

**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: <i>Kainam Thomas WONG</i> Chinese: 黃啟南				<i>Sebastian MIRON, Ph.D.</i> <i>Assistant Professor</i>			
Name of Co-Investigator (if any)	English: Chinese:				<i>David BRIE, Ph.D.</i> <i>Professeur</i>			
Institution or Institutional affiliation	<input type="checkbox"/>	CityU	<input type="checkbox"/>	HKU	<input type="checkbox"/>	CEA	<input type="checkbox"/>	INRA
	<input type="checkbox"/>	CUHK	<input type="checkbox"/>	HKUST	<input type="checkbox"/>	CNRS No.	<input type="checkbox"/>	INRIA
	<input type="checkbox"/>	HKBU	<input type="checkbox"/>	LU	<input type="checkbox"/>	INFREMER	<input type="checkbox"/>	INSERM No.
	<input type="checkbox"/>	HKIEd	<input checked="" type="checkbox"/>	PolyU	<input checked="" type="checkbox"/>	University of	<i>Nancy 1</i>	
	<input type="checkbox"/>				<input type="checkbox"/>	Others:		
Other project team members (if any)								

**Funding Period**

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

**Expenditure of Hong Kong Project Co-ordinator (HK\$)**

1 <sup>st</sup> year		2 <sup>nd</sup> year (if applicable)	
Budget allocated	Unspent balance	Budget allocated	Unspent balance
HK\$ 30,600	HK\$ 0	HK\$ 30,600	HK\$ 0

**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.

**Exchange activities taken in the whole project duration**

Name of Hong Kong traveller	Dates of visit	Address of visiting institution	Purpose of visit
<i>Kainam Thomas WONG</i>	2012/07/24 to 2012/08/17	<i>University of Nancy 1</i>	<i>Research discussions</i>
<i>Kainam Thomas WONG</i>	2013/07/01 to 2013/08/01	<i>University of Nancy 1</i>	<i>Research discussions</i>

Name of French traveller	Dates of visit	Address of visiting institution	Purpose of visit
<i>Sebastian MIRON</i>	2012/06/29 to 2012/07/24	<i>The Hong Kong Polytechnic University</i>	<i>Research discussions</i>
<i>David BRIE</i>	2013/10/14 to 2013/10/20	<i>The Hong Kong Polytechnic University</i>	<i>Research discussions</i>

[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**

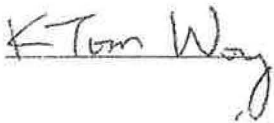
[1] S. Miron, Y. Song, B. Brie, & K. T. Wong, "CANDECOMP/PARAFAC (CP) Direction Finding with Multi-Scale Array," *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing*, Saint Martin, 15-18 December, 2013.

[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.*

**Signatures and Dates**



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Hong Kong Principal Investigator  
Dr. Kaiman Thomas WONG  
Date: 16 June, 2014



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Hong Kong Institution's Representative  
Professor Francis LAU  
Chairman, Departmental Research Committee  
Department of Electronic & Information System  
Date : 25 June 2014