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3D IMMERSIVE VISUALIZATION OF MICRO-COMPUTED TOMOGRAPHY AND XRD TEXTURE DATASETS

Exceptional service in the national interest

Sandia National Laboratories

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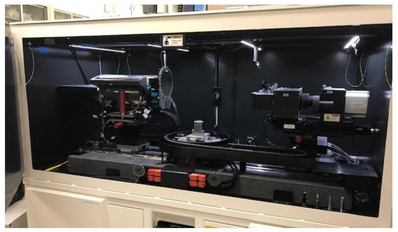
Introduction

- There are **two themes** that embody datasets from newly developed instrumentation such as micro-computed tomography (μ-CT) and XRD data from area detectors:
- file sizes are becoming **massive** and un-wielding
  - μ-CT data can approach 100 GB
- datasets are **multidimensional** in nature
  - μ-CT data (*x, y, z*) + time
  - texture analysis (χ, ϕ, 2θ)

Our Goal

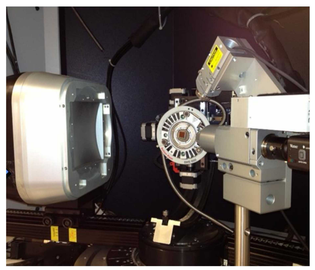
- Develop an **Intuitive and Immersive Diagnostic** for μ-CT and other 3D datasets to improve the speed and efficiency by which these massive files are explored and evaluated.

Experimental

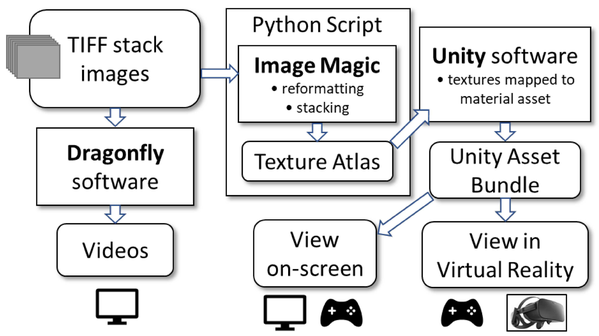


- μ-CT data collected on a Zeiss Xradia 520 Versa configured with in-situ strain stage

- Tilt-A-Whirl data collected via:
  - Bruker D8 diffractometer
  - sealed tube Cu Ka radiation
  - incident beam mirror
  - 500 μm pinhole optic
  - Bruker texture cradle (xyz, χ, ϕ)
  - Vantec 2000 area detector



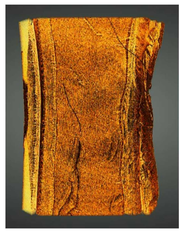
Data Formatting Flowchart



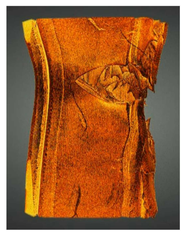
Results: Pulled Plastic Part

- A 3D printed dogbone test part made of Polyphenylene sulfide (PPS) was pulled in-situ on a strain stage within the μ-CT system and CT data were collected at various stages of material distortion.

- Stage one unstrained condition



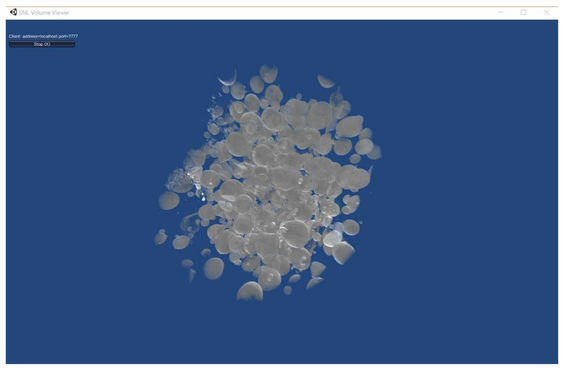
- Stage two 739 mm elongation -distortion detected



- Stage four 900 mm elongation -fracture onset

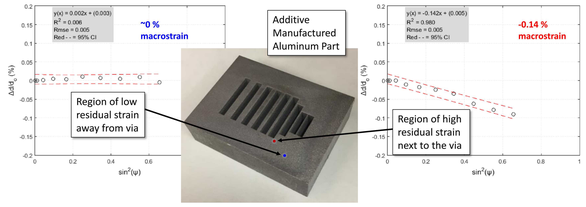
- Video constructed in Dragonfly to view CT sequence
- TIFF stack ported to Unity for viewing in VR

Results: Glass beads in Nylon

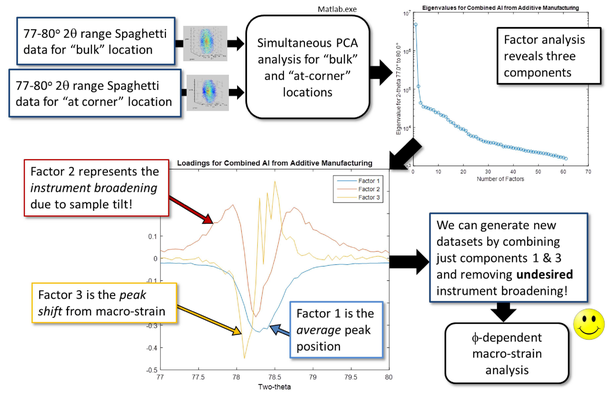


- TIFF stack ported to Unity for viewing in VR
- Density buttons employed to remove nylon matrix
- Measurement tool employed to determine bead size
- Fly-through video generated in Unity

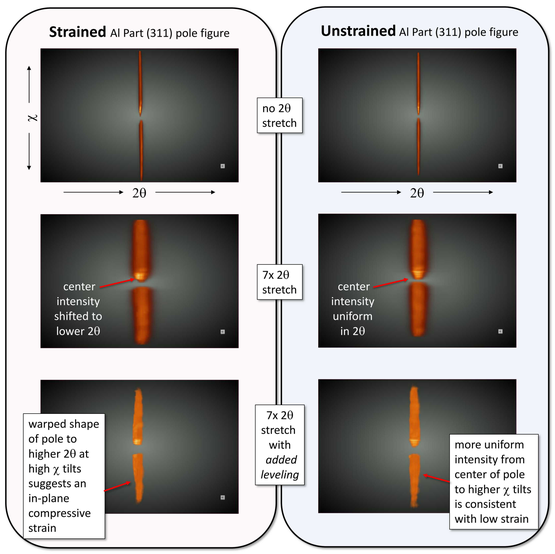
Results: Macro-strain in Pole Figures



What if we did Principal Component Analysis (PCA) on all the Aluminum (311) peak raw data?



Results: Pole Figure visualization



- Removal of defocusing component enables macrostrain visualization
- TIFF stack data ported to Dragonfly to view and generate 3D videos
- TIFF stack ported to Unity for viewing in VR
- Side-by-side comparison aids visual detection of residual strain in 3D XRD data.

Results: Collaborative Viewing

Simultaneous visualization of 3D data on multiple computers with on-screen and VR viewing options

Devon on his PC viewing 3D data in Virtual Reality on Oculus Rift headset

Bao-Loc viewing the same 3D data on his monitor and moving in 3D space using his Xbox controller

- Multiple PCs can be linked via internet
- Viewers can watch either on-screen and in Virtual Reality via attached headset
- Intuitive movement through space is accomplished using the Xbox controller.
- Host can provide tour of data for networked guest viewer (i.e. on tour bus)
- Guest can decouple from host and view data independently (i.e. off tour bus).
- In tour mode, guest can also control object orientation using his Xbox controller.
- See video

Summary

- Virtual Reality visualization allows for fast and flexible diagnosis in a 3D environment.
- Automated data processing converts TIFF stack images to VR-ready Asset Bundles.
- VR tools and options are available for data manipulation, marking, and measurement.
- VR has been extended to XRD analysis for evaluating multidimensional (χ, ϕ, 2θ) data such as pole figure images with embedded macrostrain.
- Software is network capable for collaborative and interactive viewing via the internet.
- Generic TIFF stack format translates easily for viewing 3D data from additional diagnostics.

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