Estimation of radio interferometer beam shapes using Riemannian optimization

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Abstract The knowledge of receiver beam shapes is essential for accurate radio interferometric imaging. Traditionally, this information is obtained by holographic techniques or by numerical simulation. However, such methods are not feasible for an observation with time varying beams, such as the beams produced by a phased array radio interferometer. We propose the use of the observed data itself for the estimation of the beam shapes. We use the directional gains obtained along multiple sources across the sky for the construction of a time varying beam model. The construction of this model is an ill posed non linear optimization problem. Therefore, we propose to use Riemannian optimization, where we consider the constraints imposed as a manifold. We compare the performance of the proposed approach with traditional unconstrained optimization and give results to show the superiority of the proposed approach.

Keywords Radio interferometry · Manifold optimization · Array processing

1 Introduction

Most interferometric observations are done using receivers that are more sensitive towards a part of the sky. This narrow field of view is attained using directive antennas (such as a dish) or by beamforming. Due to this reason, images made by such interferometric observations are distorted, with the distortion increasing for celestial objects further away from the direction where the beams are pointed at. Therefore, the knowledge of the beam shape is essential...