DOCTORAL THESIS

Topics in image recovery and image quality assessment

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Date of Award:
2016

Abstract

Image recovery, especially image denoising and deblurring is widely studied during the last decades. Variational models can well preserve edges of images while restoring images from noise and blur. Some variational models are non-convex. For the moment, the methods for non-convex optimization are limited. This thesis finds new non-convex optimizing method called difference of convex algorithm (DCA) for solving different variational models for various kinds of noise removal problems. For imaging system, noise appeared in images can show different kinds of distribution due to the different imaging environment and imaging technique. Here we show how to apply DCA to Rician noise removal and Cauchy noise removal. The performance of our experiments demonstrates that our proposed non-convex algorithms outperform the existed ones by better PSNR and less computation time. The progress made by our new method can improve the precision of diagnostic technique by reducing Rician noise more efficiently and can improve the synthetic aperture radar imaging precision by reducing Cauchy noise within.

When applying variational models to image denoising and deblurring, a significant subject is to choose the regularization parameters. Few methods have been proposed for regularization parameter selection for the moment. The numerical algorithms of existed methods for parameter selection are either complicated or implicit. In order to find a more efficient and easier way to estimate regularization parameters, we create a new image quality sharpness metric called SQ-Index which is based on the theory of Global Phase Coherence. The new metric can be used for estimating parameters for a various of variational models, but also can estimate the noise intensity based on special models. In our experiments, we show the noise estimation performance with this new metric. Moreover, extensive experiments are made for dealing with image denoising and deblurring under different kinds of noise and blur. The numerical results show the robust performance of image restoration by applying our metric to parameter selection for different variational models.

Keywords: DCA, total variation, primal-dual, SQ-Index, regularization.

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