Approximate Computing in CT image reconstruction

Bachelor/Master Thesis/Research Project

Research field

Nowadays, *Computer tomography* (CT) are self-contained devices that only function as stand-alone systems. Promising approaches in research show that the integration of preliminary information into the imaging parameters and reconstruction data of CT can lead to a reduction in the dosage in imaging. By using an open-interface CT is possible to add modules and explore new reconstruction optimizations, directly implemented internally the device. In literature, there are a plethora of CT reconstruction algorithms, such as iterative algorithms, Filtered-back projections and AI-based reconstruction algorithms. These algorithms have different usage based on two requirements, image quality and timing performance in the reconstruction process, with the aim to have low-dose X-ray and real-time reconstructed images. To enhance the reconstruction performance *approximate computing* techniques are exploited in literatures [1]. For example, different data formats and data representations can be explored (e.g, half-precision and fixed-point formats). These formats allow an enhancement of the CT reconstruction algorithm; by using 16 bit data size instead of 32 bits, the data bandwidth, the memory usage and computation resources are reduced, with the penalty of the accuracy [2].

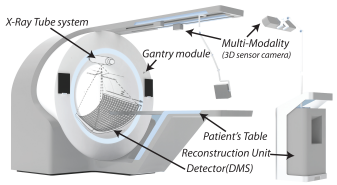

Figure 1: Computed Tomography

Research topic and working hypothesis

The goal is to explore new approximate computing solutions for real-time CT reconstruction algorithms. Provided an existing reconstruction algorithm for GPU, the student should optimize this algorithm, exploiting approximate computing techniques on a chosen architecture (GPU with Tensor Core, TPUs, FPGAs). The research steps comprehend approximate computing solution for reconstruction algorithms and the memory partitioning on the chosen architecture. For example, the student can focus on a step of the reconstruction algorithm or an image filter.

Work plan

- Study of the problem: reconstruction algorithms for CT and approximate computing techniques.
- Based on the profiling results of the CT reconstruction algorithm, an enhancement should be proposed.
- Implementation of the proposed enhancement.
- Evaluation of their work compared with the original algorithm and the state of the art in terms of performance
- Success!

Required skills

- Knowledge in Computer architecture
- Based on the chosen architecture (GPU, TPU, FPGA), knowledge of the related programming model and language, e.g., HLS, C/C++, Matlab scripting, OpenCL, Tensor Flow.

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References

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[2] Maaß C, Baer M, Kachelrieß M. CT image reconstruction with half precision floating-point values. Med Phys. 2011 Jul;38 Suppl 1:S95. doi: 10.1118/1.3528218. PMID: 21978122.