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Synthetic image generation and deep learning approach for intraoral diagnostic applications

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Intraoral imaging is a powerful technique for the assessment of oral soft and hard tissue conditions for both clinical and consumer oral health monitoring applications. Automation to analyze these oral images would save significant time for oral health professionals. To build machine learning (ML) and artificial intelligence (AI) methods to automate the effort of analyzing intraoral images for oral soft and hard tissue conditions, a large amount of intraoral image data is required for training the ML model. However, unlike dental x-rays, no open source intraoral image data sets are currently available in the public domain. Moreover, obtaining such large amounts of clinical image data are highly challenging due to privacy reasons, and in general conducting clinical studies for capturing intraoral conditions are expensive and require time-consuming annotations. In this present study we have developed and implemented an image processing pipeline based on StyleGAN, which is a generative adversarial network to generate synthetic intraoral 2D images of both oral soft and hard tissue structures. In order to train the StyleGAN network we have used a total of ~6,000 images including lingual, buccal and occlusal surfaces of both lower and upper jaw of subjects. The computational implementation was performed on an AWS EC2 instance with NVIDIA A100 GPUs. The quality of the generated images were evaluated by 6 dental professionals. To perform the quality evaluation, 100 real and generated images with a resolution of 512x512 from each resolution were randomly selected and shuffled, then the dental professionals were asked to assess whether those images were real or synthetically generated. The quality of the generated images evaluated using Frechet Inception Distance (FID) metrics and the FID score of our currently trained model was 12.10. We performed a visual survey of the generated images with dental professionals and 83.75% of the generated images were scored as real by the dental professionals. As a next step, latent vector space of the StyleGAN will be explored for generating condition-specific soft and hard tissue images and their feasibility will be tested for data augmentation for deep learning applications.



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