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Approximate Bayesian approach for volumetric reconstruction in a 3D PIV measurement SAYANTAN BHATTACHARYA, ILIAS BILIONIS, PAVLOS VLACHOS, Purdue University — Volumetric Particle Image Velocimetry (PIV) is a non-invasive flow measurement technique which resolves the 3D flow field by recording multi-camera projections of the tracer particle motion. A key step in the measurement process is the volumetric reconstruction, which solves the inverse problem of estimating the 3D intensity field from the 2D particle image projections. This inverse problem is underdetermined and often leads to a high number of false reconstructions, especially for higher particle concentrations. The MART algorithm introduced by Elsinga et al. (2006) is the most widely accepted tomographic reconstruction method. However, the accuracy in such a reconstruction decreases with increasing seeding densities (>0.05 ppp). The process is also computationally intensive. Here, we develop a Bayesian formulation to solve the inverse problem in a probabilistic sense. A maximum a posteriori (MAP) estimate is formulated using both uniform and Dirichlet process prior distributions for the 3D particle locations. The posterior is calculated using a likelihood function incorporating the camera calibration function and a Gaussian image noise. The MAP problem is recast as a stochastic optimization problem and it is solved using a stochastic gradient ascent algorithm which, in general, finds a better local maximum than a classical gradient based optimization. The cost function is iteratively solved using Tensorflow. This framework also provides an uncertainty bound on the estimate. The model is validated using a synthetic vortex ring data and an experimental pipeflow case.

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