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Effects of sinogram interpolation for increasing throughput rate of surface topography measurements using X-ray computed tomography

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Abstract

X-ray computed tomography (XCT) is a non-destructive imaging technique, in which a large set of radiographs is used to solve an inverse problem. This inverse problem is the reconstruction of the attenuation behaviour within the scanned volume. Modern XCT systems can easily require the acquisition of 3000+ radiographs to reconstruct the volume. While other approaches to reduce this number include iterative reconstruction algorithms, the work presented here utilises an approach discussed in the early medical literature: the interpolation of the sinogram data. In this work, an additively manufactured part is used as a test specimen to explore the effects of different degrees of sinogram interpolation. Datasets are collected with the full number of radiographs needed (3142 projections for this XCT system and setup) as well as with a reduced number of radiographs: 20%, 40%, 60% and 80% of the 3142 projections. The collected sinograms are then interpolated to create upsampled data sets and are reconstructed. The reconstructed volumes are analysed in terms of noise and resolution. To evaluate noise, the Shannon entropy is used as a comparison value. To evaluate resolution, an oversampled edge spread function approach is used. Surface topography data obtained from the reconstructed volumes are compared numerically and by computing areal surface texture parameters. The results reveal that the experimental condition with the least noise is, as expected, the one with the full set of radiographs. However up-sampling the sinogram data reduces the noise for all the under-sampled test conditions. The resolution is worst when using only 628 radiographs (20%). The oversampled edge spread function approach is not repeatable enough to quantify the differences between the remaining test conditions. The topography comparison showed evidence that using only 1257 (40%) radiographs but interpolating the 1257 radiographs to 3142 projections creates similar results to those obtained using 2514 (80%), or even 3142 radiographs for the presented test case.