World Journal of
Engineering

World Journal of Engineering 6(4) (2009) 75-82

Deconvolution of degraded images: comparative study between TSVD, tikhonov regularization and particle swarm optimization algorithm

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Abstract

Image deconvolution is an important matter in image processing. It is an ill-posed inverse problem, so regularization techniques are used to solve this problem by adding constraints to the objective function. Various popular algorithms have been developed to solve such problem. This paper proposes a new approach to the nonlinear degraded images restoration problem which is useful in many images enhancement applications, based on a swarm intelligence optimization algorithm, particle swarm optimization (PSO) applied on total variation (TV), instead of the standard Tikhonov regularization method which is most often used. In this work, we attempt to reconstruct or recover an image that has been degraded; using some a priori knowledge of the degradation phenomenon. Another promising method in image deconvolution which is the truncated singular value decomposition (TSVD) is also considered. A comparison of the three methods made on examples is included.

***Key words**: Deconvolution, Ill-posed, Regularization, PSO, TV, Tikhonov, TSVD*

1. Introduction

By image restoration, we seek to recover the original sharp image using a mathematical model of the blurring process. The key issue is that some information on the lost details is indeed present in the blurred image, but this information is "hidden" and can only be recovered if we know the details of the blurring process. Due to various unavoidable errors in the recorded image, we can recover the original image exactly. The most important errors are fluctuations in the recording process and approximation errors when representing the image with a limited number of digits (Hansen, 2006).

The ill-posedness of this problem arises from the fact that the kernel of the blurring function is badly conditioned and the degraded image contains noise. As a result, small perturbations in additive noise may lead to significant oscillations in the inversion result when using matrix inversion solution. Therefore, to stably recover the unknown, regularization is necessary. We can use regularization in frequency domain but this can result in unlimited amplification of noise. The main shortcoming of the frequency domain regularization methods is the

ISSN:1708-5284