Properties of the Hough Transform and applications to imaging issues in archaeology

TOMAT Internship Proposal

Applied Mathematics

Internship proposal for spring 2019.
Locations: INRIA Sophia Antipolis Méditerranée / CEPAM, MSHS, Nice.
Expected duration: 5-6 months.
Advisors: Laure Blanc-Féraud (I3S), Vanna Lisa Coli (CEPAM), Juliette Leblond (INRIA, FACTAS).

blancf@i3s.unice.fr, http://www-sop.inria.fr/members/Laure.Blanc_Feraud/
Vannalisa.Coli@cepam.cnrs.fr, http://www.cepam.cnrs.fr/contact/vanna-lisa-coli/
Juliette.Leblond@inria.fr, http://www-sop.inria.fr/members/Juliette.Leblond/

Context of the intership

Pottery studies are known to be pivotal within the archaeological field thanks to their contributions to the understanding of cultural traditions, social interactions and peopling dynamics. The reconstruction of pottery manufacturing was traditionally based on macroscopic examination until the implementation of new 3D methods from CT scan or synchrotron data. This enables to solve challenging questions on ancient materials characterization at different scales, in terms of microstructure, i.e. fabric, porosity and inclusions organization which inform on the manufacturing processes.
Our project provides a high level of expertise in Archaeology and Applied Mathematics already experienced (CIMO ANR, TOMAT IDEX), supporting a new transdisciplinary approach of ancient materials [1]. This project allows cutting edge developments both in archaeological, physical, and mathematical sciences for modelling and detecting low level signals.
The modelling of the material's microstructure needs critical improvements thanks to mathematical and physical developments, i.e. imaging issues, analysis of available heterogeneous noisy data, segmentation, 2D and 3D–shape recognition, algorithms to detect features induced by the technical gestures.

Goal of the intership

We plan to use the Hough transform, a discrete version of the Radon transform [2] in order to detect line segments and arc of spirals in 2D images (as a first step), which characterize the manufacturing process.

The aim of this internship is the study and the extension of the properties of the Hough transform. Indeed, the Hough transform is already efficiently used/employed in alignement detection between points, although its behavior with respect to perturbations (as non exact alignment, patches rather than points) requires deeper theoretical and numerical investigation. Thus, robustness properties will be considered while developing new algorithms and software. Numerical testing and validation will be performed on both synthetic and real images/data. The candidate will have access to computed tomography datasets.

Candidate profile

Second year of Master degree or Engineers School (PFE).

Strong background in applied mathematics.

Good knowledge of image processing, algorithms and numerical analysis.

Involvement in numerical simulation (MATLAB, C++, Python, ...) and in applications.

A general interest and knowledge in Social Sciences is welcome.

Bibliographical references

[1] Louise Gomart, Allon Weiner, Marzia Gabriele, Gilles Durrenmath, Sabine Sorin, Lucia Angeli, Marta Colombo, Cristina Fabbri, Roberto Maggi, Chiara Panelli, Didier F. Pisani, Giovanna Radi, Carlo Tozzi, Didier Binder. Spiralled patchwork in pottery manufacture and the introduction of farming to Southern Europe. Antiquity 91 360 (2017): 1501–1514, doi:10.15184/aqy.2017.187.

[2] M. van Ginkel, C.L. Luengo Hendriks and L.J. van Vliet. A short introduction to the Radon and Hough transforms and how they relate to each other. Number QI-2004-01 in the Quantitative Imaging Group Technical Report Series.