MatchID
Metrology beyond colors

MatchID Feature List

Below, a profound and as complete as possible overview is given about all available results, settings and processes within the MatchID workflow. The non-conclusive list below refers to MatchID features that are connected to MatchID products. If the MatchID product is not part of your license portfolio, you will not have access to the features connected to this product. In case you have any questions or would like to achieve more information about a certain topic or product, do not hesitate to contact us via www.matchid.eu

1. STANDARD RESULTS (2D AND STEREO)

- (X, Y, Z) object geometry (stereo-mode only)
- (U, V, W) Displacements: in-plane horizontal, in-plane vertical and out-of-plane component
- Units: SI units (mm/m/…), inch or custom assigned conversion unit
- Coordinate transformation to various camera frames, best-plane fit, or custom assigned
- Rigid body motion correction to retrieve displacement components inherent to deformation
- Relative motion between different regions of interest in an image

2. ADVANCED RESULTS (2D AND STEREO)

2.1 Strain

- Exx, Eyy, Exy in a local and global frame prescription
- Major and minor principal strains + shear angle
- Von-mises strain
- Green-Lagrange, Euler-Almansi, Logarithmic Euler-Almansi, Hencky, Biot undeformed and Biot deformed convention
- Units: [], [%], [µm/m]
- Strain window smoothing (adjustable) with linear or quadratic formulation
- Integrated virtual strain gauge assessment to evaluate the impact of smoothing
- Deformation gradient

2.2 Stress

- Elasticity: isotropic and orthotropic
- Plasticity: Von Mises, Hill quadratic 1948, Hill 1990, Barlat YLD2000-2D, Barlat YLD2000-2D Physical, NICE-Von Mises, NICE YLD2000-2D, NICE YLD2000-2D Physical, Barlat YLD2004, Barlat YLD89, Cazacu 2006, Karafillis-Boyce 1993, Hu 2005, Gotoh biquadratic 1978, Vegter, Banabic BBC2005, Banabic BBC2008 yield criterion. Linear, Swift, Voce I, Voce II, Ludwik hardening. Generates equivalent plastic strain too.
- Hyperelasticity: Neo-Hookean, Mooney-Rivlin, Yeoh, Eight-Chain Arruda-Boyce, Ogden, Gent, Horgan-Saccomandi, Knowles, Extended Tube, Blatz-Ko Foam, Hyperfoam. Anisotropic Eight-Chain, Bischoff, Holzapfel-Gasser-Ogden and generalized Fung model.
- Visco-elasticity: Prony series of tuneable order
- Visco-plasticity: Bergstrom-Boyce Two-Network, Three-Network model
- Custom Material Model (CMAT) Interface: couple your material model.

2.3 Velocities and Accelerations

- Vx, Vy, Vz: in-plane horizontal, in-plane vertical and out-of-plane velocity component
- Ax, Ay, Az: in-plane horizontal, in-plane vertical and out-of-plane velocity component
- Units: [m/s, mm/s, inch/s, m/s^2, …]
- Temporal window smoothing (adjustable) with linear or quadratic formulation

2.4 Strain Rates

- dExx/dt, dEyy/dt, dExy/dt derived from 4.1
- Units: [1/s, %/s, µm /ms, …]
- Temporal window smoothing (adjustable) with linear or quadratic formulation

2.5 Fast-Fourier Transform

- FFT response analysis of all abovementioned variables

2.6 Curvatures

- dw/dx and dw/dy rotations of the material around x and y
- d2w/dx2, d2w/dy2, d2w/dxy surface curvatures
- Spatial window smoothing (adjustable) with linear or quadratic formulation

2.7 Surface inspection

- Hotspot and surface irregularity determination
- Spatial window smoothing (adjustable) with linear or quadratic formulation

2.8 Equilibrium Gap Indicator & Force Reconstruction

- Checks the static admissibility of DIC stress fields
- Rank the performance of material models

2.9 Filters

- Temporal filter
- Polynomial fit (user-defined) allowing to spatially filter, fit and derive

2.10 Geometry measurements

- Updated radius of cylinders and spheres
- Object flatness
- Volume change (only multicam)
- Thickness reduction (only multicam)

3. CUSTOM RESULTS (2D AND STEREO)

- Mathematical tool to combine various data and generate a new variable
- Seamless workflow with Python, Matlab, c++, c# custom processing to generate and import new variables

- Available apps for extra strain variables, material models, …

4. DATA VISUALIZATION AND EXTRACTION (2D AND STEREO)

- Grid display, chart view, 2D overlay with experimental images, 3D view
- Dataset, multi-viewport and multi-desktop approach via floating and dockable windows: direct comparison of different variables, charts and/or processing settings
- Compare datasets: directly compare data from different tests
- Axes and legend customization: Scientific (with adjustable significant numbers) or full precision annotation, various font-formats, adjustable ranges (fixed, automatic, or inherited from other datasets)
- Color maps: various schemes (jet, rainbow, gray, plasma, vik, viridis, magma, …, customized) with adjustable number of iso-lines and imposed averaging or not.
- Visual style: continuous or discrete datapoints
- Annotations: coordinate frames, displacement vectors, major and minor principal strain directions
- Adjust your view settings and store into various display templates.
- Line, polyline, circular, ellipse, rectangle, polygon extraction tools to include or exclude data from a dataset
- Filter ranges: extract data that fits a certain interval range
- Export the analysis workflow and data manipulation as a *.mico file. Seamlessly repeat your workflow, chart generation, desktop view, extractions … on other experimental data.
- Export individual datasets as *.adat files for direct import in the results viewer.

5. DATA EXPORTING (2D AND STEREO)

- Export Data as *.stl
- Export Data as *.csv file
- Export Data as Matlab *.mat file in matrix format
- Export Image (*.bmp/*.png/*.jpeg/*.emf/*.exif/*.gif/*.tiff/*.wmf)
- Export Video (*.gif/*.avi) with indication of FPS
- Export Data as *.unv and *.ldsf
- Export Data as *.hdf
- Exporting can be done at the individual data level or at screen-recording mode to combine chart and image views.
- Export Database: single *.midb file containing all images and all data with project information ready to share to non-licensed persons. Possibility to password protect the file with a watermark overlay.
- Export in scientific/decimal or full precision format.
- Export report of the test in Latex, Pdf or Word format.

6. DEFAULT ADVANCED FUNCTIONALITIES (2D AND STEREO)

- Noise Evaluation Toolbox: evaluate spatial and temporal noise.
- Image Quality Module: inspect the quality of the speckle pattern.
- Image Averaging Module: average images to reduce the impact of noise.
- Test configuration calculation: determine the optimum lens/camera/FOV combination.
- ODS module: operational deflection shapes. (only Stereo)
- Temperature import: overlay mechanical information with temperature data. (only Stereo)
- Forming Limit Curves and Forming Limit Diagrams.

- Fracture mechanics module: crack opening displacement, crack path. More accurate strain fields: strain evaluated respecting the crack. Automatic determination of the crack path. Williams' series and J-integrals (path and domain) to get the crack tip location and stress intensity factors. J-integral study to evaluate the convergence of the J-integral geometry. Mode I-II-III.

7. STANDARDS (2D AND STEREO)

- ISO-6892: tensile testing of metallic materials
- VDI/VDE-2626: pre-acceptance DIC test
- ISO-12004-2: Determination of forming-limit curves
- ASTM D5528-13: Double Cantilever Beam standard for Mode I interlaminar fracture toughness

8. DIGITAL IMAGE CORRELATION PROCESSING (2D AND STEREO)

- Batch-mode processing workflow based on a readable txt input file
- User-levels: novice-expert-guru.
- Full access and control of all available settings – no black box
- Correlation Criterion: different options depending on lighting conditions
- Uniform and Gaussian-weighted subsets
- Partial subset filling to determine data closer to edges
- Missing data compensation to reconstruct missing data points via overlapping subsets shape function or padding
- Interpolations: Global and local bicubic-spline interpolation scheme approaching a true sinc and as such reducing the bias to a minimum
- Deformation Shape functions: rigid (translations), affine (shear, stretch, rotation), quadratic (bending) shape functions
- Stereo shape functions: first or second order to perform cross-camera correlation. Operate independently from deformation shape functions
- Regularized DIC processing: updating scheme along the path of optimum accuracy
- Image prefiltering: none, average or gaussian to reduce impact of aliasing
- Import and synchronization of external data as e.g. load force, strain gauge measurements, …
- Selection, drawing and cutting tools: rectangle, circle, polygon region of interest (ROI). Automasking tool to identify the ROI automatically.
- Different settings can be applied per ROI to measure adequately heterogeneous material behavior
- Individual subset annotation and fiducial extraction for simple marker tracking
- Extensometer annotation to perform video extensometry measurements
- Results stored in different or single file format via a working-directory principle
- Integrated grid method for analyzing fringe images
- Lens distortion compensation: radial (first, second, third order) and tangential, polynomial
- Ray-based calibration method (origin and direction): non-pinhole model procedure to account for refractive media (water, glass, mirrors, …)
- Independent camera calibration when calibration target is not simultaneously visible in both camera frames
- Correlation-optimization of calibration procedure
- Incremental correlation for large deformations. "Intelligent" approach only updating when required, as such minimizing noise accumulation.
- Parallelized algorithms with possibility to indicate number of cores to be used

9. PERFORMANCE ANALYSIS MODULE (2D AND STEREO)

- "Design of experiments" for DIC user variables (subset, step, shape function order, strain window,…) adopting a full factorial approach
- Run a combination of DIC user variables in predefined interval ranges. Data for every combination is stored separately on the hard drive
- Parallel processing at multiple levels: within a single processing run or multiple DIC analyses
- Metrological chart generation: signal vs. resolution, signal vs. VSG and resolution vs. VSG
- Find the ideal compromise between spatial resolution and noise filtering
- Retrieve whether your DIC experiment converged or if you need cameras with a higher resolution
- Line-extraction tools to visualize strain peaks

10. FINITE ELEMENT DEFORMATION MODULE (2D AND STEREO)

- Create virtual images with a benchmark answer and optimize your experimental workspace, specimen geometry and/or DIC analysis
- Numerically deform images according to displacement fields that are obtained via finite element analysis
- Pixel integration to mimic as maximal as possible a realistic image capturing
- Abaqus: direct odb interpreter allowing to indicate multiple steps, sets, instances, …
- Ansys: element-nodal file reader or via *.rst
- LSDyna: *.key file
- Nastran MSC/NX: *.op2 file
- Simcenter Nastran: element-nodal op2 file interpreter.
- Upload of actual DIC reference speckle pattern and the calibration parameters
- Projection in both camera frames, hence creating synthetic images from a stereo perspective
- Frame alignment via fiducials and markers, 3D translation and rotation functions
- Bind nodal point locations to world coordinates
- Validate the alignment of your FEA and DIC coordinate frames/geometries by validating the depth of the mesh relative to the object
- Different interpolants (polynomial or splines), background colors, parallelization options
- 8/10/12/16 bit compatibility
- Output as double-precision *.def image format or a direct *.3dat file. Automatic storing of masking files.
- Batch-mode processing workflow based on a readable txt input file
- Impose image blurring for more realistic virtual test setups.
- Impose pixel-based noise levels (not linked to the gray level value of the pixel, but purely on its location).
- Create virtual multi-camera test setups: synthetic images for more than 2 camera setups.
- Create virtual images for DIC-IR setups: synthetic thermal images.
- Create virtual images for different camera resolutions.

11. FINITE ELEMENT VALIDATION MODULE (REQUIRES FEVAL)

- Validate from a full-field perspective where the model is correct or not
- Import the virtual FEA *.def images from the FEDEF module and run through the same filters (subset, step, shape function, strain window,…) as your actual DIC data
- Automatic indication of the same regions of interest, initial point location, … from your DIC test on your virtual image
- Exact data point coincidence, hence no additional interpolation needed
- Difference maps for all variables listed in section 2
- Provide the noise threshold and generate full-field validation maps (1-3 sigma error bars) indicating where the model fails or complies
- Batch-mode processing workflow based on a readable txt input file and auto-generation of "difference" *.csv files
- Combination of FEVAL and FEDEF batch-mode operations for finite-element model updating

12. VIRTUAL FIELDS METHOD MODULE (REQUIRES VFM)

- Tool to identify mechanical material properties from complex specimen geometries
- Automatic import of 2D or stereo-DIC results
- Auto-padding procedure to reduce systematic errors
- Boundary conditions indications: horizontal axial, vertical axial, horizontal shear, vertical shear, biaxial or custom made
- Boundary condition alignment with the specimen geometry
- Upload of various force signals in accordance to the imposed boundary conditions
- Material orientation indication on the specimen geometry
- Orthotropic elasticity in cylindrical coordinates: determine cylindrical stiffness components. Useful for cross-sectional properties of ring slices (e.g. pipe structures).
- Save material cards: export of elastic, plastic, hyperelastic, viscoelastic and viscoplastic parameters. Distribution made easy and fast.
- Large or small strain formulation for non-linear material models.
- Bending correction to perform identification based on membrane strains.
- Available material models: See sec. 2.2
- Various virtual-field types: uniform, total sensitivity and incremental sensitivity. Act as weighting factors in the identification procedure. Adjust mesh density of the virtual fields mesh.
- Levenberg-Marquardt and Nelder-Mead optimizers.
- Indicate parameter "freedom": fixed, vary within an interval, unlimited variation
- Impose temporal smoothing to reduce the impact of temporal noise via an adjustable temporal window and filter order
- Visual chart inspection of the identification progress: external vs. internal virtual work equilibrium chart (evt. Parameter dependent), individual parameter update per iteration, …
- Results contain: identified parameters, stress-strain chart, external vs. internal virtual work chart, parameter evolution history chart, principal stress chart, full-field stress maps (σ_{xx}, σ_{yy}, σ_{xy}, σ_1, σ_2), full-field parameter sensitivity maps, 2D spider-sensitivity chart, …
- Integrated export to MatchID's results viewer for data extraction, manipulation, report generation, …

13. QUASI-STATIC FRAME GRABBER (REQUIRES QS-GRABBER)

- Frame grabber integrating with AVT, Daheng, Basler, Baumer, Flir PointGrey, Imaging Source cameras. Check with our team for compatibility.
- Software, hardware or external trigger-mode
- Synchronization and data acquisition via MatchID's Trigger unit
- Break-out units to invoke an "unlimited" amount of cameras
- Feedback to the machine via the MatchID feedback unit
- Grabber can operate over multiple workstations via a master-slave configuration to maximize the camera frame rate

13.1 Output

- Images recorded in *.tiff format for all connected cameras
- Automatic generation of a *.csv file synchronizing images, time information, external data, …
- Time-format indications: total seconds since startup, timestamp image, date image, date + timestamp image, …
- Adjustable image naming, folder storage, camera tag labels, …

13.2 Recording

- Mode: store to HDD or to RAM
- Settings: continuous, finite number of samples, finite duration (s)
- Speed: frames per second, frame interval, varying frames per second
- Burst mode: single or repeatable
- Averaged reference image to reduce the noise floor

13.3 Viewing, tools and experimental optimization

- Exposure time adjustment: coupled or individual camera level
- Live Histogram evaluation: complete image or within region of interest (Rectangle, ellipse, …)
- Live Noise evaluation: complete image or within region of interest (Rectangle, ellipse, …)
- Live Speckle-Analysis tool: automatic determination of the average pixel-sampling per speckle in a certain region.
- Live Focusing tool: intuitive radar revealing whether your camera is fully focused
- Image display options: gray image, over exposure indication, heat image (pseudo-color image indicating local changes) and low-light option to increase contrast for visualization
- Inspect subset size and evaluate grid pitch
- Image quality determination
- Alignment: line, square, circle, aim for camera alignment
- Cropping: crop the field of view to achieve faster frame rates
- Integrated cross-camera correlation and calibration
- Remote camera control via a local network. Use your smartphone as a trigger button.

13.4 Live DIC and experimental feedback

- Displacement (U,V,W), strain and extensometer strain (m/m, %)
- Access to all settings and regions of interest of a general post-processing DIC analysis
- Full-field view, multiple extensometer (axial or biaxial) mode signal graphs
- Direct recording of extensometer data to output *.csv file
- Export via RS232 protocol or analog out via feedback unit

13.5 Vibration and Signal-locking

- Advanced triggering when combined with the trigger unit
- Locking to a synchronization signal enabling high accuracy triggering
- Adjustable oversampling rate
- Virtual “elevated” artificial acquisition frame rates for vibration measurements (in principal up to 2 kHz)
- Dedicated procedure for long-enduring fatigue measurements to reduce the number of recorded images to a user-defined set of relevant information

14. HIGH-SPEED FRAME GRABBER (REQUIRES HS-GRABBER)

- Integrates with Phantom, iX, NAC and Photron cameras. Check with our team for compatibility.
- All tools and view settings listed in 13.1, 13.2 and 13.3.

15. DOCUMENTATION (DEFAULT)

- Wiki directly integrated in the software immediately revealing relevant information to a certain setting or option
- Software manuals, tutorials and videos
- Theory manuals revealing the mathematics behind a certain procedure or calculation
- Access to recorded DIC course lectures and exercises