COMBINING IMAGE RECONSTRUCTION AND IMAGE ANALYSIS

Alfred K. Louis
Saarland University, Saarbrücken, Germany
louis@num.uni-sb.de

Abstract

The tasks of image reconstruction from measured data and the analysis of the so produced images are more or less strictly separated. One group computes – by applying reconstruction algorithms – the images, the other starts out of that by operating on these images to enhance the analysis.
The aim of this presentation is to provide a tool to combine these two steps; i.e., already in the reconstruction step the future image analysis step is taken into account leading to a new reconstruction kernels. Here we concentrate on linear methods.
In image analysis one applies operators on a given image. In a final step the searched – for information is then extracted from these enhanced images. Prominent examples are edge detection methods where in a first step partial derivatives of smoothed versions of the image are computed, followed then by recognition methods. A typical example is the well – known Canny edge detector. Here we restrict, as above mentioned, to linear operators. We have to mention that of course also non - linear methods play an essential role. But this does – at least at the moment – not fit in our framework.
As example we consider computerized tomography where the images are produced by applying reconstruction algorithms to the measured data. In that way one calculates images which are smoothed version of the original density distributions. The result can be presented as $f_\gamma = f * e_\gamma$ where f is the original object and e_γ is a mollifier depending on the reconstruction method. In the image analysis part, for example in the above mentioned edge detection methods, one computes then derivatives of smoothed versions of this image. Typically one calculates in a first step

$$L_{k,\beta} f_\gamma = \frac{\partial}{\partial x_k}\big(G_\beta * f_\gamma\big) = \frac{\partial}{\partial x_k}\big(G_\beta * e_\gamma * f\big)$$

where G_β represents a mollifier, for example a Gaussian kernel, and where the two parameters β and γ are chosen independently. The aim of this presentation is to provide a method which allows for directly computing in one step the smoothed version of the derivative. To this end we generalize the concept of approximate. Here we precompute independently of the data g a reconstruction kernel ψ_γ by solving an auxiliary problem $A^*\psi_\gamma = L^*_{k,\beta} e_\gamma$. Then the solution is calculated as $g * \psi_\gamma$. A further advantage is that invariances of the operator combined with suitable mollifiers lead to very efficient reconstruction methods.
As practical example we consider the image reconstruction problem in computerized tomography followed by an edge detection. We calculate a new reconstruction kernel and present results from simulations.