

IMAGE SMOOTHING

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INTRODUCTION

Smoothing, also known as image filtering or image smoothing, is a technique used to remove noise and other unwanted artifacts from images. This technique can be applied to various types of noise, including salt-and-pepper noise and Gaussian noise.

1. Linear Filter (Mean Filter)
2. Order Statistics (Non-linear) filter

Mean Filter:

Linear spatial filter is simply the average of the pixels contained in the neighborhood of the filter mask. The idea is replacing the value of every pixel in an image by the average of the grey levels in the neighborhood defined by the filter mask.

Types of Mean filter:

- (i) Averaging filter: It is used in reduction of the detail in image. All coefficients are equal.
- (ii) Weighted averaging filter: In this, pixels are multiplied by different coefficients. Center pixel is multiplied by a higher value than average filter.

Order Statistics Filter:

It is based on the ordering the pixels contained in the image area encompassed by the filter. It replaces the value of the center pixel with the value determined by the ranking result. Edges are better preserved in this filtering.

Types of Order statistics filter:

- (i) Minimum filter: 0th percentile filter is the minimum filter. The value of the center is replaced by the smallest value in the window.
- (ii) Maximum filter: 100th percentile filter is the maximum filter. The value of the center is replaced by the largest value in the window.
- (iii) Median filter: Each pixel in the image is considered. First neighboring pixels are sorted and original values of the pixel is replaced by the median of the list.

Sharpening Spatial Filter: It is also known as derivative filter. The purpose of the sharpening spatial filter is just the opposite of the smoothing spatial filter. Its main focus is on the removal of blurring and highlight the edges. It is based on the first and second order derivative.

First order derivative:

Must be zero in flat segments.

Must be non zero at the onset of a grey level step.

Must be non zero along ramps.

First order derivative in 1-D is given by:

$$f' = f(x+1) - f(x)$$

Second order derivative:

Must be zero in flat areas.

Must be zero at the onset and end of a ramp.

Must be zero along ramps.

Second order derivative in 1-D is given by:

$$f'' = f(x+1) + f(x-1) - 2f(x)$$

Original



Original



Image smoothing is an operation that's used to remove noise, sharpness and clutter in the image to give you much more smoother and blended effect. With power of opencv and python, you can achieve several smoothing effects with few lines of code.

Basically the way it works is first selecting a kernel (3x3, 5x5 etc) and then convolving with image. The intensity of center pixel is determined by pixel intensities of neighborhood pixel. Depending upon kernel values and the type of aggregation you get several smoothing effects

Average Smoothing:

Here the kernel has uniform weights as shown below. Convolving with this filter simply yields average of pixel intensities in the neighborhood

We apply this filter on following image