Industrial X-ray Tomography from Very Limited Projections and Views

V. Vengrinovich
Institute of Applied Physics, Belarus Academy of Sciences, 220072 – Minsk - Belarus

Abstract

Traditional process imaging of industrial and medical objects is usually related with difficulties in multi data collecting and large computational burden. On the other hand, limited data do not allow to acquire for quality image. We demonstrate here the new techniques of x-ray image reconstruction from limited number of sparse projections, what opens wide doors for expansion of x-ray tomography towards new important industrial applications. Among them the 3D visualization of massive objects in the conditions of x-ray source power inconsistency, in-situ corrosion detection of technology pipe lines, 3D imaging of massive castings within reverse engineering processes, etc.

We developed several computerized techniques which goal is to overcome strong data deficit in case of insufficient number of projections and views for observation. The potentialities of several, including those based on image warping, Filtered Back Projections (FBP), Maximum Likelihood (ML), elastic matching (EM) are demonstrated in the report through few examples of tomographic imaging, made with real physical and virtual phantoms. Their ability to restore different kinds of geometrical distortions of the objects are compared and discussed.

The impressive results of x-ray 3D imaging in near future are expected being transferred from the medical tomography facilities which have been developed very intensively during past years. We emphasize also on the EM like the virtual deformation technology which gives the opportunity to provide tomographic imaging of objects given limited input projection data in case when a source object image is available. The goal can be formulated as follows: to restore the target image given limited x-ray data, made within a limited observation angle, under the constraint of preserving some characteristic morphology parameters of a source or reference image.

This technique recently obtained the recognition in medical imaging procedures. The article gives start to the application of this technique for industrial x-ray tomography demonstrating its main peculiarities using elastic matching deformation of simulated input data. The application examples are: (i) limited excess to the object observation by x-ray acquisition system; (ii) strong need in reduction of a number of projections due to acquisition time or radiation dose restrictions; (iii) reduction of informative projections
number due to beam hardening effect. We consider here the new technique of elastic matching as a counterbalance to the strong data deficit arose in the situations mentioned above.

Thus investigated algorithms in many practical cases, characterized by limited input x-ray data, give the way to the development of a new techniques for fast high quality tomographic visualization of industrial parts and products.