FORENSIC ANTHROPOLOGY AS AN APPLICATION OF GEOMETRIC MORPHOMETRICS

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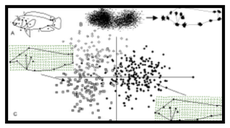
ABSTRACT: In the following investigation, the remains of *Lontra canadensis*,or else known as the River Otter, were excavated,cleaned,dried,and sorted in order to form main skeletal structures. Then through the use of a structured 3D light scanner, the bones part of each structure were scanned on an individual basis,creating a digital 3D representation of the physical bones.The final result is a collection of files containing scanned 3D replicas of actual bone structures that are accessible to any user. This is a foundation to a database containing the scanned remains of various organisms for the purposes of research, general exploration, and even education.

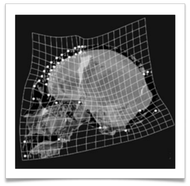
YOUNG SCHOLARS PROGRAM

BACKGROUND

Morphometrics is defined as “the field of multivariate statistical analysis concerned with the quantification of shape, the description of shape variability, the assessment of group differences in shape, and the covariation of shape with other variables.” (Slice,Lecture1(ppt)) Put simply,morphometrics is shape analysis.Is it possible to visually compare two objects and declare one as “big” or “small”? Yes, however morphometrics can use statistical analysis to declare one shape as statistically different from the other. Morphometrics looks closely at the shape and form of the object being observed, and quantifies scientifically the differences in form.

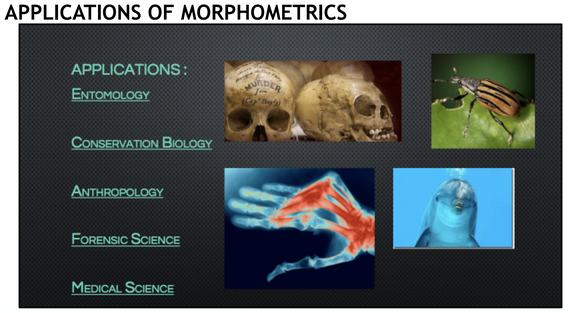


Forensic anthropology, often dismissed as just forensics, and not “true” anthropology is a field that is the “application of the science of physical or biological anthropology to the legal process.(ABFA)” In essence anthropology applied to real world legal cases ranging from murder investigations,mass genocide identification,and any circumstance in which information is unknown. Thus the field is a subfield of anthropology that concentrates on the identification of human remains based on legal cases, thus the term forensic anthropology. In essence it is a mixture of both fields, not one or the other.



Geometric morphometrics can aid forensic anthropologists in their investigations. The ability to use shape analysis on unknown bone structures can more accurately contribute to a forensic anthropologist’s analysis.

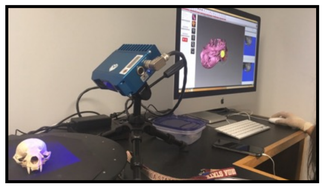
APPLICATIONS OF MORPHOMETRICS



3D LASER SCANNER TECHNOLOGY

3D laser scanning technology is an essential accompaniment to morphometrics.The function of a 3D laser scanner is actually similar to morphometric analysis. Laser scanners employ lasers as a method of measurement,as they measure the geometry of an object.Laser scanning technology in essence is morphometrics in action.

There are two main types of lasers,short range lasers which can be laser triangulation scanners or structured light scanners,and long range scanners identified as either laser pulse based scanners or laser phase shift scanners.



These various types of laser scanners empty different approaches to the same problem.Laser triangulation scanners use a line or one single point to scan across the object.Use trigonometry based on the reflection of the light distance is calculated and the object’s shape is recorded. The scanner in this particular investigation is an 3DLMI structured light scanner which uses LED to project light onto the surface, the patterns are captured by camera and the object is reconstructed.

The other two long range scanner types mentioned are similar as both send out pulses from the laser itself in order to measure distance and rely on time of flight.

APPROACH AND DISCUSSION OF METHODS

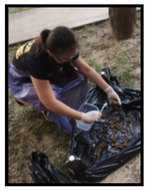
1. Objective and Aims

Objective: To identify the remains of various animal species and document them using 3D Laser scanning technology,to effectively model the shape and structure of the organism.

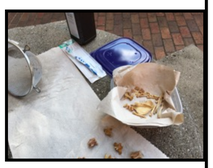
Aims: The documentation of bones in a 3D Laser scanned format has various applications as shown, this project aims to contribute to the field of Forensic Anthropology. The goal of this project is to create a database of 3D laser scans of multiple organisms for the purpose of scientific use.

2. Excavation of Unidentified Animal

The initial steps taken to approach this project required the excavation of a gallon trash bag containing the one year remains of an animal killed on the road.



3.Cleaning of Excavated Bones



Using a solution of hydrogen peroxide and water, the bones were scrubbed and left to soak in the solution for a weeks time.Following that week, each bone was scrubbed once more,and left outside in the sun to dry.

4. Identification and Sorting of Bones

In order to identify the animal uncovered,an attempt to use a dichotomous key was made, however with just the skeletal structure of the organism it was difficult to determine what the organism was.

By using a book of Florida animals, and their skeletal structures, the bones were closely compared,and the animal was determined to be a *Lontra canadensis*,more commonly known as the River Otter.

The skeletal structure of the otter that was excavated was then closely matched up and analyzed with an enlarged generalized diagram of an otter’s skeletal structure.

This provided for a comparison and classification of major bone structures such as the vertebrae forming the spinal structure, the cranium and mandible,and the majority of the otter’s pelvic structure.

5. Scanning and Documentation

The scanning process consists of 5 Steps:

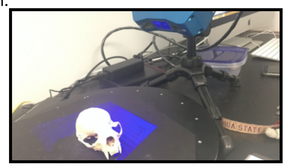
1.Calibration allows the scanner to properly adjust its lasers to accurately scan the object.

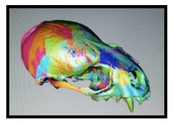
2.Rotary scans take a 360 degree view of the object by rotating the table the object stands upon. Individual scans or easy scans are simple stationary scans, basically what the camera sees.

3.Alignment is a process that occurs after multiple scans have been edited. Basically, the scans are adjusted together so that the scans can be layered properly.

4.Combining the layered aligned scans allows the multiple scans to be compiled into one.

5. Finalizing saves the end result of aligning and combining, and now minor editing and the filling of holes in the scan are added resulting in a finished end product scan.



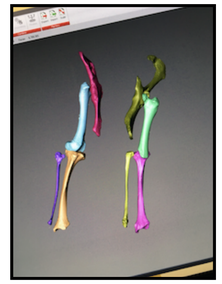


DISCUSSION OF RESULTS

The entirety of the *Lontra canadensis*' structure was not fully reconstructed,however the pelvic structure (as shown below), the spinal structure, and the skull and mandible were all scanned and reconstructed to represent the structure as accurately as possible.

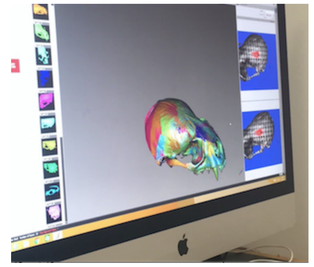
In essence, the structures that were scanned are now in a position to be examined by a user devoid of the actual otter’s bones. The bones can also be 3D printed providing close to accurate, realistic models of the actual bone structure. In addition to these possibilities, morphometric application can be used to study the statistical difference between this structure and any compared to it, thus the ability to study and compare the pelvic structure of this specimen to another similar to it is now achievable.

Bone Structure



Laser Scanned Version

Bone Structure



Laser Scanned Version

FUTURE IMPACTS

Morphometrics is still an emerging field but its application can be widespread.In this particular investigation, the results of this project set the foundations for far-reaching effects. 3D scans of various organisms can be uploaded into a common database and the project can upgrade to a collaborative effort involving different contributors and a common storage point. Multi-Variate statistical analysis (morphometrics) can then be applied to analyze models and structures. This database can also become a tool to be used by scientists,educators(3D Printing),and the general public.