Parallel Multi-Wavelength Calibration Algorithm for Radio Astronomical Arrays

Martin Brossard, Mohammed Nabil El Korso, Marius Pesavento, Rémy Boyer, Pascal Larzabal, Stefan J. Wijnholds

PII: S0165-1684(17)30427-9
DOI: 10.1016/j.sigpro.2017.12.014
Reference: SIGPRO 6683

To appear in: *Signal Processing*

Received date: 24 May 2017
Revised date: 23 November 2017
Accepted date: 14 December 2017

Please cite this article as: Martin Brossard, Mohammed Nabil El Korso, Marius Pesavento, Rémy Boyer, Pascal Larzabal, Stefan J. Wijnholds, Parallel Multi-Wavelength Calibration Algorithm for Radio Astronomical Arrays, *Signal Processing* (2017), doi: 10.1016/j.sigpro.2017.12.014

Parallel Multi-Wavelength Calibration Algorithm for Radio Astronomical Arrays[☆]

Martin Brossard[a,b], Mohammed Nabil El Korso[c], Marius Pesavento[b], Rémy Boyer[d], Pascal Larzabal[a], Stefan J. Wijnholds[e]

[a] *SATIE, UMR 8029, École Normale Supérieure de Cachan, Cachan, France*
[b] *Communication Systems Group, Technische Universität, Darmstadt, Germany*
[c] *University of Paris Ouest Nanterre La Défense, IUT de Ville d'Avray, LEME EA 4416, France*
[d] *University of Paris-Sud, Laboratoire des Signaux et Systèmes (L2S), Gif-Sur-Yvette, France*
[e] *Netherlands Institute for Radio Astronomy (ASTRON), P.O. Box 2, NL-7990 AA, Dwingeloo, The Netherlands*

Abstract

In order to meet the theoretically achievable imaging performance, calibration of modern radio interferometers is a mandatory challenge, especially at low frequencies. In this perspective, we propose a novel parallel iterative multi-wavelength calibration algorithm. The proposed algorithm estimates the apparent directions of the calibration sources, the direction dependent and direction independent complex gains of the array elements and their noise powers. Furthermore, the algorithm takes into account the specific variation of the aforementioned parameter values across wavelength. Numerical simulations reveal that the proposed scheme outperforms the mono-wavelength calibration scheme and approaches the derived constrained Cramér-Rao bound even with the presence of non-calibration sources at unknown directions. Finally, simulation results on LOFAR real data assess the usefulness of the proposed scheme.

Keywords: Calibration, radio astronomy, radio interferometer, sensor array, direction-of-arrival estimation, consensus optimization

[☆]This work was supported by MAGELLAN (ANR-14-CE23-0004-01) and ON FIRE project (Jeunes Chercheurs GDR-ISIS). This work is also funded by IBM, ASTRON, the Dutch Ministry of Economic Affairs and the Province of Drenthe

Email addresses: martin.brossard@ens-cachan.fr (Martin Brossard), m.elkorso@u-paris10.fr (Mohammed Nabil El Korso), mpesa@nt.tu-darmstadt.de (Marius Pesavento), remy.boyer@l2s.centralesupelec.fr (Rémy Boyer), pascal.larzabal@satie.ens-cachan.fr (Pascal Larzabal), wijnholds@astron.nl (Stefan J. Wijnholds)