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COLLOQUIUM

Bayesian image analysis in Fourier space

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Cudahy Hall, Room 401

Abstract

Bayesian image analysis provides a solution for improving image quality relative to deterministic methods such as linear filtering, by balancing a priori expectations of image characteristics with a model for the noise process. However, conventional Bayesian image analysis models, defined in the space of the image itself, are not as frequently used in practice as they could be. The reason for the limited application is likely that these models can be difficult to specify and implement for the average user, and are relatively slow to compute (typically requiring iterative methods).

We will give a reformulation of the conventional Bayesian image analysis paradigm in Fourier space, i.e., such that the prior and likelihood are defined in terms of probability density functions (pdfs) across spatial frequencies. These pdfs are tied together across Fourier space by defining a function over Fourier space for each of the pdf parameters. In this way, spatially correlated priors, that are relatively difficult to model and compute in conventional image space, can often be more efficiently modeled as a set of independent processes across Fourier space. The originally inter-correlated and high-dimensional problem in image space is thereby broken down into a series of independent one-dimensional problems. The Fourier space independence definition leads to easy model specification and relatively fast and direct computation that is on the order of that for deterministic filtering methods.

We will describe the Bayesian image analysis in Fourier space (BIFS) modeling approach, and demonstrate useful properties of isotropy and resolution invariance to model specification. We will give specific applications of BIFS in medical imaging, and contrast with results based on Markov random field based models.

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