STATISTICAL 4D RECONSTRUCTION OF DYNAMIC CT IMAGES: PRELIMINARY RESULTS

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Introduction: Dynamic contrast enhanced CT, like other imaging modalities such as ultrasound and MRI, can be used to measure perfusion, thus enabling a quantitative assessment of vascular integrity [1]. Conventional dynamic CT involves the reconstruction of a dynamic sequence of 3D images from complete projections acquired at relatively short time intervals. This approach is suitable for spiral scanners but it is unfeasible for most of small-animal cone-beam scanners, as the distribution of the contrast agent changes during the acquisition and leads to inconsistent projections. We present a new algorithm to achieve 4D reconstructions of dynamic CT in case of slow cone-beam scanners.

Methods: The algorithm is based on modelling the object inside the field of view with a spatio-temporal grid. The system matrix was built in two steps: in the first step a conventional 3D system matrix was generated; in the second step a 4D matrix was obtained as the product of the 3D matrix and three non-uniform temporal B-splines that varied quadratically in time. The algorithm iteratively minimizes the negative Poisson likelihood with the addition of a penalty term. It makes use of ordered subsets to reduce computational time. The algorithm was tested on a dynamic contrast-enhanced CT rodent study: an injection of 0.7ml of iodine contrast (Iopamiro 300, Bracco) at 37ºC was administered i.v. and the scan was started immediately after the injection. Data were acquired with the CT subsystem of an ARGUS/CT (SUINSA Medical Systems) [2], a cone-beam micro-CT scanner based on a flat panel detector. We obtained 90 views covering 360º in step-and-shoot mode (step: 0.360 sec, shoot: 0.125 sec). Projections at each angle were binned into frames of 512×512 pixels, with pixel size of 0.2×0.2mm2. In order to reduce the dimension of the system matrix, these projections were down sampled to 128x128 pixels and only a volume of 66x66x8 pixels was reconstructed, resulting in a voxel size of 0.8x0.8x0.8mm3.

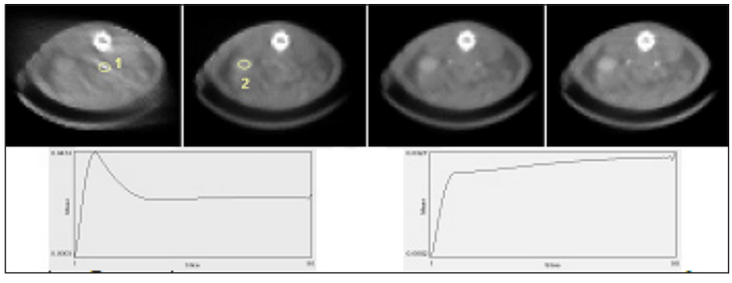

Figure 1. Top: Central slice of the 4D reconstruction of dynamic data at four different times. Bottom: Time activity curves for aorta (left) and kidney (right) corresponding to points 1, 2, respectively

Results: Preliminary results in Figure 1 show the time-activity curves for the contrast in the kidneys as well as the blood input function.

Conclusions: Preliminary results are presented of a 4D reconstruction algorithm for dynamic contrast enhanced CT, in a micro-CT based on cone beam geometry. The method is based on modelling the spatial and temporal distribution of the contrast inside the field of view. The use of non-uniform time sampling with B-splines yielded smooth time-activity curves that captured the relatively fast rise and fall of contrast in the aorta, as well as the uptake and retention of contrast in the kidneys.

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References:

1. Purdie TG et al.; Phys. Med. Biol. 45:1115–26 (2000)
2. Vaquero JJ et al.; IEEE Trans. Nucl. Sci. 55(3): 898-905 (2008)