Novel 3D Convolutional Neural Network for Age-At-Death Estimation From Cranial CT Scans

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Accurate Age-At-Death (AAD) estimation is integral in determining biological profiles, specifically of unidentified and skeletonized human remains. To date, AAD estimation relies primarily on subjective and imprecise skeletal assessments. Currently, many researchers study visually identifiable factors in the skull that are correlated with age, such as dental eruption, suture closure and other degenerative changes. This project aims to design and develop an algorithm for automating AAD estimation based on morphological characteristics of the skull. A dataset containing 1,224 de-identified cranial CT studies with known AAD from the New Mexico Decedent Image Database was used to develop a 3-dimensional convolutional neural network (3D CNN). Based on the network architecture, a classification, regression and bracket-based regression model were each developed, trained and tested for their ability to predict age from a cranial CT scan. While the regression model outputs a single age value, the classification and bracket-based models predict a skull's age into one of nine age brackets of 0-9, 10-19...80-89 years. The bracket-based regression outperformed the others, with a mean squared error of 2.35, indicating that this model can be used on other cranial CT scans to predict age within 1.5 age brackets. This project addresses the need for a novel age estimation methodology by encompassing multiple cranial factors, defined bracket age ranges and generalizable cranial CT scan inputs and demonstrates the capability of computational pathways to improve analytical processes in the fields of archeology, anthropology and forensics. Future work will focus on model optimization and graphic user interface development to transform this model into a viable format for anthropologists.

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