PROCORE - FRANCE/HONG KONG JOINT RESEARCH SCHEME COMPLETION REPORT

Project Reference Number

F-HK21/11T

Project Title

A New Paradigm for Geophysical Imaging – with Applications for Mineral/Energy Exploration, Seismic Surveying, and Archeological Subsurface Imaging

Particulars

	Hong Kong team	French team
Name of Project Co-ordinator (with title)	English: *Kainam Thomas WONG* Chinese: 黃啟南	*Sebastian MIRON, Ph.D.* *Assistant Professor*
Name of Co-Investigator (if any)	English: Chinese:	*David BRIE, Ph.D.* *Professeur*
Institution or Institutional affiliation	[ ] CityU [ ] HKU [ ] CUHK [ ] HKUST [ ] HKBU [ ] LU [ ] HKIEd [√] PolyU	[ ] CEA [ ] INRA [ ] CNRS No. [ ] INRIA [ ] INFREMER [ ] INSERM No. [√] University of *Nancy 1* [ ] Others:
Other project team members (if any)		

Funding Period

	1st year	2nd year (if applicable)
Start Date	*1/1/2012*	*1/1/2013*
Completion Date	*31/12/2012*	*31/12/2013*

Objective(s) as per original application

1. Investigate hyper-complex numbers' signal-processing potentials and drawbacks.

2. Develop novel hyper-complex models for various polarized seismic waves (e.g. Love, RTG). Adopt the existing signal-processing algorithms of ESPRIT and MUSIC to seismic imaging using the hyper-complex algebra and polarized vector-sensors.

3. Apply the above obtained hyper-complex vector-sensor geophysical imaging algorithms to extensive and diverse sets of empirical data.

[Please attach relevant document(s)]

i) Outline of proposed research and results obtained

We introduce a novel direction finding algorithm for a multi-scale sensor-array, that is, an array presenting multiple scales of invariance. We show that the collected data can be represented as a Candecomp/Parafac (CP) model, for which we analyze the identifiability properties. A two-stage algorithm for direction-of-arrival (DOA) estimation with such an array is also proposed. This approach generalizes the results given in [1] to an array that presents an arbitrary number of spatial invariances.

ii) Significance of research results

We illustrate, on a particular array geometry, that our method outperforms the ESPRIT-based approach introduced in an earlier reference. Moreover, we show that the single-snapshot case can be handled by our method, provided that the array includes at least three scale-levels.

iii) Research output

[1] S. Miron, Y. Song, B. Brie, & K. T. Wong, "CANDECOMP/PARAFAC (CP) Direction Finding with Multi-Scale Array," *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing*, Saint Martin, 15-18 December, 2013.

[2] S. Miron, Y. Song, B. Brie, & K. T. Wong, "Multilinear Direction Finding for Sensor Array with Multiple Scales of Invariance," under review by the *IEEE Transactions on Aerospace and Electronic Systems*.

iv) Potential for or impact on further research collaboration

We are exploring the possibility to extend the above-mentioned results to a polarization-sensitive antenna array.