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**Propagation of Instantaneously Varying Systematic and Random Uncertainties into the Measurement Mean, Variance, and Covariance**

BRANDON M. WILSON, Los Alamos National Laboratory, BARTON L. SMITH, Utah State University — Particle Image Velocimetry (PIV), has numerous error sources, introducing non-linear, instantaneously varying systematic and random errors. Traditional uncertainty quantification (UQ) methods assume linear or constant uncertainty on the time-averaged quantity and may be inadequate for methods with this sort of error behavior. The Uncertainty Surface, and other methods can provide the instantaneous systematic and random errors of a PIV measurement. Equations to propagate these non-linear, instantaneously varying uncertainties into measurement statistics (e.g. mean, variance, and covariance) are derived using the Taylor series uncertainty equations and presented. The mean and variance uncertainty equation validity is verified using Monte-Carlo simulations for various instantaneously varying errors. The effects of the relative magnitude, asymmetry, and variance of random and systematic errors on the measurement uncertainty are demonstrated. The mean and variance uncertainty equations are demonstrated with actual PIV measurements for two experiments. Instantaneous uncertainties are estimated using the Uncertainty Surface method for four error sources: particle image density, diameter, and displacement and gradients. The first experiment consists of a rectangular jet with known error sources. Hot wire measurements are compared to the PIV measurements to assess the accuracy of the mean and variance uncertainties. These uncertainties are also demonstrated for flow through a confined bank of cylinders.

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