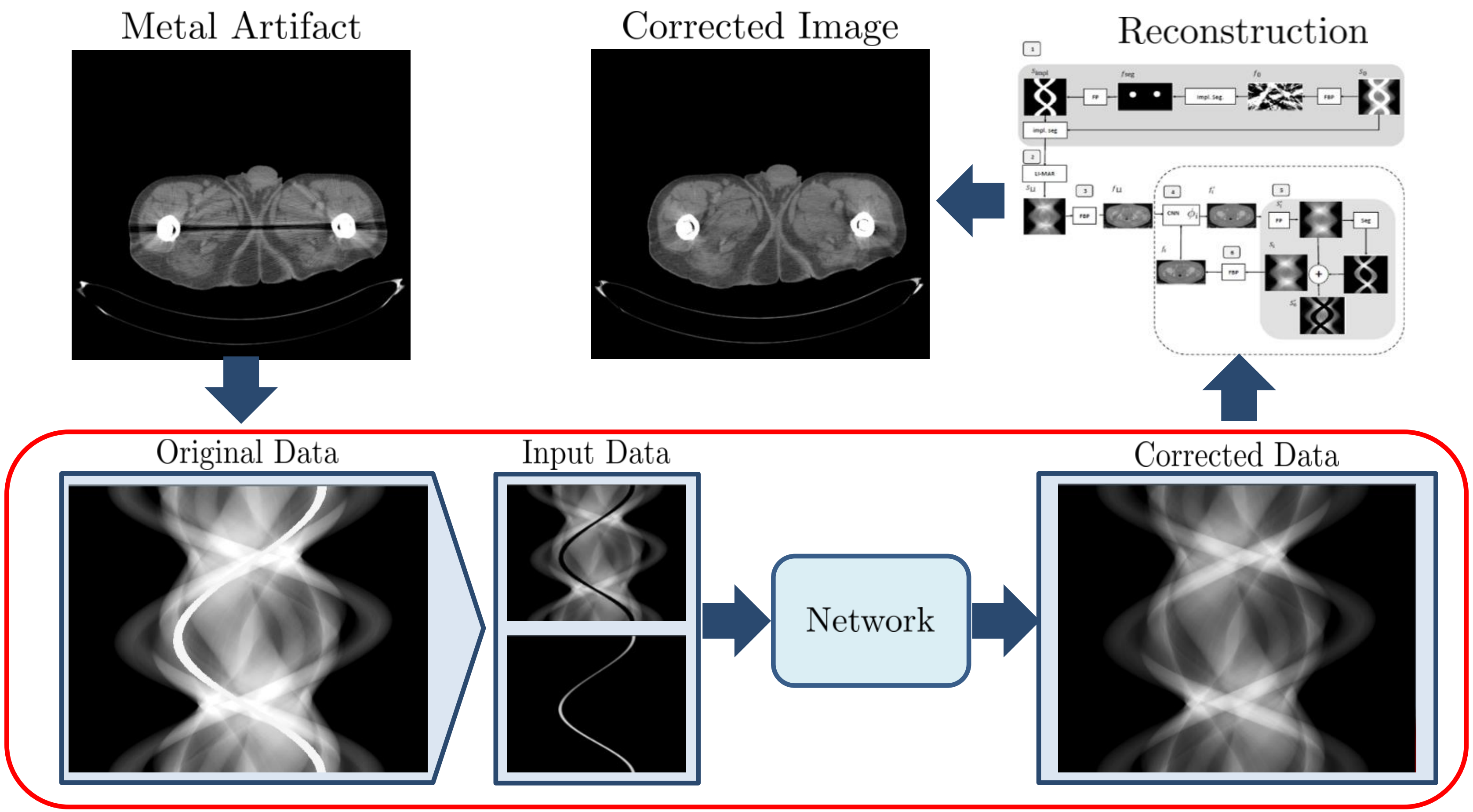
Projection Domain Artifact Reduction in CT using cGANs

Nele Blum[1], Thorsten Buzug[1,2] and Maik Stille[1,2]

Institut für Medizintechnik

MIDL Lübeck 2021



Motivation

- Design a network, which can be applied directly to the measured projection data
- Integration in modern CT image reconstruction to get the best possible result

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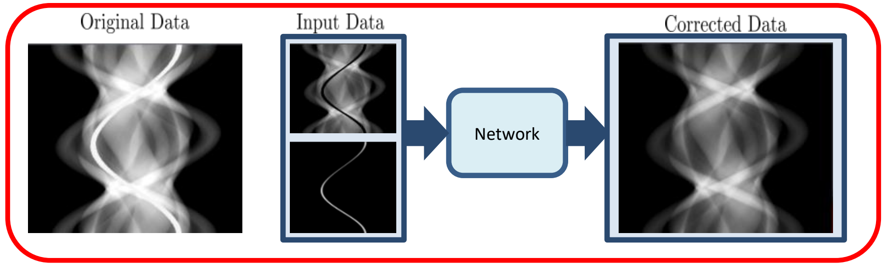
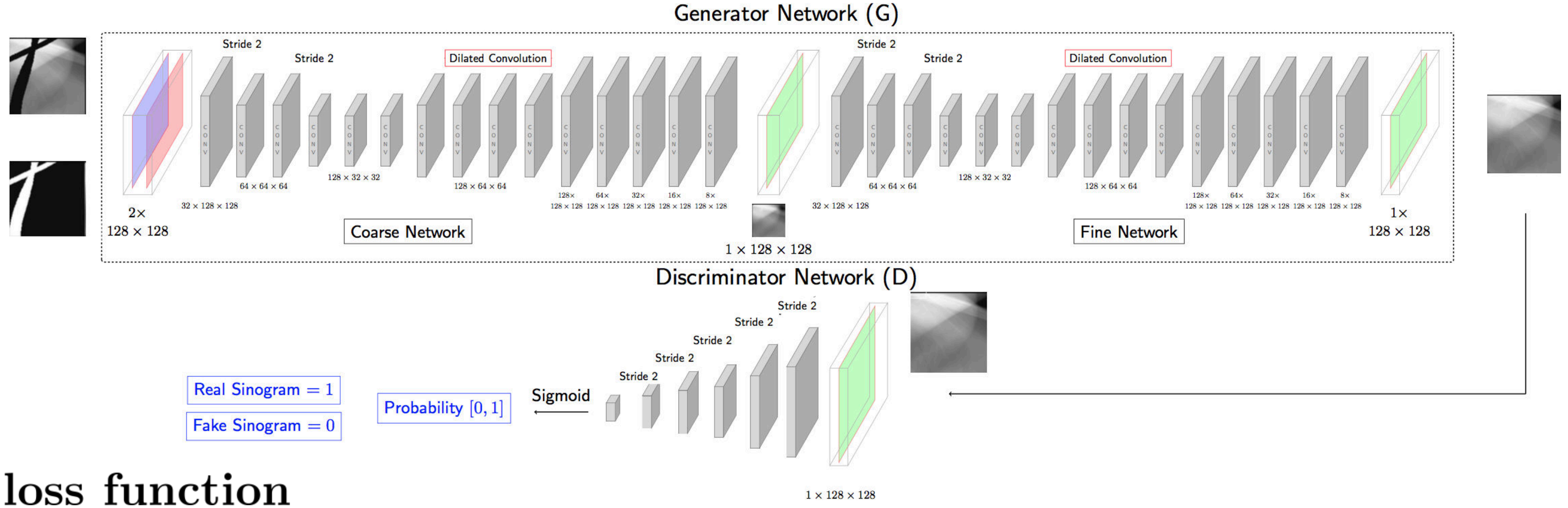
Trained network



Training with 128×128 image patches

- Input:
  - Projection data missing metal trace
  - Binary mask
- Output: refilled projection data

cGAN



loss function

Adversarial loss + l1 loss (local and global)

$$G^* = \arg\min_G \max_D L_{\mathrm{GAN}}(G,D) + \lambda \mathbb{E}_{x,x_{\mathrm{ref}}}[\|(x_{\mathrm{ref}} - G(x))_{\mathrm{local}}\|_1 + \|(x_{\mathrm{ref}} - G(x))_{\mathrm{global}}\|_1]$$

with

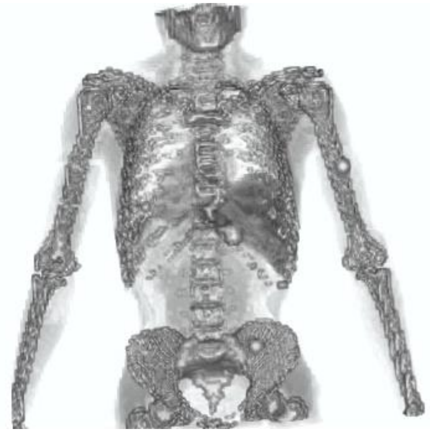
$$L_{\mathrm{GAN}}(G,D) = \mathbb{E}_{x,x_{\mathrm{ref}}}[\log(D(x,x_{\mathrm{ref}}))] + \mathbb{E}_x[1 - D(x_{\mathrm{ref}}, G(x))]$$

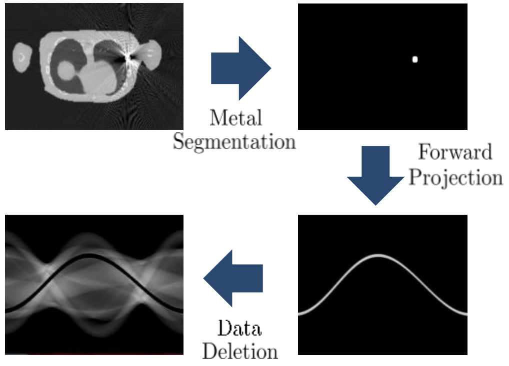
G	Generator network
D	Discriminator network
x	Training data: missing metal trace
x_{ref}	Training data: gound truth
$\mathbb{E}$	Expectation value over the training data
λ	Weighting parameter

Data

120 simulated sinograms of the XCAT Phantom

Divided in traing/validation/test data (90/15/15)





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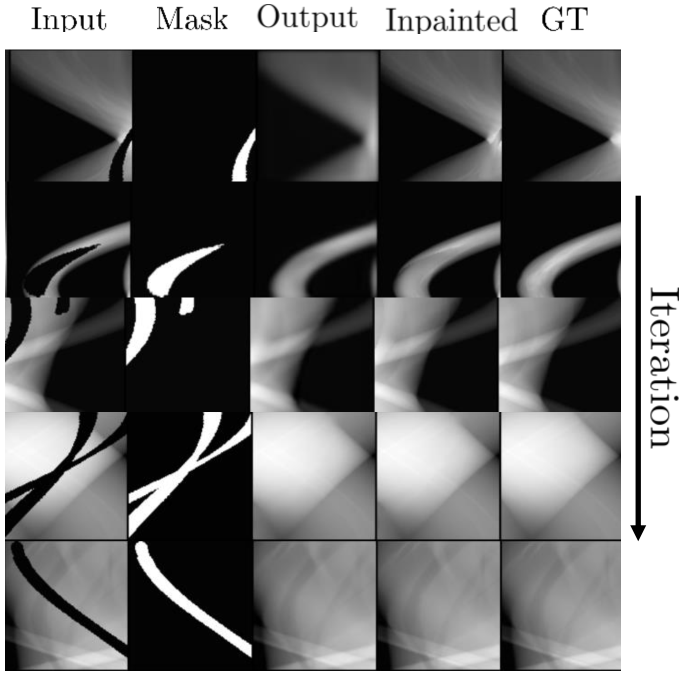
Training

Parameter	Value
number training data	183 000
number validation data	31 000
batch size	32
epochs	100
learning rate	$1 \cdot 10^{-5}$



Results

Projection domain

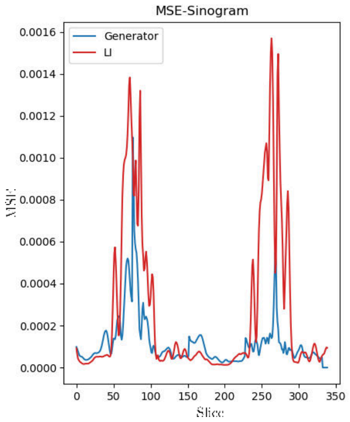
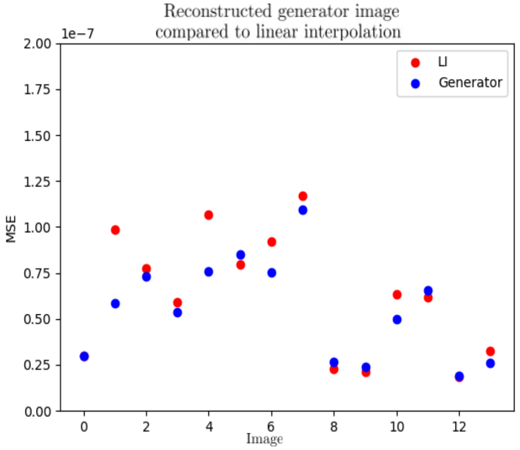
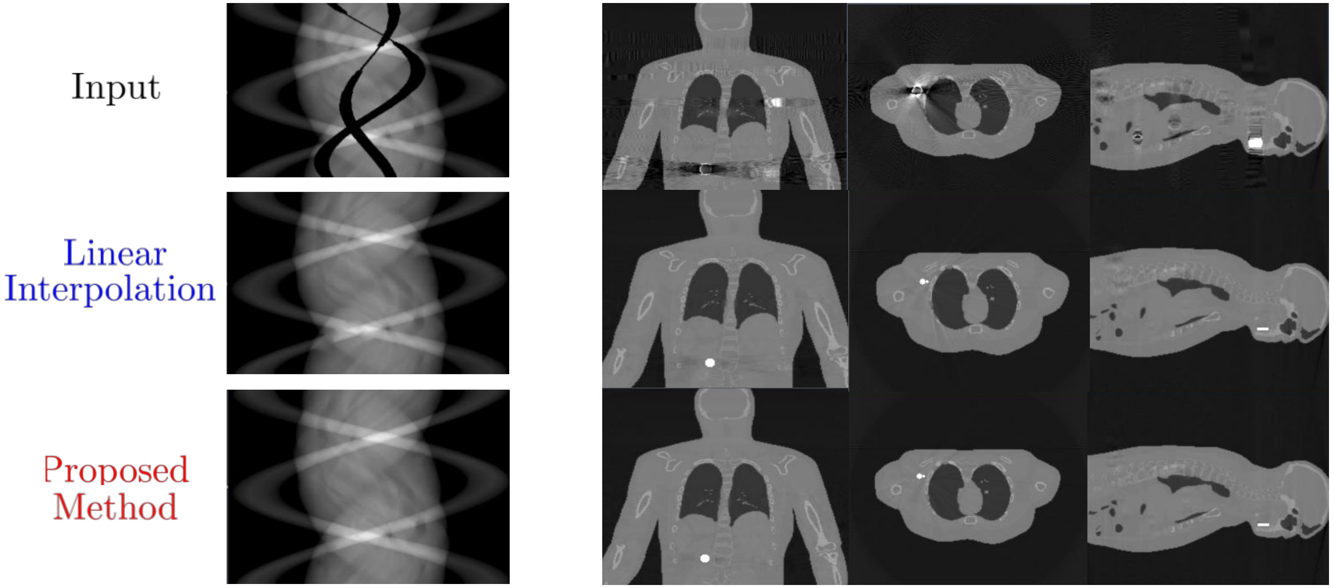


Image domain





W:1500 HU, L:0 HU