INDIAN INSTITUTE OF TECHNOLOGY
KHARAGPUR

DIGITAL IMAGE PROCESSING LABORATORY

A REPORT ON
Experiment-3

Spatial Filtering

Group No: 10

B.Sai Manoj 17EC35007
Sanku Yogesh 17EC35020

Dept of Electronics and Electrical Communication
Engineering
Visual Information and Embedded Systems

February 15, 2021

Contents

1 Introduction

It is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement.

Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel. A pixel's neighborhood is some set of pixels, defined by their locations relative to that pixel.

Mean Filter: This filter is used for high-frequency noise reduction and image smoothing.

Median Filter: This is a non-linear filter used for noise reduction. It finds particular use in Salt Pepper noise reduction. For applying it, we find the median of all the values in the neighborhood and assign it to the center. Unlike the mean filter, it preserves edges.

Prewitt Operator: This operation is used to find the directional change in intensity in the image. This helps in the detection of edges in the image. Edge detection helps in feature extraction and sharpening of the image.

Laplacian Filter: Laplacian filter works on the principle of Laplace operator i.e. it uses second-order derivative instead of the first-order derivative to detect edges.

Sobel Operator: This operator is also used for edge detection. Sobel operator finds more edges or makes edges more visible as compared to gradient operators because in Sobel operator we have allotted more weight to the pixel intensities around the edges.

Laplacian of Gaussian: Laplacian filters are derivative filters used to find areas of rapid change (edges) in images. Since derivative filters are very sensitive to noise, it is common to smooth the image (e.g., using a Gaussian filter) before applying the Laplacian. This process is called the Laplacian of Gaussian.

2 Algorithms

Mean Filter:

1. The **Mean** function performs the filtering.
2. For each pixel the sum of all the neighbour pixels is calculated and it is divided by the square of the size of the kernel.

Median Filter:

1. The **Median** function performs the filtering.
2. For each pixel all the neighbour pixels are stored.
3. All the stored pixels are now sorted and we take the middle one.

Prewitt, Laplacian & Sobel Filters:

1. All the kernels are hard coded accordingly.
2. Now the kernels are sent into **allocateWindow**function to change the data type.
3. Now the image and the kernel are sent into the **general** function. Here the convolution is done and the output is returned.

Gaussian Filter:

1. The kernel is generated using the gaussian function and it is normalised.
2. Now the kernel and image is sent into the **convolute** function. Here the convolution is done and the output is returned.

Laplacian of Gaussian Filter:

1. The image is processed using the Gaussian Filter at first.
2. Now the output from the Gaussian Filter is sent to Laplacian Filter and the output is returned.

3 Results

We have added tracker to observe live results as there are many possibilities.

4 Analysis

1. The mean filter is used as a blur tool to round off edges in an image. It is useful when images have noise other than salt and pepper noise.
2. The median filter works exceptionally well with images containing salt and pepper noise. The outlier pixels in the image are removed by making a median of the pixels in the neighborhood, as the outliers always the highest intensity or the lowest intensity pixels.
3. The edge detection filters such as gradient, Laplacian and Sobel filters perform terribly on images with noise. It is recommended to de-noise the images using a low-pass filter such as the mean filter or the median filter.
4. The Laplacian filter, being isotropic, can detect edges in all directions. The gradient and Sobel filters can be made isotropic by superimposing the filtered outputs from horizontal, vertical and diagonal axes.
5. The laplacian edge detector is extremely sensitive to noise. LoG gives better results as it removes the noise before applying the Laplacian operator.