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A Deep Learning-based Method for Tooth Segmentation on CBCT Images Affected by Metal Artifacts

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Abstract— **Manual or semi-automatic tooth segmentation is an essential step in the dental field. However, this process is very tedious, challenging, and time-consuming. Also, tooth segmentation is often affected by metal artifacts on CBCT images. To overcome this problem, we proposed a U-Net with EfficientNet backbone (Efficient-UNet) for an automated tooth segmentation on CBCT images. Experimental results show that Efficient-UNet achieves higher performance than simple UNet.**

I. INTRODUCTION

Accurate tooth segmentation is essential in the dental field to build a clinical diagnosis and an appropriate surgical plan. However, tooth segmentation mostly depends on manual or semi-automatic segmentation by operators, which is very tedious, challenging, and time-consuming, and it involves prior expert knowledge [1]. Also, tooth segmentation is often affected by metal artifacts on CBCT images [1].

In this study, we proposed a U-Net with EfficientNet backbone (Efficient-UNet) for an automated tooth segmentation on CBCT images affected by metal artifacts.

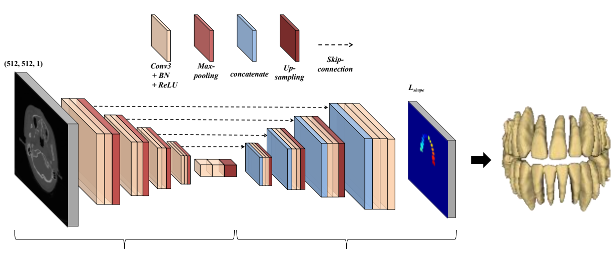

Figure 1. Efficient-UNet architecture.

II. METHODS

Materials. We used a total of 20 CBCT datasets including metal artifacts for network training and testing. The ground truths were annotated by an expert. The number of training, validation, and test sets was randomly split into 10, 5, and 5 CBCT dataset, respectively.

Network Architecture. The proposed network architecture was inspired by U-Net and EfficientNet-B4 backbone [2], which consist of the backbone encoder and decoder. to predict the segmentation mask. EfficientNet designed for balancing network depth, width, and resolution can lead to better segmentation performance [2].

Training setup. The proposed network was trained for 100 epochs with a mini-batch size of 8. The input images were resized from 800×800 to 512×512. Data augmentation was performed with random rotation (-45°-45°), image shift (-10 to 10%), random brightness and contrast (-30 to 30%). We adopted Dice loss and Adam optimizer with learning rate of 10^{-4} for network training. We used Dice similarity coefficient (DSC) for evaluating performance.

TABLE I. COMPARISION OF SEGMENTATION PERFORMANCE (DSC).

Models	1	2	3	4	5
Simple UNet	0.87±0.20	0.93±0.07	0.92±0.10	0.89±0.15	0.90±0.14
Efficient-UNet	0.88±0.15	0.94±0.08	0.93±0.09	0.90±0.13	0.91±0.12

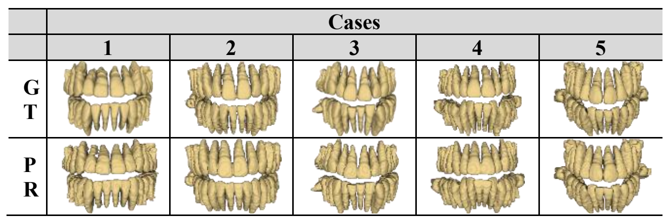

Figure 2. 3D visualization of ground truth (GT) and predicted results (PR).

III. RESULTS & CONCLUSION

We compared the performance of Efficient-UNet with simple U-Net. Experimental results show that Efficient-UNet achieves higher performance than simple U-Net (Table 1). Fig. 2 shows the 3D visualization of predicted results on Efficient-UNet. We observed that Efficient-UNet could perform accurate and robust tooth segmentation on CBCT images affected by metal artifacts.

References

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