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PIV accuracy improvement near stationary walls using interrogation window masking

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ABSTRACT

PIV accuracy near stationary walls suffers from the fact that the interrogation area (IA) in which the cross-correlation is performed has a finite size. The problem arises because the geometric center of the interrogation area often does not coincide with the centroid of the seeded area (Fig 1a). Vector relocation [1] and Particle Tracking Velocimetry [2] are known to produce better results near walls. In this study, a novel wall-mask technique (Fig 1b) is tested to improve accuracy of PIV results from a previous experiment, where long-distance MicroPIV measurements were taken on an airplane model [3]. This dataset is selected because two different flow configurations can be tested: the raw PIV images contain both a stagnating flow and a boundary layer flow in the field of view (Fig. 2a and 2b). A digital mask is applied on the interrogation windows close to a stationary wall, so that the center of the interrogation window and the centroid of the particle cloud coincide. A comparison is made by calculating the difference between results obtained with and without interrogation window masking. As expected the wall-window only effects the velocity computation near the boundaries (Fig 2c). A histogram of the mean relative error distribution shows that the wall-masking method significantly improves PIV accuracy near walls by as much as 95% and most of the accuracy improvements are within 15% (Fig 3).

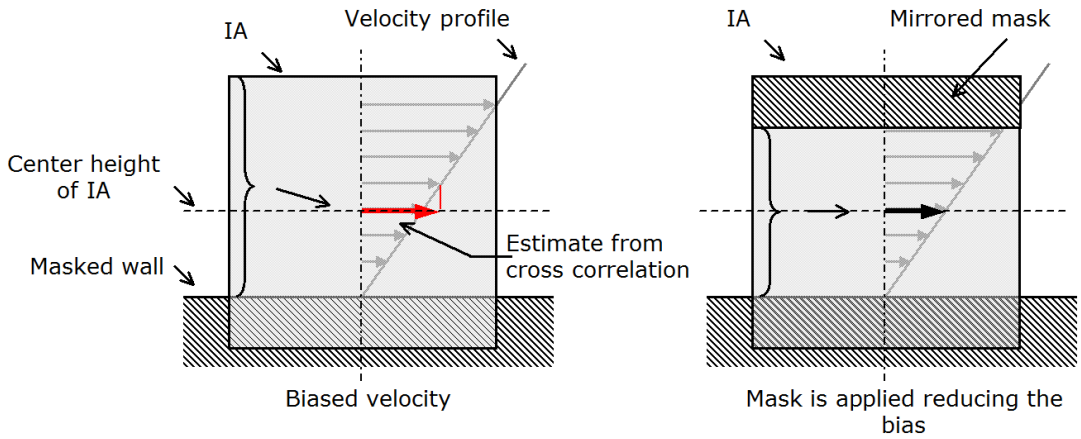

Figure 1 (a) IA without wall correction results in overestimated velocity, (b) Flow masking reduces the bias.

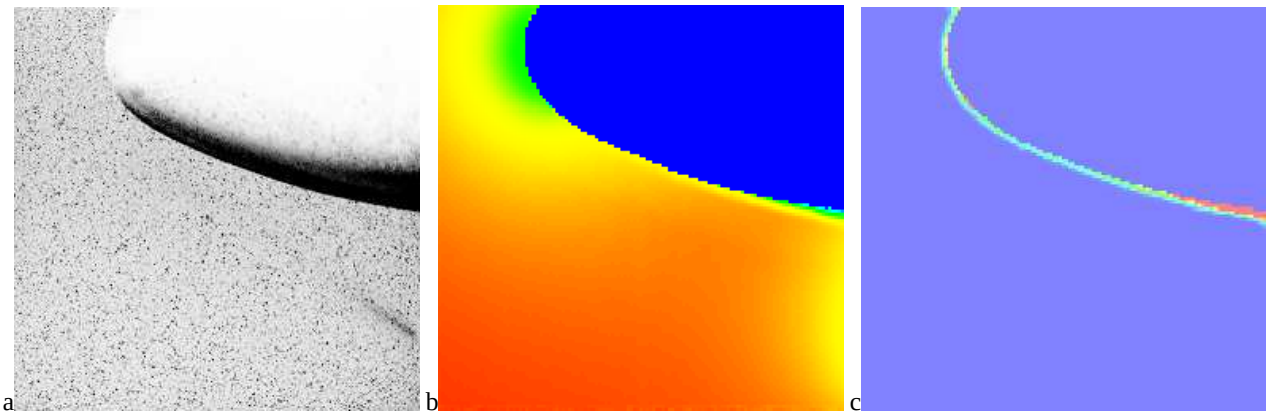

Figure 2 Application of interrogation window masking in a boundary layer flow over a model airplane (a) Typical raw particle image (b) Mean of the horizontal velocity component, *U* (average of 61 vector maps) (c) Mean relative error distribution due to interrogation window masking.

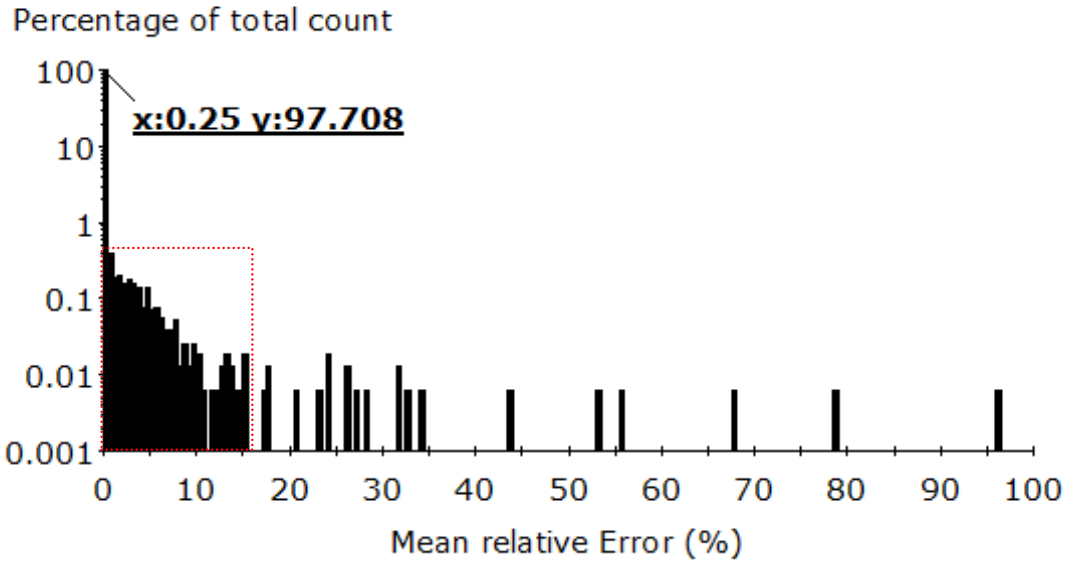

Figure 3 Histogram of mean relative error [%]

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