# Denoising

In the realm of image processing, denoising assumes a critical role by rectifying the imperfections introduced by unwanted variations in pixel intensities, commonly known as noise. This essential pre-processing step is pivotal in ensuring the accuracy and interpretability of images.

In applications such as medical imaging and satellite photography, where precision and clarity are paramount, denoising emerges as a foundational task. Moreover, denoising significantly contributes to refining image datasets in the context of computer vision and advanced technologies, thereby enhancing the reliability of subsequent analytical processes and model predictions. In essence, denoising is vital for optimizing visual data, ensuring the underlying content remains clear, coherent, and conducive to accurate interpretation.

Our primary goal in this project is to utilize the filters discussed in the first chapter to remove image noise. The images are subjected to three main types of noise, namely Gaussian noise, salt and pepper noise, speckle noise, and Poisson noise, which you must generate by implying the correct noise configurations on the main images.

By following these steps, report the evaluated quality metrics as the result of this assignment. Make sure to improve your results by experimenting with the different filter values.

- Firstly, imply Salt and Pepper noise. Try different noise densities such as (0.05, 0.1, 0.2, 0.4). For each density, discuss the effect of filters with different sizes.
- secondly, imply speckle noise. Try different noise variance such as (0.0001, 0.0005, 0.001, 0.002)
- thirdly, utilize Poisson noise. try various noise scaling such as (0.1, 0.5, 1.0, 2.0)
- finally, imply Gaussian noise. Try different noise densities mentioned below. For each density, discuss the effect of filters with different sizes.

| Noise | Mean | Standard deviation |
|---|---|---|
| Noise 1 | 0 | 40 |
| Noise 2 | 4 | 30 |
| Noise 3 | 10 | 0 |
| Noise 4 | 10 | 25 |

- Additionally, utilize these different kinds of filters to remove the three types of noises both in the frequency domain and the spatial domain:
    1. smoothing filters (median, blur, Bilateral)
    2. sharpening filters (Laplacian, Sobel, Robert, High-pass, Unsharp Masking)
    3. wavelet (Haar, Coiflet, Gaussian, Shannon)
    4. shearlet

  Use these filter types in various sizes, orders, and levels to achieve close results to the main images.

  * Be aware to use quality metrics mentioned in your first chapter to evaluate your filters.

  * https://shearlab.math.lmu.de/