Internship proposal : *Lung image segmentation*

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The development of new image-based diagnostic techniques is a crucial issue in the context of medical research. In particular, the determination of pathological regions in images makes it possible to establish new diagnostic indicators. This internship will focus on the study of interstitial pneumopathies. Interstitial pneumopathy is a lung disease with various origins that can lead to a gradual destruction of the lung parenchyma. Monitoring can be performed using scanner imaging. The evaluation of the evolution of the disease is typically achieved by quantifying several apparent image indicators such as : the size of the condensation zones, the size of the so-called "frosted glass" or "honeycomb" zones, etc... These areas, although qualitatively easy to qualify, are complicated to quantify. Figures 1 and 2 show two typical examples of images.

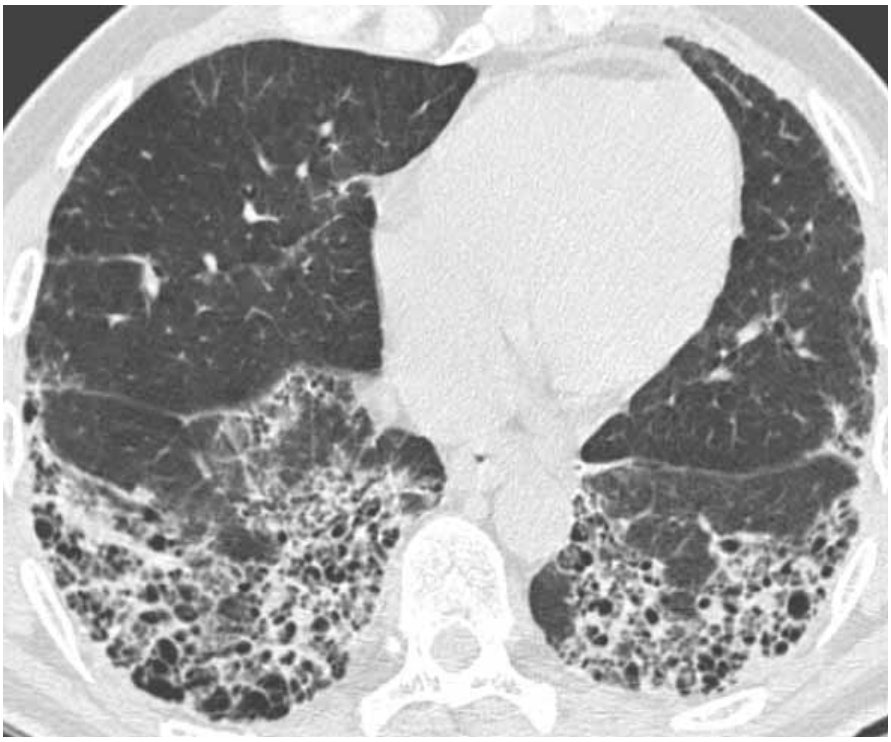

FIGURE 1 – Typical example of a "honeycomb" lesion.

Image segmentation algorithms can be used to determine pathological regions in images. The problem of image segmentation is one of the basic image processing tasks. It consists in finding a partition of the image so that it becomes easier to analyse its content. Many approaches have been proposed for this purpose [1], and this internship will focus on variational methods. The following energy has been introduced in [2] :

$$\inf_u \int_\Omega |\nabla u| + \lambda \int_\Omega \left((f-c_1)^2 - (f-c_2)^2\right) u(x)\, dx \tag{1}$$

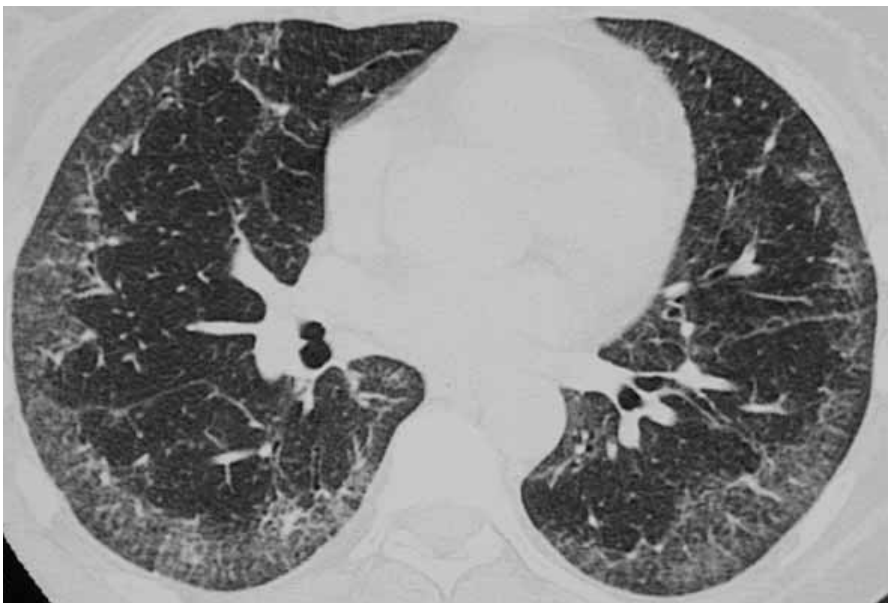

FIGURE 2 – Typical example of a "frosted glass" lesion with crosslinking.

This energy is convex, and it is easy to compute a solution with a primal-dual approach [3]. There remains just a thresholding step to get the segmentation result.
The goal of this project is to extend model (1) to texture features to segment lung images. One could consider local histograms such as in [4], or features based on Gabor functions or wavelets. It will be necessary to develop a code adapted to 3D data.
The code developped during this internship will be quantitatively evaluated on clinical images. Manual delineations encompassing pathological regions, manually determined by a radiologist, will be used as "gold-standard" to quantify the performance of the implemented algorithm.

Comments :

- Pluridisciplinary project (applied mathematics, compiter science, medicine, image processing).
- 5 months internship.

Contacts : send a detailed CV and a letter stating the reasons of your application to :
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References : [1]*Active contours without edges*, Chan, T.F. ; Vese, L.A., IEEE TIP 2001.
[2] *Algorithms for finding global minimizers of denoising and segmentation models*, Chan, T. F. ; Esedoglu, S. ; Nikolova, M. , SIAM J. Appl. Math., 2006.
[3] *A first-order primal-dual algorithm for convex problems with applications to imaging*, Chambolle, A. ; Pock, T., JMIV, 2011.
[4] *A Convex Formulation for Global Histogram Based Binary Segmentation*, Yildizoglu, R. ; Aujol, J-F. ; Papadakis, N., EMMCVPR 2013.