DSE 312, Summer 2023

Assignment 1

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Abstract

This assignment involves applying different kinds of 2-D filters on images and seeing their results. We learn to build and write a Convolution function and perform operations on it. We first apply some elementary filters and see the shifting results they have. Later, we apply custom X-Direction and Y-Direction filters for edge detection. In the end, we apply an averaging filter and Gaussian filter on images.

Keywords
Filters, Averaging Filter, Gaussian Filters, Convolution

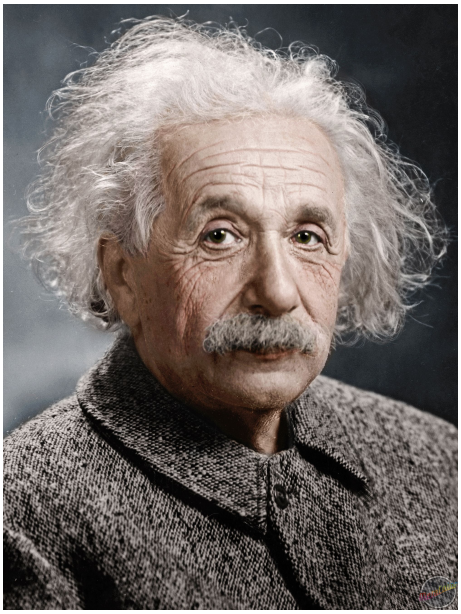

Figure 1: Input Image 1

Figure 2: Input Image 2

1 Question 1

We begin by writing a custom function to perform a Convolution(or Cross-Relation) operation on an image using a 3x3 kernel. In the first question, we then create 5 kernel matrices to perform convolutions on the image and observe the results; the results will be discussed later.

The five matrices obtained are: $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

2 Question 2

In the second question, we use two 3x3 filters and apply them on the images. $\begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$, $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$.

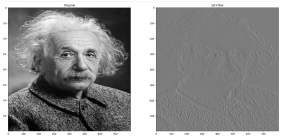

Figure 3: Result – Question 2 First Filter

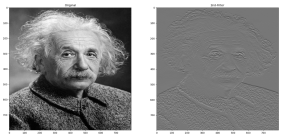

Figure 4: Result – Question 2 Second Filter

3 Question 3

In this question, we apply convolution using an average filter and a Gaussian filter on the image and see it's output.

Averagaing Filter: $\begin{bmatrix} \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \end{bmatrix}$

Gaussian Filter: $\begin{bmatrix} \frac{1}{16} & \frac{1}{8} & \frac{1}{16} \\ \frac{1}{8} & \frac{1}{4} & \frac{1}{8} \\ \frac{1}{16} & \frac{1}{8} & \frac{1}{16} \end{bmatrix}$

4 Results

For the first question, the difference between the original images and new images is not visibly apparent, and hence, by matching the shape of the original image, by dropping one layer of outermost pixels; we find the difference between the original matrix and obtained convoluted images. We observe that the shift observed is opposite to the direction in which the 1 element was kept in the matrix.

In the second question, we see that the first filter applies X-direction edge detection and the second filter applies Y-direction edge detection.

In the third question, we see that because of the Averaging filter, the intensity of the pixels has decreased in comparison to the original image. And because of the Gaussian Filter the noise in the image has reduced, and it has become smoothened.

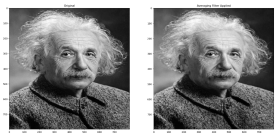

Figure 5: Result – Question 3 Averaging Filter

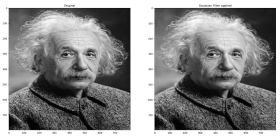

Figure 6: Result – Question 3 Gaussian Filter

5 Refernces

But what is a convolution? - 3Blue1Brown