3831 Coursework Part 3 Report

# Introduction to the Problem

The problem I am looking to solve is the denoising of dirty images utilising a Fourier transformation and other denoising methods, then comparing the results against other prominent methods of denoising images. This process is important for improving the quality of images so they can be effectively used for many applications like photorealistic visuals [fourth paragraph of introduction - Reference 1] and computer vision so important features are more easily segmented from the image for cases like object detection or facial recognition [4. Enhanced image recognition and computer vision - Reference 2].

# Description of my Algorithm

To begin I will import the image to be denoised. As a pre-processing step I will convert the image to float values to be able to conduct the denoising methods, as an additional pre-preprocessing step I will convert the image to greyscale so the values in each pixel location represent the intensity across all colour channels. I will then apply a series of denoising methods to the image (Fourier transform [Reference 3], Total Variation Filter [Reference 4] and Gaussian filter [Reference 5]) to produce the final clean image.

A diagram of a process

Description automatically generated

# Presentation of Results

My program iterates through each of the images, for each it converts the noisy images to float values and then to greyscale, it subsequently denoises the images with each of the denoising algorithms (mean, median, wavelet and my own). It then generates a 2x3 comparison grids for each level of noisy image (noisy10, 25 and 50) which contain the initial noisy image, the cleaned images as well as their MSE/SSIM metrics from each of the denoising algorithms. These grids are then placed into a 1x4 record with the original cleaned image for comparison. Each of these records are output as well as appended to a results file if that option is selected, I have included the first image below – the full results file is included in the zip file.

A screenshot of a computer generated image

Description automatically generated

# Key Findings

My algorithm results in a smaller MSE than the other prominent denoising methods aside from the Mean Filter algorithm at noise level 50.

My algorithm results in a high SSIM score for noise levels 10/25 aside from the Wavelet algorithm that usually outperforms it at all levels, additionally Mean Filter typically outperforms my algorithm slightly at noise level 50.

The Median filter algorithm is typically the worst scoring in terms of MSE and SSIM at all noise levels, in some cases wavelet has a worse MSE score.

# Conclusions

From my key findings I would select my denoising algorithm in cases where there is a low to medium level of noise in the sample image due to its good performance at these levels, for cases where there is a high level of noise, I would select either the Mean Filter or the Wavelet algorithm due to their slightly better performance at this higher level of noise. To improve upon my algorithm, I would implement a post-processing step of applying morphological operations.

# References

1. (NVIDIA Blog, JJ Kim), 2022, URL = <https://blogs.nvidia.com/blog/what-is-denoising/#:~:text=Removing%20noise%20from%20imagery%20—%20which,to%20the%20quality%20of%20images> , Last Accessed 14/12/2023.
2. Visionary.AI Blog, 2023, URL = <https://www.visionary.ai/blog/7-benefits-to-removing-video-noise> , Last Accessed 14/12/2023
3. M. Henry, 2023, URL = <https://www.sciencedirect.com/science/article/pii/S0263224123009363?via%3Dihub> , Last Accessed 14/12/2023
4. (S. Huang, S Wan), 2020, URL = <https://arxiv.org/abs/2001.00150> , Last Accessed 14/12/2023
5. (M. Wang, S. Zheng, X. Li and X. Qin), 2014, URL = <https://ieeexplore.ieee.org/document/6948089> , Last Accessed 14/12/2023