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Development of Comprehensive Theoretical Morphospaces for Canine Cranial Morphology

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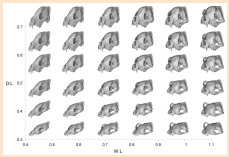
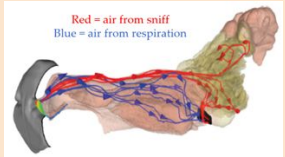
By Alexa Ortega, Dr. Nicholas Hebdon, Dr. Lindsay Waldrop

Introduction

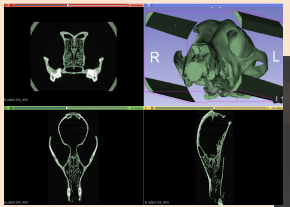
Throughout the evolution of the family Canidae, there is a continuous belief that canines have an exceptional olfactory system which allows them to have a heightened sense of smell. Because of this olfactory sophistication, canines have become prevalent as detection animals in the military, homeland security, law enforcement, forensics, and civilian applications. However, while the trait is highly regarded, the exact role of the nasal morphology is understudied.

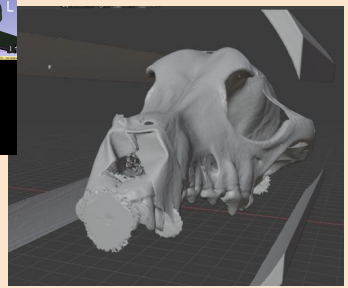




Research Question

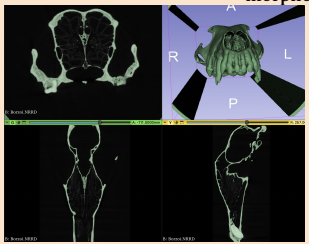
We aim to investigate the influences of nasal cavity and internal structure morphology in odor detection.

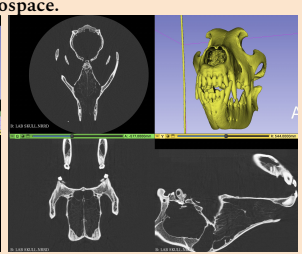




Methods

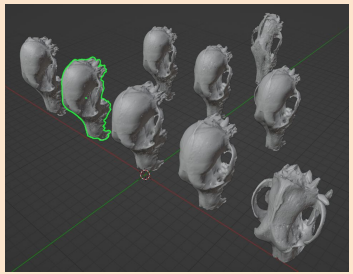
To develop this method, we employ three Computerized Tomography (CT) scans; a Golden Retriever (Mesocephalic), Daschund (Doliocephalic), and Borzoi (Doliocephalic). From these we create 3D models of these skulls within SlicerMorph. We then use the subsequent morphospace in tandem with Blender to build out theoretical morphotypes that are used to measure how varying parameters (cranial length and height) individually influences functional outcomes. The value of this method's development study is the creation of a procedural workflow to populate a theoretical morphospace.





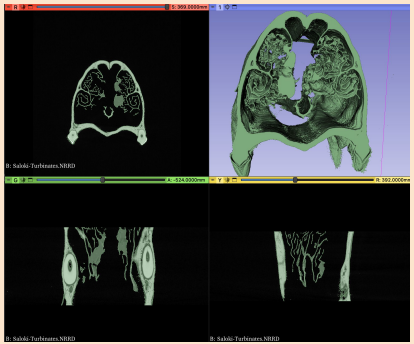
Results

Using canid skulls as a case study, the development of this workflow can lead to possible automation allowing for quick and efficient creation of large theoretical morphology data sets to examine structure-function interactions at high resolution.



Future Directions

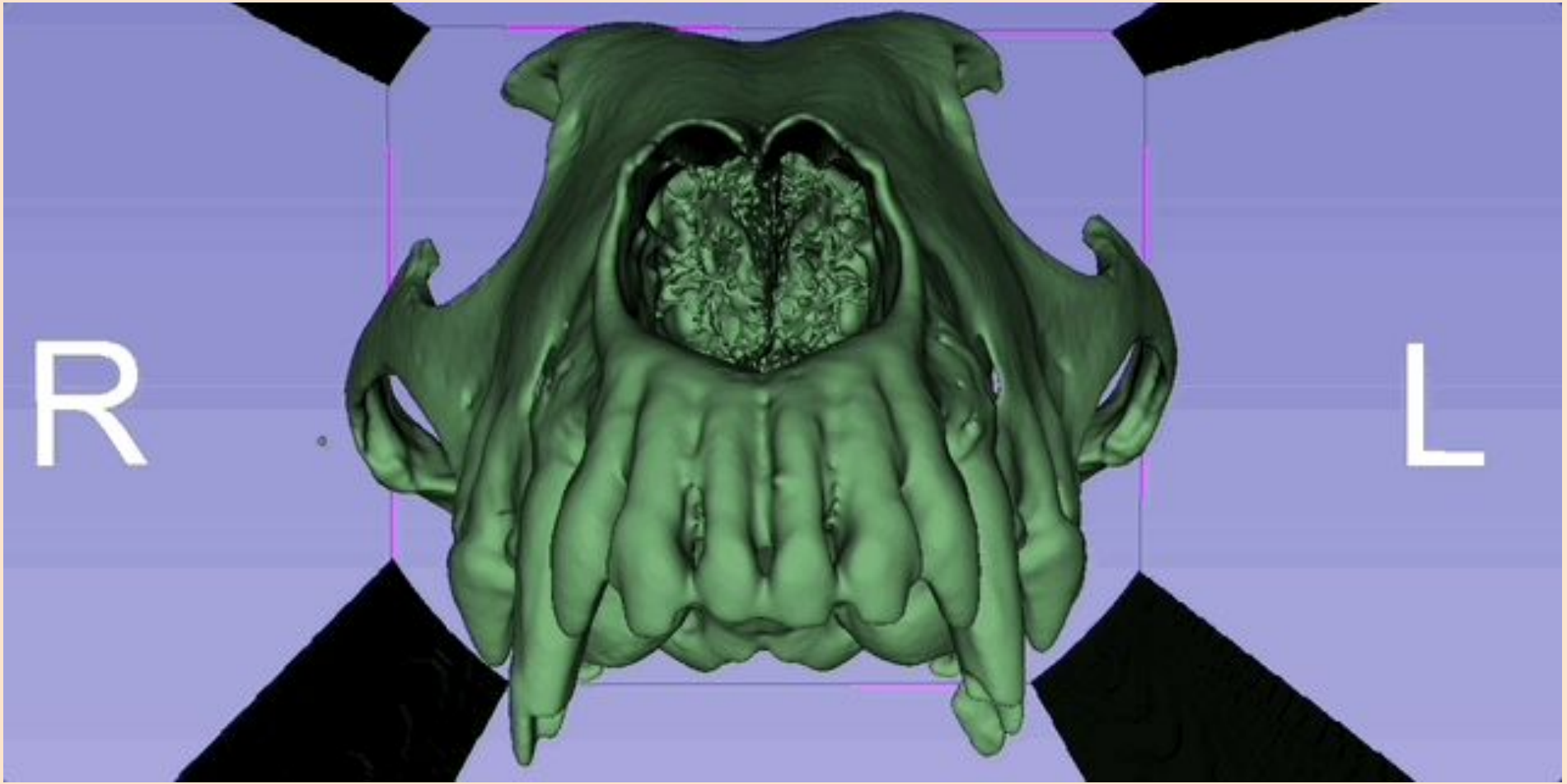
In the future, we will expand our data set with CT scans from the LA County Natural History Museum and integrate them into computational fluid dynamics analyses to assess shape-olfaction interactions. With more variance in canine skull morphology, the application of this investigation proceeds in the area of Canine Nosework and how olfaction varies across size. In order to study the effects of morphological differences between dog breeds, further uses of our research will include a simplified Computational Fluid Dynamics model of the nasal passages. Additionally, we plan to analyze the simplified CFD model using uncertainty quantification (UQ) to understand the impacts of differences in an efficient way.



References

1. B. A. Craven, E. G. Paterson and G. S. Settles, "The fluid dynamics of canine olfaction: Unique nasal airflow patterns as an explanation of macrosmia," Journal of the Royal Society Interface, vol. 7, no. 47, pp. 933-943, 2004.
2. J. Z. Tseng. Testing adaptive hypotheses of convergence with functional landscapes: a case study of bone-cracking hypercarnivores. PLOS One, vol. 8. issue 5, e65305, 2013.


B: LAB SKULL.NRRD
G
A: -577.0000mm
Y
R: 544.0000mm
B: LAB SKULL.NRRD
B: LAB SKULL.NRRD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