22437 - Industrial Vision
Lab 6: Image Restoration (Noise Removal)

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Useful functions: *imfilter*, *medfilt2*, *ordfilt2*, *imnoise*

Image restoration attempts to recover images that have been degraded. In this lab, we will work with noise as a unique source of degradation. Noise comes mainly from the acquisition phase, since cameras can be affected by environmental conditions, and the transmission phase, where, in some occasions, interferences can appear. There can be several noise models. The most typical examples are:

- **Gaussian**, where the ideal pixel value is modified according to a Gaussian function. It is usually modeled as:

$$g(x, y) = f(x, y) + \eta(x, y)$$

  where $f(x, y)$ is the original image, $\eta(x, y)$ is the noise term, defined as a Gaussian function, and $g(x, y)$ is the resulting noisy image. The intensities of all the pixels are altered.

- **Salt & Pepper**, where the intensities of the pixels in the output image are not related to the original ones and takes the maximum value (*salt*, white) or the minimum value (*pepper*, black). It is also known as impulse noise.

In noise removal, it is important to estimate the noise model which is affecting an image to determine the best filtering technique to apply. Gaussian noise can be removed using linear spatial filters, such as an *average filter*. Salt, pepper and its combinations can be removed using nonlinear spatial filters. In this case, these filters are also called *order statistics filters*, since they are based on ordering the pixel values that make up the neighborhood operated by the filter. Main filters that fall into this category include *median*, *max* and *min* filters.

Perform the following tasks:

1. Load and display the image *board1.jpg*.

2. What kind of noise is affecting the image? Which filter would you apply in this case?

3. Apply the following filters to the image: *average*, *median*, *max* and *min*.

4. Compare the results displaying the resulting images in the same figure. Which filter works better?

5. Once selected the best filter to apply, check the effect of the filter size for this case. Display the best results obtained.

6. Use the *imnoise* function to add a different noise than the original to the restored image. Display the resulting image.

7. Repeat exercises 1-6 using the following images: *board2.jpg*, *board3.jpg*, *board4.jpg*.

8. Explain the main advantages and disadvantages of each of these filters, indicating when should be used each one and the effects that produces in the output image.