

VIC-Volume

3D Volumetric Strain & Displacement

Technology Overview

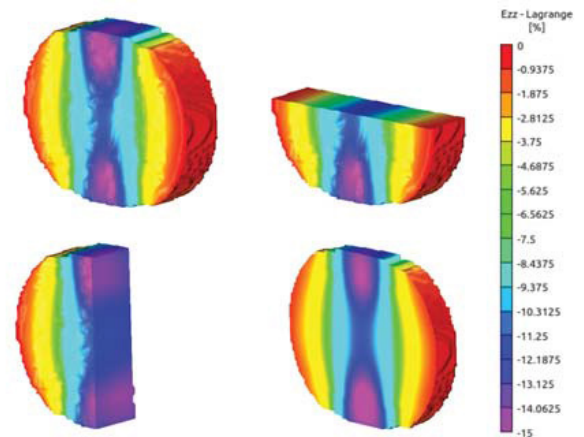
The VIC-Volume software is an important part of the VIC image correlation product line. VIC-Volume utilizes volumetric images from X-Rays or CT-Scanners to measure internal deformation of a specimen under an applied load. VIC-Volume analyzes the acquired images to create three-dimensional volumetric displacement and strain data of the specimen's internal behavior. The resulting data is a full-field contour plot of the deformation data that can be viewed, animated, and extracted for FEA validation. The image to the right displays the internal strain (Ezz) of a rubber puck undergoing compression.

Background

Digital Volume Correlation (DVC) is a quantitative image analysis technique for measuring internal deformation of a volume from image slices acquired via an X-Ray or CT scanner. The theory is similar to 2D and 3D DIC analysis, except the z dimension (through the material) is added allowing for full characterization of the material. To achieve this measurement the DVC algorithm tracks displacement information from small volumes called voxels, similar to pixel subset tracking in 2D and 3D DIC analysis. These voxels are the building blocks of the sub-volume. Image matching is then performed to locate sub-volumes in a series of images with optimal accuracy. The voxel matching is performed through minimization or maximization of a metric function that quantifies the level of similarity in sub-volumes between the reference and deformed volumetric images. The result is a 3D volumetric data set containing the selected strain tensor variables, which now includes the z strain components (Exx, Eyz, & Ezz).

DVC & Speckling

Similar to DIC, DVC requires a random high contrast pattern to reliably track the deformation. This can be a challenge for DVC, because now the speckle pattern is created from the change in density through the material. To achieve this, particles with lower or higher densities can be added to the material, or in some cases, natural occurrences within the material will produce an image with enough contrast for the DVC algorithm to generate high-quality data. In the application example on the next page, sand particles were added to the uncured rubber to produce a high-quality speckle pattern. In cases where introducing artifacts into the material may not be possible, a simple static CT or X-Ray scan of your material will allow our engineers to evaluate if VIC-Volume will work for your material(s). This service is completely free of charge.



Various slices of the volumetric strain data of a rubber puck obtained from VIC-Volume

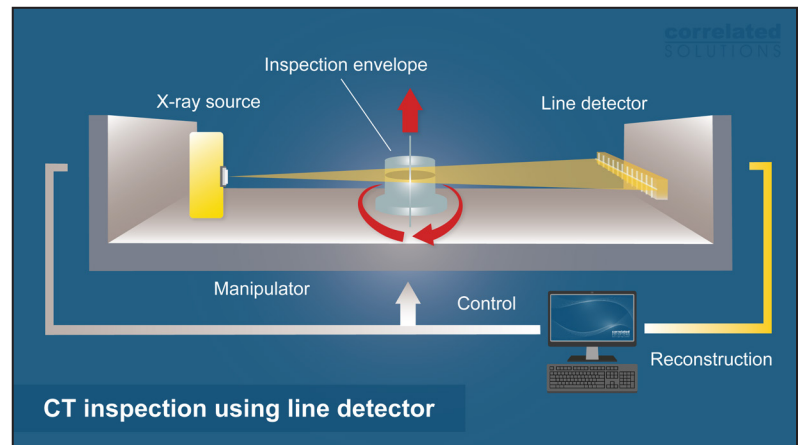
VIC-Volume Software Features

- ▶ Convenient AOI selection method through "Tweening"
- ▶ Semi-automatic initial guess computation
- ▶ Non-linear filter optimization to reduce bias and interpolation artifacts optimizes accuracy
- ▶ Volumetric 3D displacements & strains
- ▶ Highly optimized code for fast analysis time
- ▶ Advanced memory management permits analysis of extremely large volumetric data sets

CASE STUDY

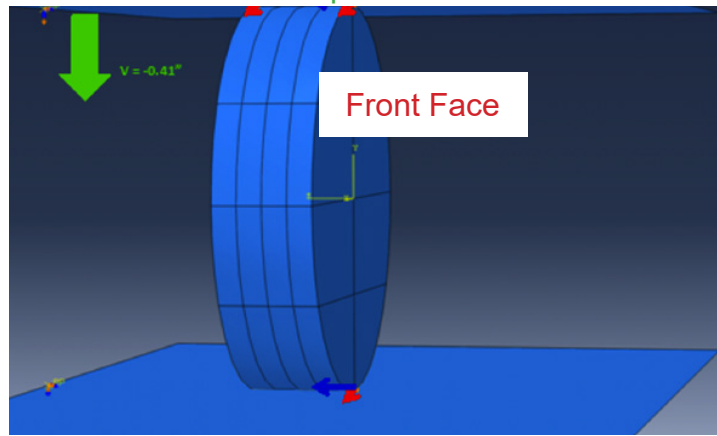
Volumetric Measurement of a Rubber Torus

The diagram to the right displays a typical setup of how the images are acquired during a test. The scanner acquires images at specific depth coordinates, and then VIC-Volume analyzes the image slices to construct a 3D volume made up of voxels. The individual voxels are the building blocks for the sub-volume, which contain the volumetric image correlation data. A rubber puck is mounted between two grips, and a set of reference images are acquired from a CT scanner at known increments. Each 'slice' of data is then analyzed to compute a static volume measurement. After the puck undergoes a compression load, images are acquired again by the CT scanner at the same locations.



Typical setup of the VIC-Volume system

Origin, Coordinate Directions and Constraints Contact Between Specimen and Flat Plane



Digital image correlation algorithms are used to calculate the volumetric change or deformation at each individual voxel, which make up the 3D volume. The images below display the internal strain (E_{zz}) of a reinforced rubber matrix composite undergoing tension. The volumetric strain data can be viewed, analyzed, or extracted as a volume or as individual data slices. The internal tension strain can clearly be seen.

This data is a full-field contour plot of the deformation data that can be viewed, animated, and extracted for FEA validation. Contact one of our sales engineers for more details.

