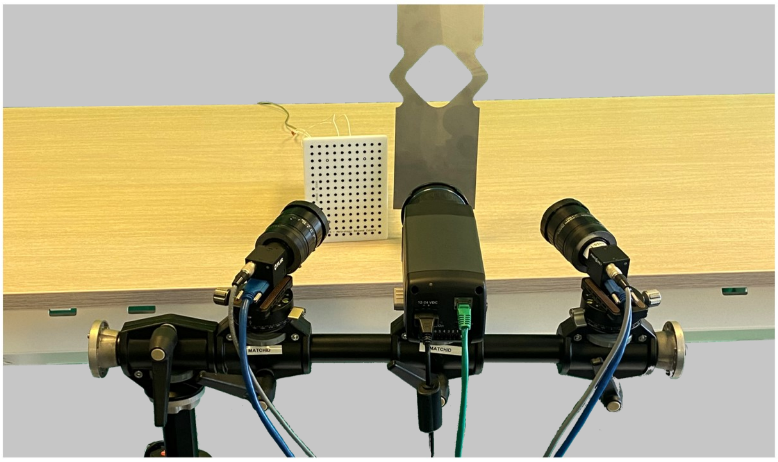
MatchID
Metrology beyond colors

Application Note

Integration with Thermal Data

Case Description



Some applications require synchronized registration of temperature and mechanical information. These include e.g. structural cases such as heating PCB's, solar panels or vehicle dynamics as well as material testing for temperature dependent constitutive parameters.

Accordingly, full-field DIC data needs to be adequately aligned with temperature hereby relying on both white-light and IR imaging equipment that generally come with fully different specs.

In this note, focus is on a complex geometry that generates biaxial strain conditions from a uniaxial testing loading.

Experimental Setup

- ✓ **White-light Cameras:** Flir Pointgrey Blackfly S USB3 5MPx 75Hz
- ✓ **IR-Camera:** Flir A615 0.3MPx 50 Hz
- ✓ **Acquisition Speed:** 10 Hz
- ✓ **Field of View:** ~100mm x 100mm

Analysis

- ✓ **Calibration:** 50 calibration images with heated glass calibration plate links DIC and IR systems
- ✓ **Mapping:** Reprojecting temperature data in the frame of the master DIC camera

Results

- ✓ Full-field mechanical and temperature information
- ✓ Temperature data at displacement corrected positions
- ✓ Input for calibrating temperature dependent constitutive models

Why MatchID

- ✓ Dedicated **heated glass calibration plate** visible in both white-light and IR spectra
- ✓ Direct **synchronization** and linking of images in the MatchID grabber
- ✓ Reprojecting **temperature data in various datasets** onto mechanical data
- ✓ Identification of material models

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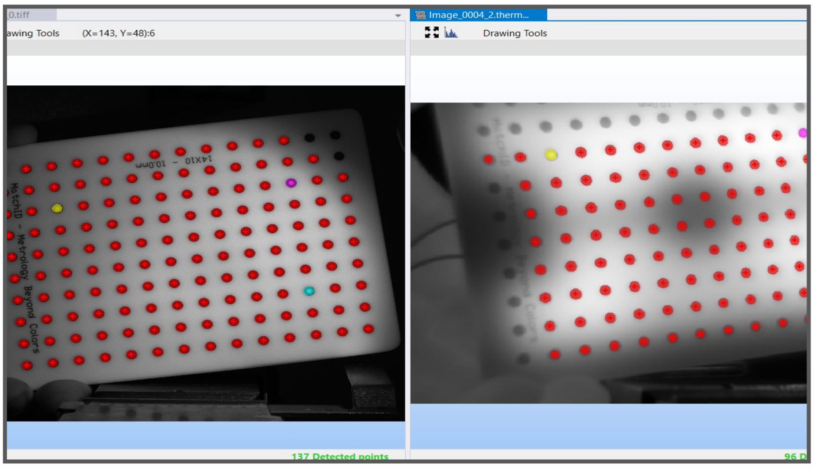
Linking IR and Stereo Cameras

In order to initiate the thermal mapping, one needs to link geometrically the IR camera and the two white-light cameras. To this purpose, we use a procedure that is generally adopted to calibrate the DIC system relying on a flat calibration plate with a regular grid of points. In this case a special heated glass calibration plate is used that is visible in both the white-light and IR spectra.

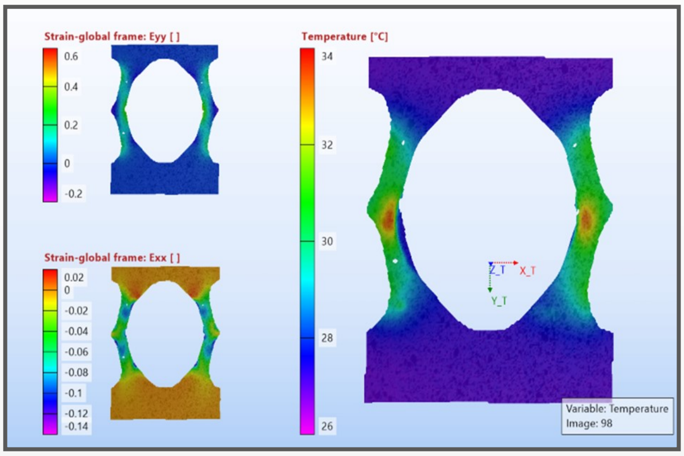


By translating, rolling, twisting and plunging the calibration target, a full-bundle approach allows to retrieve at once the stereo calibration parameters, the 3D link between the DIC master camera and IR camera, with IR lens aberration corrections included.

Combining Mechanical and Thermal data

The actual test sample is a complex geometry that is subject to tension, compression and buckling in a uniaxial test. Since the process is adiabatic, non-unfirm plastic deformation should result in local temperature increase.

During the test we capture perfectly synchronized images. The DIC algorithm reconstructs the geometrical shape hereby providing (X,Y,Z) and deformation info at every data point. Via the abovementioned calibration procedure one can then reproject (X,Y,Z) into the sensor plane of the IR camera.

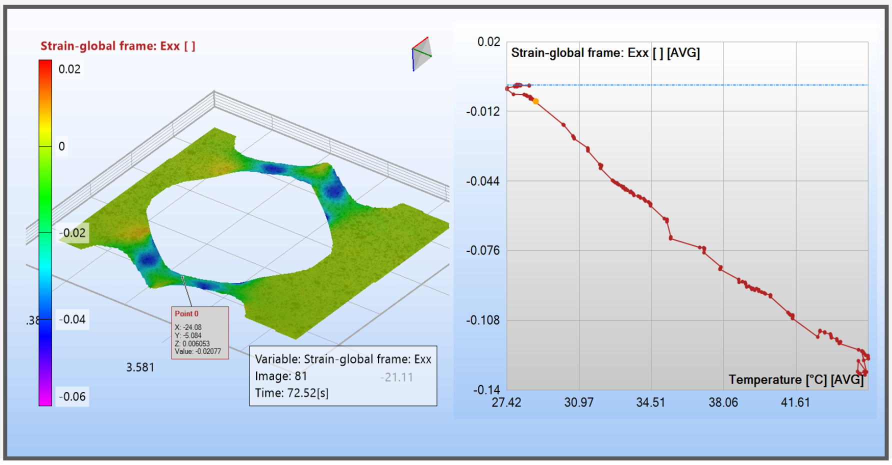


Accordingly, full-field mechanical and temperature data are automatically mapped. Moreover, the temperature data is directly recovered at the displacement corrected data point loca-

Strain—Temperature Relationship

As can be observed, strain concentrations and varying strain rates coincide with a local temperature increase. One can now investigate the relationship between a strain component and the temperature at any point. The compressive transverse strain component reveals an approximate linear behavior with temperature.

In the future, this application can feed into inverse methods such as the Virtual Fields Method or Finite Element Model Updating with both temperature and mechanical information, accordingly enabling the identification of thermomechanical constitutive models.



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