# **Methods**

**Noise Injection:**Salt-and-pepper noise is injected with three intensity levels of 30%, 50%, and 70%.

**Plan Median Filter:** A 3x3 window passes over the image and replaces the central pixel with the median value of the pixel values in the window.

**Adaptive Median Filter:** Initially with size 3x3 and increase to 7x7. The window is changed according to the noise property in the local region.

**Evaluation**

* **Mean Squared Error (MSE)** is calculated between the input clean image and the filtered images.
* **MSE Formula**: MSE = (1 / (m × n)) × Σ Σ [I(i,j) - K(i,j)]² Where:
  + **I(i,j):** pixel value of the original image
  + **K(i,j):** pixel value of the filtered image
  + **m, n:** number of rows and columns in the image
* A smaller value of MSE means that the restoration result is better.

**Analysis**

* The Standard Median Filter works well at low densities, but tends to smooth out fine detail at higher densities.
* The adaptive median filter, significantly more complex computationally, preserves the fine detail and yields superior performance at all noise levels.
* By the virtue of the flexibility of the filter results in improved removal of salt and pepper noise especially for larger corrupted regions.

**Summary**

* At 30% noise both filters perform comparably.
* At 50% and 70% noise: the Adaptive Median Filter achieves visually better results and less MSE.

**Conclusion**

In presence of high noise, the pervasive character of noise and local adaptation make the adaptive median filter better than rest. It provides better accuracy and edge preservation than the Standard MF, and is thus the technique of choice for heavy salt-and-pepper noise.