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High-speed Schlieren Imaging using Event-based Vision Cameras

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This study investigates the potentials of the recently introduced event-based vision (EBV) technology in the context of schlieren visualization. Unlike the ubiquitous framing cameras, EBV sensors record only contrast changes within the observed scene producing an asynchronous stream of contrast change "events" consisting of spatial coordinates and time-stamp of the event. With a response latency of order 100 µs, dynamic scenery can be acquired at the equivalent of 10,000 frames/s. In flow diagnostics the technology has already found increased interest for particle tracking velocimetry (PTV) [1] or background oriented schlieren (BOS) [2]. In the present contribution the authors apply EBV for high-speed schlieren visualization to assess its potential in comparison with conventional frame based-imaging.

Fig.1 shows schlieren recordings obtained in a transonic compressor cascade with both HS-imaging and EBV at an incidence flow velocity of Ma 1.2. The optical setup – based on principles originally described by Toepler [3] – is a two-mirror schlieren system (so called "Z-configuration"), in which the source is collimated by the first spherical mirror, the collimated light traverses the object and then is focused by the second mirror. Illumination is provided by a short-pulsed LED (500ns) at 20 kHz for the high-speed camera and 5 kHz for the EBV-camera. Due to the high sensitivity of the EBV camera with a dynamic range exceeding 120 dB only a fraction of light is required in comparison to conventional high-speed camera. The color-coding of pseudo-frame compiled from 5 ms of event-data reveal the highly unsteady nature of the cascade flow and is suitable for both spectral analysis and spatial correlation similar to image-processing performed on the HS-images. The reduced data rate of very cost-effective and compact EBV cameras allows the capture for extended periods of time compared the HS-cameras operating at similar frame rates.

Aside from providing an in-depth comparison of EBV-based schlieren with its high-speed imaging counterpart, the proposed contribution will investigate the possibilities of EBV for other schlieren related imaging concepts, such as retro-reflective imaging or self-focusing schlieren.

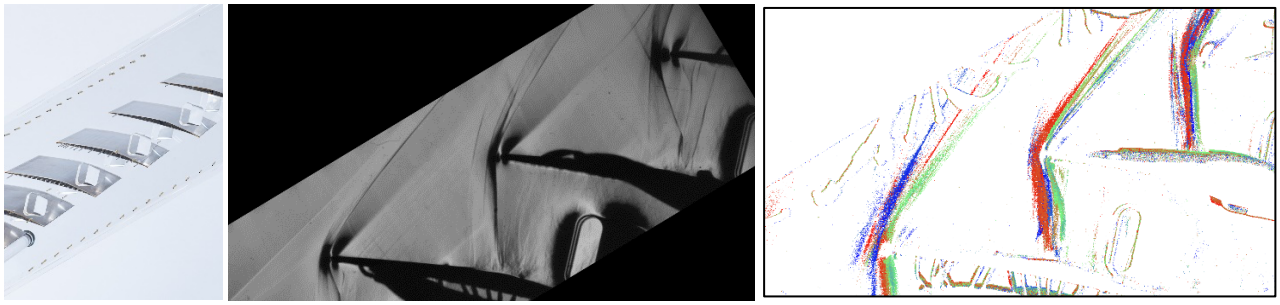

Fig.1: Transonic compressor cascade (left) and HS-schlieren imagery obtained at Ma 1.2 from HS-camera (middle) and EBV camera (right), color-coding represents relative time of events from blue (t_0-2.5ms), green (t_0) to red (t_0+2.5ms).

References

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