Introduction

Noise is an unavoidable artifact in digital images, often introduced during acquisition, transmission, or storage. Common types of noise include Gaussian noise and Salt & Pepper noise. In this study, we apply an Average (Mean) filter of different kernel sizes to analyze its effectiveness in reducing these two noise types.
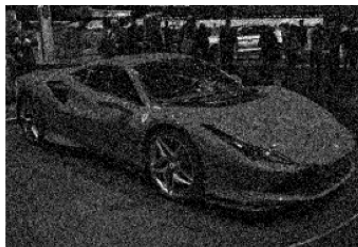
Original RGB Image:

Gray Scale Image:

Original Grayscale

Gaussian Noise

Salt & Pepper Noise

Filtering Approach

The Average filter works by replacing each pixel's value with the mean of its neighboring pixel intensities. Larger kernel sizes result in stronger smoothing but may also lead to information loss.

We apply the filter using three different kernel sizes:

- **3×3 Kernel**
- **7×7 Kernel**
- **15×15 Kernel**

Results and Observations

Effect on Gaussian Noise

The second image presents the results of applying an Average filter on an image affected by Gaussian noise.
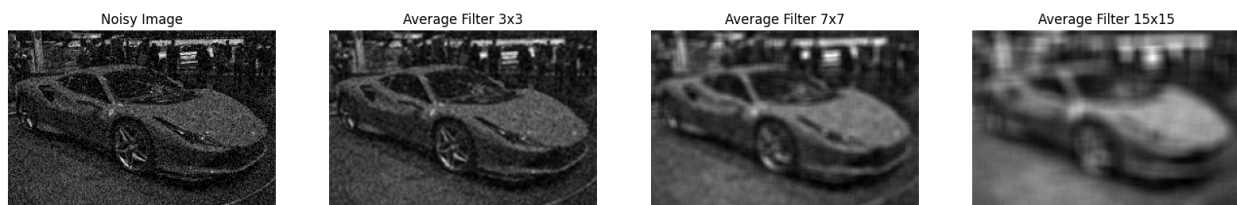
1. **3×3 Kernel**:

   - Slight noise reduction while preserving details.
   - Some grainy texture remains.
2. **7×7 Kernel**:

   - Further noise reduction, but minor blurring of edges.
   - Image appears smoother with slightly lower sharpness.
3. **15×15 Kernel**:

   - Strong noise reduction but at the cost of significant blurring.
   - Loss of fine details, making the image appear overly smooth.

Noisy Image   Average Filter 3x3   Average Filter 7x7   Average Filter 15x15

Effect on Salt & Pepper Noise

The third image presents the results of applying an Average filter on an image corrupted by Salt & Pepper noise.

1. **3×3 Kernel**:

   - Slight reduction in noise but does not remove most white and black pixel artifacts.
   - Image retains details but is still significantly noisy.
2. **7×7 Kernel**:

   - Improved noise removal, but many small noise spots remain.
   - Slight loss of fine image details.
3. **15×15 Kernel**:

   - Strong blurring effect with noise reduction.
   - Many salt & pepper noise spots are reduced, but the image loses significant details.

| Noisy Image | Average Filter 3x3 | Average Filter 7x7 | Average Filter 15x15 |
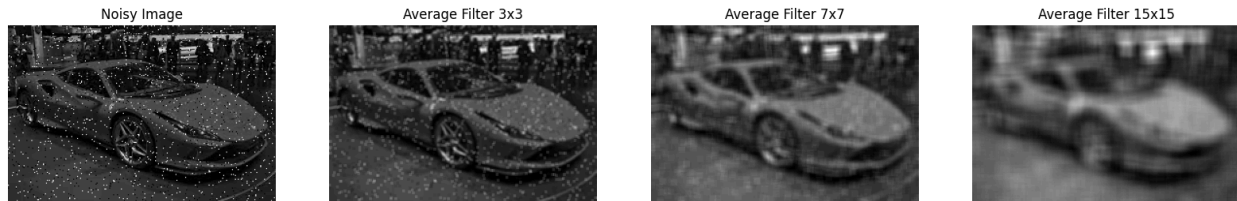
Comparison and Conclusion

- The Average filter performs **better on Gaussian noise** than on Salt & Pepper noise, as it effectively reduces noise while maintaining a reasonable level of detail.
- For **Gaussian noise**, a **7×7 kernel** provides a good balance between noise reduction and detail preservation. A **15×15 kernel** excessively smooths the image, leading to loss of sharpness.
- For **Salt & Pepper noise**, the Average filter is **not very effective** as it does not specifically target outliers. The **Median filter** would be a better alternative for Salt & Pepper noise reduction.