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ON SHRINKAGE-BASED EDGE DETECTION IN A PCA SUBSPACE FOR PENUMBRAL IMAGING

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Abstract. *We propose a robust edge extraction algorithm based on Principal component analysis (PCA) for Poisson noise reduction. In the proposed edge detection, the image is firstly transformed to PCA subspace with sparse PCA basis functions and then the noisy components are removed by a soft threshold (Shrinkage). The proposed edge extraction method, which is used as a preprocessing step of the reconstruction, has been successfully applied to penumbral imaging. Both simulation results and real experimental results show that the reconstructed images are dramatically improved in comparison to that with the conventional noise-removing filter.*
Keywords: Penumbral imaging, Edge detection, Principal component analysis shrinkage function, Poisson noise

1. **Introduction.** Penumbral imaging [1], one of the Coded Aperture Imaging (CAI) techniques, is proposed for imaging objects that emit high-energy photons, where such objects arise, for example, in nuclear medicine, X-ray astronomy, and laser fusion studies. The penumbral aperture is extremely simple, being just a large circular aperture. The spatial information of an unknown source can be recovered from the shadow or penumbral cast by the source. Compared with the conventional pinhole camera, penumbral imaging has the following two advantages: The first is its high collection efficiency and it can be used for imaging of weak radiation source such as high-energy x-ray. The second is that since such an aperture can be "drilled" through a substrate of almost any thickness, the technique can easily be applied to highly penetrating types of radiations such as neutrons and γ rays. To date, the penumbral imaging technique has been successfully applied to image the high-energy x rays [1,2], protons [3] and neutrons [4-6] in laser fusion experiments.

Since penumbral images are always degraded by noise, a Wiener filter [3-5], where the mean square error is minimized, is used for decoding process. Though the Wiener filter is a powerful technique for noise minimization, it is impossible to avoid reduction of resolution