Abstract

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Journal of Oral Hygiene & Vector Biology

2022
Vol .3 No.3

The use of "Mask R-CNN" deep learning algorithm with a small training database for fast teeth detection in CBCT

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Abstract

Statement of the Problem: Accurate teeth segmentation is an essential step for reconstructing three-dimensional teeth models used in various clinical applications. However, manual segmentation is time-consuming and prone to intra- and inter-observer variability. Teeth segmentation can be performed automatically by convolutional neural network (CNN) algorithms, but most CNN algorithms require also manual marking on a large training database and extreme computational power. Methodology & Theoretical Orientation: This study evaluates the ability to use a transfer learning algorithm, called "Mask R-CNN", which requires a small training database and low computational power, in order to detect teeth contour in Cone Beam Computerized Tomography (CBCT) imaging. This algorithm produces a bounding box around the detected teeth and simultaneously produces an instant high-quality contour of each tooth. In The contours of the teeth were marked manually only 6 CBCT slices from different cases, and the training process was performed with a standard CPU of an Intel Core i7 laptop. The performance of the trained neural network was tested on 383 CBCT slices with various fields of view obtained for several patients by different imaging protocols. Findings: Each training epoch, with standard computational power, lasted less than 1 hour. Using only one epoch, the trained "Mask R-CNN" neural network detected the teeth on the CBCT slices, with sensitivity of 90.7% and a specificity of 98.3%. When The training process was performed with 16 epochs, the detection sensitivity was improved to 95.1% and the specificity was improved to 99.1%. Conclusion & Significance: The use of the “Mask R-CNN” algorithm with a very small training database and standard computational power produces high-quality teeth detection within a reasonable train duration. This can eliminate subjective errors and enables more precise diagnosis and treatment planning.

Received: March 25, 2022; **Accepted:** April 07, 2022; **Published:** April 30, 2022

Biography

Talia Yeshua holds a Ph.D. in applied physics from the Hebrew University of Jerusalem. She is a researcher and a lecturer in the Department of Applied Physics/Electro-Optics Engineering at the Jerusalem College of Technology. Her research activities include the use of computer vision, machine learning and deep learning tools for automatic diagnosis of pathologies in CT and CBCT imaging, and in radiographic, fluoroscopic and panoramic images. The focus of the research is on the early diagnosis of osteoporosis and of kidney disfunction and on mapping of dental restorations and of oromaxillofacial lesions.

