

AI Powered Contrast Enhanced CT Generation and Segmentation for Heart Substructures in Breast RT Patients

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Purpose:

Recently, there has been a growing interest in breast cancer among cancer species that may develop cardiac toxicity after radiation treatment. The increase in the long-term survivor of breast cancer has shown that the cause of non-cancer death is heart disease caused by dose to the heart during breast cancer radiation treatment.

Thus, we should consider the effect of radiation on the heart. This will be minimized if the substructures of the heart can be contoured when receiving breast cancer treatment. So currently the contrast enhanced CT are used to contour the heart's substructures in radiation therapy planning. However, there are some patients who are unable to take contrast enhanced CT due to clinical or other reasons. Therefore, we want to solve this problem by creating a contrast CT image only with non-contrast CT images with the use of deep learning.

Materials and Methods:

Our framework includes three main parts: a preprocessing part, a training part, and a prediction part. The preprocessing was performed by adjusting the contrast for better training of the heart's substructures and the position of each patient was registered by affine transform. The training and prediction parts were implemented by Generated Adversarial Networks (GANs) which includes two image types: a non-contrast CT image for input and a contrast CT image for output. Of 19 patients, 13 patients (8,646 2D paired images) were used for training, 3 patients (2,554 2D paired images) were used for validating, and the remained 3 patients (2,554 2D paired images) were used for testing.

Results:

The result CT images were generated by GAN. It is necessary to compare the image quality between the result CT images and the contrast enhanced CT images which are used as a reference data. The image quality assessment was implemented by Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index Map (SSIM) for 3 patients. The results of PSNR are 21.65, 21.87, and 22.73. The results of SSIM are 0.68, 0.67, and 0.67.

Conclusion:

The results represent a potential of generating the contrast enhanced CT image from the non-contrast CT image. We will conduct a further study with different methods of preprocessing or post processing to get better results and with larger data set. Furthermore, not only the proposed methods, we plan to segment automatically the substructures of heart from the generated CT using deep learning methods.

Keywords : Breast RT, Synthetic Contrast CT, Deep Learning