A novel algorithm for blind deconvolution applied to the improvement of radiographic images

G. L. de Almeida[1], M. I. Silvani[1]
e-mail: gevaldo@ien.gov.br

[1] *Division of Nuclear Engineering - IEN*

Keywords: blind deconvolution, image improvement, neutron & gamma-ray radiography

Image Acquisition Systems of any kind, disregarding the principle they work, are affected by spoiling agents which degrade the final image. The impact of these agents, belonging to the main branches of random and systematic errors, can be reduced by proper techniques. Random uncertainties, as those arising from electronic noise and statistical fluctuation, are usually treated by cutting the high frequency components off, through an adequate methodology such as smoothing or Fourier transform for instance. Systematic errors, theoretically could be utterly eliminated if the properties of the spoiling agent were known, by applying an unfolding procedure. For 2D images, this agent arises as the *Point Spread Function – PSF*, a bell-shaped surface with the FWHM representing the resolution of the image acquisition system - henceforth named *w* in this work - which generated the final image. A full characterization of the PSF is however a cumbersome or even an unfeasible task, which led to the development alternative procedures such as *Blind Deconvolution* which makes use of some image information or constraints [1, 2]. This approach concomitantly determines the *w*-value of a previously assumed bell-shaped function and the final unfolded image, but unfortunately it may return the same input image and a consequently narrow PSF.

A novel algorithm for blind deconvolution is proposed in this work, which does not require any previous information concerning the image to be unfolded but solely an assumed shape for the PSF. This algorithm, incorporating a Richardson-Lucy unfolding procedure [3, 4], assesses the *overall contrast* for each image unfolded with an increasing *w*, seeking for the highest value. The basic idea behind this concept is that when the spatial resolution [5] of the image is improved, the contrast is improved too, because the pixel overlapping diminishes. Trials with several different images acquired with neutron and gamma-ray transmission radiography have been carried out in order to evaluate the correctness of the proposed algorithm [6]. It has been found that for a steadily increasing *w*, the overall contrast increases, reaches a maximum and then decreases. The *w*-value yielding the highest contrast can be achieved after 1 to 3 iterations and further iterations do not affect it. Images deconvoluted with this value, but with a higher number of iterations, exhibit a better quality than their companions deconvoluted with neighbor values, corroborating thus the best *w*-value. Synthetic images with *known* resolutions return the same *w*-values used to degrade them, showing thus the soundness of the proposed algorithm.

References

[1] D. Kundur and D. Hatzinakos, *IEEE Signal Processing Magazine,* **13**, 43-64 (1996).
[2] M. Jiang and G. Wang, *Journal of X-Ray Science and Technology*, **11**, 13-19 (2003).
[3] W. H. Richardson, *Journal of the Optical Society of America,* **62**, 55-59 (1972).
[4] L. B. Lucy, *The Astronomical Journal* **19**, 745-754 (1974).
[5] M. I. Silvani, G. L. Almeida, R. C. Furieri and R. T. Lopes, "On the Performance of X-ray Imaging Plates in Gamma Radiography employing Reactor-produced Radioisotopes" in *XXXIII Brazilian Workshop on Nuclear Physics 2010*, edited by V. R. Vanin, AIP Conference Proceedings 1531, American Institute of Physics, Melville, NY, 2011, pp. 262-267.
[6] G. L. Almeida, M. I. Silvani, and R. T. Lopes, "Active filtering applied to radiographic images unfolded by the Richardson-Lucy algorithm", in *XXXIV edition of the Brazilian Workshop on Nuclear Physics 2011,* Proceedings of Science.