Engineering Internship (4–6 months)

Sparse-Slice 3D Muscle Reconstruction from Ultrasound Segmentations Using Implicit Neural Representations

Duration: 4–6 months

Starting period: Between late 2026 and Winter 2027

Research laboratory : Motricité, Interactions, Performances UR4334

Location: Nantes Université, Nantes, France

Compensation: Paid internship (according to French regulations)

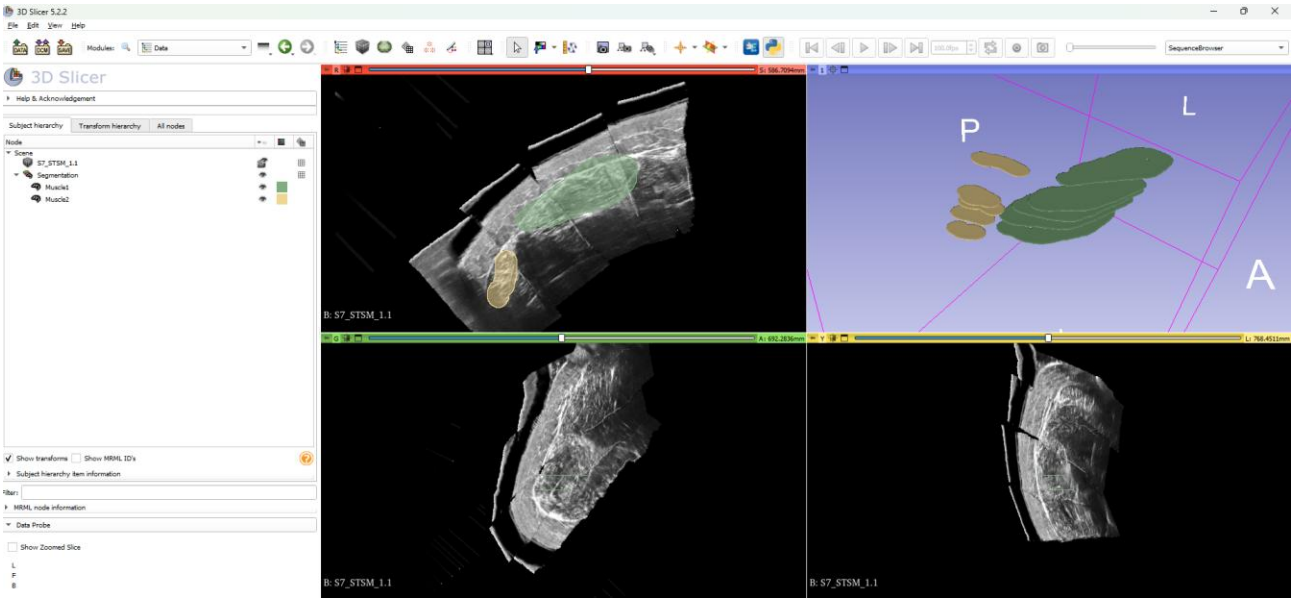
Application: contact Aurelie.sarcher@univ-nantes.fr, answer end of August 2026.

Context

Three-dimensional ultrasound is increasingly used to investigate skeletal muscle morphology in biomechanics and clinical research. Although the acquisition itself is relatively fast, obtaining a complete muscle segmentation remains a labor-intensive process, requiring manual delineation on numerous image slices.

Recent advances in **Implicit Neural Representations (INRs)** have demonstrated their ability to model continuous three-dimensional anatomical shapes from segmented volumes. These approaches raise an important question: *how many manually segmented slices are actually required to accurately reconstruct an entire muscle?*

This internship aims to investigate whether high-quality muscle reconstructions can be obtained from only a limited number of manually segmented ultrasound slices, paving the way toward practical semi-automatic segmentation protocols.



Objectives

The successful candidate will build upon an existing PyTorch implementation of an INR-based shape reconstruction framework and develop a methodology for sparse-slice muscle reconstruction. The main objectives include:

- Understand the architecture and training strategy of an existing Implicit Neural Representation framework.
- Reproduce the complete training and inference pipeline.
- Adapt the framework to reconstruct complete muscle volumes from only a subset of manually segmented slices.
- Design and implement different sparse segmentation strategies (e.g. proximal/distal slices only, uniformly distributed slices, adaptive sampling strategies).
- Evaluate reconstruction accuracy using complete manual segmentations as the reference standard.
- Quantify reconstruction performance using geometric and morphological metrics (Dice score, surface distances, Hausdorff distance, volume error, shape analysis, etc.).
- Identify the optimal trade-off between segmentation effort and reconstruction accuracy.
- Produce practical recommendations for efficient semi-automatic muscle segmentation in 3D ultrasound.

Candidate Profile

- Final-year Engineering student or Master's student in Medical Image Computing, Computer Vision, Artificial Intelligence, Biomedical Engineering or a related field.
- Strong Python programming skills.
- Experience with PyTorch or deep learning frameworks.
- Interest in medical image analysis and 3D geometry.
- Ability to work independently while documenting and validating scientific developments.

Experience with implicit neural representations, neural fields or 3D reconstruction is appreciated but not required.

Expected Outcomes

By the end of the internship, the candidate will have:

- implemented and validated a sparse-slice reconstruction pipeline based on Implicit Neural Representations;
- compared multiple sparse segmentation strategies on 3D ultrasound muscle datasets;
- identified the minimum number and optimal distribution of segmented slices required for accurate muscle reconstruction;
- delivered guidelines for reducing manual segmentation time while preserving reconstruction accuracy.

The project may lead to conference or journal publications depending on the results.