PHOTOGRAMMETRY TECHNIQUES IN COMPUTATIONAL PALEOPHYSIOLOGY

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BACKGROUND

The purpose of this project is to increase the participation and impact of undergraduate student contributions to the development of a new, project-based course, Computational Paleophysiology, in order to enhance teaching methodologies and student learning.

They will begin by studying the methods scientists use to reconstruct body mass, volume, and surface area. This is particularly important because these traits are inextricably linked with many other life-history characters (posture, gait, growth rates, daily energy expenditures, rates of reproduction, rates of heat loss or gain, foraging ranges, etc.).

Basic Process

1. Acquisition of the photographs of the specimen.
2. Production of a spare then dense point cloud.
3. Post processing

Acquisition of photographs

The three type of cameras that were used were the Pentex Optio S5i, Nikon D3000, and the Canon EOS Digital Rebel XT. The camera choice was based off of the availability and not off of any technical specifics.

The number of photographs to generate a viable model ranged greatly based upon camera choice and model complexity. In order to generate a good model, every point photographed has to be in at least three photographs from three different positions (Falkingham, 2012). For the best results, photographs every 15 degrees around the specimen is recommended (at least 24) (Falkingham, 2012). Also ideally, there should be a ~50% overlap in photos (Falkingham, 2012).




Production of point clouds and 3d models

Generating The Point Cloud

To generate the point clouds we used a free software called Bundler.

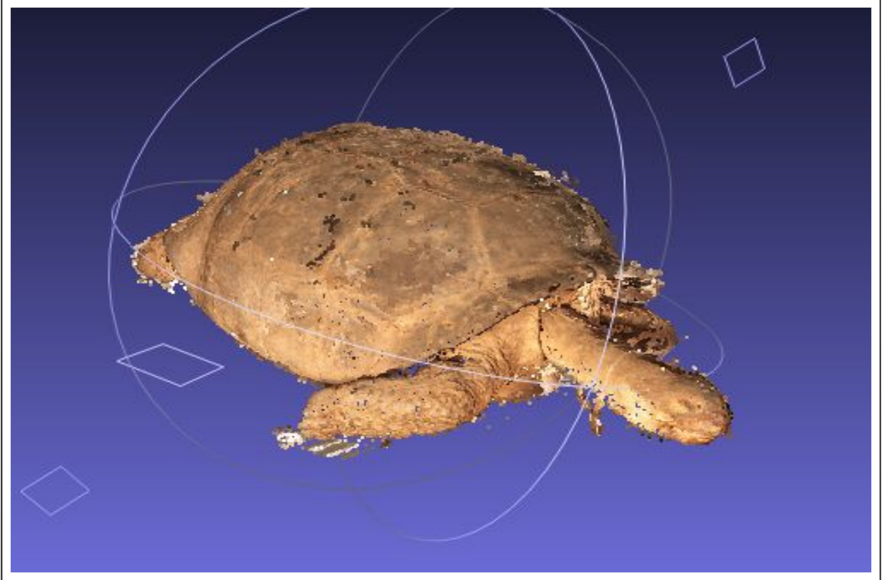
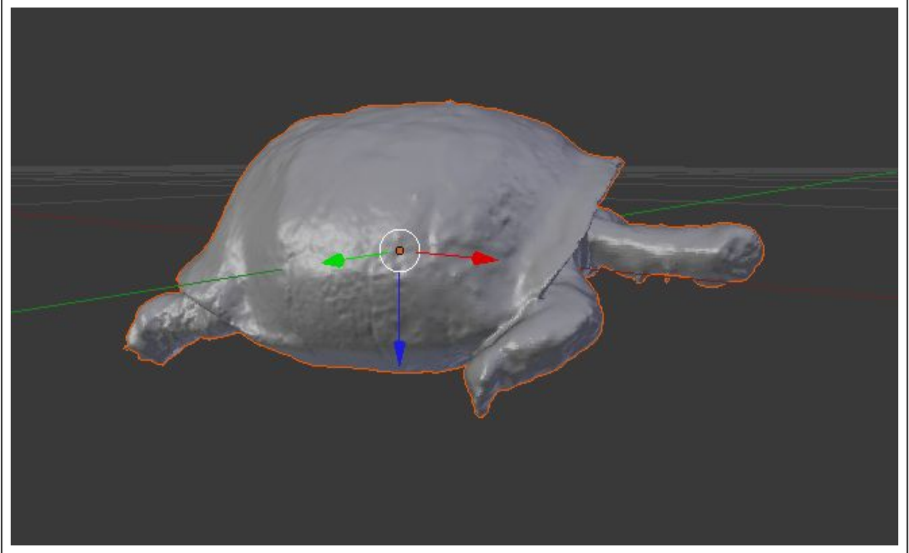
The Bundler package that is available is all inclusive. The basic Bundler package generates a sparse point cloud, and the PMVS and CMVS (Patch-based Multi-view Stero system and Clustering Views for Multi-view Stero) are two methods to generate a point cloud from from the sparse point cloud.

3d Model Generation

To generate the models we used an array of modern techniques.

The simplest technique is to use use one iteration of a surface reconstruction. This is done by first calculating the normal of the point set and then preforming a Poisson reconstruction. The advantage of this way is that it is simple and produces models that you can 3d print. However this method prefers convex objects and will tend to overfit the points.

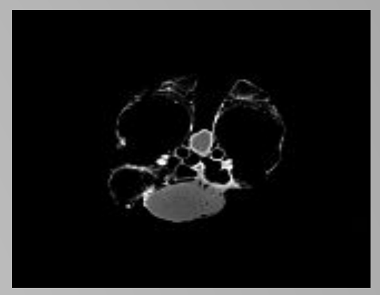
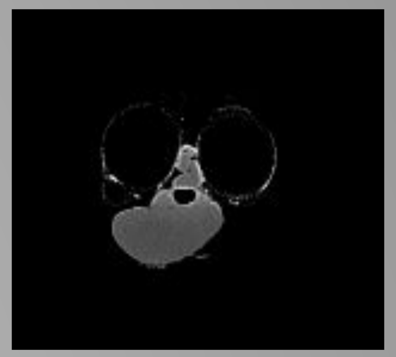
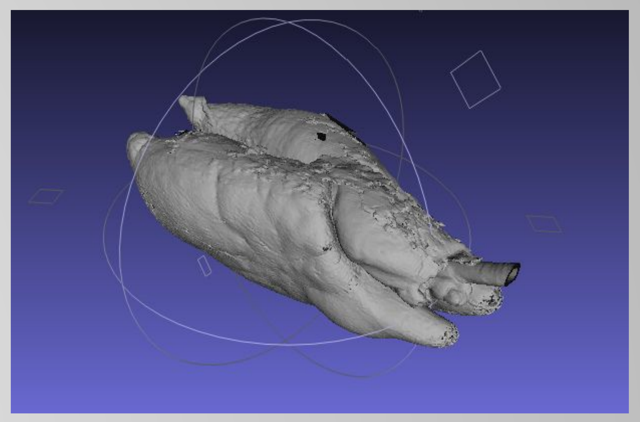
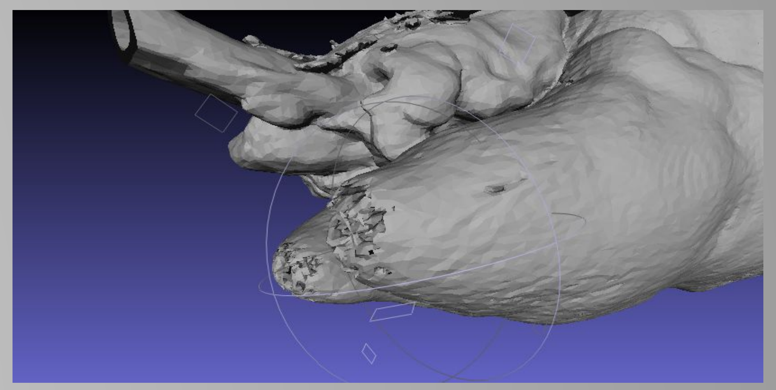
The second technique is to use two iterations of a surface technique. To do this we first generate a simplistic model from Ball Pivot surface reconstruction. Then using some variant of random sampling we can generate a larger more complete point cloud. Then we run the Poisson reconstruction on this new point cloud. The advantage of this is that the Ball Pivoting fits the data very closely while still filling the wholes in the model. Then resampling and the Poisson reconstruction makes a good 3d model that fits the data closely and can be 3d printed.

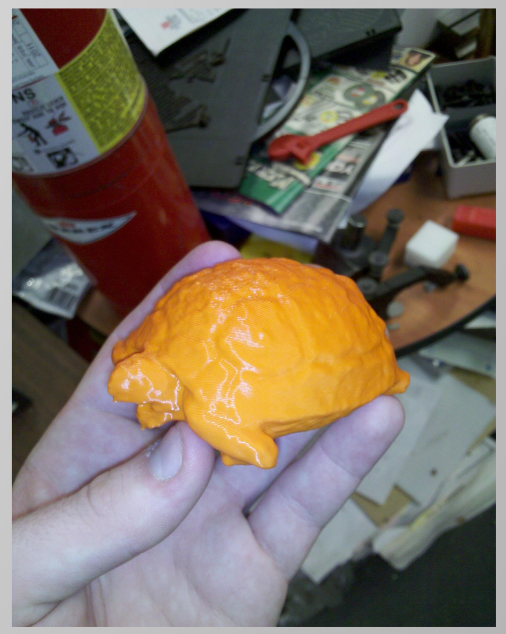
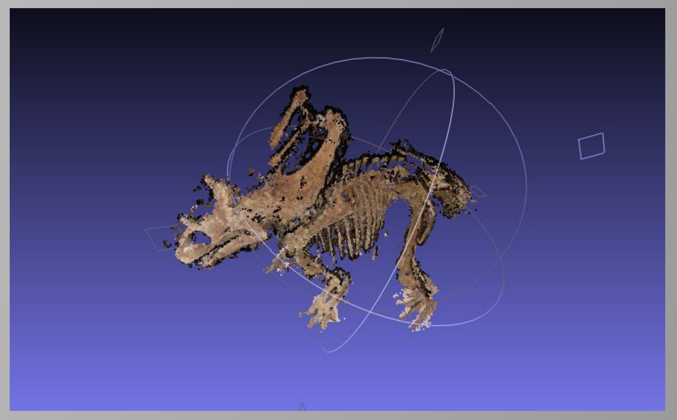



Lab Advantages

- Extremely portable and can easily be taken into the field to get laser scanner quality models, while only requiring a camera
- Extremely cheap and affordable
- Can be automated
- Can make 3d printed models

Using CT scans

ACKNOLWEDGEMENTS & REFERENCES

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Falkingham, Peter L. 2012. Acquisition of high resolution 3D models using free, open-source, photogrammetric software.
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