TIME-DEPENDENT INTERFEROMETRIC IMAGING OF NON-STATIONARY OBJECTS

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Standard approaches to radio-interferometric image formation typically assume that the source brightness distribution has negligible time-variability over the course of the data acquisition. Nevertheless, in astronomical aperture synthesis, there are sources for which this standard assumption cannot be made, including studies of solar phenomena and relativistic jet sources in the Galaxy ("microquasars"), both of which may exhibit flux density variability within the span of a given observing run. Traditionally, several approaches have been taken to mitigate this problem, including sub-dividing the measured visibility data into snapshot time intervals, over which the standard assumption of a constant source brightness distribution has greater validity. These data segments can then be imaged separately, but at the cost of reduced image fidelity as a result of sparser u-v plane coverage and lower sensitivity in each individual interval. Furthermore, this approach does not take advantage of the fact that image at one measurement time is closely related to the image at the next measurement time.

We address this problem by formulating the image formation process as a time-dependent, or dynamic estimation problem. We investigate the effectiveness of a state-space formulation for interferometric imaging by incorporating recursive estimation and optimal filtering strategies based on the the Kalman filter, which models the temporal evolution of the unknown object explicitly in the reconstruction. We assume no knowledge of the deterministic temporal evolution of the dynamic object but instead rely on a purely stochastic model. We illustrate that dynamic estimation offers the possibility of improved image fidelity in radio-interferometric imaging of objects of this type.

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