HAAG Weekly Report (Simplified) – Omar Moursy – 3D Modeling

Time-Log

What did you do this week?

- Uploaded the Weekly reports and meeting recordings for Week 6.
- Had a progress update meeting with Nikita and Steve where we went through pseudocode for adding PCA into CPD algorithm and maths behind it.
- Had a meeting with Dr. Arthur Porto to discuss updates and demo progress where we shared a working initial version of the code and testing suite.
- Read through Dr. Arthur Porto's ALPACA paper.
- Tested the PCA constrained point cloud registration on the 3D rabbit and did some testing on the mouse dataset from Dr. Porto.
- Coded some testing functions to compare different registration methods and visualize their performance metrics and registration results
- Debugged the PCA constrained registration method to understand why it takes so long to run with mouse dataset

What are you going to do next week

- Meet with researchers and discuss the pca registration code and how we can optimize it.
- Push the test examples to the shared repo after meeting.
- Add more relevant performance metrics based on the ground truth data from Dr. Porto

Blockers, things you want to flag, problems, etc.

- None for this week

Abstracts:

ALPACA: A fast and accurate computer vision approach for automated landmarking of three-dimensional biological structures

https://pubmed.ncbi.nlm.nih.gov/35874971/

Abstract

Landmark-based geometric morphometrics has emerged as an essential discipline for the quantitative analysis of size and shape in ecology and evolution. With the ever-increasing density of digitized landmarks, the possible development of a fully automated method of landmark placement has attracted considerable attention. Despite the recent progress in image registration techniques, which could provide a pathway to automation, three-dimensional (3D) morphometric data are still mainly gathered by trained experts. For the most part, the large infrastructure requirements necessary to perform image-based registration, together with its system specificity and its overall speed, have prevented its wide dissemination.Here, we propose and implement a general and lightweight point cloud-based approach to automatically collect high-dimensional landmark data in 3D surfaces (Automated Landmarking through Point cloud Alignment and Correspondence Analysis). Our framework possesses several advantages compared with image-based approaches. First, it presents comparable landmarking accuracy, despite relying on a single, random reference specimen and much sparser sampling of the structure's surface. Second, it can be efficiently run on consumer-grade personal computers. Finally, it is general and can be applied at the intraspecific level to any biological structure of interest, regardless of whether anatomical atlases are available.Our validation procedures indicate that the method can recover intraspecific patterns of morphological variation that are largely comparable to those obtained by manual digitization, indicating that the use of an automated landmarking approach should not result in different conclusions regarding the nature of multivariate patterns of morphological variation.The proposed point cloud-based approach has the potential to increase the scale and reproducibility of morphometrics research. To allow ALPACA to be used out-of-the-box by users with no prior programming experience, we implemented it as a SlicerMorph module. SlicerMorph is an extension that enables geometric morphometrics data collection and 3D specimen analysis within the open-source 3D Slicer biomedical visualization ecosystem. We expect that convenient access to this platform will make ALPACA broadly applicable within ecology and evolution.

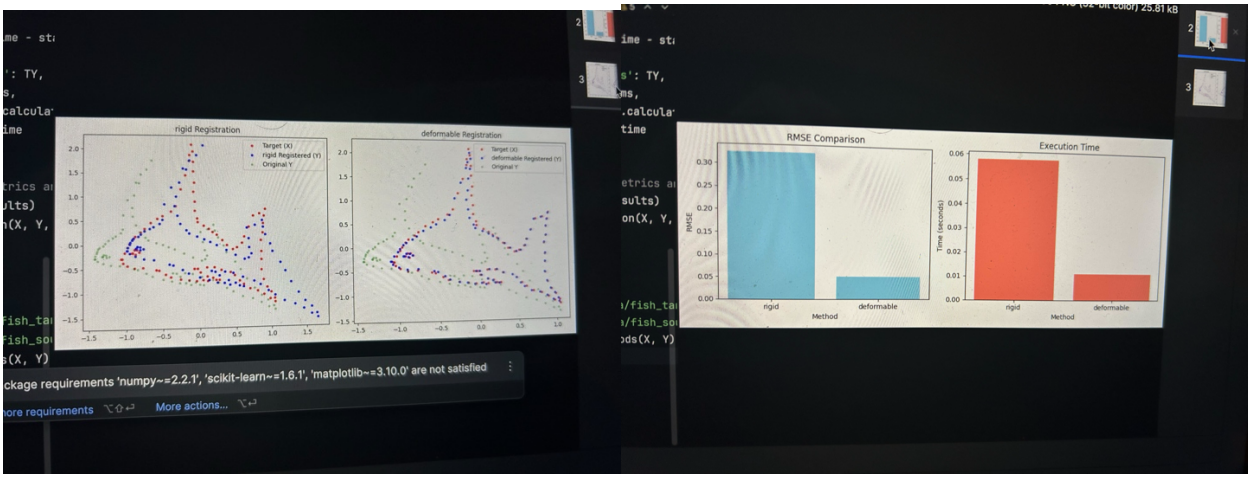
What did you do and prove it

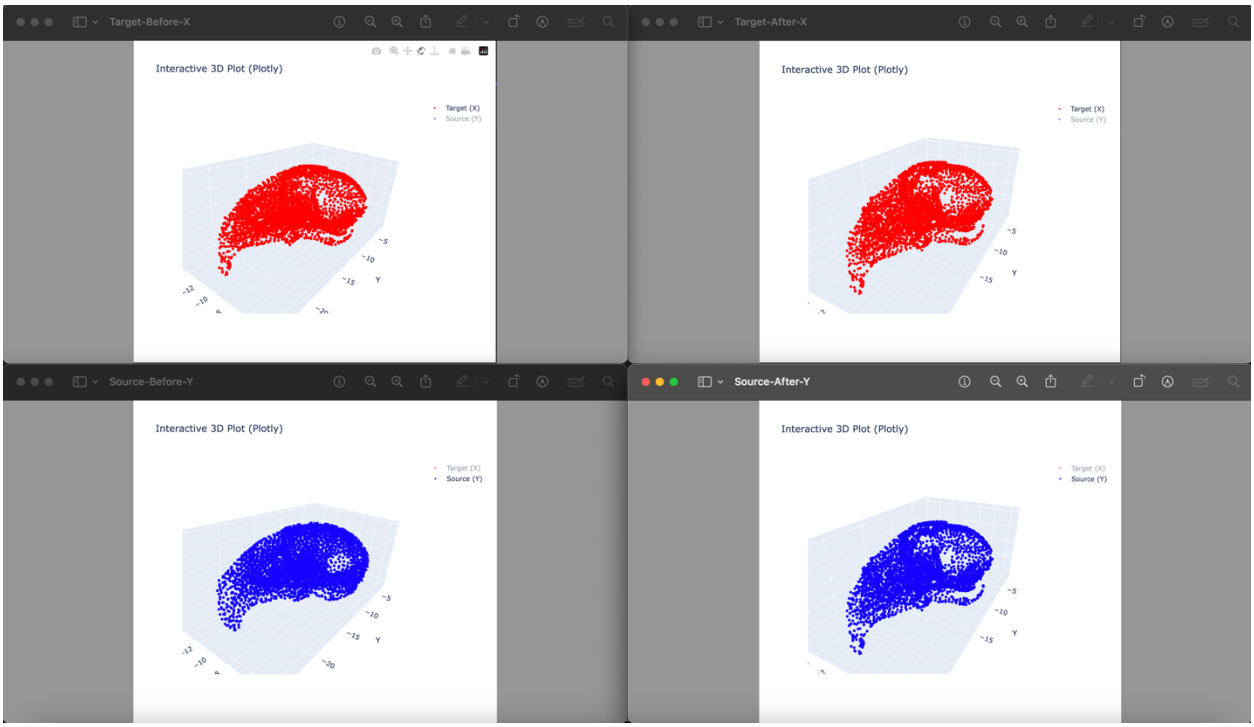
Uploaded the missing weekly reports and meeting recordings.

We had a team meeting to discuss pseudocode for replacing gaussian kernel of deformable registration with a PCA based kernel. We also had a team meeting to demo our current progress with most functions implemented and some testing code to compare performance metrics.

Found a time consuming nested loop in the pca kernel that needs to be optimized.

Read through Dr. Porto's ALPACA paper, to better understand the vision and success metrics for the project.

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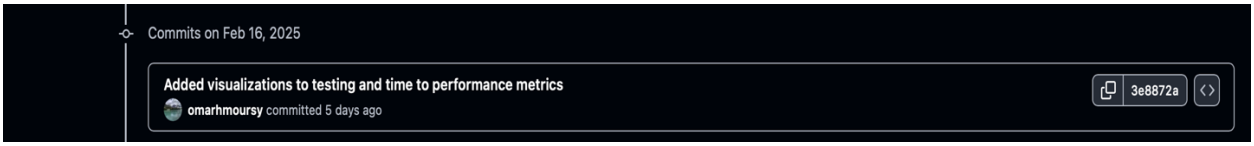
Commits on Feb 16, 2025
Added visualizations to testing and time to performance metrics
omarhmoursy committed 5 days ago
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