Contrast Measure-based Automated Regularization Parameter Selection for Radar Image Restoration

Cher Hau Seng, Abdesselam Bouzerdoum and Son Lam Phung

School of Electrical, Computer and Telecommunications Engineering
University of Wollongong, Wollongong, NSW 2522, Australia
{aseng; bouzer; phung}@uow.edu.au

I. Abstract

Images formed by acquisition devices are usually corrupted by noise and other interferences. Hence, regularization methods have been introduced to restore the degraded images and obtain solutions that are stable in the presence of perturbations. While the regularization parameter is crucial to the characteristics of the restoration, most existing selection methods either require memory-intensive computation or prior knowledge of the noise [1]. Moreover, the use of a small regularization parameter will produce a restoration that is dominated by large, high frequency noise components, whereas large regularization parameter imposes greater importance on the regularizer, causing important information to be lost. Therefore, we investigate and present a contrast measure-based method for automated selection of regularization parameter that will produce a balanced choice.

In the proposed method, empirical observations show that the highest peak in the absolute derivative of the contrast measure tends to correlate directly with the optimum regularization parameter for any norm value. The effectiveness of the proposed method is then evaluated on Synthetic Aperture Radar images of the T72, BTR70 and BMP2 military vehicles provided by the MSTAR database [2] against the Generalized Cross-Validation (GCV) method.

Fig. 1 shows the results for norm values less than 1. It is clear that the proposed method perform better than the GCV method; it enhances the main body and the edges of the object. This is consistent with observations by Cetin and Karl [3] that the regularizer, when used with norm values less than or equal to 1, enhances point-based features and improves the resolvability of objects. For norm values greater than 1, shown in Fig. 2, although the proposed method sometimes chooses a smaller parameter value than the GCV method, the parameter choices are quite reasonable to allow for object identification.

In conclusion, the proposed method provides similar performance to the GCV method, but with the advantage that it is computationally less intensive and is also independent of prior knowledge of the noise.

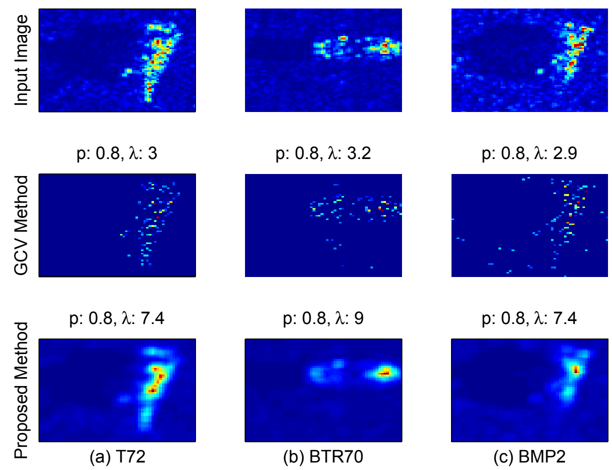

Fig. 1. Original and restored images with $l_{0.8}$-norm.

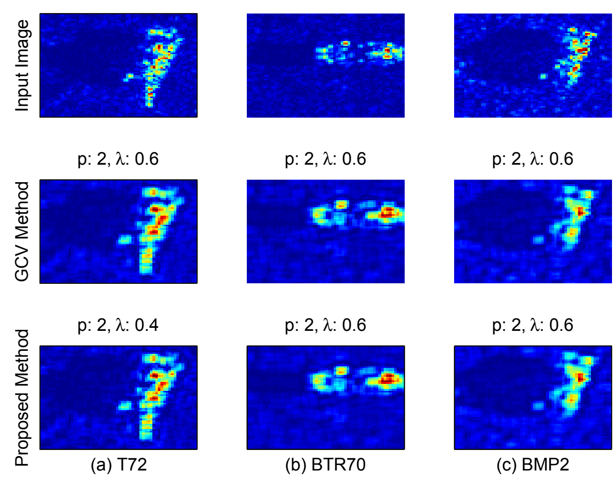

Fig. 2. Original and restored images with l_2-norm.

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References

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