Evaluating the microstructure of human brain tissues using synchrotron radiation-based micro computed tomography

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 1196050
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Year 2010
Title Evaluating the microstructure of human brain tissues using synchrotron radiation-based micro computed tomography
Journal Proceedings of SPIE
Volume 7804
Pages / **Article-Number** 7804F1-8
Keywords X-ray phase contrast, X-ray grating interferometry, X-ray Talbot interferometry, human brain tissue, human thalamus, histology, stereotactic brain atlas
Minimally invasive deep brain neurosurgical interventions require a profound knowledge of the morphology of the human brain. Generic brain atlases are based on histology including multiple preparation steps during the sectioning and staining. In order to correct the distortions induced in the anisotropic, inhomogeneous soft matter and therefore improve the accuracy of brain atlases, a non-destructive 3D imaging technique with the required spatial and density resolution is of great significance. Micro computed tomography provides true micrometer resolution. The application to post mortem human brain, however, is questionable because the differences of the components concerning X-ray absorption are weak. Therefore, magnetic resonance tomography has become the method of choice for three-dimensional imaging of human brain. Because the spatial resolution of this method is limited, an alternative has to be found for the three-dimensional imaging of cellular microstructures within the brain. Therefore, the present study relies on the synchrotron radiation-based micro computed tomography in the recently developed grating-based phase contrast mode. Using data acquired at the beamline ID 19 (ESRF, Grenoble, France) we demonstrate that grating-based tomography yields premium images of human thalamus, which can be used for the correction of histological distortions by 3D non-rigid registration.
Publisher SPIE
ISSN/ISBN 0277-786X
edoc-URL http://edoc.unibas.ch/dok/A6006228
Full Text on edoc No;
Digital Object Identifier DOI 10.1117/12.859273
ISI-Number WOS:000287816200013
Document type (ISI) Proceedings Paper