

EE 367 Project Proposal

Denoising Image Corrupted with Gaussian Noise using SURE-LET Approach

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1 Motivation

The process of image capturing always introduce noise to the image. For example, images captured by SLR camera will have noises from artifacts on the sensor, electronic noise sources, photon-to-electron conversion, etc. Often times, we do not have access to the ground truth, and there can be multiple solutions to an image denoising problem. Many existing algorithms assume priors, such as minimization of total variation (TV) norm [1] and non-local similarity [2] in order to denoise an image. However, by assuming certain statistics of the image, the denoising algorithms may not perform well on some images whose characteristics do not agree with the assumption. In this work, I will explore the SURE-LET image denoising algorithm, a denoising method which does not make assumptions about statistics of the ground truth image.

2 Related Work

The SURE-LET approach to image denoising is proposed in [3]. This approach uses Stein's unbiased risk estimator (SURE) to estimate the mean squared error and the linear expansion of thresholds (LET) principle, which states that a denoising process is a linear combination of elementary denoising processes, to improve the results. SURE, first proposed in [4], estimates the mean-squared error of the means of independent Gaussian random variables. Hence, the only hypothesis about the image that SURE-LET assumes is that the image is corrupted by the Gaussian noise.

3 Project Overview

In this work, I will implement the SURE-LET denoising algorithm in MATLAB. I will compare the results of denoising Gaussian-noise corrupted images with SURE-LET to other algorithms, including deconvolution with TV-norm regularized ADMM and a non-local denoising algorithm based on [5]. I also will apply SURE-LET to denoise images corrupted by Poisson noise and compare the performance to other methods, such as Richardson-Lucy algorithm.

4 Milestones

- February 12: Project proposal.
- February 19: Complete implementations of baseline denoising algorithms, including ADMM with TV prior, ADMM with non-local means, and Richardson-Lucy algorithm.
- March 2: Complete implementation of SURE-LET.
- March 6: Test performance of SURE-LET.
- March 11: Project poster presentation
- March 13: Project report due

References

- [1] Osher Stanley Rudin, Leonid I and Emad Fatemi. Nonlinear total variation based noise removal algorithms. *Physica D: Nonlinear Phenomena*, 60(1-4):259-268, 1992.
- [2] Foi Alessandro Dabov, Kostadin and Vladimir Katkovnik. Image denoising by sparse 3-d transform-domain collaborative filtering. *IEEE Transactions on Image Processing*, 60(8):2080-2095, 2007.
- [3] Thierry Blue and Florian Luisier. The sure-let approach to image denoising. *IEEE Transactions on Image Processing*, 16(11):2778-2786, 2007.
- [4] Charles M Stein. Estimation of the mean of a multivariate normal distribution. *The Annals of Statistics*, 9(6):1135-1151, 1981.
- [5] Coll Bartomeu Buades, Antoni and Jean-Michel Morel. A non-local algorithm for image denoising. In *2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05)*. IEEE, jun 2005.