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Optical Flow Technique for Supersonic Jet Measurements

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Abstract : This paper outlines the development of a novel experimental technique in quantifying supersonic jet flows, in an attempt to avoid seeding particle problems frequently associated with particle-image velocimetry (PIV) techniques at high Mach numbers. Based on optical flow algorithms, the idea behind the technique involves using high speed cameras to capture Schlieren images of the supersonic jet shear layers, before they are subjected to an adapted optical flow algorithm based on the Horn-Schnuck method to determine the associated flow fields. The proposed method is capable of offering full-field unsteady flow information with potentially higher accuracy and resolution than existing point-measurements or PIV techniques. Preliminary study via numerical simulations of a circular de Laval jet nozzle successfully reveals flow and shock structures typically associated with supersonic jet flows, which serve as useful data for subsequent validation of the optical flow based experimental results. For experimental technique, a Z-type Schlieren setup is proposed with supersonic jet operated in cold mode, stagnation pressure of 8.2 bar and exit velocity of Mach 1.5. High-speed single-frame or double-frame cameras are used to capture successive Schlieren images. As implementation of optical flow technique to supersonic flows remains rare, the current focus revolves around methodology validation through synthetic images. The results of validation test offers valuable insight into how the optical flow algorithm can be further improved to improve robustness and accuracy. Details of the methodology employed and challenges faced will be further elaborated in the final conference paper should the abstract be accepted. Despite these challenges however, this novel supersonic flow measurement technique may potentially offer a simpler way to identify and quantify the fine spatial structures within the shock shear layer.

Keywords : Schlieren, optical flow, supersonic jets, shock shear layer
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