Elliott Marsden

elliott.marsden@utah.edu - 208-970-4568

EDUCATION

M.S. Mechanical Engineering — **Expected September 2023**
University of Utah — Salt Lake City, Utah
Advisor: Ashley D. Spear, Ph.D.

Deep Learning Graduate Certificate — **May 2023**
University of Utah — Salt Lake City, Utah
Advisor: Thomas Henderson, Ph.D.

B.S. Mechanical Engineering — **August 2020**
University of Idaho — Moscow, ID

TECHNICAL SKILLS

Programming languages:	Python, C/C++
Python libraries:	PyTorch, OpenCV, NumPy, SciPy, matplotlib, pandas, scikit-learn, scikit-image
Engineering software:	Abaqus, SolidWorks, ImageJ, PTC Creo, Simpleware, Paraview

RESEARCH EXPERIENCE

University of Utah Multi-scale Mechanics and Materials Laboratory — **May 2021 – present**
Graduate Research Assistant — Salt Lake City, Utah

1. Experimental data collection and post-processing

Objective: Collect and process x-ray computed tomography (X-CT) imagery of as-built laser powder bed fusion (LPBF) aluminum tensile specimens provided by Sandia National Laboratories

Approach:

- Acquired raw X-CT data at the Advanced Photon Source 2-BM beamline at Argonne National Laboratory
- Trained a U-NET model to precisely segment aluminum (a low-attenuation material) and μm-scale defect structures from the background without loss of information, improving upon binary thresholding techniques that cause defect structures to be routinely mislabeled
- Developed a Python program to automatically identify and eliminate duplicate X-CT images residing across multiple folders, thereby facilitating stitching procedures of large scan volumes
- Created a Python program to identify and characterize internal pores and surface defects within large stacks of high-resolution X-CT images, which could not be accomplished using ImageJ or similar software due to the sheer size of data ($\sim$650 GB per volume)

Skills acquired/used: Python, Keras, OpenCV, national laboratory collaboration

Significance: Accurate and comprehensive characterization of internal pore networks and surface defects within the tensile specimens enabled prediction of the failure response for each component

2. Numerical study

Objective: Create a set of 240 virtual tensile specimens that reflect as-built additively manufactured (AM) specimens containing realistic void and surface defects, and employ predictive modeling to anticipate their fracture locations

Approach:

- Utilizing parameters gathered from the literature, generated a representative as-built surface condition on the virtual specimens using discrete ellipsoidal surface notches that induce stress concentrations similar to those on realistic as-built surfaces

- Developed a new method for generating FE (finite element) models of as-built tensile specimens that reduced their mesh element count from ∼10 million to ∼3 million by uniformly partitioning defect faces, exponentially reducing runtime and ensuring tractability of the 240 simulations
- Devised an algorithm to pinpoint the 3D fracture initiation location within FE simulation results, enabling precise identification of the pore or surface defect responsible for final fracture
- Statistically analyzed the population of 240 simulated samples to quantify the interactions between and relative influence of pore structures and surface defects on fracture behavior in AM parts
- Extended an analytical void descriptor function (VDF) used to correlate defects in AM materials to fracture location by accounting for surface and void defect interactions

Skills acquired/used: Abaqus, Python

Significance: Insights gained will support qualification procedures for AM materials containing void defects and as-built (non-machined) surfaces

TECHNICAL PROJECTS

Geo-locating and grading crosswalks — January 2023 – present

Objective: Locate and characterize all crosswalks in the D.C. area using aerial imagery and evaluate their paint quality using consumer dashcam imagery

Approach:

- Trained two Mask R-CNN models for crosswalk object detection: one employing annually captured aerial imagery for precise localization, and the other utilizing street-level dashcam imagery for near-real-time paint quality assessment
- Devised an interpretable, quantitative metric for evaluating paint quality in detected street-level crosswalk objects, marking a significant advancement over the previous CNN-based assessment approach using subjective quality scores
- Devised a methodology to relate dashcam crosswalk object paint quality scores to their corresponding crosswalk objects localized via aerial imagery

Skills acquired/used: PyTorch, Python, industry collaboration

Significance: Continuous city-wide monitoring of crosswalk conditions will significantly increase the efficiency of crosswalk maintenance scheduling and reduce associated costs

Idaho trail camera animal classification — November 2022 – December 2022

Objective: Automatically filter out images without animals in large caches of trail camera images

Approach:

- Given a limited home-sourced dataset, 30,000 images and their associated metadata were collected from the Biology and Conservation of Idaho Camera Traps online repository
- Merged the home-sourced and web-scraped datasets, forming the basis for training a CNN model to predict animal presence within the home-sourced image dataset

Skills acquired/used: PyTorch, web scraping, Python

Significance: Trail camera pictures without animals are uninteresting and employing this method prevents the tedium of manually sifting through trail camera images

Semantic segmentation of metal foam X-CT images **May 2022 – July 2022**

Objective: Semantically segment metal foam and precipitate structures within X-CT images

Approach:

- Preprocessed the metal foam X-CT image data and trained a U-NET model to segment the precipitate structures, solid foam, and background components of each image
- Generated 3D renderings of segmented foam X-CT images for inclusion in a publication

Skills acquired/used: Keras, Python

Significance: This work automated a previously intractable manual task, paving the way for new studies involving precipitate structures in metal foams

Predicting fracture location using machine learning **March 2022 – May 2022**

Objective: Predict the fracture location in 120 porous virtual tensile specimens

Approach:

- Engineered features to characterize pores within a FE tensile specimen
- Trained an Extreme Gradient Boosting model to predict which pore was responsible for the final fracture in each specimen

Skills acquired/used: machine learning, Python, FE analysis

Significance: This study will inform future machine learning-based studies that involve predicting fracture location in porous metals

PUBLICATIONS

- (In Preparation) **E.S. Marsden**, B.R. Phung, D.S. Watring, K. McGrath, A.D. Spear. "Predicting fracture location in AM tensile specimens with internal porosity and surface defects using a modified Void Descriptor Function"
- Q.C. Johnson, P. Kenesei, S. Petruzza, J.C. Plumb, H. Sharma, J.-S. Park, **E.S. Marsden**, K.Matheson, M.W. Czabaj, A.D. Spear. "Mapping 3D Grain and Precipitate Structure during In Situ Mechanical Testing of Open-cell Metal Foam using Micro-computed Tomography and High-energy X-ray Diffraction Microscopy", ***Materials Characterization***, Vol. 195, pp. 112477, 2023

PRESENTATIONS (presenter)

- (In Preparation) **E.S. Marsden**, G. Kudirka, D. Sacharny, T.C. Henderson. "Geolocating and Grading Crosswalks using Deep Learning", IEEE Multisensor Fusion and Integration, Bonn Germany, Nov 2023
- **E.S. Marsden**, B.R. Phung, D.S. Watring, A.D. Spear. "Predicting fracture location in AM tensile specimens with internal porosity and surface defects using a modified Void Descriptor Function", USNCCM17, Albuquerque, NM, July 2023
- **E.S. Marsden**, D.S. Watring, J. Erickson, L.C. Ziegler, A. Chuang, A.D. Spear, "Parameterizing surface defects and internal porosity to predict fracture location in as-built AM tensile specimens using a modified void descriptor function", TMS 2023, San Diego, CA, March 2023
- A.D. Spear, C.K. Cocke, B.R. Phung, L.C. Ziegler, **E.S. Marsden**, V.B. Rao. "Predicting Microstructure-sensitive Fracture Behavior in AM IN625 Using a Damage-enabled Elasto-viscoplastic FFT Framework", TMS 2023, San Diego, CA, March 2023