M1/M2 Intership position
Texture segmentation with deep learning

Key-words – CNN, proximal algorithms, multiscale analysis, segmentation

Location: SYSIPH team, Laboratoire de Physique de l'ENS Lyon
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Quand : 4-6 month between february and september 2021.

Context – Automated image segmentation constitutes a crucial task in image processing, for many different purposes ranging from medical imagery to geophisics (cf. Figure 1). For years, texture segmentation was performed via a classical two-step procedure: First, prior knowledge or expert choice driven features are computed (e.g., Gabor, gradients, differencesof oriented Gaussians,...) ; Second, these features are combined via a clustering algorithm. Recently, research focus has been on combining these two steps into a single one to improve interface detection and thus segmentation performance. This has been first envisaged by retaining hand-crafted features but modifying classical frameworks. Recently, deep learning renewed this topic, jointly performing feature selection as well as segmentation, rapidly followed by texture segmentation.

In SYSIPH team we recently develop efficient segmentation tools relying both on unsupervised and supervised strategies. On the one hand, the combinaison of scale-free descriptors (based on wavelets transforms) and nonsmooth optimization (based on proximal algorithms) allowed us to perform unsupervised segmentation on synthetic and real texture data [1,2]. On the other hand, we developed supervised tools to achieve the same task but from labeled data relying on standards CNN architecture, whose performance stays limited due to few labeled data on real experiments [3].

The goal of this internship is to further improve the developed technique in [1,2,3] by considering neural architecture relying on proximal algorithms structure (inspired from [4]) and whose benefit would be to take advantage of both worlds.

Subject – This internship is devoted to the design of a neural network for the specific task of texture segmentation and its application to multiphasic flow data:

- the design of the network;
- the performance evaluation on synthetic and real data;
- the comparison with standard unsupervised and supervised alternative.

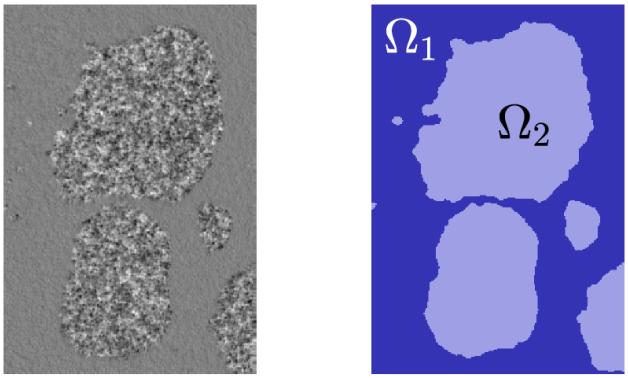

Figure 1: *Multiphasic flow experiment conducted at Laboratoire de Physique de l'ENS de Lyon (LPENSL) modeling gas and liquid in a porous medium. Goal: identifying the interface between gas and liquid.*

Skills: The candidate must have have skills in some of the following areas: Signal and Image Processing, Data science, Optimization, Machine Learning.

Application: The deadline for applications to this post is 30 november 2020. Applicants must send by email a CV and a statement of interest to Nelly Pustelnik and Patrice Abry. For further information, candidate can contact us with questions related to this position.

References:

[1] B. Pascal, N. Pustelnik, and P. Abry, How Joint Fractal Features Estimation and Texture Segmentation can be cast into a Strongly Convex Optimization Problem, submitted, 2019. (PDF).

[2] B. Pascal, N. Pustelnik, P. Abry, M. Serres and V. Vidal, Joint estimation of local variance and local regularity for texture segmentation. Application to multiphase flow characterization, IEEE ICIP, Athens, Greece, October 7 - 10, 2018. (PDF)

[3] B. Pascal, V. Mauduit, P. Abry, and N. Pustelnik Scale-free texture segmentation: Expert feature-based versus Deep Learning strategies, European Signal Processing Conference (EUSIPCO), The Netherlands, Amsterdam, January 18 - 22, 2021. (PDF).

[4] M. Jiu, N. Pustelnik, A deep primal-dual proximal network for image restoration, submitted, 2020. (PDF).