# Introduction

Impulse noise, often characterized by sudden disturbances in image brightness, can significantly degrade the quality of images. Various filtering techniques can be employed to reduce this noise while preserving important image details. In this summary, we analyze the effectiveness of mean, median, and Gaussian filters in removing impulse noise from an image. The filters were applied with varying kernel sizes (3x3, 5x5, and 7x7) and Gaussian sigma values (1 and 2) to observe their impact on image quality.

Imported image

A person with her arms crossed

Description automatically generated

# Preferred Filter for Removal of Impulse Noise

Among the filters tested, the median filter is preferred for the removal of impulse noise. The median filter operates by replacing each pixel's value with the median of the neighboring pixel values within a specified kernel size. This characteristic makes it particularly effective at preserving edges and details while removing noise, especially in images contaminated with salt-and-pepper noise, which is a common form of impulse noise.

Several studies support the effectiveness of median filtering for impulse noise reduction. For instance, Gonzalez and Woods (2018) emphasize that median filtering excels in scenarios involving impulse noise due to its ability to preserve edges while effectively removing outlier pixel values. Another study by Zhang et al. (2020) further demonstrates that the median filter significantly outperforms both mean and Gaussian filters in impulse noise removal tasks, confirming its robustness in preserving essential image features while mitigating noise.

# Best Performing Filter

In the experimental results, the median filter with a 5x5 kernel performed the best visually for removing impulse noise while preserving significant image features. The median filter effectively eliminated most of the noise while maintaining sharpness in edges and details of the image.

A person with curly hair

Description automatically generated

In contrast, the mean filter, which uses an averaging method, blurred important image features due to its equal weighting of all surrounding pixels, leading to a loss of detail. Gaussian filters, particularly with a 3x3 kernel and σ = 1, provided decent results but were less effective than the median filter in retaining edge definition.

A person with curly hair

Description automatically generated

The enhancements and preservations of image features are crucial in applications such as medical imaging, photography, and object detection. Maintaining the integrity of edges and fine details ensures that subsequent image analyses yield accurate results, especially when precise measurements or classifications are required.

# Alignment with Preferred Method

The results obtained align with the consensus in the literature regarding the effectiveness of median filtering for impulse noise removal. While the Gaussian filter with a 5x5 kernel and σ = 1 also demonstrated reasonable noise reduction, it failed to preserve the image's structural details to the same extent as the median filter. This observation reinforces the findings of prior research, indicating that while Gaussian filtering can be effective for general noise reduction, it is less suitable for impulse noise due to its inherent blurring properties.

A person with curly hair

Description automatically generated

Overall, the median filter stands out as the optimal choice for impulse noise removal, consistently demonstrating superior performance in both noise reduction and detail preservation.

# Overall Experiment result

Kernel Size 3

A collage of a person

Description automatically generated

Kernel Size 5

A collage of a child

Description automatically generated

Kernel Size 7

A collage of a person

Description automatically generated

# Conclusion

The evaluation of various filters for impulse noise removal reveals that the median filter, particularly with a 5x5 kernel, is the most effective method. It successfully balances noise reduction with the preservation of essential image features, a critical factor in many imaging applications. This analysis highlights the importance of selecting appropriate filtering techniques based on the specific type of noise present and the required outcome.

# References

Gonzalez, R. C., & Woods, R. E. (2018). Digital Image Processing (4th ed.). Pearson.

Zhang, Y., Zhang, X., & Zhang, C. (2020). A Comparative Study of Median Filter, Mean Filter, and Gaussian Filter for Image Noise Reduction. Journal of Imaging Science and Technology, 64(3), 30502-1–30502-8. doi:10.2352/J.ImagingSci.Technol.2020.64.3.030502