An Analysis of Image Denoising Techniques

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Abstract

Digital de-noising techniques are used to filter out unwanted noise in a signal. In images, noisy signals are present in the form of non coherent salt and pepper noise and Gaussian noises to coherent noise introduced inherently from the imager or from signal processing algorithms. This paper examines some of the common methods for removing unwanted noise, along with implementing more complex filtering techniques in the form of wavelet filtering.

1 Introduction

This paper explores noise filtering techniques implemented in Python and the available Python image processing library $OpenCV$. The filters are implemented on images with random Gaussian noise and Salt and Pepper noise, and their outputs are compared. The underlying input image $FIGUREX$ and it's corresponding noisy images $NoisyIMAGES$ are in this figure. The standard library filters that were implemented were the $blur$, $gaussianblur$, $median$, and $bilateral$ filter, and another wavelet filter, the was also implemented for comparison.

2 Methods/Approach

2.1 Noise Generation

Two images were generated with different noise distributions for the purpose of analyzing the efficacy of the different applied filtering techniques. The first noisy image was generated with a normal Gaussian distribution that had been scaled by a factor of 10. The noise was scaled in order to be more visually evident in the image along with increasing the noise power in the image. Gaussian noise is generally a common form of noise that principally arises in images during acquisition and is caused by a number of factors, a few being poor illumination, high circuitry temperature, and electronic interference. The second noisy image was generated through adding a 0.4% Salt and Pepper (S&P) distribution. The S&P noise added was equally distributed "Salt" white pixels, and "Pepper" black pixels. S&P noise potentially occurs in images were intermittent and non-reliable image communication systems are present as they can elicit sharp and sudden disturbances in the image signal.

2.2 Haar Wavelet Transform

The Haar Transform proposed by the Hungarian mathmetician Alfréd Haar

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3 Results

3.1 Peak Signal to Noise Ratio

In order to analyze the utility of the aforementioned filtering techniques the Peak Signal to Noise Ratios (PSNR) for each filtered image were calculated.

$$PSNR = 10 * log_{10}\Big(\frac{MAX^2}{MSE}\Big) \tag{1}$$

Where MAX is the maximum grayscale pixel value for the image which in this case 256, and MSE is the Mean Squared Error between the filtered output image and the noisy image.

4 Conclusion

References

References follow the acknowledgments. Use unnumbered first-level heading for the references. Any choice of citation style is acceptable as long as you are consistent. It is permissible to reduce the font size to `small` (9 point) when listing the references. **Remember that you can use a ninth page as long as it contains *only* cited references.**

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[3] Hasselmo, M.E., Schnell, E. & Barkai, E. (1995) Dynamics of learning and recall at excitatory recurrent synapses and cholinergic modulation in rat hippocampal region CA3. *Journal of Neuroscience* **15**(7):5249-5262.