

Tensor learning for color and polarimetric imaging

Context Many imaging applications rely on the acquisition, processing and analysis of 3D or 4D vectorial data pixels: this includes notably color imaging (red, blue and green channels) or polarimetric imaging (4D Stokes parameters at each pixel). Such multichannel data is often represented using quaternions – a generalization of complex numbers in four dimensions - in order to simplify expressions and leverage unique geometric and physical insights offered by this algebraic representation. Therefore, datasets of color or polarimetric images can be viewed as a collection of quaternion-valued matrices, which form multidimensional quaternion arrays – also called *quaternion tensors*.

Summary The aim of this internship is to demonstrate the potential of quaternion tensor decompositions for learning features from databases of color and polarimetric images. Quaternion tensor decompositions have only been introduced recently [1]. They generalize usual tensor decompositions [2] to the quaternion field. The candidate will take advantage of the algorithms proposed in [1]. He / she will focus on two main cases of uses of quaternion tensor decompositions (Canonical Polyadic and Tucker) to

1. learn features from a standard color image database (such as ImageNET)
2. perform source separation on polarimetric hyperspectral data

One key complementary objective will be to benchmark performances of quaternion tensor decompositions against standard real-domain tensor decompositions.

Candidate profile He/she should be enrolled in a M1/M2R or engineer diploma in one or more of the following fields: signal and image processing, machine learning, applied mathematics. The candidate should have good writing and oral communication skills.

Supervision and environment Position can be started anytime from February, 2023 and duration is up to 6 months. This internship will be jointly supervised by Julien Flamant (CNRS research scientist), Sebastian Miron (Associate Professor at Université de Lorraine), Xavier Luciani (Associate Professor at Seatech, Toulon) and Yassine Zniyed (Associate Professor at Seatech, Toulon) Depending on its preferences, the candidate will be either located at CRAN, Nancy or either at LIS, Seatech, Toulon.

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References

- [1] J. Flamant, X. Luciani, Y. Zniyed, and S. Miron, “Tenseurs à valeurs quaternioniques : un objet mathématique à identifier,” in *GRETSI 2022 - XXVIIIème Colloque Francophone de Traitement du Signal et des Images*, Nancy, France, Sep. 2022.
- [2] T. G. Kolda and B. W. Bader, “Tensor decompositions and applications,” *SIAM review*, vol. 51, no. 3, pp. 455–500, 2009.