Automated detection and segmentation of the lungs in CT datasets

Master thesis
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Abstract

In this project algorithms have been developed for automatic detection and segmentation of the lungs in CT-images, as a pre-processing step for lung-oriented CAD algorithms (e.g. automatic nodule detection) and for visualization of the structures inside the lungs.

Detection

A very important problem to be addressed in the detection algorithm was to distinguish lungs from colon, since colon contains air as well, especially as in colon CT-examinations the colon is inflated. A very accurate method has been developed within the following conditions: 1) the part of the lungs that is present must be large enough to be recognized (at least 125 ml), 2) the lungs must be relatively healthy and normal looking, and 3) in the slices the lungs must be surrounded by body tissue (i.e. not be on the border of the scanned volume).

Investigation of various features resulted in the choice for an anatomy-oriented approach. The amount of bone in a margin of approximately 5 mm around a 3D air filled object, measured in a slice, turned out to be the best discriminating feature. This feature reflects the presence of the ribs surrounding the lungs; the colon is only surrounded by soft tissue. The feature is invariant to scaling, rotation, translation and shape deformations.

The accuracy with which the lungs could be detected with the algorithm has been tested on 181 datasets of 126 patients, of which 90 had been acquired for lung examinations and 91 for colon examinations. Very high sensitivity and specificity values have been achieved. It is expected that the specificity can be further increased by a verification step, which determines which objects are most next to each other. Further investigation is needed.

Segmentation

To create a binary volume suitable for various applications, the lungs must be segmented. Different applications require a different segmentation protocol. For both nodule detection algorithms and visualization purposes the hilar vessels must be included in the segmentation. A segmentation protocol consisting of three steps has been developed: first the two lungs are separated from each other, then the hilar vessels are included, followed by an erosion or dilation of the volume, depending on the needs of the application.

The segmentation algorithm has been tested on 26 datasets of 26 patients. The results have shown that a fixed segmentation protocol leads to reasonable results. Some improvements are still needed.

The segmentation of lung lobes has been investigated as well. Lung lobe segmentation can be used to visualize each lobe separately. Furthermore, lung function and pathology can be described on a regional level. One segmentation method has been tested. The results were not very accurate, but might be used to initialize more accurate methods. Further investigation is needed.