

A phase field approach to tomographic reconstruction of incomplete sinogram

Abstract

During tomographic acquisition some angular sector may not be (or be only partly) exploitable because of the environment of the sample casting a shadow on the radiographs. It is important to be able to correctly reconstruct volumes despite this missing data. A classical approach consists in performing Iterative Reconstruction Re-projection (IRR). A rough reconstruction (obtained with FBP for instance) is first computed and re-projected to provide an approximation of the missing data in the sinogram. Together with the reliable sinogram data, wherever available, a better determination of the reconstruction is computed, providing a more trustworthy estimate of the missing data. This process is repeated up to stationarity. The quality of the obtained volume, although not as good as from complete data, is generally fair; FBP can be used, thus the computation cost is low, and controlled by the number of iterations. So as to significantly improve the quality of the reconstructed volume consists in applying a regularization filter at each iteration. In most applications, the scanned object is composed of a limited number of phases. If the volume were perfect, its histogram should consist of a few distinct peaks. Building upon this assumption, it is proposed to use a phase field model which will sharpen the histogram peaks. Such a regularization can be formulated as a free energy minimisation and is able to reduce noise and artefacts due to missing angles. To further improve the filter, a gradient norm can be added to the free energy favouring either smooth boundaries (L2 norm) or sharper ones (L norm or TV). This procedure has been tested and has proven its efficiency on SiC/SiC ceramic matrix composite, with large missing-angle intervals (more than 25%). The contrast within this material is rather low because the different constitutive phases have the same chemical composition. This algorithm is built so that any shape of missing-data domains of the sinogram (including "so-called" metal artefact) can be restored.