Master Thesis: Simulation Based Approach for Algorithm Design, Evaluation and Data Mining for X-ray Imaging

X-ray imaging is an invaluable method to reveal internal structures of opaque objects because X-ray radiation is able to penetrate them. State-of-the-art X-ray imaging methods often require sophisticated processing of the acquired data (e.g. advanced pre-processing, 3D reconstruction, segmentation, etc.). To achieve accurate analysis results, the imaging conditions should be tuned for a particular data processing workflow. However, it is often not straightforward to assess how a change in imaging quality will affect the analysis result. Moreover, often there is a variety of algorithms available for solving a specific task (filtered back projection or iterative methods for 3D reconstruction), each of them performing differently on the same input data. For these reasons, it is beneficial to create virtual X-ray imaging data sets (for which ground truth information is available) representing typical imaging problems and systematically investigate and disentangle the dependencies between datasets with different image quality, algorithms and their parameters.

In this work you will employ simulation framework syris [1] developed at KIT in order to:

- Investigate and propose metrics, workflows and general guidelines to perform systematic evaluation of data processing algorithms
- Benchmark selected algorithms (3D reconstruction, segmentation) using the developed evaluation workflows
- Investigate and develop two approaches which use forward simulation to improve the accuracy of algorithms:
    - The usage of simulated datasets for training of algorithms in terms of parameter optimization by some suitable metric
    - Incorporation of the simulated data into iterative algorithms which use forward-backward modeling to converge to a result

Required skills

- Basics of Python programming
- Knowledge of Image processing, Computer vision or Computer graphics

[1] Farago, Tomas, et al. "syris: a flexible and efficient framework for X-ray imaging experiments simulation." *Journal of synchrotron radiation* 24.6 (2017).

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