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Correlation plane statistical analysis for estimation of measurement uncertainty for Particle Image Velocimetry ZHENYU XUE, Department of Mechanical Engineering, Virginia Tech, JOHN CHARONKO, Los Alamos National Laboratory, PAVLOS VLACHOS, Department of Mechanical Engineering, Virginia Tech — Early development of Particle Image Velocimetry (PIV) methods did not involve quantification of measurement uncertainty, which in result created skepticism about the reliability of PIV. Quantification of PIV uncertainty is complex because coupled sources are involved in PIV measurement. Recently several attempts have been proposed. However, most of those methods were "posteriori" methods: deducing the uncertainty from post-processing of recorded images, or using observed relationships between metrics calculated from images, flow field and the resulting error distribution. Here we propose a novel theoretical and statistical PIV uncertainty estimation approach. It is based on the notion that the correlation plane represents the probability distribution function (PDF) of all possible particle displacements convoluted with particle shape information. The PDF can be obtained by de-convolving the particle information from original correlation plane. Knowing the primary peak of correlation plane indicates the most probable displacement, and the PDF, standard deviation of measured displacement, i.e. the uncertainty, can be calculated by computing the second order moment about the most probable displacement. We will present theoretical and statistical foundations of this method, we will validate each performance with synthetic image sets, and finally we will show its application on real experiment data.

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