IMAGE QUALITY IMPROVEMENT USING A DEEP LEARNING U-NET MODEL

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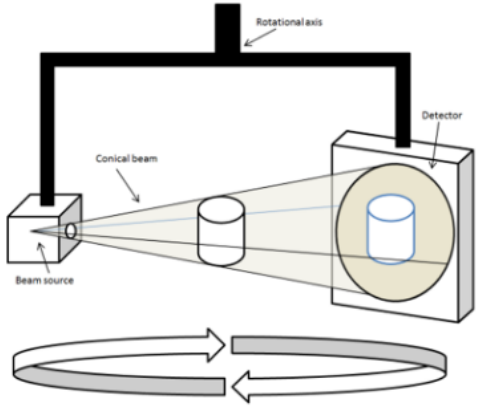
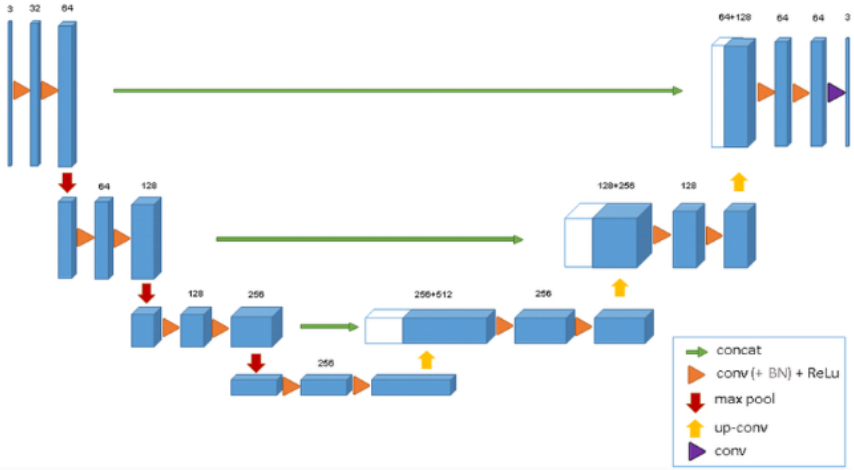


Cone Beam

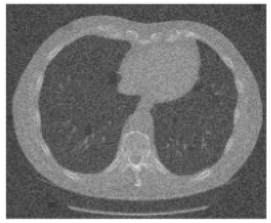
A cone beam CT scanner works the same as a regular CT but it uses a conical shaped beam. This way, larger portions of the head are covered with each images which results in less radiation being used to get a 3D image of the whole head. The downside is that, for some parts, the radiation does not receive the detector. This results in general noise over the complete image combined with bigger black spots occasionally arising in the output image.



Results

Original

This is a regular CT scan of a lung image. This will be the original image fed in the the model.



Added Noise

This is a self-made version of a cone beam CT scan. The real cone beam dataset could sadly not be retrieved due to the corona virus. But general noise and groups of black spots has been added in to the image to replicate a cone beam image as much as possible.

Reconstructed

Using the 'Added Noise' image as its training data input and the 'Original' image as its label, the U-NET model is able te recreate a reconstructed, higher quality CT scan. Very detailed parts (like the white matter in the middle of the lung) are a little blurry. But this was achieved after two days of training and the quality could still be improved a little more after some more training.

U-NET Model

As you can see, the U-NET model is shaped like a 'U'. The main operations that are tipically used are conv_3d, maxpool_3d, concat and transpose_conv layers. Each of them has their own role important for a higher quality output image.

- Conv_3d (orange arrow): This operations is called the convolutional layer which creates multiple high resolution feature maps from the input image.
- Maxpool_3d (red arrow): This operation is needed to reduce dimensionality to overcome Out Of Memory issues with the GPU. It reduces the dimensionality of the image in order to create less feature maps with the following convolution.
- Concat (green arrow): High resolution feature maps concatenate with upsampled layers from the same level. This increases pattern learning with the following convolutions.
- Upsampled_conv_3d (yellow arrow): This operation increases dimensionality again. Here it recreates the image as good as possible. The output dimensionality should be exactly the same as the input dimensionality.