TomAS – Tomographic Algorithms and Ultrasound Simulation ⋆

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TomAS is a new tool to simulate medical imaging techniques such as computer tomography (CT) and ultrasound (US) imaging. The main goal of **TomAS** is to support the development and evaluation of algorithms in medical imaging. **TomAS** can also be regarded as an educational tool illustrating the principles of imaging and diagnostics.

The CT package of **TomAS** generates raw data by simulating tomographic scans using interactively chosen scanner geometries (fan or parallel beam, numbers of detectors, rotation steps, etc.) and 2D or 3D phantom data sets. The package contains a phantom description language for generating phantoms built from a set of basis objects. Noise and scattering effects, which are the main interest, evolve naturally during the simulation.

In addition to elementary 2D and 3D visualization features and data manipulation operators, **TomAS** employs different reconstruction algorithms (like filtered backprojection, ART, Fourier method, convolution method), which can be compared interactively.

Special attention is given to the study of artifacts (caused by metal, lack of data, motion, different kinds of noise etc.) specific to the imaging and reconstruction techniques. For these reasons **TomAS** enables us to compare quality and deviations between exactly known phantoms and their reconstructed images. Therefore we have an environment for developing and evaluating different kinds of algorithms (e.g. for image enhancement).

Moreover **TomAS** contains tools for simulated ultrasound imaging, approximating wave propagation by finite difference methods, which allows data acquisition for A and B mode scans. Single transducers and phased arrays are supported, which allow the generation of complex wave fronts. Again in all the situations described additional noise can be taken into consideration. Ultrasound specific physical effects such as interferences, scattering, phase jumping etc. can be demonstrated as artifacts in B mode scans.

In addition **TomAS** serves as an educational and test tool in computer science and medical education. The principles of different medical imaging methods can so be learned efficiently. New algorithms can easily be added and evaluated on the screen. Properties of implemented signal transformations (like Wavelet, Fourier transforms etc.) can be visually demonstrated leading to a better intuitive understanding of the respective properties.

TomAS allows the description of the principles of medical imaging on a technical level appropriate to medical education. Especially effects of choosing different parameters (like scanner geometries, ray energy, phased arrays) as well as artifacts based on phantom properties can easily be visualized and will make the technical part of medical imaging more transparent for students of medical science.

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