X-ray microtomography for 3D imaging of cultural heritage artefacts

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Basic principles and the use of X-ray microtomography for 3D imaging of cultural heritage artefacts will be described. X-ray microtomography (μCT) combines the principles of X-ray shadow microscopy together with the computed tomography CT. The current technical possibilities allow achieving submicron resolution by the use of μCT facilities. Primary use of this method can be found particularly in materials research, precision engineering and electronics industry. In all these areas there is a need for non-destructive, high resolution visualization of internal microstructures, measurement of interior dimensions of 3D objects and testing for the presence of internal defects. In the cultural heritage field the X-ray microtomography method can be used for non-destructive visualisation of internal structure of archeological and historical artefacts and for precise 3D imaging of artefacts.

Keywords: X-ray, CT, microtomography, cultural heritage, 3D imaging, non-destructive testing

X-ray radiation is electromagnetic radiation in the wavelength range from 10 nm to 0.01 nm. Waves from the region 10 nm to 0.1 nm are usually classified as soft X-rays and waves from 0.1 nm to 0.01 nm are then classified as hard X-rays. Outstanding feature of X-ray is - similarly to other high-energy waves like the gamma radiation and cosmic rays - the high penetration power through a matter. This property of X-ray radiation can be effectively used for non-destructive visualisation of internal structures of objects, detection of defects, cracks, inclusions in materials and other applications.

X-ray microtomography measurement is composed of two phases – acquisition of projections and volume reconstruction. During the first phase – acquisition of projections the object under test is step by step turned around the rotational axis at a small defined angle. After each elementary rotation, so called X-ray projection is recorded. When all necessary projections are obtained, the second phase starts: volume image reconstruction. It is a set of mathematical operations that are in general called inverse Radon transform, when from the group of measured projections the cross-sections and 3D image of X-ray absorption in object are reconstructed.

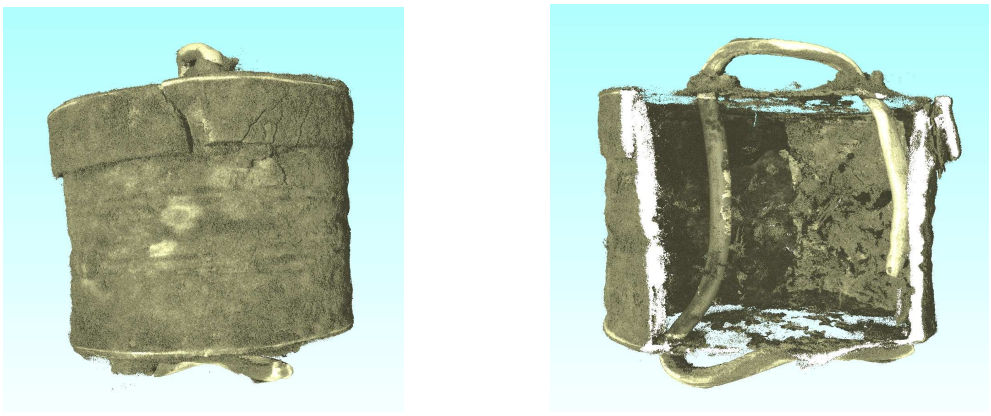

Fig. 1 3D visualisation of an archeological artefact by X-ray microtomography – view of outside and inside

Presented results were achieved using X-ray microtomograph GE Phoenix|X-ray Nanotom 180 with tungsten target. For rendering, filtering and visualisation of 3D data the software VG StudioMAX 2.1 was exploited.