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Can Deep Learning Bring the Quality of Low-dose CT Images to Better than that of Normal-dose CT Images?

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INTRODUCTION

- Ionizing Radiation remains the major concern in X-ray diagnostic CT
- Deep learning (DL) based image processing techniques have witnessed unprecedented success
- Current DL-based denoisers still can not compete with normal dose CT (NDCT)

AIM

- To investigate the possibility whether deep learning can raise the low-dose CT image quality above that of normal-dose CT

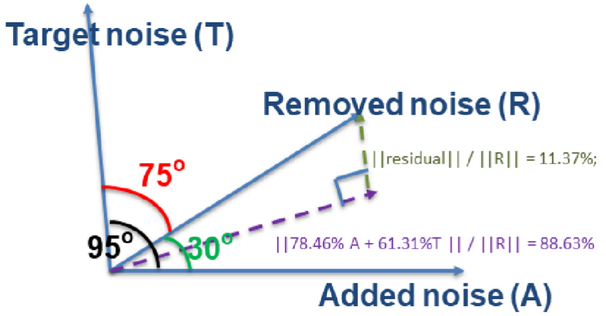
METHODS

- A high-resolution network was introduced
- Resolution-maintance module: repeated convolutional layers consisting of non-downsampled convolution operators
- Noise-removal module: aggressive downsampled convolution operators for large receptive field
- Feature fusion module: multiscale features are extracted to further enhance the sematic features by fusing low/middle/high level features
- Group normalization (GN) and weight starndardization (WS) to stablize training

DATASETS

- AAPM 2016 Low-dose CT Challenge dataset
- 8 training patients/2 testing patients
- 4800/1136 training/testing slice CTs

NOISE REMOVAL ANALYSIS

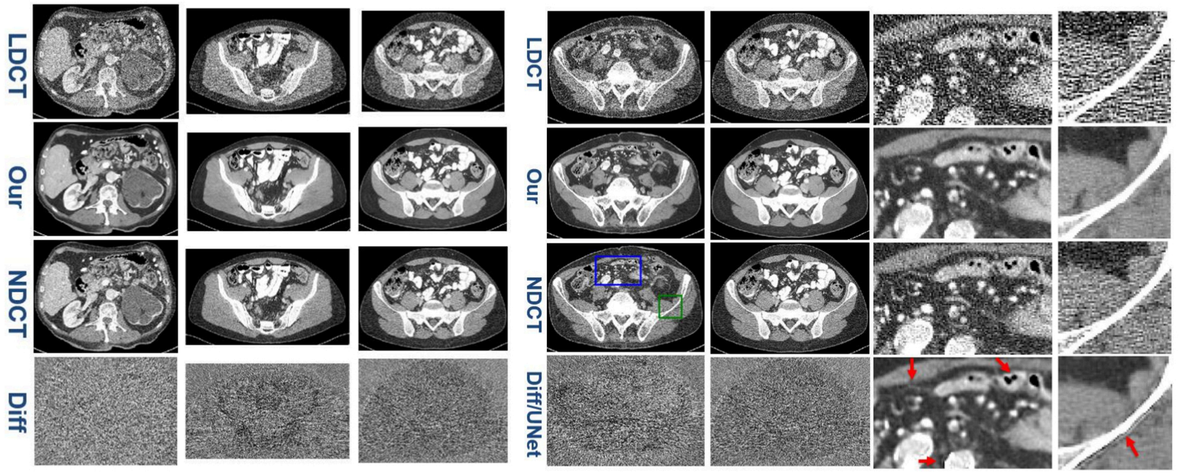


- Target noise (T): noise in original NDCT
- Added noise (A): LDCT – NDCT
- Removed noise (R): the noise in the input LDCT – the residual noise in the denoised output

CONCLUSIONS

- The proposed denoiser could produce much lower noise levels than both the quarter/normal dose CT images, but exhibited comparable resolution property as the normal-dose CT image.

RESULTS



	UNet	HRNet + IN	HRNet + GN + WS
SSIM	0.7079	0.738	0.746
RMSE	62.78	55.546	54.51

REFERENCES

- *Ronneberger, Olaf et.al., " U-Net: Convolutional Networks for Biomedical Image Segmentation" , MICCAI 2015*
- *Ke Sun et.al, " Deep High-Resolution Representation Learning for Human Pose Estimation" arxiv 1902.09212v1*