CALL FOR PhD APPLICATIONS

PhD in mathematical image processing

Remote Sensing Image Processing with multiple data modalities

Application deadline: **May 3, 2015**

Find this call for PhD applications with clickable links on
`http://web.univ-ubs.fr/lmam/froment/OpenPositions/OpenPhD2015.pdf`

CONTEXT

The PhD student will be hired under a doctoral contract that includes pension and health benefits. The thesis will be prepared in the LMBA Maths Lab (UMR CNRS 6205) at University of South Brittany (UBS) in the city of Vannes, France, under the direction of Pr. Jacques Froment and the codirection of Pr. Bartomeu Coll as part of an international dissertation supervision program between UBS and The University of the Balearic Islands (UIB), Spain. Under this joint supervision the doctoral student will do part of his research in the Mathematical Processing and Analysis of Images research team of UIB and he may receive the doctoral degree from the two universities. The PhD student will also benefit from a co-supervision by Dr. Nicolas Courty from the IRISA Lab (UMR CNRS 6074) located on the same UBS' Vannes campus. This new campus enjoys a privileged position in front of the Gulf of Morbihan, yet close to the city center that offers residence halls and many furnished apartments at attractive rates.

TOPIC

Observation is one of the key issues in the understanding of environmental systems. High spatial resolution is a requirement to get a precise description of shapes, functions and structures. A large amount of possibilities, ranging from local probes or networks to hyperspectral remote sensing images, is at the moment available to sense and extract environmental parameters. Among them, aerial or satellite imaging sensors allows for observation at a very large scale. Impacts are numerous and related to a wide range of application fields, often related to environmental issues: classification of land cover; estimation of water depth; soil moisture; vegetation mapping; agricultural monitoring and planning for a better exploitation of crops and fields; urban remote sensing for built-up area assessment; analysis of coastal ecosystems through geomorphology studies; land cover mapping and monitoring for identifying the impact of our society on Earth; crisis management and global security aiming to deliver rapid and critical information to rescue operations. The design of high-resolution spectral and spatial sensors is limited by technical constraints of onboard storage and transmission of images from the satellite to the earth. The most effective solution for providing high-resolution multispectral and spatial is to develop efficient data fusion techniques. Beyond the exceptional data volume to be handled in remote sensing, image intrinsic complexity also brings hard scientific and technological challenges. With the continuous improvement of earth observation satellite sensors, geospatial data are now multi- or even hyperspectral delivering rich information about observed objects or lands from across the electromagnetic spectrum, beyond the visible light our visual system is used to deal with. This also raises the problem of multiple observations of the same object or part, at various resolutions, and thus with various viewpoints expecting to deliver a globally better understanding of our environment. Moreover, the generalization of very high spatial resolution sensors has a direct influence on the data volume tackled by

methods and systems in the field. Finally, the complexity also comes from the significant noise and incompleteness that characterized observations provided by remote sensing.

The overall objective of the PhD is the processing of complex multimodal images for environmental purposes. In such a context, available data form a massive amount of multidimensional noisy observations with high spatio-temporal variability and coming from multiple sources. The joint exploitation of all those different sources of data is the core problem to be tackled. Among the different problems, we plan to work on : spatial resolution increasing from multi and hyperspectral data; image coregistration; hyperspectral unmixing with spatial regularization coupled resolution increase and unmixing. The different convex optimization problems derived from a mathematical formulation of the aforementioned problems will benefit from dedicated regularization terms, such as sparsity inducing norms (l^1 norms, projections onto simplices), atomic norms, or spatial/frequency regularity enforcing terms (non-local means) and spatial/spectral correlation. Dedicated algorithms and operational settings on real-world datasets are expected as contributions of this PhD. As such, this PhD subject will be at the crossroad of several scientific fields of mathematics and computing sciences, such as image processing, optimization, data fusion, interpolation and machine learning.

PROFILE

We expect the PhD candidate to contribute significantly to the aforementioned problems, with publications in high-standard journals and conferences. A particular attention will be given to the production of softwares and codes. A strong background in undergraduate mathematics is therefore required as well, at the postgraduate level, in applied mathematics in fields covered by the thesis' subject (such as numerical analysis, applied and computational harmonic analysis, optimization). Numerical experiments and scientific programming being a core aspect of this thesis, the candidate must also possess a taste for scientific computing. A master degree in applied mathematics, vision and machine learning would be particularly appreciated. At the date of establishment of the doctoral contract (September / October 2015), the candidate must hold a French master's degree or equivalent and have followed a course of study that has established its aptitude for carrying out research. International candidates with an equivalent level may be accepted by derogation granted by the President of UBS.

CONTACT

Applications must contain a CV, a letter of motivation, copies of transcripts including class rank and certificates, and letters of recommendation from former university lecturers and professors (especially ones who supervised research internships). Files must be mailed no later than **May 3, 2015** to Jacques Froment with copy to Bartomeu Coll and Nicolas Courty.

REFERENCES

- «Multiclass feature learning for hyperspectral image classification: sparse and hierarchical solutions», D. Tuia, R. Flamary, N. Courty, ISPRS J. of Photogrammetry and Remote Sensing, Elsevier, 2015.
- «SAGA: Sparse And Geometry-Aware non-negative matrix factorization through non-linear local embedding», N. Courty, X. Gong, J. Vandel, T. Burger. Machine Learning, 2014.
- «An end-member based ordering relation for the morphological description of hyperspectral images», E. Aptoula, N. Courty, S. Lefèvre. Proc. of the IEEE International Conference on Image Processing (ICIP), 2014.
- «A Nonlocal Variational Model for Pansharpening Image Fusions», J. Duran, A. Buades, B. Coll, C. Sbert. SIAM J. Imaging Sci., Vol. 7(2), pp. 761-796, 2014.