

Towards a unified USCT data and code interface



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Abstract

The academic USCT research community is hampered in collaboration and progress by missing defaults in data formats, meta data specifications and comparable code bases.

We present some initial contributions and starting points to address these shortcomings.

Ideas and general favorable properties

Freely available, by an established open source licenses



- Concurrent collaboration with versioning: GIT
- Creation of "single point of source" code repository at GitHub
- MATLAB as common denominator for scientific code

Initial Contribution

- Github repository <u>https://github.com/KIT-3DUSCT</u>
 - Central point of source, code versioning, concurrent development, branching and forking, Issue and bug tracker

KIT 3D USCT data import and imaging script

Repository:

https://github.com/KIT-3DUSCT/3DUSCT-data-access-script

- Import and usage of KIT 3D data & metadata
- Advanced signal processing chain
- Iterative reflectivity imaging with synthetic aperture focusing technique (SAFT)

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Parallelized CPU SAFT implementation "SAFT CPU"

- Repository: <u>https://github.com/KIT-3DUSCT/SAFT-CPU</u>
- CPU parallelized, up to 1GV/s, ~40 x faster than MATLAB code
- Hardware agnostic C implementation
- Highly optimized x86 assembly
- Auto-partitioning and run-time optimization
- Portable, works for Windows and Linux calling conventions
- Wrapped as MATLAB MEX
- Under open source LGPL

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Further community synchronization



Data challenge webpage

http://ipeusctdb1.ipe.kit.edu/~usct/challenge

Wikipedia page

https://en.wikipedia.org/wiki/Ultrasound_computer_tomography Page information Wikidata item Cite this page

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с II	
	Ultrasound computer tomographs use ultrasound waves for creating images. In the first measurement step a defined ultrasound wave is generated w
	typically Piezoelectric ultrasound transducers, transmitted in direction of the measurement object and received with other or the same ultrasound
	transducers. While traversing and interacting with the object the ultrasound wave is changed by the object and carries now information about the
	object. After being recorded the information from the modulated waves can be extracted and used to create an image of the object in a second step
	Unlike X-ray or other physical properties which provide typically only one information, ultrasound provides multiple information of the object for imagin
	the attenuation the wave's sound pressure experiences indicate on the object's attenuation coefficient, the time-of-flight of the wave gives speed of
	sound information, and the scattered wave indicates on the echogenicity of the object (e.g. refraction index, surface morphology, etc.). Unlike
	conventional ultrasound sonography, which uses phased array technology for beamforming, most USCT systems utilize unfocused spherical waves
	imaging. Most USCT systems aiming for 3D-imaging, either by synthesizing ("stacking") 2D images or by full 3D aperture setups. Another aim is
	quantitative imaging instead of only qualitative imaging.
	The idea of Ultrasound computer tomography goes back to the 1950s with analogue compounding setups, [5][6][7] in the mid 1970s the first "compute
	USCT systems were built up, utilizing digital technology.[8] The "computer" in the USCT concept indicates the heavy reliance on computational
	intensive advanced digital signal processing, image reconstruction and image processing algorithms for imaging. Successfully realization of USCT
	systems in the last decades was possible through the continuously growing availability of computing power and data bandwidth provided by the digit
	revolution.

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USCT systems designed for medical imaging of soft tissue typically aim for resolution in order of centimeters to millimeters and require therefore ultrasound waves in the order of mega-hertz frequency. This requires typically water as low-attenuating transmission medium between ultrasound transducers and object to retain suitable sound pressures.

Measurement procedure of a 3D USCT: semi-spherical water filled measurement container lined with ultrasound transduce arrays in cylindrical housings (transducer elements as green dots). Centrally placed simple object (red). Spherical wave emitted (semi-transparent blue), all other transducers gather data. Wave-front interacts with object and re-emits a secondary wave (semi-transparent purple Repeated iteratively for all transducers.

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Ð USCT systems share with the common Tomography the fundamental architectural similarity that the aperture, the active imaging elements, surround Add links

the object. For the distribution of ultrasound transducers around the measurement object, forming the aperture, multiple design approaches exist. There exist mono-, bi- and multistatic setups of

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