Abstract: Fan-to-Parallel Beam Conversion

Deriving Neural Network Architectures Using Precision Learning

Christopher Syben[1,2], Bernhard Stimpel[1,2], Jonathan Lommen[1,2], Tobias Würfl[1], Arnd Dörfler[2], Andreas Maier[1]

[1]Pattern Recognition Lab, Department of Computer Science, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
[2]Department of Neuroradiology, Universitätsklinikum Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
christopher.syben@fau.de

In this paper, we derive a neural network architecture based on an analytical formulation of the parallel-to-fan beam conversion problem following the concept of precision learning [1]. Up to now, this precision learning approach was only used to augment networks with prior knowledge and or to add more flexibility into existing algorithms. We want to extent this approach: we demonstrate that we can drive a mathematical model to tackle a problem under consideration and use deep learning to formulate different hypothesis on efficient solution schemes that are then found as the point of optimality of a deep learning training process. The network allows to learn the unknown operators in this conversion in a data-driven manner avoiding interpolation and potential loss of resolution. The concept is evaluated in the context of Hybrid MRI/X-ray imaging where transformation of the parallel-beam MRI projections to fan-beam X-ray projections is required. The proposed method is compared to a traditional rebinning method. The results demonstrate that the proposed method is superior to ray-by-ray interpolation and is able to deliver sharper images using the same amount of parallel-beam input projections which is crucial for interventional applications. Based on the reconstruction problem and the problem description, we derived a network topology which allows to learn the unknown operators. We believe that this approach forms a basis for further work uniting deep learning, signal processing, physics, and traditional pattern recognition.

References

1. Syben C, Stimpel B, Lommen J, et al. Deriving neural network architectures using precision learning: parallel-to-fan beam conversion. Proc GCPR. 2018; p. 1–15.