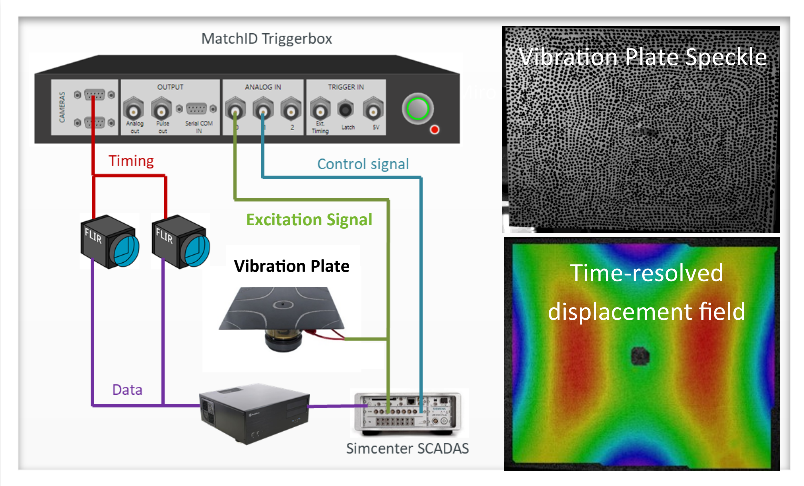
MatchID
Metrology beyond colors

Application Note

Vibration Analysis: combining high spatial and temporal resolution with basic DIC hardware

Case Description

An aluminum plate is equipped with an optimized DIC speckle pattern and vibrated for 1 second with a controlled signal of varying frequency ranging from 100 to 750Hz via a modal shaker. The vibration of the plate is simultaneously recorded using high-speed cameras and basic quasi-static DIC hardware. High-speed imaging solutions need to compensate on the spatial resolution of the sensor to operate at high frequencies. We developed a solution based on phase subsampling enabling the application of quasi-static cameras at high frame rates for repeatable signals, hereby combining a high spatial and temporal resolution. As such, a much lower noise floor and higher sensitivity can be achieved.



Experimental Setup

- ✓ **Cameras:** 2 x Phantom VEO 710s High-Speed cameras and 2 x Flir Pointgrey Blackfly S USB3 5MPx 75Hz cameras
- ✓ **Acquisition Speed:** 1500Hz for high-speed cameras and 1500Hz subsampled with 20Hz for low-speed cameras

Analysis

- ✓ **Type:** Stereo DIC with optimized settings
- ✓ **Vibration:** Modal parameters identified with Simcenter Polymax
- ✓ **Mode Shapes:** Deflection shape determination with MatchID ODS App

Results

- ✓ **Stereo DIC:** Time resolved displacements results
- ✓ **Natural frequencies:** structural resonances and damping
- ✓ **Operational Deflection Shapes** 3D deformation at the identified natural frequencies

Why MatchID

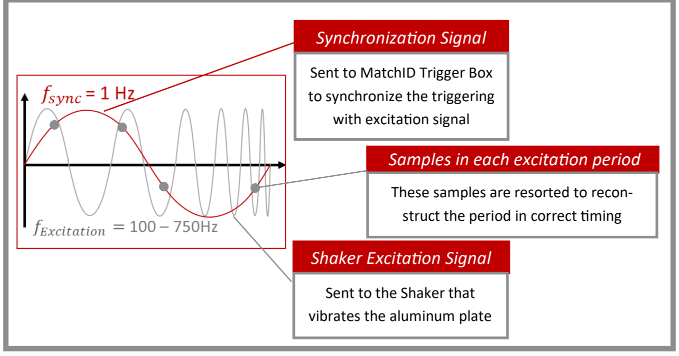
- ✓ Applying **basic DIC hardware** for **high-frequency signals**
- ✓ Achieving **optimum spatial and temporal resolution**
- ✓ **Continuous buffering** of images for an **unlimited amount of cameras**
- ✓ Seamless coupling with **Simcenter Testlab**

Image Acquisition By Subsampling

The image acquisition is performed through 2 separate Stereo-DIC systems. A first pair consists of high-speed Phantom VEO710 cameras, while the other pair involves basic DIC hardware, i.e. Flir 5MPx 75Hz cameras. The basic DIC hardware is used with the vibration trigger module of the MatchID grabber. This triggering mode subscribes to a synchronization sine signal that has the same period duration as the event excitation signal. The images are acquired in different phase angles of the synchronization to reconstruct the entire excitation duration.

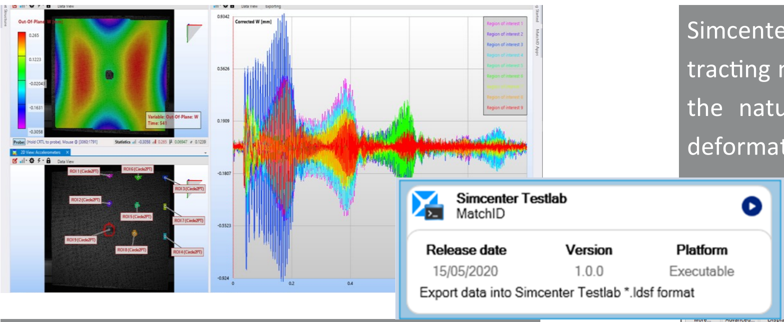
Basic DIC Hardware	High Speed Cameras
2x Flir Pointgrey Blackfly S USB3 5MPx 75Hz cameras and a MatchID Trigger Box	2x Phantom VEO 710s High Speed cameras
5Mp ~ 146 µm / pixel	1Mp ~ 375 µm / pixel
8mm subset = 21 Pixels	8mm subset = 54 Pixels
Noise Floor = 3.8 µm	Noise Floor = 11.6 µm

Subsampling Strategy Using MatchID Trigger Box (Basic DIC Hardware)

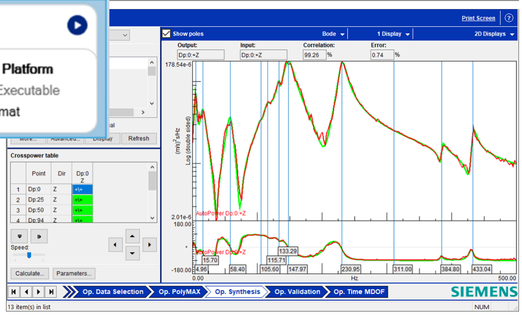


Mode Shape Frequency Detection

The deformation data is seamlessly exported to Simcenter Testlab. Next, the Polymax algorithm is used to perform modal analysis on the acquired and processed data.



Simcenter Polymax, a powerful tool for extracting modal parameters, is used to identify the natural frequencies and corresponding deformation shapes.



Out-of-plane deformations are calculated using MatchID DIC software. The time domain signal of arbitrary locations on the plate are exported to Simcenter Testlab for further processing.

Operational Deflection Shapes

The deformation shapes corresponding to the frequencies determined with Polymax are then reconstructed using our ODS Application. An identical procedure is adopted for the high-speed camera results as such allowing a benchmark validation comparison for the followed strategy. As can be retrieved from the results below, when it concerns repeatable excitation signals the basic DIC hardware correctly reproduces the ODS at higher frequencies, although in principle the cameras have a limited modus operandi of 75Hz. Moreover, due to an improved camera spatial resolution the obtained data is less subject to noise.