Suppression of blooming artifact in coronary computed tomography angiography via DIRA

Myocardial infarction is the most common cause of death in high-income countries. One of the causes is plaque building up along the inner walls of the arteries of the heart, which narrows the arteries and reduces blood flow to the heart. Coronary computed tomography angiography is used to visualize these arteries and help doctors to diagnose the disease. Accurate determination of the severity of the disease is, however, difficult when the plaque contains high concentration of calcium. Conventional single-energy computed tomography (SECT) may overestimate the amount of calcification by a factor of 2-3 owing to an image artifact called blooming, see the figure (taken from Sun Z. Cardiac CT imaging in coronary artery disease: Current status and future directions. Quant Imaging Med Surg 2012;2(2):98-105). A special version of dual-energy computed tomography (DECT) known as dual-energy CT angiography (DECTA) improves the accuracy. The results, however, are not perfect. Our research group develops a model-based iterative reconstruction (MBIR) algorithm called DIRA. Of interest is whether the algorithm can further improve the accuracy of calcified plaque determination.

The task:
1. Design a mathematical phantom simulating heart arteries.
2. Calculate DECT projections using simulation software from Siemens. Reconstruct these projections via the DIRA algorithm. Modify the algorithm so that it suppresses the blooming artifact, and analyze the results.

Requirements:
The student should be familiar with general principles of computed tomography and interactions of x-rays (10 – 150 keV) with matter. Knowledge of Matlab is needed. The project is suitable for medical physics, biomedical engineering or electrical engineering students.

The work will consist of computer simulations, software development, and evaluation of data. The student will learn about DECT. Active approach to problem solving will be encouraged; results will be discussed in a research group. Student’s location: the Division of Radiological Sciences, Linköping University.

For more information contact
- Gudrun Alm Carlsson, Prof em, (Gudrun.Alm.Carlsson@liu.se) or
- Michael Sandborg, Prof, (Michael.Sandborg@liu.se) or
- Maria Magnusson, PhD, (Maria.Magnusson@liu.se) or
- Alexandr Malusek, PhD, (Alexandr.Malusek@liu.se) or
- Chunliang Wang, PhD, (chunliang.wang@liu.se)

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