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Synthetic CT Generation from Body Surface Data

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Purpose/Objective:

This study aims to generate CT scans from body surface data to reduce radiation exposure, enhance patient safety, and improve imaging access, particularly for frequent follow-ups or resource-limited settings. A key use case is in radiotherapy, where synthetic CT can support accurate patient positioning without repeated scans, reducing cumulative radiation.

Material/Methods:

We developed two machine learning models using multicentric data from 4000 patients to generate synthetic CT (sCT) images through a conditioned diffusion model [1]. These models utilized partial external surface contours (PESC) and, optionally, planning CT data. In our study, we compared the performance of two versions of the model: one trained with the inclusion of PESC and planning CT data and one trained with only PESC. The planning CT was used as a baseline reference image, and a target CT was generated by adjusting the planning CT to simulate a different patient position from the original scan. The models incorporate additional anatomical context, by using external contours and, optionally, planning CT data to more accurately match the target CT that corresponds to the given external contour. Quantitative performance was evaluated on unseen data from 40 patients using Mean Square Error (MSE), Structural Similarity Index (SSIM), and Normalized Cross-Correlation (NCC) metrics. We evaluated quantitative performance using Mean Square Error (MSE), Structural Similarity Index (SSIM), and Normalized Cross-Correlation (NCC) on unseen data from 40 patients.

Results:

The model trained with planning CT data performed slightly better than the model trained without it across all metrics (Figure 1). Specifically, the MSE for the model with planning CT was $3.955e-2$, compared to a slightly higher MSE of $5.079e-2$ for the model without planning CT, indicating a marginally lower error with planning CT included. The SSIM score was 0.7533 with planning CT versus 0.7327 without, and the NCC, measuring intensity correlation, was 0.8551 with planning CT and 0.8189 without.

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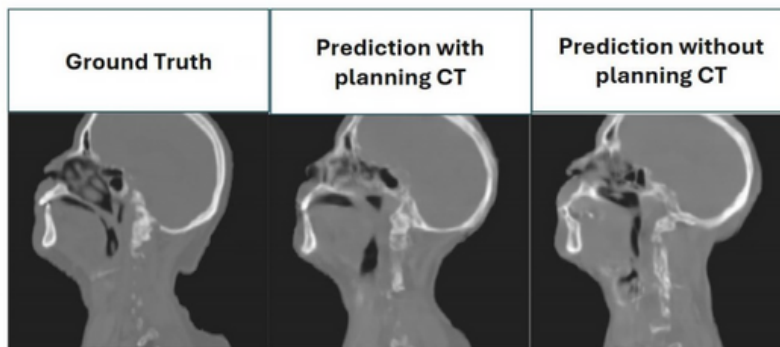


Figure 1: Illustration of ground truth CT, sCT prediction with planning CT and partial external surface contour, sCT prediction with only partial external surface contour.

Conclusion:

Our results demonstrate promising potential for generating synthetic CT (synCT) from external contours alone. Further studies are planned to refine this approach and evaluate its performance in a clinical setting.

Keywords: Synthetic CT, AI, Diffusion model