Dictionary-Based Spatio-Temporal Flow Estimation for Echo PIV

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Echo Particle Image Velocimetry (Echo PIV) is a promising technique for measuring velocities of blood flows in arteries using ultrasound transducers. Corresponding B-mode image sequences provide the basis for estimating such flows and related flow patterns through image processing. So far, Echo PIV has employed standard 2D cross-correlation analysis to estimate velocities of seeding microbubbles based on the multiple correlation of local interrogation windows in subsequent B-mode images. However, estimating motion through cross-correlation to satisfying accuracy is difficult as the microbubbles move between consecutive measurements when constructing a B-mode image.

Our present work focuses on improving the motion estimation step by incorporating physical and spatio-temporal information. We reformulate the velocity estimation problem for laminar and steady flow within Echo PIV experiments as a sparse representation problem for globally estimating the flow vector field. The input data is the whole B-image sequence which is assumed to be well approximated by the sum of few elements from a flow dictionary. The sparsifying dictionary describes both the flow type and the acquisition method and represents possible trajectories, while the sparse indicator vector assigns microbubbles to trajectory atoms. The resulting sparse representation problem is solved with ℓ_1-minimization technique. Numerical examples show the robustness of our multiple trajectory fitting approach. Armed with these results, we point out promising research directions on how to update the trajectory dictionary when a priori velocity information is incomplete.