHMIDT[1], PAULO CEZAR PINTO CARVALHO[2], RODOLFO A. NUNES[3]

[1]Tecgraf/PUC-Rio - Departamento de Informática - Rio de Janeiro, RJ, Brasil
anaelisa@tecgraf.puc-rio.br

[2]VISGRAF Laboratory / IMPA - Instituto de Matemática Pura e Aplicada - Rio de Janeiro, RJ, Brasil
pcezar@impa.br

[3]Faculdade de Ciências Médicas / UERJ - Rio de Janeiro, RJ, Brasil

Abstract: We describe an on-going project involving the development of tools to assist the planning of lung reduction surgeries, a technique that has been proposed for the treatment of certain illnesses. Doctors need to decide which portions of the lungs to remove to achieve a certain reduction goal. This requires estimating lung capacity both before and after this surgery. Volume segmentation techniques are used to extract lung structures from the original data slices

1 Objective

In the current stage, we are manipulating CT lung images obtained from animals; more precisely, dogs. Our main goal is to estimate the lung volume based on the density information extracted from a set of images like those shown in Figure 1.

2 Volume segmentation

The first problem to be solved is about how to extract only the lung structures from each slice image. As lung densities are very similar or equal to other object densities, such as the CT table and CT noise, we cannot use just threshold segmentation to distinguish lung structures.

We have implemented an algorithm that takes advantage of the regular geometry of the table to make the segmentation in a correct way. It also uses lung density limits values to distinguish between the lung and other non-interesting structures like the CT table. Figure 1 shows the result of this segmentation algorithm applied to one slice of a CT lung exam.

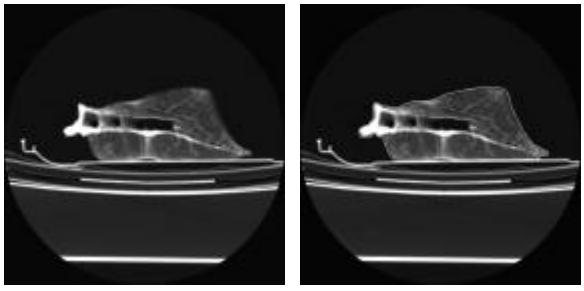

Figure 1 – Original and segmented slices

3 Volume estimation and visualization

Once all slices have been segmented, we can estimate lung volume by multiplying the thickness of each slice by the sum of the areas enclosed by the boundaries of the segmented regions in each slice.

Table 1 compares volume estimation results obtained through computational methods with the physical measures obtained by the doctors, for one test exam.

Physical Measurement	Volume Estimation
102 ml	104 ml

Table 1 – Volume estimation results

We can also use the segmented slices to build a 3D volumetric data set that can be visualized by an in-house volume-rendering algorithm.

Figure 2 shows the result of visualizing two lung lobes extracted from dogs. The first picture shows the 3D lung lobes reconstruction before segmentation and the second one shows the lobes after segmentation.

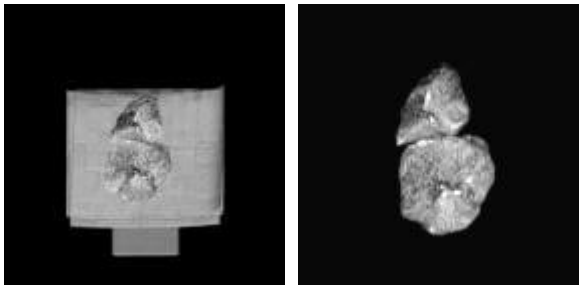

Figure 2 – 3D lung reconstruction

In the next stage we intend to analyse CT lung images obtained from human patients. This will require some changes in the segmentation algorithm, in order to correctly separate lung structures from those of organs having similar densities (the bowels, for instance).