# COMP2005 Laboratory Sheet 3: Linear & Non-Linear Filtering

The noise reduction methods discussed in the last lecture are all based on the idea of spatial filtering, and as discussed, there are two types of filtering: linear and non-linear.

## 1. Linear Filtering

Linear filtering is done using convolution, whereby a linear filter is slid over every pixel in the image and multiplication/addition operations are performed. The output of each pixel is the weighted sum of the neighbouring pixels. We will explore two types of linear filters, which are mean filtering and Gaussian filtering. The Moodle page contains a version of the cameraman image where salt and pepper noise has been added. Using that image, apply the different types of filters to reduce the noise as much as possible.

- Use *blur* to perform mean filtering on the image with a kernel size of 3, 5 and 7.
- Use *GaussianBlur* to perform Gaussian filtering with sigma values of 0.5, 1.0 and 1.5. **Remember that you will need to vary the size of the mask as you change the Gaussian parameter.** Refer to the lecture notes for guidance on mask size.
- Examine your results. Where do you see differences between Gaussian filtering and mean filtering with a similarly sized filter?

## 2. Non-Linear Filtering

Non-linear filtering, on the other hand, is done without convolution. Instead, a non-linear mathematical operation is performed on each pixel independently based on the neighbouring pixel values, resulting in the output pixel value. The three non-linear filters we will explore are median filtering, anisotropic diffusion and bilateral filtering.

- Use *medianBlur* to perform median filtering with a kernel size of 3, 5 and 7.
- Use *anisotropicDiffusion* to perform anisotropic diffusion and understand the parameters in the function. Try experimenting with the parameter values: alpha (0.01 – 0.1), *K* (0 – 100) and with iterations of 1, 2 and 3. Compare the effects of changing the parameter values.
- Use *bilateralFilter* to perform bilateral filtering and understand the parameters. Try experimenting with the parameter values *d* (1 – 100) and sigma (50 – 250). You may keep both sigma values the same for simplicity's sake. Compare the effects of changing the parameter values.
- Compare the differences between all the filters. Which filter performed the best?

It is good to note that different filters perform better in different scenarios as it is dependent on the image used. The type of noise in the image, the image content and the details you intend to preserve play an important role in choosing which filter is the best. Hence, it is always best to experiment with different filters to see which produced the required result.

# 3. Expected Results

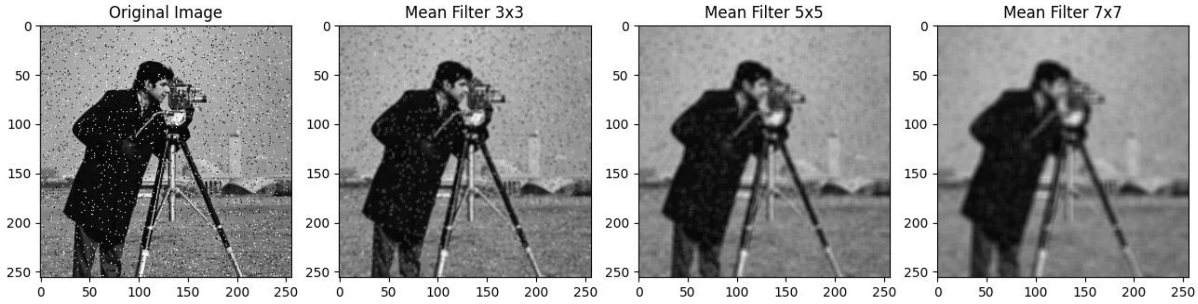


**Figure 1: Mean Filtering**

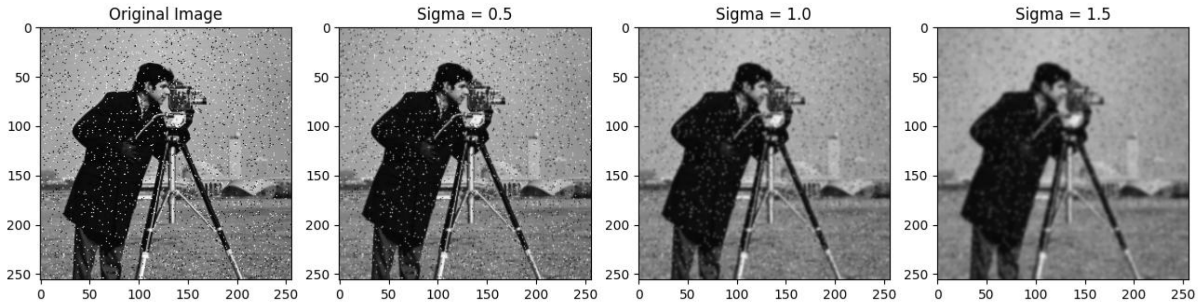


**Figure 2: Gaussian Filtering**

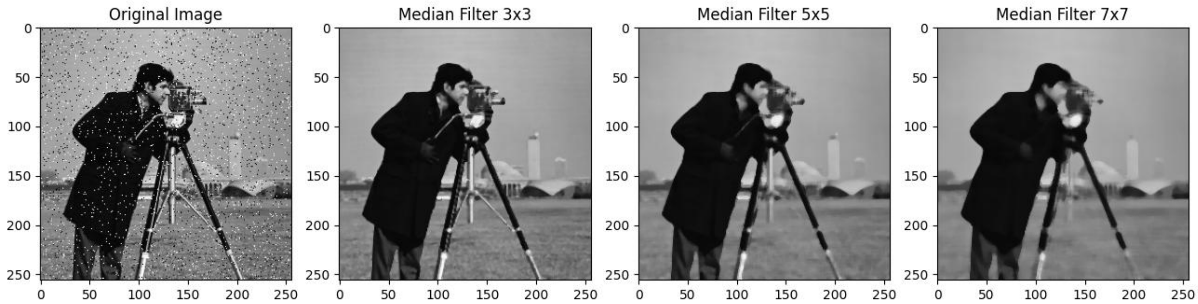


**Figure 3: Median Filtering**

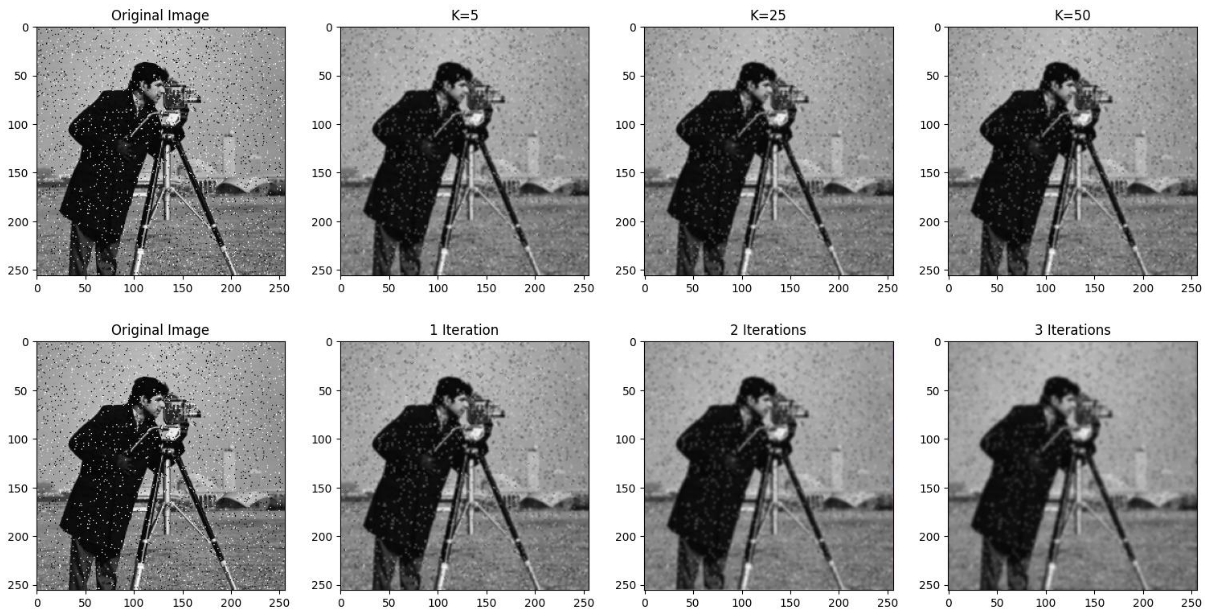


**Figure 4: Anisotropic Diffusion**

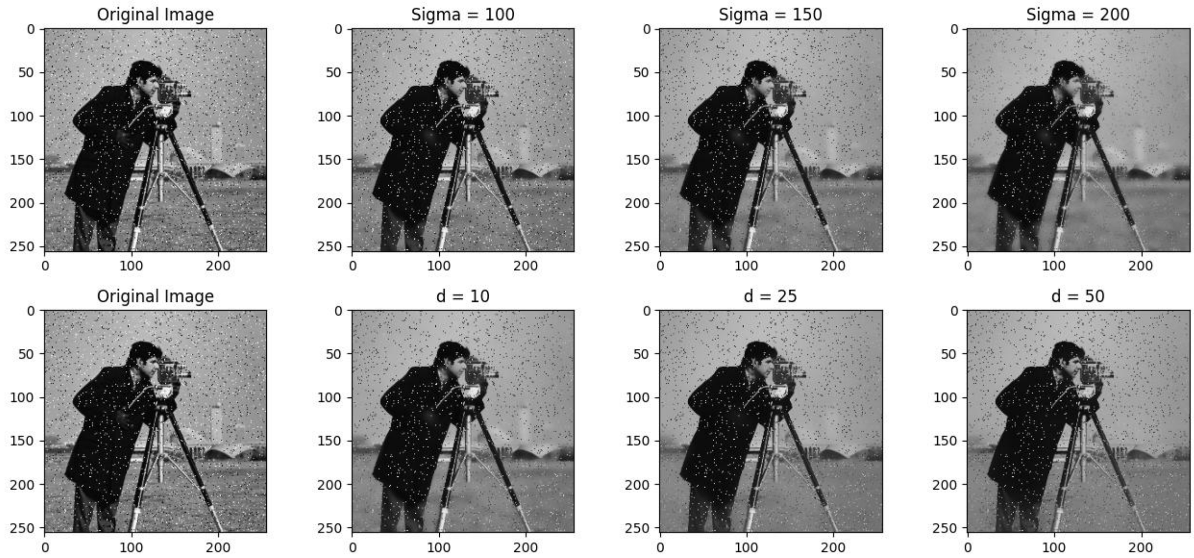


**Figure 5: Bilateral Filtering**