Smooth Criminal Edges: Developing a New Edge-preserving Image Smoothing Algorithm for Impulse Noise

Sherry Cherniavsky
University of Texas at Dallas
800 W. Campbell Road
Richardson, Texas 75080-3021
Sherry.Cherniavsky@UTDallas.edu

Pax Gole
Pax.Gole@UTDallas.edu

Jonah Markham
Jonah.Markham@UTDallas.edu

1. Problem Statement

This research investigates techniques to enhance edge-preserving image denoising algorithms, in order to better restore images that have been corrupted with impulse noise, while maintaining sharp edges and fine details [2–4, 7].

2. Approach

The approach leverages the characteristics of impulse noise to enhance edge-preserving smoothing techniques [1, 5]. Noisy pixels will be detected then replaced using surrounding pixels, rather than indiscriminately filtering all pixels. This should better preserve edges compared to basic techniques like bilateral filtering.

3. Data

The image dataset will consist of photographs from the USC-SIPI image database corrupted with varying levels of salt and pepper noise. This will allow testing under different noise conditions [6].

4. Evaluation

The final results will be evaluated by benchmarking against common filtering techniques, including staple methods such as applying Gaussian, Bilateral, and Non-Local Means filters uniformly across all pixels. Quantitative metrics and visual inspection will compare output images to the originals, judging the performance of our proposed technique against these conventional benchmarks. This comparative analysis will reveal how well our approach preserves edges and details relative to establish filters applied indiscriminately without excluding noisy pixels.

References

[1] E. Abreu, M. Lightstone, S. K. Mitra, and K. Arakawa. A new efficient approach for the removal of impulse noise from highly corrupted images. *IEEE Transactions on Image Processing*, 5(6):1012–1025, June 1996.

[2] Raymond Chan, Chung-Wa Ho, and Mila Nikolova. Salt-and-pepper noise removal by median-type noise detectors and detail-preserving regularization. *IEEE Transactions on Image Processing*, 14(10):1479–1485, 2005.

[3] R. H. Chan, C.-W. Ho, and M. Nikolova. Salt-and-pepper noise removal by median-type noise detectors and detail-preserving regularization. *IEEE Transactions on Image Processing*, 14(10):1479–1485, 2005.

[4] Keya Huang and Hairong Zhu. Image noise removal method based on improved nonlocal mean algorithm. *Complexity*, 2021:Article ID 5578788, 10 pages, 2021.

[5] M. Nikolova. A variational approach to remove outliers and impulse noise. *Journal of Mathematical Imaging and Vision*, 20:99–120, 2004.

[6] USC Signal and Image Processing Institute. SIPI Image Database. https://sipi.usc.edu/database/database.php?volume=misc, 2023. [Online; accessed 18-October-2023].

[7] Zhifei Zhang. Image noise detection, measurement, and removal techniques. https://zzutk.github.io/docs/reports/2015.07%20-%20Image%20Noise%20%20Detection,%20Measurement,%20and%20Removal%20Techniques.pdf, 2015.