REVIEWER 2:

Title

Please, write the type of study.

DONE

Three-Dimensional Semantic Segmentation of Palatal Rugae and Maxillary Teeth and Motion Evaluation of Orthodontically Treated Teeth Using Convolutional Neural Networks

Abstract

-Please, check the rules of journal for words number.

DONE

-Please, write number of patients (1 or 100).

DONE

-Please, check keywords according to MeSH.

We agree with the reviewer. We edited the keywords according to MeSH terms.

Keywords: Three-Dimensional Imaging; Orthodontics; Convolutional Neural Networks; Palate; machine learning; artificial intelligence

Introduction

-This section is too short, please, enlarge it, for example, with detailed description of previous study (ref.1-5)

We added these two paragraphs to expand on the introduction and the current literature.

Recent developments in deep learning have advanced the segmentation of 3D dental meshes. Krenmayr et al. [1] proposed DilatedToothSegNet, enhancing segmentation accuracy through expanded receptive fields. Wang et al. [2] introduced STSN-Net, which effectively segments and numbers teeth even in crowded conditions. Estai et al. [3] demonstrated successful automated detection and numbering of permanent teeth on panoramic images, supporting the growing role of AI in dental diagnostics.

Despite this progress, challenges remain with partial or low-quality scans. Jana et al. [4] highlighted the limitations of current deep learning models in handling incomplete dental meshes. Raith et al. [5] showed that artificial neural networks can classify 3D tooth features effectively but remain sensitive to data quality. These findings suggest that while AI tools hold significant promise, further refinement is needed for broader clinical use.

-The aim of one study could be only one but there are several tasks. Please, choose what is the aim and what are the tasks

We agree with the reviewer. We edited the study aims as stated below

This study aimed to develop a fully automated tooth segmentation algorithm based on machine learning for evaluating dental movement following orthodontic treatment. To achieve this, a labeled

dataset of 3D texture-colored models from real patients, along with their corresponding 2D projections, was created.

-Lines 52-58 are more appropriate for materials and methods
We agree with the reviewer. We moved the paragraph to the materials and methods section

Materials and methods
Legend 1. Please, add explanation. Also, please, check the quality of image as it is not clear especially after light zoom.
We added the following figure legend:
Overview of the SegNet architecture. The decoder upsamples using encoder pooling indices, followed by convolution to densify features, with final pixel-wise classification via a softmax layer.

Dataset collection
Please, add description because it is not clear the number of men, women, children, there is no age or their diagnosis.
We added the following description:
One hundred maxillary arch scans were randomly selected from patient records, regardless of age or gender.

As I know the dataset must be maximally clear and has one main characteristic for better machine learning.
The randomly selected sample includes both primary and permanent dentitions, reflecting clinical reality, as orthodontic treatment is often initiated during the mixed dentition phase.

Also, there is the question about local ethical committee protocol for human study (as You made the scans and did not use former database).
We thank the reviewer for bringing this up. The intraoral scans (non-invasive digital impressions using light technology) used in this study were obtained from routine orthodontic records of patients who sought treatment in our clinics. Ethical approval was secured through the Institutional Review Board (IRB), as detailed in the manuscript under the Institutional Review Board Statement.

Please, write how many scientists made intraoral scan protocol, how many times and what was agreement between them and between tries of each.
We added the following description:
One investigator performed the intraoral scan protocol.

Lines 132-133: please, write the variation for ration.
We added ± 4.4 SD

Lines 144-146: please, write the base for number of spheres and their position (previous study, reference etc.)

We added the pertinent reference:
Ashmore JL, Kurland BF, King GJ, Wheeler TT, Ghafari J, Ramsay DS. A 3-dimensional analysis of molar movement during headgear treatment. Am J Orthod Dentofacial Orthop. 2002 Jan;121(1):18-29; discussion 29-30. doi: 10.1067/mod.2002.120687. PMID: 11786867.

Lines 208-209: one of the article is Yours as I understood and the conclusion is that rugae could change due to orthodontic treatment. Please, make this fragment clear.
Among the 3 pairs of palatal rugae, the first set of rugae are the most stable specially on their medial aspect, while the other two pairs may vary during the orthodontic expansion. Accordingly, we added the following statement for clarification:
Changes at the medial rugae points were less clinically significant than those at the lateral points. This aligns with previous findings showing that medial rugae are the least affected by conventional orthodontic treatment.

3.3 subsection
Please, explain choice of number of sample for each action for learning. Please, write the base of statement that 80 samples would be enough for adequate machine learning.
The 80/20 train-test split is a common practice in machine learning. This choice ensures the model is trained on a larger portion of the data, allowing it to better capture feature variability and learn complex patterns. The increased training size also helps reduce overfitting and improves generalization on the test set.

Figure 7. Please, add explanation for legend.
We chose to present the worst, average, and best prediction results to offer a representative overview of the model's performance. Since it is impractical to display all outputs, this selection provides insight into the range of outcomes.
We added the following:
The average result demonstrates a fairly high accuracy and is close in performance to the best case, indicating consistent behavior. The worst result, while visibly poorer, can be interpreted as an outlier; its contrast against the average and best highlights the model’s overall robustness and reliability.

Also, please, explain the colors on models/layers for each figure for better understanding.
Each color in the segmentation visualizations corresponds to a specific tooth label, allowing for clear differentiation between classes. While the model operates on class indices, colors are mapped for visualization purposes only. The choice of colors is arbitrary and does not affect the segmentation results.

Please, write the limitations of Your study and method after discussion. Also, please, write if You could advise or not Your method for assessment of orthodontic treatment quality.
We added a paragraph entitled “Limitations and Future Considerations”:
The proposed method showed excellent performance in 3D semantic segmentation and motion analysis, with high accuracy and no need for additional processing steps. However, there are several opportunities to further strengthen and expand its clinical applicability. While our dataset

of 100 scans provided a solid foundation for model development and testing, future studies involving larger and more diverse patient groups to include various age ranges, malocclusion types, and dentition stages that may help confirm the method's generalizability. The current approach also offers potential for comparison with other segmentation techniques in the literature, which could further highlight its efficiency across different clinical scenarios. Additionally, applying the method to early stages of treatment could reveal its value in detecting changes and improving treatment planning. This method holds strong potential as a tool for evaluating orthodontic treatment quality, and we encourage further validation in broader clinical contexts to fully realize its benefits.