Image Processing for Computer Vision
Session 8

Filtering in Image Processing

Topics

- Filtering
- Image Blurring

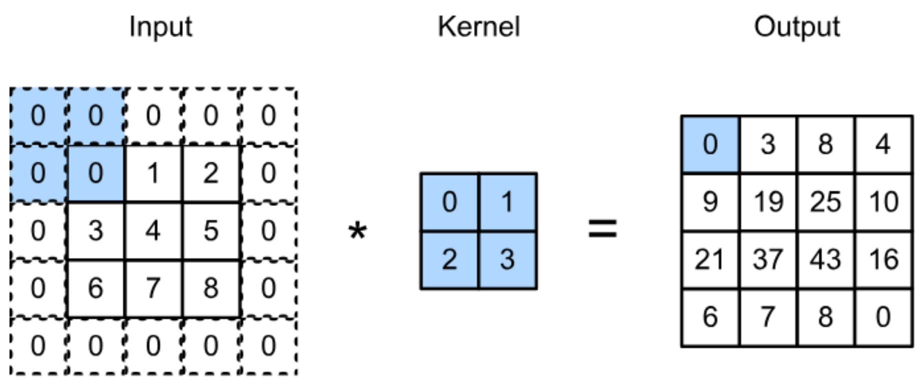
What is filtering in image processing?

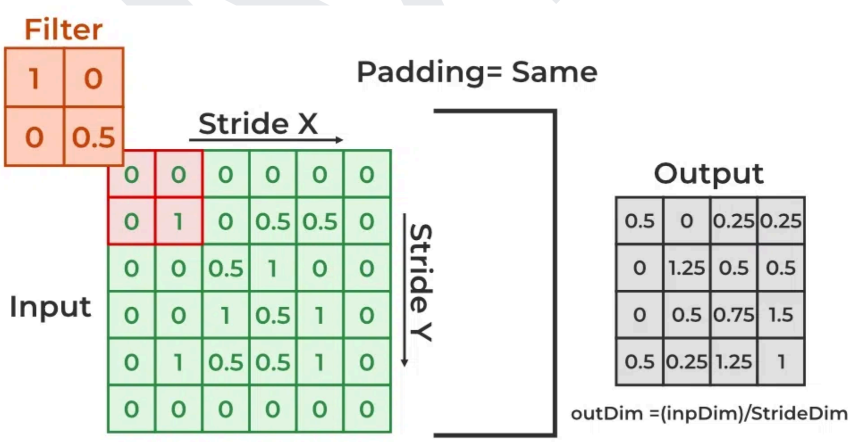
In computer vision filtering is a core technique used to **process** and **analyze** images by modifying pixel values based on certain operations. Filtering can **enhance** important features (like edges, corners, textures), remove noise, or transform an image to make it more suitable for further analysis.

Applications of image filtering:

1. Noise Reduction
2. Edge Detection
3. Feature Extraction
4. Image Segmentation
5. Object Recognition

Key Concepts:





Kernel (Filter): A small matrix (e.g., 3x3, 5x5) that is applied to each pixel in the image. It represents the shape and size of the neighborhood that will be sampled when calculating the pixel values to be modified.

Padding: When applying a filter near the edges, padding is often added to the image so that every pixel can be processed. Padding can involve filling with zeros, replicating the nearest edge pixel, or other methods.

Convolution: A mathematical operation where the kernel slides across the image, and the pixel values are multiplied by corresponding kernel values and summed. This operation transforms the image based on the filter applied.

Stride: determines the step size when moving the kernel (or filter) across the image.

Gaussian Blur

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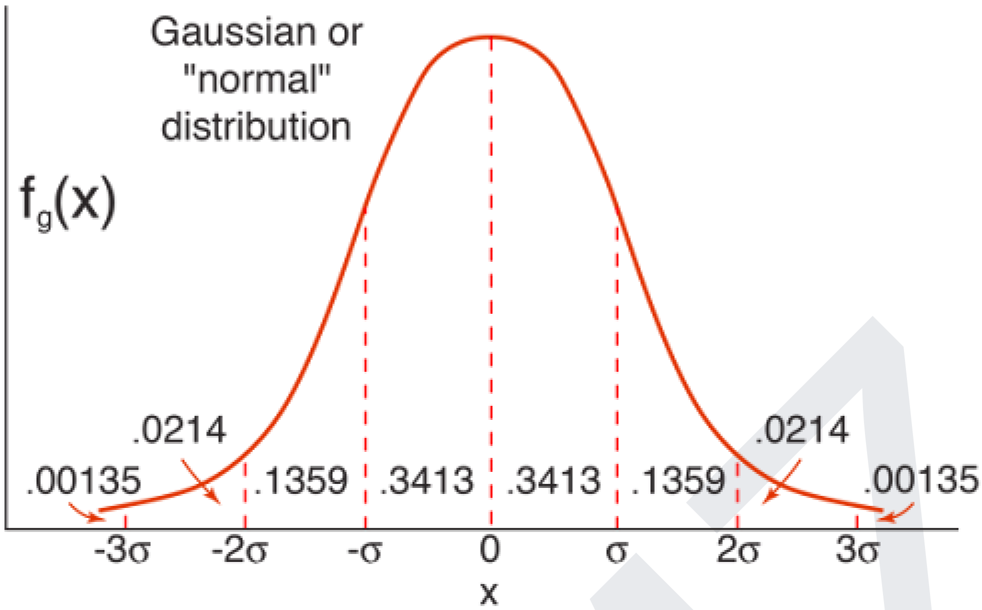
Gaussian blur is a widely used image processing technique to reduce noise and detail in an image. It works by applying a Gaussian function to the image, which smooths out pixel values and blends neighboring pixels based on their proximity to the center of a convolution kernel.

The Gaussian function is a bell-shaped curve described by the equation below:



$$G(x, y) = \frac{1}{2\pi\sigma^2} \cdot \exp\left(-\frac{x^2 + y^2}{2\sigma^2}\right)$$

Where:

- x and y are the coordinates of a pixel relative to the center of the kernel.
- **sigma** is the **standard deviation** of the Gaussian distribution, which controls the amount of blurring. A larger σ\sigmaσ produces a more spread-out blur.
- The function decreases as x and y move away from the center of the kernel.