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Assignment	**01**
Course	**Computer Vision**
Selection	**A**

Question #01

Image filtering techniques are commonly used in image processing to enhance or modify images. These techniques involve applying filters, also known as kernels or masks, to the pixels of an image to achieve desired effects such as noise reduction, edge detection, or image sharpening.

Box Filter:

Definition: The box filter is a simple linear filter that applies a uniform weighting to each pixel within a neighborhood.

Filter/Kernel Description: The box filter consists of a square kernel with equal weights assigned to each pixel in the kernel.

Filtering Process: For each pixel in the image, the box filter replaces the pixel value with the average value of all the pixels within the kernel. This process is repeated for every pixel in the image.

Example: We can apply a box filter with a larger kernel size, such as 5x5 or 7x7. This filter will replace each pixel with the average value of its surrounding pixels. The result will be a smoother version of the image with reduced sharpness and details.

Gaussian Filter:

Definition: The Gaussian filter is a linear filter that applies a weighted average to the pixels in a neighborhood, with weights determined by a Gaussian distribution.

Filter/Kernel Description: The Gaussian filter uses a Gaussian-shaped kernel, with higher weights assigned to closer pixels and lower weights assigned to farther pixels.

Filtering Process: The Gaussian filter convolves the kernel with the image, replacing each pixel with the weighted average of the neighboring pixels. The weights are determined by the Gaussian distribution, which creates a smoothing effect while preserving edges to some extent.

Example: Consider an image with noise or unwanted variations. We can apply a Gaussian filter with an appropriate kernel size and sigma value. The Gaussian filter will reduce the noise by applying a weighted average to the pixels. The higher weights assigned to nearby pixels will preserve the overall image structure while smoothing out the noise.

Sobel Filter:

Definition: The Sobel filter is a widely used linear filter for edge detection in images.

Filter/Kernel Description: The Sobel filter uses two separate kernels, one for horizontal gradients and another for vertical gradients, to detect edges in the image.

Filtering Process: The Sobel filter convolves the horizontal and vertical gradient kernels with the image separately. It calculates the gradient magnitude and direction at each pixel, which highlights areas of significant intensity changes and indicates the presence of edges in the image.

Example: Suppose we have an image and we want to highlight the edges present in it. We can apply the Sobel filter by convolving the image with the horizontal and vertical gradient kernels. The result will be an image where areas with significant intensity changes, indicating edges, are enhanced. This filter is commonly used in edge detection algorithms.

Median Filter:

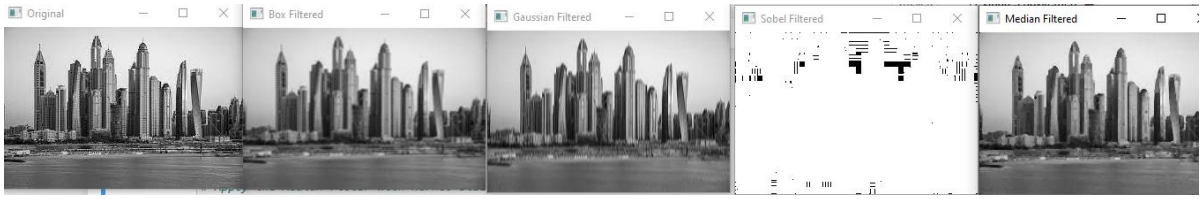
Definition: The median filter is a non-linear filter that replaces each pixel with the median value of its neighboring pixels.

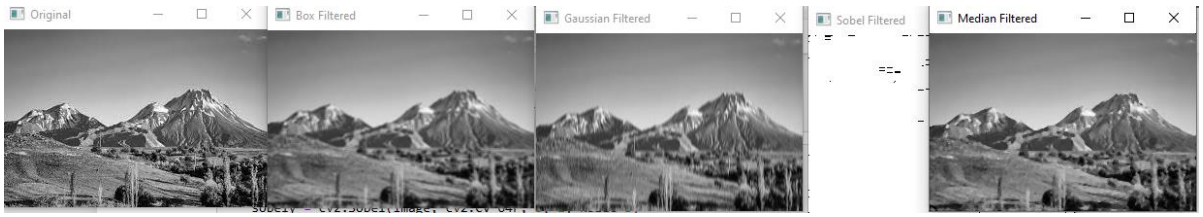
Filter/Kernel Description: The median filter uses a sliding window or kernel to capture a neighborhood of pixels. It then replaces the central pixel with the median value of all the pixels in that neighborhood.

Filtering Process: For each pixel in the image, the median filter slides the kernel over the image, collects the pixel values within the kernel, and calculates the median value. The central pixel is then replaced with this median value. This process is repeated for every pixel in the image.

Example: Imagine we have an image with salt-and-pepper noise, which appears as random white and black pixels scattered throughout the image. Applying a median filter with an appropriate kernel size will replace each pixel with the median value of its neighborhood. The median filter is effective at reducing such noise, as it replaces outliers with more representative pixel values. The result will be a cleaner image with reduced noise.

Question 03


Original
Box Filtered
Gaussian Filtered
Sobel Filtered
Median Filtered


Original
Box Filtered
Gaussian Filtered
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Box Filter

The box filter is a simple linear filter that applies a uniform weighting to each pixel within a neighborhood.It is effective for reducing high-frequency noise in images while preserving edges to some extent.However, the box filter tends to blur the image and may not be suitable for images with fine details or sharp edges.

Gaussian Filter

The Gaussian filter is a widely used linear filter that applies a weighted average to the pixels in a neighborhood, giving more importance to closer pixels.It effectively reduces noise and blurs the image while preserving edges better than the box filter.The Gaussian filter is suitable for a wide range of image categories, including natural scenes, portraits, and textured images, as it provides a smooth and visually pleasing result.

Sobel Filter

The Sobel filter is a linear filter commonly used for edge detection in images.It computes the gradient magnitude and direction, highlighting areas of significant intensity changes.The Sobel filter is especially useful for images where edge information is crucial, such as medical imaging or object detection tasks. However, it does not directly reduce noise and may enhance noise

Median Filter

The median filter is a non-linear filter that replaces each pixel with the median value of its neighboring pixels.It is effective at removing impulse noise (salt-and-pepper noise) while preserving edges and fine details.The median filter is particularly useful for images with a lot of random noise, such as medical images or images captured in low-light conditions.However, it

may introduce blurring or smoothing effects and may not be suitable for images with structured noise or Gaussian noise.

Summary

In summary, the choice of filter depends on the specific requirements of the image and the type of noise present. The box filter and Gaussian filter are generally suitable for noise reduction in various image categories, with the Gaussian filter providing a smoother result. The Sobel filter is primarily used for edge detection, while the median filter excels at removing impulse noise without blurring fine details. It is advisable to experiment with different filters and their parameters to achieve the desired result for a particular image category.