MULTISOURCE DATA FUSION FOR BANDLIMITED SIGNALS: A BAYESIAN PERSPECTIVE

André Jalobeanu
LSIIT (UMR 7005 CNRS-ULP) @ ENSPS, Illkirch, France
(e-mail: jalobeanu@lsiit.u-strasbg.fr, web: lsiit-miv.u-strasbg.fr/paseo)

Abstract

We consider data fusion as the reconstruction of a single model from multiple data sources. The model is to be inferred from a number of blurred and noisy observations, possibly from different sensors under various conditions. It is all about recovering a compound object (signal+uncertainties) that best relates to the observations and contains all the useful information from the initial data set.

We wish to provide a flexible framework for bandlimited signal reconstruction from multiple data. In this paper, we focus on a general approach involving forward modeling (prior model, data acquisition) and Bayesian inference. The proposed method is valid for n-D objects (signals, images or volumes) with multidimensional spatial elements. However, for clarity reasons, both formalism and test results will be shown in 1D for single band signals. The main originality lies in seeking an object with a prescribed point spread function (psf), for which we choose a B-spline. This ensures an optimal sampling in both signal and frequency spaces, and allows for a shift invariant processing.

The model resolution, the geometric distortions, the psf and the regularity of the sampling grid can be arbitrary for each sensor. The method was designed to handle realistic Gauss+Poisson noise. Although a simple Gaussian Markov chain was used for regularization, any efficient prior model could be employed instead.

We obtained promising results in reconstructing a super-resolved signal from two blurred and noisy shifted observations. Practical applications are under development within the SpaceFusion[1] project. In astronomical imaging, we aim at a sharp, well-sampled, noise-free and possibly super-resolved image. Virtual Observatories could benefit from such a way to combine large numbers of multispectral images from various sources. In planetary imaging or remote sensing, the 3D image formation model has to be taken into account even for flat terrains. Nevertheless, this can be addressed within the same framework.

Key Words: Model-based data fusion, reconstruction, generative models, uncertainties, B-splines, super-resolution

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