ISCS 30.65-M1
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Submission 1: Classical Denoising

Research on a method that measures the quality of denoising between the clear image and the processed image. The method should return a score.

The group has chosen to research the Peak Signal-to-Noise Ratio (PSNR) to measure the quality between an original image and a resultant image. In the context of denoising between the clear image and the processed image, the group used the PSNR score to identify how relatively high or low the quality of the output image is based on a certain filter applied (Nadipally, 2019). Typical values for the PSNR in lossy image and video compression are between 30 and 50 dB, where higher is better. Values over 40 dB are normally considered very good and those below 20 dB are normally unacceptable. (Bull & Zhang, 2021)

Which method had the best score? Why do you think this denoising method performed the best (explain in terms of its inherent steps / properties)?

PSNR Scores

Mean filter: 28.069614366194536 dB (lowest score)
Median filter: 28.710748321807138 dB
Bilateral filter: 29.205961116752043 dB (highest/best score)
Gaussian blur: 28.242578365352106 dB

The mean blur produced the lowest PSNR score, which means that the processed image from the mean blur had the lowest quality. Given that it uses mean, it can be affected by extremes and may add color that does not exist in the original image. As such, the mean blur also does not preserve the edges well, resulting in the lower quality of the processed image.

The median blur performs better than the mean blur, especially in noisy images, due to its ability to preserve edges. It can preserve edges since it does not create a new or unrealistic value. Moreover, the median statistic is less sensitive to outliers compared to the mean blur which is why it can reduce salt and pepper (SAP) noise wherein corrupted pixels take either maximum or minimum gray value (Liang & Zhao, 2021).

The bilateral blur typically has higher PSNR scores compared to mean and median blur because it preserves edges and fine details while reducing noise. It's very strong with regions of uniform color, and given that edges have high color variance. The Bilateral Filter considers both spatial closeness and intensity similarity when smoothing an image. Spatial weight ensures that pixels close to each other are given higher importance, while intensity weight ensures that pixels with similar intensity are preferred. The Bilateral Filter adapts to the local characteristics of the image, adjusting the filter strength based on the content of the neighborhood. It is particularly effective in scenarios where preserving fine details and edges is crucial, such as medical imaging, computational photography, and computer vision applications

The Gaussian blur showed the second-highest PSNR score among all the methods used. Gaussian blur works by applying a weighted averaging operation to each pixel in an image using a Gaussian kernel. The kernel's characteristics, such as size and standard deviation, influence the extent of smoothing, allowing users to control the balance between noise reduction and preservation of image details. Adjusting these different values can result in different PSNR scores that may or may not score higher than bilateral blur. However, the result of the experiment showed that bilateral blur worked better in this case.

References

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