Optical 3D Deformation Analysis

3D Surface - Displacements - Strains in Material and Component Testing
Optical 3D Deformation Analysis

ARAMIS helps to better understand material and component behavior and is ideally suited to monitor experiments with high temporal and local resolution. ARAMIS is a non-contact and material independent measuring system providing, for static or dynamically loaded test objects, accurate:

- 3D surface coordinates
- 3D displacements and velocities
- Surface strain values
- Strain rates

Unlike other techniques, ARAMIS is a robust solution for full-field analysis of small specimens (mm) up to large components (multiple 10 m). Measurements are carried out independently from geometry and temperature without time-consuming and expensive specimen preparation.

ARAMIS is the solution for ...

- Determination of material properties
- Component analysis
- Verification of Finite Element Analysis
- Real-Time controlling of testing devices

ARAMIS Features

- Non-contact
- Material independent
- Geometry independent
- 2D and 3D measurement
- Mobile and flexible
- Full-field
- High accuracy
- High temperature
- High speed
- Easy specimen preparation
- Integration in testing environments
- Smallest to largest object sizes
- Smallest to largest deformations
**Sub-pixel accurate image processing for 3D surface, displacement and strain measurement**

ARAMIS evaluates high-resolution images recorded from any test object during loading. With the help of adjustment computations, a precise mathematical calibration model of the sensor setup is calculated including camera positions and lens distortion parameters.

The image processing is based on the principle of digital image correlation. Grey value distributions are calculated for a large amount of small subsets in each camera image and provide sub-pixel accurate positions about corresponding points between all images.

Strains are calculated considering the component’s geometry and plasticity theory. As the image acquisition is time-based, 3D velocities and strain rates are automatically achieved.

ARAMIS provides the measurement results as

- Full-field 3D coordinates, displacements and strains
- Fine resolution 3D mesh
- Plain strain tensor
- Object contour based visualization

The mathematical model of the sensor setup, the digital image correlation method and a triangulation calculation are combined to derive high accurate 3D coordinates. Subtracting the surface information in all loading stages in 3D space provides precise X,Y and Z displacement values.
Important factors in product development processes are the dimensioning of components, the exact determination of material properties and the validation of FE calculation models. ARAMIS helps to better understand material and component behavior.

Material testing

The precise full-field ARAMIS results improve the accuracy of material characteristic values. Existing evaluation procedures are enhanced and thus more reliable, like the determination of flow curves and forming limit curves. A lot of material tests can only be evaluated because of the non-contact measurement and the high local resolution ARAMIS results.

- High temperature tests
- High speed tests
- Very small specimen sizes

Today, ARAMIS is an established and proven measuring solution in hundreds of material research facilities around the world for:

- Strain-Stress evaluation
- R-Values
- Poisson ratio
- Young’s modulus
- Forming limit curves
- Residual stress
- Shear modulus

Real-Time 3D measuring

ARAMIS provides real-time results for multiple measurement positions on a specimen’s surface. These are directly transferred to testing devices, data acquisition units or processing softwares (e.g. LabView, DIAdem, MSExcel, etc.) and are used for:

- Controlling of testing devices
- Long-term tests with smallest storage requirements
- Vibration analysis
- 3D Video Extensometer
Component testing and analysis

ARAMIS is the right tool for the understanding of the component itself as it is

- independent from material, size and geometry
- and measuring under real-use conditions.

ARAMIS considers the real component geometry which would not be possible with traditional measuring devices like strain gauges, displacement sensors (LVDT), vibrometers, etc.

3D measurement results are always required as a 3D object leads to non-linear deformation behavior. ARAMIS links to the component’s original 3D CAD data for transformations, direct comparisons and visualizations.

ARAMIS provides all results for static and dynamic tests even at high speeds for smallest to largest components for

- Strength assessment
- Vibration analysis
- Durability studies
- Crash tests

Finite Element Analysis

New products and production processes are designed and optimized with numerical simulation methods. Material parameters and component deformation behavior have a significant influence on the accuracy of simulation calculations and their reliability.

ARAMIS is used for the determination of material parameters as FE input values and the validation of numerical simulations by calculating the differences between experimental measurements and FE data.
The basic workflow

**Preparation**
The mobile ARAMIS sensor is adjusted to the required specimen size and positioned in front of the specimen.

**Measurement**
ARAMIS acquires the images and analog data during loading of the component.

- User-definable image acquisition
- Flexible triggering (manual, time sequence, TTL, analog signals)
- Integrated data logger
- Real-Time measurement

**Evaluation**
ARAMIS automatically computes 3D coordinates for all loading stages and derives surface, displacement and strain results.

- Computation of material parameters
- CAD import and comparison
- Coordinate transformation (3-2-1, CAD, Best-Fit, ...)
- Rigid body motion compensation
- Calculation of geometrical elements (cylinders, circles, cones, spheres, planes, ...)
- Evaluation of acquired analog data
- Comparison to Finite Element Simulation including import and export

**Reporting**
The ARAMIS reporting engine is based on templates for complete automatic report generation. All results are available for user-definable 3D visualizations, diagrams, tables, videos, images and can be exported in standard file formats.
ARAMIS Advantages

Non-contact 3D surface, displacements and strains
ARAMIS is the unique solution delivering complete 3D surface, displacement and strain results where a large number of traditional measuring devices are required (strain gauges, LVDTs, extensometers, …).

Local and global deformation behavior
ARAMIS results are comparable to values from hundreds or thousands of strain gauges, LVDTs and extensometers on one specimen. These full-field measurement data represent local effects and global deformations for an easy understanding of material and component behavior.

More information - faster
ARAMIS preparation and setup is easy, leading to quickly available measuring results.

From smallest to largest strains
ARAMIS is the only reasonable method to measure from smallest strains to multiple hundred percent deformation (e.g. polymer specimens with 1000% strain).

Matching the applications
ARAMIS can be set up to meet optimum measuring speeds, resolutions and areas of interest.

Sensor Controller
ARAMIS comes with an integrated sensor controller which allows adaptation to the testing environment. This controller is used for aligning the image acquisition to the test procedure, recoding analog values and communicating with testing devices.

The sensor controller is specially developed by GOM to provide an automated and secure integration in material and component testing process chains.

Process reliability
The ARAMIS sensor is based on GOM’s proven stereo-camera technique, guaranteeing
• Compensating for environmental influences (e.g. room temperature, vibration)
• Monitoring the sensor calibration automatically
• Identifying and compensating rigid body motion
The Complete ARAMIS System

Cameras
- CCD and CMOS cameras
- Different image resolutions
- Adjustable image size
- User-definable acquisition speeds to meet application requirements
- Stable and certified lenses

Sensor
- Adjustable or fixed camera frame
- Robust and stable
- No tools for sensor adjustment required
- Integrated object illumination
- Integrated laser pointer for simplified positioning

Sensor Controller
- Power supply for cameras, illumination and positioning pointer
- Trigger unit
- Synchronized image acquisition
- Analogue data input and output

Computer / Notebook
- 64 bit processing power
- Industrial grade and certified components

Transport Cases
- Adjustable work plate for sitting or standing working height
- Robust and proven sensor protection case

Certification
- Certified calibration artifacts
- NIST and PTB certified software algorithms
- FCC certified computer

Software
- Complete software from one source
**ARAMIS Technical Data**

<table>
<thead>
<tr>
<th>Configuration</th>
<th>5M</th>
<th>4M</th>
<th>12M</th>
<th>HS</th>
<th>High Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame Rate</td>
<td>15Hz up to 29Hz</td>
<td>60Hz up to 480Hz</td>
<td>24Hz up to 200Hz</td>
<td>500Hz up to 4000Hz</td>
<td>5kHz up to 1MHz</td>
</tr>
<tr>
<td>Camera Resolution</td>
<td>2448 x 2050 px</td>
<td>2352 x 1728 px</td>
<td>4096 x 3072 px</td>
<td>1280 x 1024 px</td>
<td>up to 1024 x 1024 px</td>
</tr>
</tbody>
</table>

- **Measuring Area**: mm² to > m²
- **Strain Measuring Range**: 0.01 % up to >100%
- **Strain Measuring Accuracy**: up to 0.01%

| Ring Buffer     | •               | •               | •               | •               | •               |
| Image Memory    | uses PC RAM    | uses PC RAM    | uses PC RAM    | uses PC RAM    | camera RAM     |
| Camera Frame    | adjustable/fixed | adjustable/fixed | adjustable/fixed | adjustable/fixed | adjustable     |
| Tool Free Mounting | •               | •               | •               | •               | •               |
| Integrated Cable Guide | •             | •               | •               | •               | •               |
| Positioning Pointers | 1 or 3         | 1 or 3         | 1 or 3         | 1 or 3         | •               |
| Illumination    | integrated     | integrated     | integrated     | external        | external       |

- **High-End Rack Mount PC**: sensor controller
- **Notebook**: sensor controller
- **Control Device**: sensor controller
- **Sensor Dimensions (height x depth)**: 175 x 180 mm, 235 x 185 mm, 215 x 185 mm, 230 x 185 mm
- **Sensor Dimensions (length)**: variable, variable, variable
- **Weight**: 5 kg, 6.5 kg, 6.5 kg, 6 kg
- **Operating Temperature**: 5 – 40°C, 5 – 40°C, 5 – 40°C, 5 – 40°C
- **Humidity**: non-condensing, non-condensing, non-condensing, non-condensing

Additional sensor configurations available on request.

**Sensor Controller Technical Data**

<table>
<thead>
<tr>
<th>Analog Input</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>Channels</td>
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<tr>
<td>Digital Resolution</td>
<td>16 bit</td>
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<tr>
<td>Voltage Range</td>
<td>-10 V to +10 V</td>
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<tr>
<td>Sampling Frequency</td>
<td>up to 100 kHz</td>
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</table>

<table>
<thead>
<tr>
<th>Analog Output</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channels</td>
<td></td>
</tr>
<tr>
<td>Digital Resolution</td>
<td>12 bit</td>
</tr>
<tr>
<td>Voltage Range</td>
<td>0 V to +10 V</td>
</tr>
<tr>
<td>Sampling Frequency</td>
<td>up to 500 Hz</td>
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</table>

- **Trigger**: pre / direct / post
- **Event List Based Triggering**: points in time, analog values, external signals

<table>
<thead>
<tr>
<th>Power for Communication / Data Transfer</th>
<th>cameras, illumination, positioning pointers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>445 x 44 x 270 mm³</td>
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<tr>
<td>Weight</td>
<td>2.8 kg</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>5 – 40°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>non-condensing</td>
</tr>
<tr>
<td>Power Supply</td>
<td>90-230V AC</td>
</tr>
</tbody>
</table>
GOM provides a complete solution with the ARAMIS system for measuring, evaluation and reporting.

- Optimized workflows – time saving
- User friendly – one training session
- One support contact

GOM completely develops the ARAMIS hardware and software in house. The software is designed to run the sensor and controller, to process all measurements, to automatically compute result data and to perform post-processing.

ARAMIS is an industrial grade solution providing all necessary functionalities even for complex research tasks.

ARAMIS is integrated in standard process chains through versatile import and export capabilities. Material parameters, testing device outputs and data logs are imported and used for further calculation of characteristic values.

CAD data are used for transformations and deviation calculations.
- Native: Catia v4/v5, UG, ProE
- General: IGES, STL, VDA, STEP

To close the process loop, all result data are exported in standard or free definable formats.

All workflows are available for automated use with a record and play procedure. New analysis models can easily be implemented by the operator and added to the standard evaluation as ARAMIS offers a scripting interface.

All built-in features enable ARAMIS to:
- Integrate in existing testing and measuring workflows
- Link with existing evaluation strategies
- Adapt to any measuring and evaluation task
The “Gesellschaft für Optische Messtechnik” (GOM) develops, produces and distributes optical measuring equipment for the three-dimensional coordinate measurement and deformation measurement of components. The measuring systems are based on digital image processing and are used in material and component testing, product development and quality assurance.

All over the world, companies of the automotive, aviation and space industries, their suppliers and various manufacturers of consumer goods as well as research facilities use GOM systems.

GOM was founded in 1990 as spin-off of the Technical University Braunschweig, Germany. The company owns subsidiaries in Switzerland, France, Great Britain and Belgium. Worldwide, more than 30 committed and competent partners install, support and market GOM products.

Today, GOM offers a complete in-house solution covering hardware, software, technical support and training.

GOM customers (extract)

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