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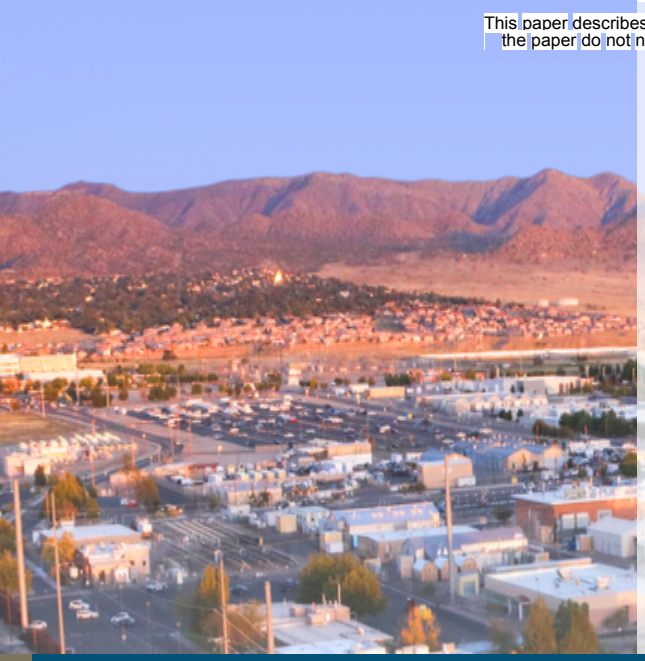

Naval Force Health Protection Program Review 2022

Dualization for Automatic Mesh Generation in the Pixel to Mesh Workflow

Chad Hovey, Adam Sokolow, Ryan Terpsma
Sandia Injury Biomechanics Laboratory (SIBL)

Brown University, Providence RI, June 14-16, 2022

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DUALIZATION FOR AUTOMATIC MESH GENERATION IN THE PIXEL TO MESH WORKFLOW

Chad Hovey, Sandia National Laboratories

Abstract:

The Sandia Injury Biomechanics Laboratory (SIBL) seeks to automate the generation of a human digital twin based on a specific patient's medical imaging.

The numerical assessment of injury risk to the U.S. Warfighter subjected to the potentially injury-causing environments of blast, blunt, and ballistics depends on the fidelity of the computational model used for simulations. Existing models typically bear only the class-based resemblance of male/female and small, medium, large, extra-large; they do not have high geometric fidelity to any specific human. Human-specific models (e.g., the SIBL's "Bob" model) have been created with high fidelity, but such models require significant commitment of resources in their creation.

Two bottlenecks, manual segmentation and mesh generations, currently confound the automated creation of human digital twin models. The current effort seeks to unlock the latter bottleneck. Specifically, we examine the use of dualization methods generated from quadtrees in 2D (and later, octrees in 3D) to automatically create high-quality, high-fidelity all-quadrilateral (and later, all hexahedral) meshes. If dualization can lead to highly automated meshes, then this approach can be a catalyst for future patient-specific models, leading to highly-personalized assessment of injury risk.

SAND2022-to-come

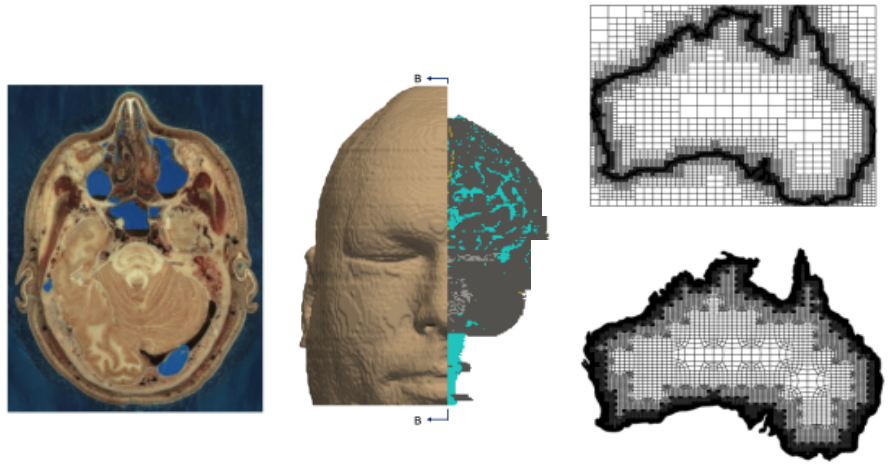
DUALIZATION FOR AUTOMATIC MESH GENERATION IN THE PIXEL TO MESH WORKFLOW

Chad Hovey, Sandia National Laboratories

Description: The Sandia Injury Biomechanics Laboratory (SIBL) seeks to automate the generation of a human digital twin based on a specific patient's medical imaging.

Technical Approach: Two bottlenecks, manual segmentation and mesh generation, currently confound the automated creation of human digital twin models.

The current effort seeks to unlock the latter bottleneck. Specifically, we examine the use of dualization methods generated from quadtrees in 2D (and later, octrees in 3D) to automatically create high-quality, high-fidelity all-quadrilateral (and later, all hexahedral) meshes.



- **PERFORMERS:** Sandia Injury Biomechanics Laboratory (SIBL)

FY23-FY24 Plans:

- FY23: Support existing 2D Complete SIBL Geometry Engine 2D Dualized Automatic Mesh Generation
- FY23: Assess existing 3D dualization library (e.g., CinoLib, Gena)
- FY23-24: SIBL Geometry Engine 3D Dualized Automatic Mesh Generation.

FY25 Plans: (As applicable)

- FY25: Pixels (CT/MR) to Mesh Generation
- FY25: Digital Twin Component Anatomy

FY22-23 Accomplishments:

Fully Automated 2D Workflow Boundary to Dualized Quadrilaterals
We have created and demonstrated a fully automated 2D workflow, taking a discrete boundary representation into a fully quadrilateral mesh *without human interaction in the workflow.*

Success with Software Service Delivery
Continuous Integration/Continuous Deployment (CI/CD).

Success with RMU/PANTHER Collaboration
Military Medicine publication, MHSRS 2022 acceptance, Python code integration into SIBL GitHub repository with Sushan Nakarmi.

Impact Statement: We have created a dualization approach for automated mesh generation in 2D, which is extensible to 3D. This is a critical component of a human digital twin.

Naval Need: The Navy needs the ability to create many personalized digital twins, not just a single class of generic twins (e.g., AF5, AM95).

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