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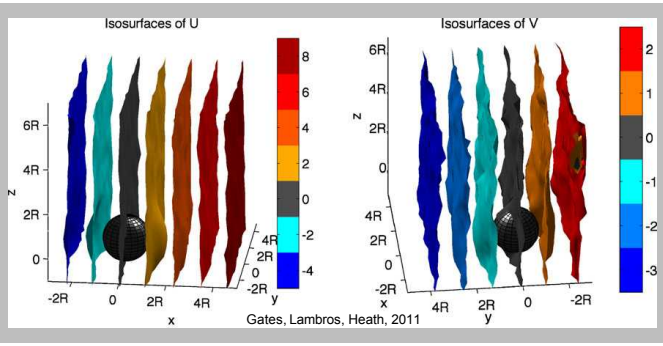

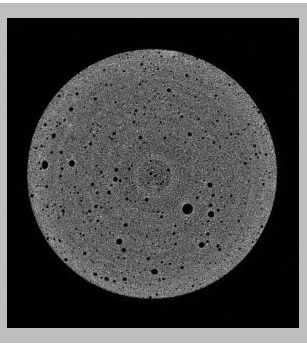

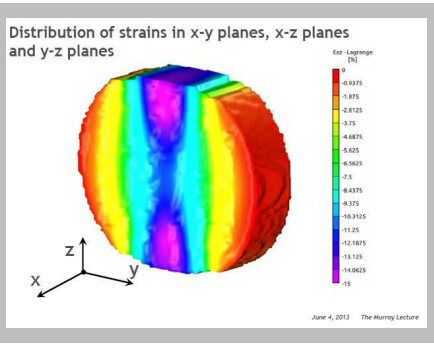

Digital Volume Correlation Using Computed Tomography

Enrico Quintana, Phillip Reu, Kyle Thompson, Tim Miller, Sharlotte Kramer

ASNT Digital Imaging XVII

July 29, 2014

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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Digital Volume Correlation

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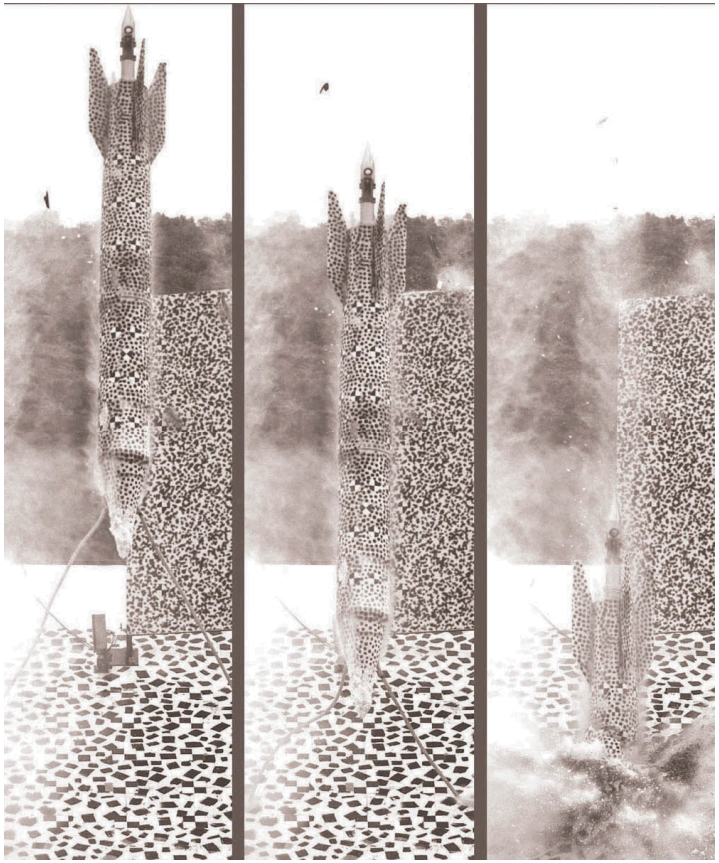
- Digital volume correlation (DVC) is based on digital image correlation (DIC)
- DIC (1980's)
  - Optical imaging
  - Speckle pattern
  - 2D and 3D *surface* measurements
- DVC (1999)
  - Computed tomography (CT)
  - Naturally occurring speckle patterns
  - Seed particles for speckle pattern
  - 3D *volumetric* measurements



DIC Images acquired from a recent Sandia National Laboratories test

DVC Data Requirements

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- Features need to be 3 to 5 voxels in size
- 3 to 4 features in a subset
- Step size ~half subset size
- Minimize noise
- High contrast

Material Applications

- Foam
- Bone
- Wood
- Composites
- Precipitate Metals
- …Anything with naturally occurring voids, porosity, etc.

DVC Challenges

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- CT scan process
  - Time
  - Spatial Resolution
  - Noise
  - Artifacts
- No control over naturally occurring structure

CT System Hardware

- Optical table to adequately (and accurately) assemble the CT system
  - Set up to use a variety of x-ray machines and detectors
- Need to finalize part manipulation setup

DVC Hardware

- CT Specific Tensile Stage
  - Allow for compression or tension mounted to CT stage
- Several Options
  - 500N
  - 5kN
  - 25kN
  - Add-on temperature control

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Software Solutions

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- Commercial Options
  - LaVision
  - Correlated Solutions
- University Partnerships
  - LMT-Cachan
  - Illinois-Urbana Champaign

Initial Data

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- Acquired PMDI Foam Data
  - Optimize CT scan time for eventual use with CT tensile stage
    - Faster the better?
    - Initial scans too “noisy”
    - Aliasing valuable features
    - Increase spatial resolution
    - Seed foam
- Analyze existing foam CT data
  - Adequate contrast
  - Adequate void distribution
  - Low noise
  - CT artifacts

Data Analysis

- Determine Noise Floor
  - Acquire 5-10 datasets
  - Perform DVC Analysis
  - Ideally x,y,z to u,v,w would be zero
    - No physical movement in system
  - Standard deviation of u,v,w is noise floor
  - Determine step size based on noise flor
- Perform translation tests
  - Very basic, controlled experiment
  - x,y,z to u,v,w should reflect corresponding axis movement

Path Forward

- Complete translation and noise floor experiments
- Installation of CT specific tensile stage
- Materials study
- Quantify accuracy and repeatability