Detail-Revealing Deep Low-Dose CT Reconstruction

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Abstract

Low dose CT Reconstruction

- Existing methods & weaknesses:
  2. Iterative reconstruction: Recasts the reconstruction as an iterative optimization process. Objective functions based on naive assumptions.
  3. CNN-based methods: Learn the mapping between low-dose CT image and normal dose CT image with deep networks. Details damage.

Motivation

- No hand-designed filters and not rely on raw data.
- Learn better mapping between low-dose CT and full-dose CT.
- Suppressing the noise effectively and retaining the structures well simultaneously.

Method

Dual-Branch Network Architecture

- Pixel-wise Loss $L_P$:
  $$L_P = \frac{1}{N} \sum_{t=1}^{N} \left[ \sum_{p_t} ||\nabla^2 R(p_t)|| e^{-\gamma S(p_t)} \right]$$
  where $N$ is the total number of training samples, $P_t$ means a given pixel at $t$-th sample. $R$ and $S$ are the refined CT image and the structure image obtained from reconstruction branch and prior branch, respectively. $\gamma$ is an empirical parameter.

Experimental

- Holistic Loss $L_H$: LDCT image $I$, and produces refined CT image $R$ ('fake sample'), NDCT image $I_T$.
  $$L_H = \frac{1}{N} \sum_{t=1}^{N} \left[ \sum_{p_t} ||R(p_t) - I_T^t|| \right]$$

- Total Loss $L$:
  $$L = L_P + \alpha_1 L_T + \alpha_2 L_H.$$