World Academy of Science, Engineering and Technology
International Journal of Mechanical and Materials Engineering
Vol:12, No:07, 2018

Speckle-Based Phase Contrast Micro-Computed Tomography with Neural Network Reconstruction

Authors : Y. Zheng, M. Busi, A. F. Pedersen, M. A. Beltran, C. Gundlach

Abstract : X-ray phase contrast imaging has shown to yield a better contrast compared to conventional attenuation X-ray imaging, especially for soft tissues in the medical imaging energy range. This can potentially lead to better diagnosis for patients. However, phase contrast imaging has mainly been performed using highly brilliant Synchrotron radiation, as it requires high coherence X-rays. Many research teams have demonstrated that it is also feasible using a laboratory source, bringing it one step closer to clinical use. Nevertheless, the requirement of fine gratings and high precision stepping motors when using a laboratory source prevents it from being widely used. Recently, a random phase object has been proposed as an analyzer. This method requires a much less robust experimental setup. However, previous studies were done using a particular X-ray source (liquid-metal jet micro-focus source) or high precision motors for stepping. We have been working on a much simpler setup with just small modification of a commercial bench-top micro-CT (computed tomography) scanner, by introducing a piece of sandpaper as the phase analyzer in front of the X-ray source. However, it needs a suitable algorithm for speckle tracking and 3D reconstructions. The precision and sensitivity of speckle tracking algorithm determine the resolution of the system, while the 3D reconstruction algorithm will affect the minimum number of projections required, thus limiting the temporal resolution. As phase contrast imaging methods usually require much longer exposure time than traditional absorption based X-ray imaging technologies, a dynamic phase contrast micro-CT with a high temporal resolution is particularly challenging. Different reconstruction methods, including neural network based techniques, will be evaluated in this project to increase the temporal resolution of the phase contrast micro-CT. A Monte Carlo ray tracing simulation (McXtrace) was used to generate a large dataset to train the neural network, in order to address the issue that neural networks require large amount of training data to get high-quality reconstructions.

Keywords : micro-ct, neural networks, reconstruction, speckle-based x-ray phase contrast
Conference Title : ICXRNO 2018 : International Conference on X-Ray and Neutron Optics
Conference Location : Stockholm, Sweden
Conference Dates : July 12-13, 2018