AI Lab Pratical3 : Reducion Noise Image and Smoothing Filter

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Introduction

In this section we will discuss on the fundamental filters and Machine Learning in order to noise enhancement for the real image. Now given that two noise images "`noise1.tif`" and "`noise2.tif`" from folder name "`noise_image`".

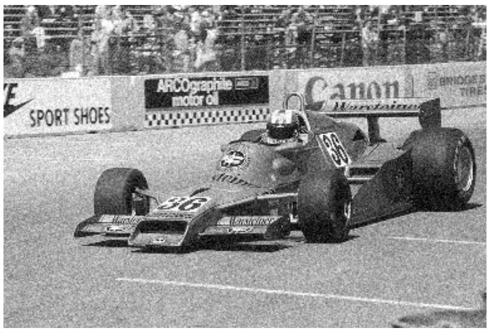


Fig1: noise1.tif

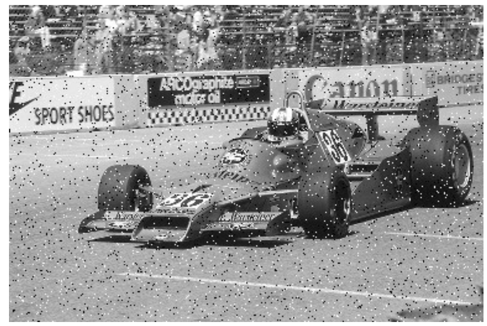


Fig2: noise2.tif

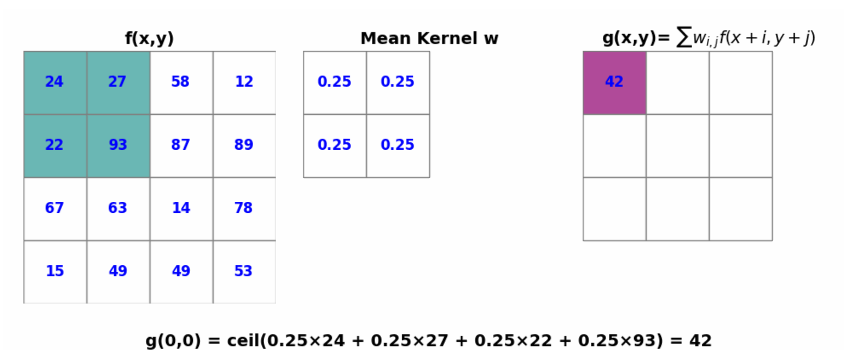
1. Convolutional Operation

Suppose that an image was device into $M \times N$ pixels where represent the density as the function $f(x, y)$. We define the linear operation transformation neighborhood or convolutional operation T and the output $g(x, y)$ was given:

$$g(x, y) = T[f(x, y)] = w * f = \sum_{i}^{M} \sum_{j}^{N} w(i, j) \cdot f(x + i, y + j)$$

- w: is an array with size $m \times n$ defines the neighborhood of operation and was called kernel.
- In common practice, the kernel w is defined as a square matrix of size $n \times n$, such as 3×3, 5×5, and so on.
- In this lab practical, we also introduce several filters in objective to fixed the noise image such as Mean Filter (Mean Kernel), Gaussian Filter (Gaussian kernel), Median Filter and application K-nearest neighbor in Machine Learning.

Now let's discuss an image with array 4×4 and given intensity value, mean kernel 2×2 as illustrated bellow:



Question 1: If an image was size 64×64 and kernel size 3×3, what is the output size you will get? Could you give any techniques should be applied to get the same size of input and output?

Question 2: Create an input matrix named "in_matrix" with size 4×4 and kernel name "kernel_matrix" for size 2×2 from the value given in figure above. Programming to determine the output matrix name"out_matrix".

2. Mean Filter

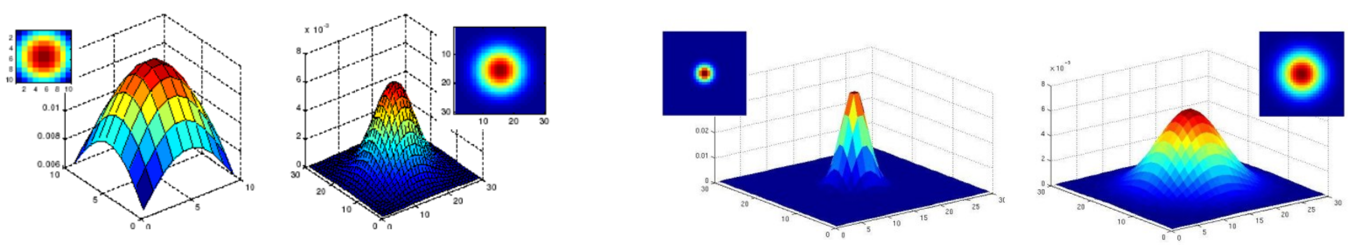
Evaluate the noise reduction performance of two image were provided "noise1.tif" and "noise2.tif" with average filter $w[i,j]$ in dimension 3×3 given by:

$$w[i,j] = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Given a result and remake for kernel $w[i,j]$.

3. Gaussian Filter

In general Gaussian Filter has the form $w[i,j] = C \exp\left(-\frac{i^2+j^2}{2\sigma^2}\right)$ where σ^2 known as the variance.



σ = 5 pixels with 10 x 10 pixel kernel | σ = 5 pixels with 30 x 30 pixel kernel | σ = 2 pixels with 30 x 30 pixel kernel | σ = 5 pixels with 30 x 30 pixel kernel

In this experiment, the noise reduction performance will be tested on two provided images "noise1.tif" and "noise2.tif". The objective is to determine the optimal filter Gaussian $w[i,j]$ that effectively suppresses noise while preserving image details.

For instance, of Gaussian Kernel 3×3 express as form:

$$w[i,j] = \frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

4. Medain Filter

In addition to the above linear filtering techniques, images can be smoothed by nonlinear filtering, such as mathematical morphological processing. Median filtering is one of the simplest morphological techniques, and is useful in the reduction of impulsive noise. For input image dimension $M \times N$ with pixel value $f(x,y)$ and the output $g(x,y)$ given by:

$$g(x,y) = median\big(f(x-i, y-j)\big), \quad (i,j) \in M \times N$$

Exploration median transform by determine the optimize size of kernel on two images given "noise1.tif" and "noise2.tif" and discuss this result.