Annual Report Form

Project Name

Tissue Classification using Dual Energy CT and Iterative Reconstruction

Project Leader

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Main Project Participants

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Grants

Cancerfonden 2013-2015

Key publications

[1] Magnusson, M., Malusek, A., Muhammad, A. and Alm Carlsson, G. Iterative Reconstruction for Quantitative Tissue Decomposition in Dual-Energy CT. In: Proceedings of the 17th Scandinavian Conference, SCIA 2011, Ystad, Sweden, May 2011, (pp. 479-488). Springer Berlin/Heidelberg.

[2] Malusek, A., Karlsson,M., Magnusson, M., and Alm Carlsson, G. The Potential of Dual-energy Computed Tomography for Quantitative Decomposition of Soft Tissues to Water, Protein and Lipid in Brachytherapy. Physics in Medicine and Biology 58, no. 4 (February 21, 2013): 771.

[3] Malusek, A., Magnusson, M., Sandborg, M., Westin, R. and Alm Carlsson, G. Prostate tissue decomposition via DECT using the model based iterative image reconstruction algorithm DIRA. In: Proceedings of the SPIE conference Physics of Medical Imaging, San Diego, California, USA, February 16-20, 2014

Popular Scientific Summary

Today's computed tomography (CT) images are affected by artifacts caused by the X-ray spectrum. These artifacts are called beam-hardening artifacts. Due to the artifacts the CT-images are not completely quantitatively accurate. We have developed a mathematical method, an algorithm, which eliminates the artifacts. With our dual energy iterative reconstruction algorithm (DIRA) the pixels of the image are first classified into bone and soft tissue. Bone pixels carry information about percentages of compact bone, red and yellow bone marrow. Soft tissue pixels carry information about percentages of water, protein and lipid. It is also possible to reclassify specific tissue, e.g. the liver can be classified into liver tissue, lipid and iron. Consequently, DIRA provides quantitative information that can be used for improved medical diagnosis and treatment. As an example, DIRA can be used for determination of lipid content in the liver or the composition of plaques in aorta. The method can also be used in radiation treatment planning of brachytherapy for prostate cancer.

To verify the method we applied DIRA to simulated projection data of a mathematical phantom of the human pelvic region by using "DRASIM", a CT-simulation tool provided by Siemens. The X-ray spectra were 80 and 140kV, photon noise was included, and the geometry was basically the same as for the real CT-Scanner at CMIV.

Figure 1 shows conventionally filtered back-projection 80kV reconstructed images of the human pelvic region after 0 iterations in DIRA (left) and after 8 iterations in DIRA (right). It is apparent that the beam-hardening artifacts corrupt the image causing streaks and shift of values after 0 iterations (left). These artifacts are to a large extent reduced after 8 iterations (right). The image for 140kV was improved in a similar way.

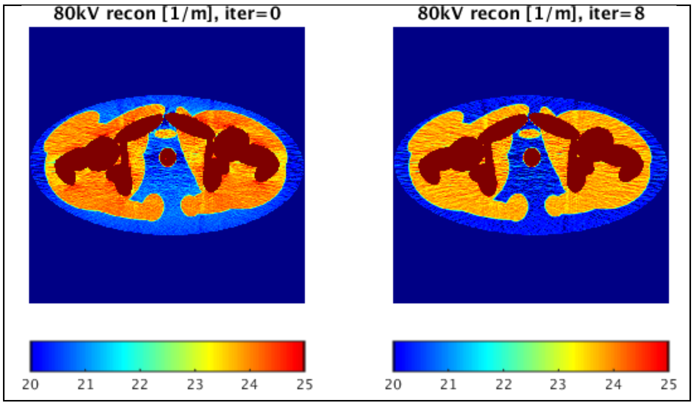

Figure 1. Suppression beam hardening artifacts in the human pelvic region from iteration 0 to iteration 8 in DIRA.

One key point in DIRA is to classify the soft tissue of the reconstructed images for 80 and 140kV into the base material triplet lipid, protein and water (LPW). The classification based on the 8th iteration is consistent with the true values and provides quantitative information of the tissue, see figure 2. As mentioned above, such information can be used for improved medical diagnosis and treatment. Ongoing research includes more advanced segmentation, test of different noise levels and implementation on parallel CPU architecture.

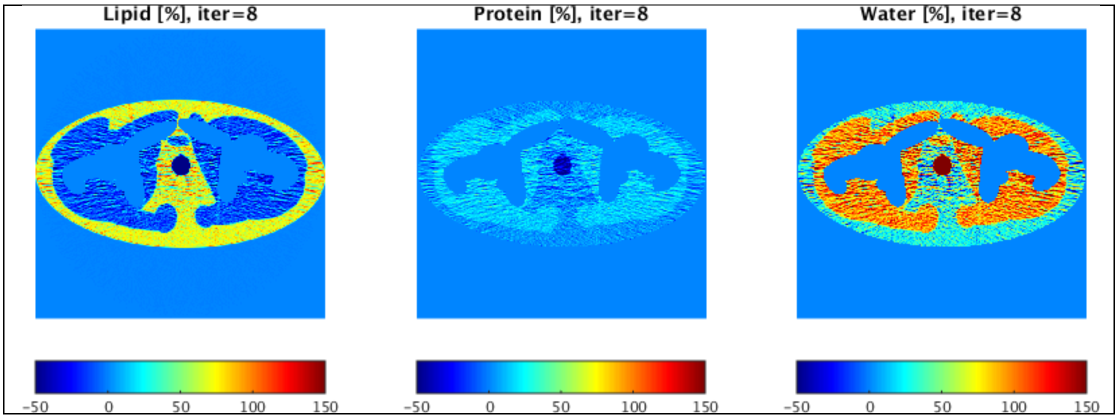

Figure 2. Soft tissue classification into lipid, protein and water (LPW) after 8 iterations of DIRA.