

[KAIST Research Group of Future Emerging Technology on Medical Imaging]

Group C

Metal artifact reduction for X-ray CT with deep learning

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Bio Imaging and Signal Processing Lab.

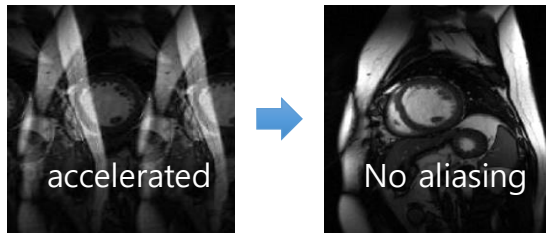
Hansang Lee

Statistical Inference and Information Theory Lab.

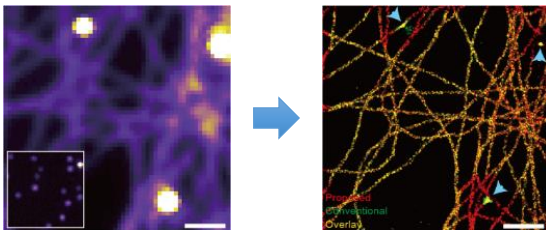
BISP Lab

- Advanced signal processing for bio-medical imaging (MRI, CT, Optics, etc.) using mathematical tools.
- Compressed sensing theory
- Annihilating filter based LOW rank Hankel matrix Approach (ALOHA)

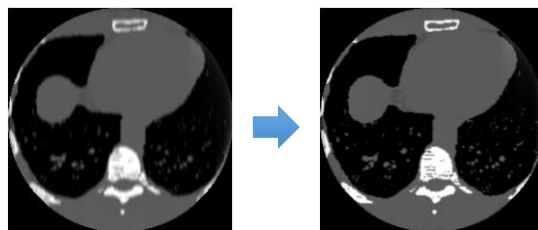
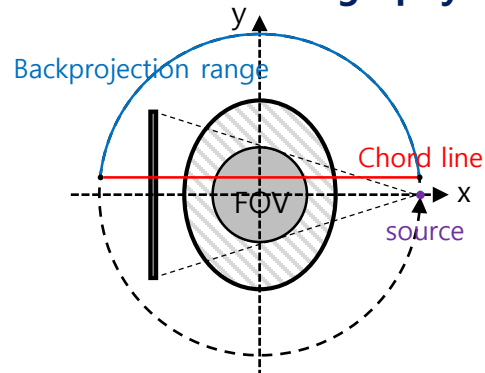
MRI acceleration (k-t FOCUSS)



Super-resolution (FALCON)



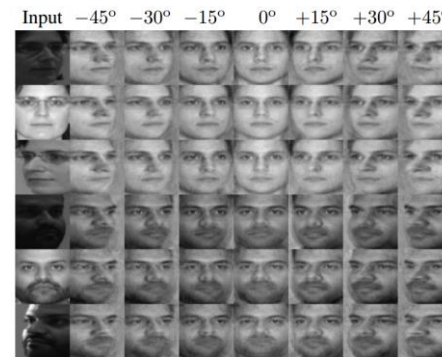
CT interior tomography



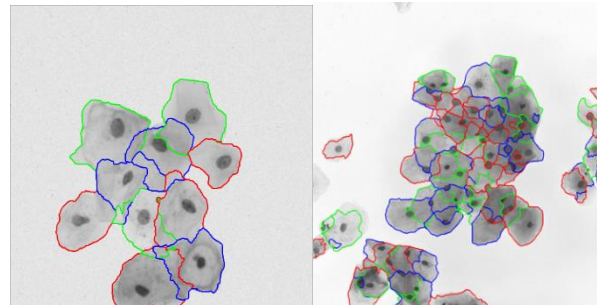
SIIT Lab

- Deep learning for computer vision
- Object segmentation in bio-medical images
- Radiomics
- Deep learning in medicine
- Deep learning in medical imaging

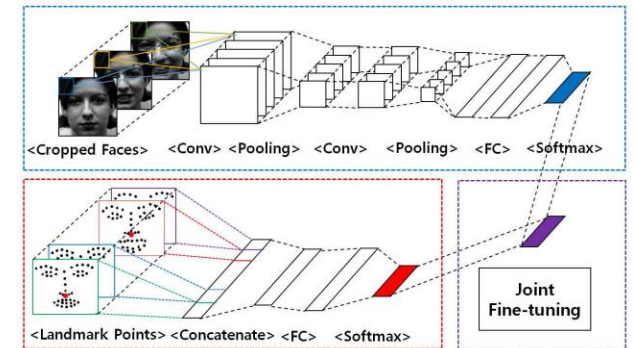
Rotating face



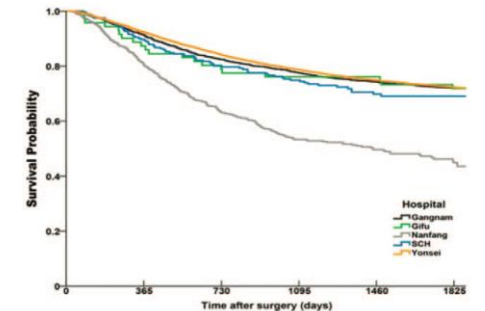
Cell segmentation



Facial expression recognition

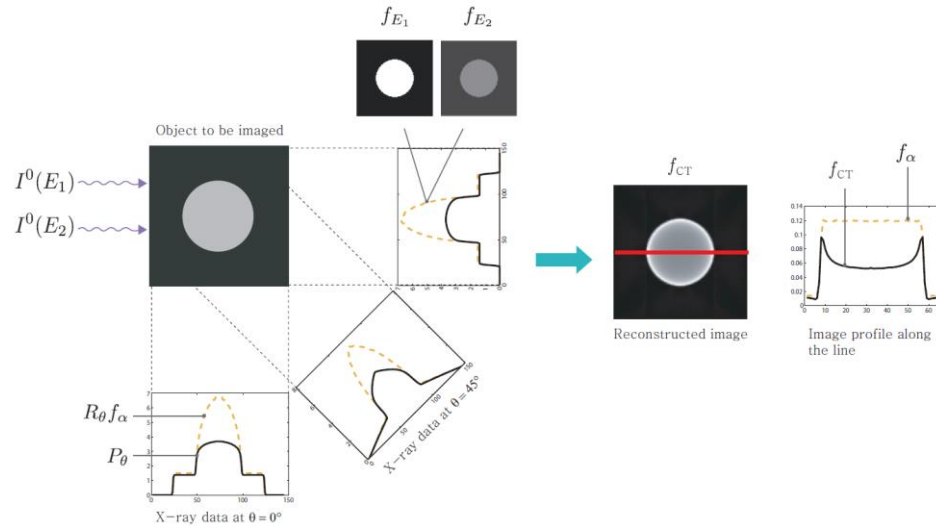


Cancer survival prediction

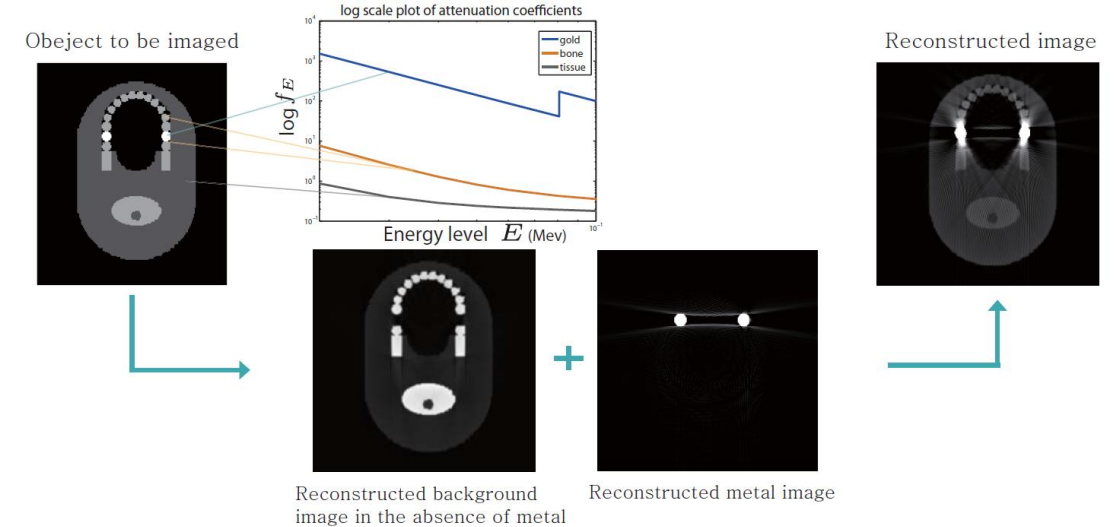


What is metal artifact?

Non-linear effect

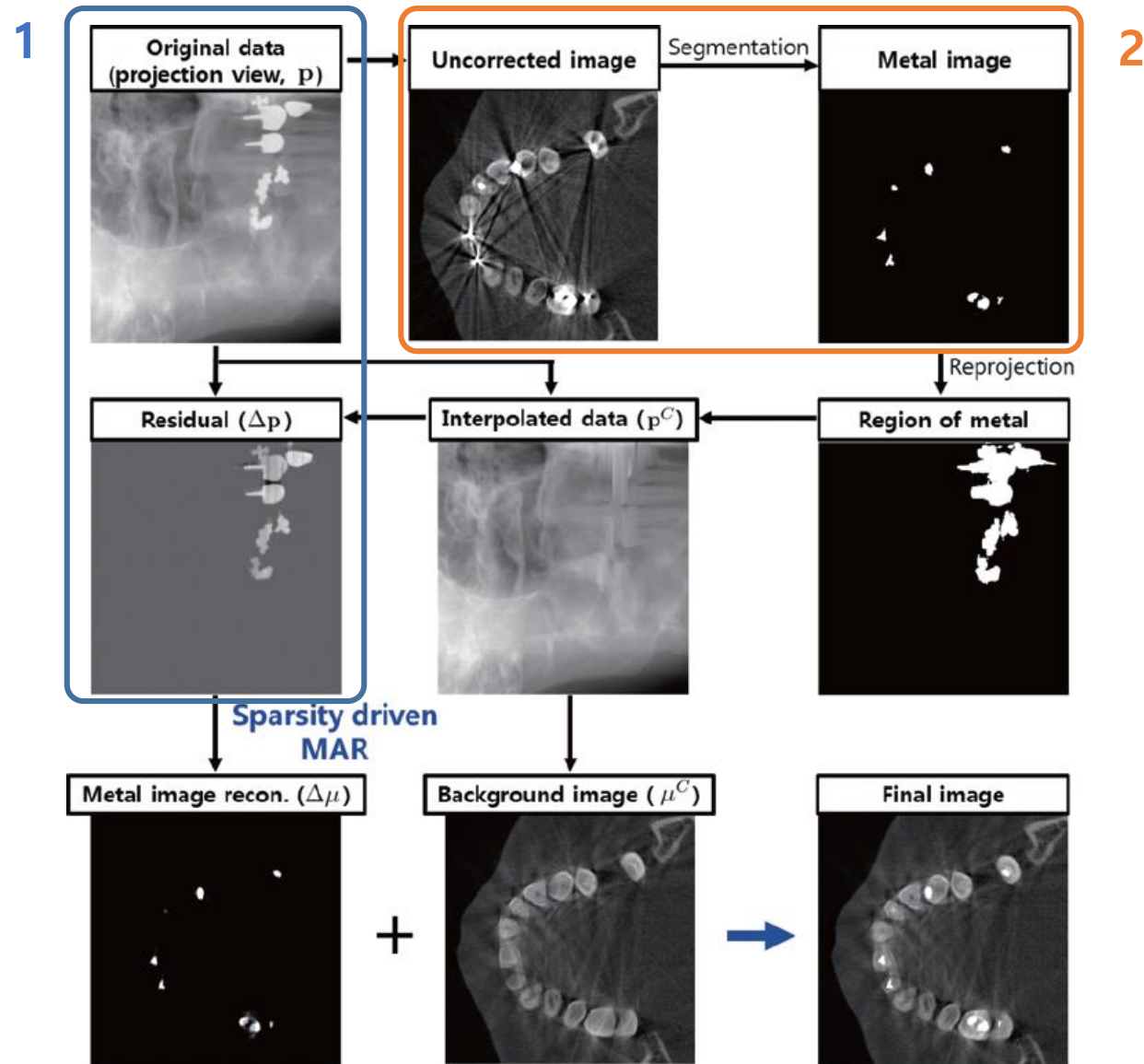


Streaking artifact



- Main cause: beam hardening effect
- X-ray beam has multiple energy.
- Attenuation coefficient of metals have strong non-linearity with respect to energy level.

Metal artifact reduction algorithm



Age of deep learning (1)

ImageNet challenge



 AlexNet [Krizhevski, Sutskever, Hinton 2012]

▶ 15% top-5 error on ImageNet

 OverFeat [Sermanet et al. 2013]

▶ 13.8%

 VGG Net [Simonyan, Zisserman 2014]

▶ 7.3%

 GoogLeNet [Szegedy et al. 2014]

▶ 6.6%

 ResNet [He et al. 2015]

▶ 5.7%

 <http://torch.ch>

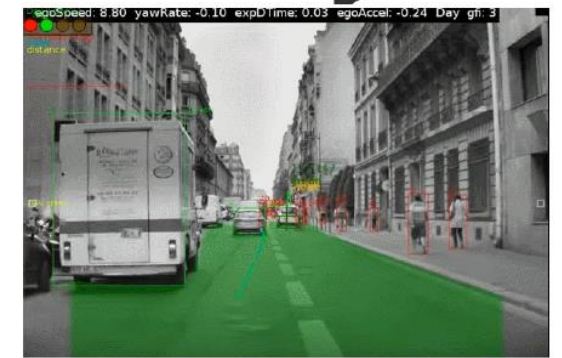
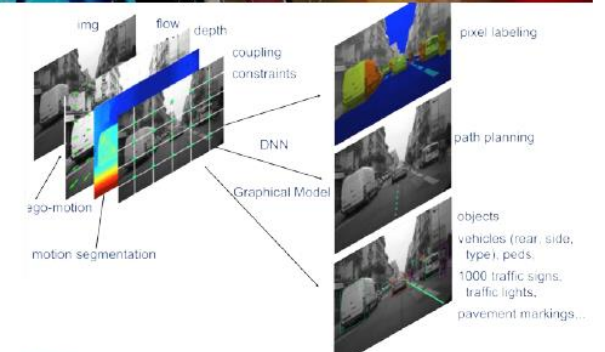
 <https://github.com/torch/torch7/wiki/Cheatsheet>

FULL 1000/Softmax
FULL 4096/ReLU
FULL 4096/ReLU
MAX POOLING 3x3sub
CONV 3x3/ReLU 256fm
CONV 3x3ReLU 384fm
CONV 3x3/ReLU 384fm
MAX POOLING 2x2sub
CONV 7x7/ReLU 256fm
MAX POOL 3x3sub
CONV 7x7/ReLU 96fm

DL for autonomous driving



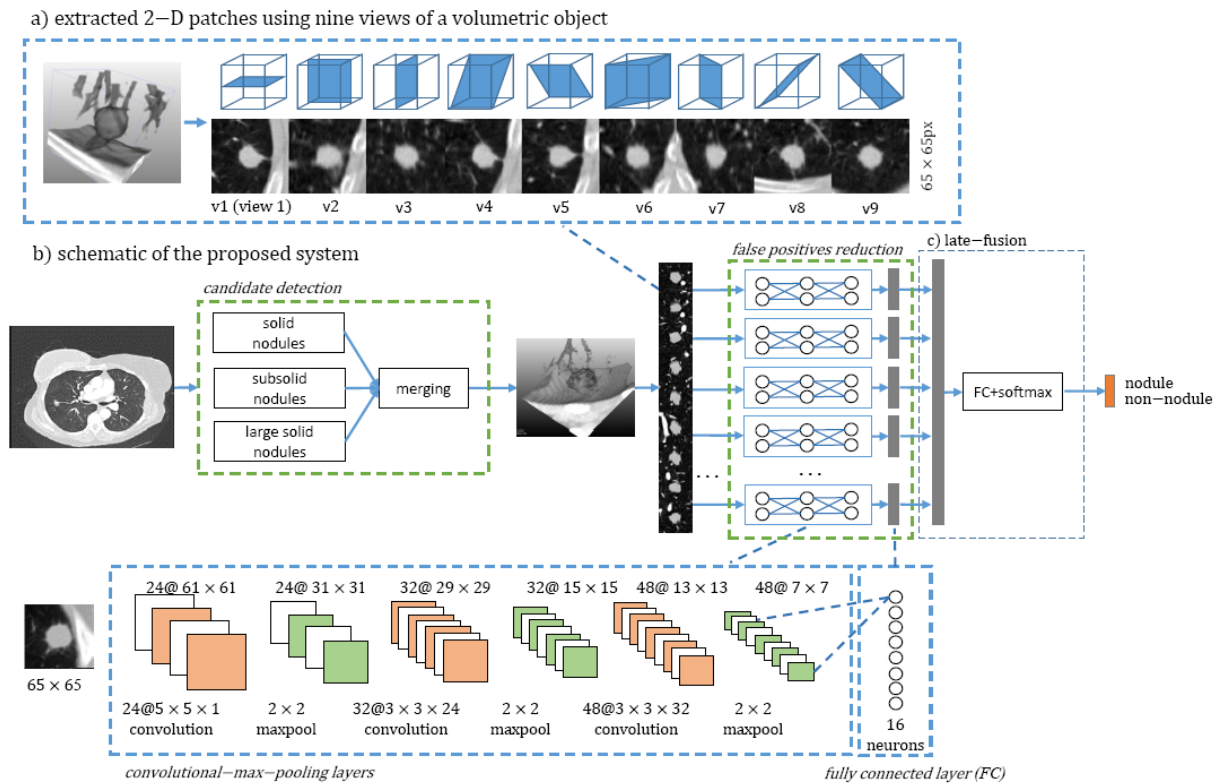
Deployed in the latest
Tesla Model S and Model X



(Yann Lecun's lecture note)

Age of deep learning (2)

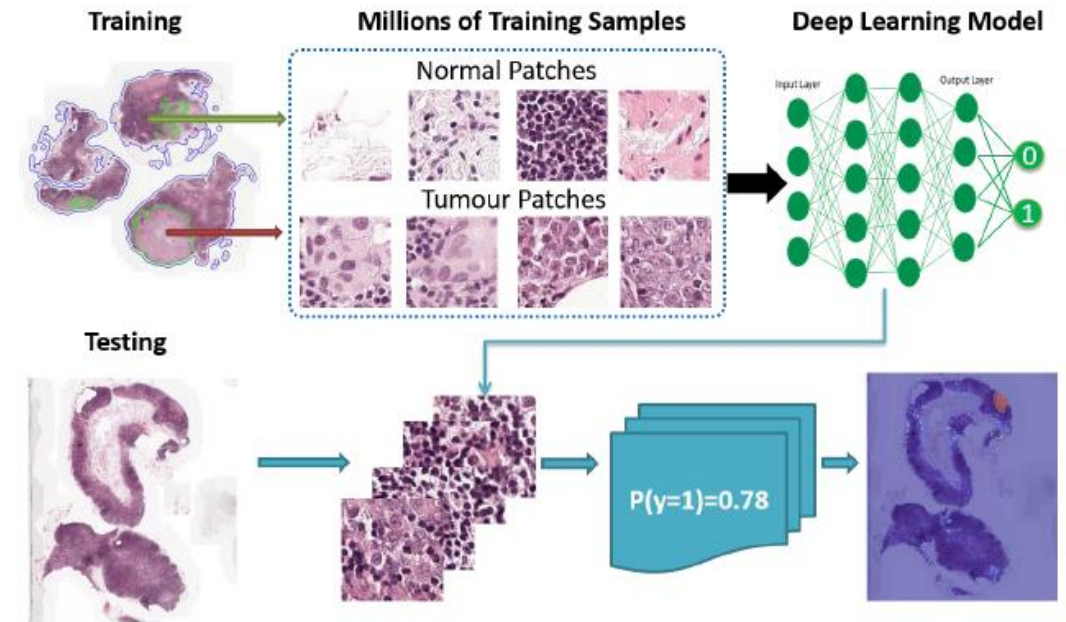
Lung nodule detection & classification challenge



(LUNA ISBI 2016 Challenge)

Lymph node metastasis detection challenge

SYSTEM FRAMEWORK



(CAMELYON ISBI 2016 Challenge)

Deep learning for image processing

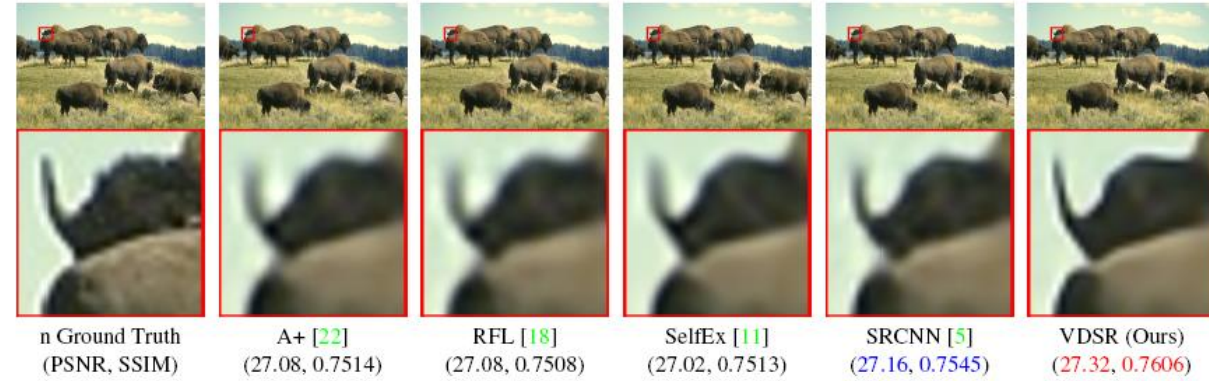
Denoising



Motion deblurring



Super-resolution



Colorization



Thank you!
Any comments?