Laboratory for Structural, Physiologic and Functional Imaging

CT Segmentations for Oral and Maxillofacial Surgical Planning and Modeling
Image Segmentations with Deep Learning

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PURM Penn Undergraduate Research Mentoring Program

Penn Medicine

Introduction

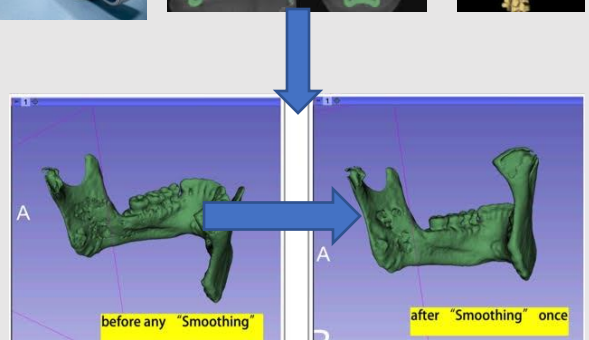
- Currently, CT scans are used on a vast majority of patients for prospective craniofacial operations
- CT scans use radiation and are of lower image quality than alternate medical imaging methods but are the current widespread technique for evalulating craniofacial issues
- Creating a large quantity of mandible masks can be used to train deep learning models to generate cranial models that can be used as surgical aids
- Additionally, the greater the quantity of mandible masks that are created, the greater accuracy with which abnormalities can be detected regarding operations
- Segmentation is the technique that is commonly used to create these masks in the field of radiology, but deep learning models are being developed to automate this process
- As such, segmented masks are used in this lab to model the segmentation process in spinal MR scans using convolutional neural networks with tensorflow software

Objectives

- The overall goal of this project is to develop solid state imaging as a radiation free alternative to CT scans for craniofacial imaging
- Specifically, a large quantity of craniofacial CT scans must be segmented and developed into masks with isolated mandibles to be used as training data for the deep learning model
- Train this data using deep learning to eventually create accurate 3-dimensional models of these craniofacial CT scans
- The final objective is translation to the clinic to detect and examine craniofacial abnormalities prior to operation or after surgery

Segmentation Methods

- Manual segmentation process of training data involves isolating sections of head CT scan using 3D Slicer software
- There are 200-500 slides in each scan that are segmented using multiple tools as follows
- The first procedural step is to load the DICOM images, denoting the threshold of mandible visibility, and selecting and highlighting the mandible in each slide of the CT scan, as shown below
- Then any connections to unwanted bone must be removed at each overlap location
- Smoothing of final mask then takes place to provide more consistent readable images by the deep learning model



Ongoing Deep Learning in Related Projects

- In addition to the head CT segmentations, we analyze the spinal MR scans to develop an automated segmentation process of the vertebrae
- After the MR images are manually segmented, they are used as training data in our deep learning model, which first refines, scales, and augments the 3-dimensional images and then generates a trained U-Net model
- Tensorflow, Google's software library for python machine learning, is used to gauge the fit of the model relative to the input data

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