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ECE4
Automatic Rigging of 3D Ant Models from CT

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Problem

Micro-CT scanning captures ant specimens with microscopic detail, but scans are difficult to analyze.

To animate or repose a specimen, the mesh must be **rigged** with an internal, anatomically accurate armature. Doing this by hand is slow, tedious, and hard to scale.

Objective

- Build on the work of the **Antscan**[1] project, a database of thousands of micro-CT scans of ants.
- Automatically convert a static ant meshes into **rigged, poseable 3D models**.

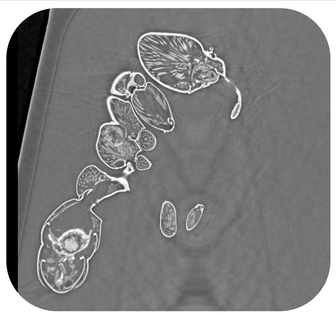
Methods Evaluated

DeepLabCut[2] pose estimation
Machine learning approach which required training and did not generalize reliably across specimens.

Spectral segmentation[5]
Effectively separated major structures, especially legs, but was too inconsistent for the final solution.

Voxel methods (CT)
Added preprocessing cost and did not outperform direct mesh-based methods.

CGAL skeletonization[4]
Produced the most accurate centerline graph and became the basis of the final pipeline.



Applications

Entomology
Research using detailed models of ants

Biodiversity/Museum Collections
Make 3D specimen collections dynamic

Animation, Games, VR
Use realistic models for rigged assets

Final Skeleton-based Pipeline

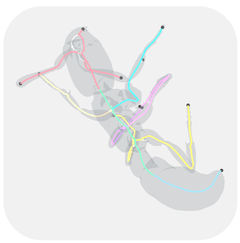
① Input Mesh

Downsample and remesh input ant model from AntScan

② Skeleton

Extract a center skeleton[4] from the mesh geometry with CGAL[3]

③ Labeled Skeleton



Label body and leg branches using graph structure and thickness

④ Joint Selection

Solve for joint locations along skeleton for legs and body

⑤ Rig + Pose

Build a weighted Blender rig for posing

Our Results

Average Runtime*	Successful Rigs	Specimens Tested
143.9s	**15+**	**30+**

We built a **geometry-based** pipeline that converts static ant meshes into **rigged, poseable 3D models** directly from cues such as skeleton structure, thickness, curvature, and anatomical heuristics. This transforms a process that might take hours by hand to one that automatically runs in minutes.

Future Work

Improve preprocessing and upstream CT-to-mesh extraction so legs are separated before rigging

- Connected or fused legs can distort skeletonization, which then affects part labeling and joint placement.
- Only a minority of raw AntScan meshes have fully separated legs, so input mesh quality remains a major bottleneck.

Scan to view our project website:

References

1. Katzke, J. et al. High-throughput phenomics of global ant biodiversity. Nature Methods 23, 663–672 (2026).
2. Mathis, A. et al. DeepLabCut: markerless pose estimation of user-defined body parts with deep learning. Nature Neuroscience 21, 1281–1289 (2018).
3. The CGAL Project. CGAL User and Reference Manual. CGAL Editorial Board, 6.1.1 edition (2026).
4. Tagliasacchi, A. et al. Mean curvature skeletons. Computer Graphics Forum 31(5), 1735–1744 (2012).
5. Wang, H. et al. Spectral 3D mesh segmentation with a novel single segmentation field. Graphical Models 76(5), 440–456 (2014).
6. Google Material Icons / Symbols, Apache License 2.0.

* Tested on an i5-13600K CPU across 18 specimens from the Antscan database