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Structural Insight v3: A stand-alone program for micro structural analysis of computed tomography volumes

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Abstract. Structural Insight is a software for the analysis of 3D quantitative computed tomography volumes with a special weight for the analysis of the trabecular microstructure of human vertebrae. The software provides functionality to visually inspect, calibrate, segment, register and analyze the 3D volumetric data with standard structural parameters. The current version 3 includes the entire functionality of the two former versions (v1 and v2) from 2004 and 2010 respectively. The mayor changes between version 2 and 3 are the modular interior program structure, new and innovative functions of visualization and analysis, less hardware restrictions and an adapted user-friendly appearance. The software is written in c++, combined with QT and the insight visualization toolkit ITK and contains more than 10k lines of code (without code of the graphical user interface). Supported import and export formats are DICOM, GIPL, VTK and two proprietary formats BST (from version 1) and XML (from version 2), screenshots are stored as BMP or PNG. Various definitions of e.g. the calibration phantoms, particular presets, preferences for the registration, and visualization (colormaps etc.) are loaded at runtime, thus can be adapted by the user without the need of re-compiling the code. The software supports batch analysis and provides supervised makros for monotonic tasks or to learn the program. Two segmentation modes are implemented: a non-rigid registration with a snake model segments an entire vertebra into cortex and spongiosa and the geometric segmentation segments manually placed ellipsoids, boxes or pacman-shaped volumes of interest. The 3D visualization methods include slice-, mean-, maximum-,depth-field- projection and ray casting. Various image processing functions are implemented: crop, resample, rotate, blur, morphological filtering and inversion. Registration can be performed via rotation and translation of either the image data or the data of the segmentation using one of four interpolators (nearest neighbor, linear, b-spline and windowed sinc). The user can adapt settings for either high precision or low run-time. Implemented analysis functions contain most standard methods using the voxel-counting, marching cubes-, distance transform-, direct secant- and run-length method, besides experimental functions for the computation of gray scale texture information. The analysis can be restricted to certain volumes-of-interest and computation of all scans of a entire study can executed at once. Results are visualized on a table and can be exported in csv-, txt- or xml-format. Time-consuming features (e.g. pyramid-based rendering) are realized by threads, thus allowing smooth user feeling. The program was used in various presentations and journal publications.

Keywords. Radiology Software, Quantitative Computed Tomography, Microstructural parameters