LAPORAN PRAKTIKUM PENGOLAHAN CITRA DIGITAL
9. CONVOLUTION AND CORRELATION

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TUTORIAL : CONVOLUTION AND CORRELATION

Goal

The goal of this tutorial is to learn how to perform a correlation and convolution calculations in MATLAB.

Objectives

- Learn how to perform a correlation of two (1D and 2D) matrices.
- Learn how to perform a convolution of two (1D and 2D) matrices.
- Explore the `imfilter` function to perform correlation and convolution in MATLAB.

Procedure

We shall start by exploring convolution and correlation in one dimension. This can be achieved by means of the `imfilter` function.

1. Specify the two matrices to be used.

```
a = [0 0 0 1 0 0 0];
f = [1 2 3 4 5];
```

2. Perform convolution, using a as the input matrix and f as the filter.

```
g = imfilter(a,f,'full','conv')
```

```
>> a = [ 0 0 0 1 0 0 0];
>> f = [ 1 2 3 4 5];
>> g = imfilter(a,f,'full','conv')

g =

     0     0     0     1     2     3     4     5     0     0     0

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```

Question 1 What is the relationship between the size of the output matrix, the size of the original matrix, and the length of the filter?

length(a)+length(f)−1

Question 2 How does changing the third parameter from `'full'` to `'same'` affect the output?

Full: a+f-1, preserve all conv data Same: same as input a, keep result size consistent

3. Perform correlation on the same set of matrices.

```
h = imfilter(a,f,'full','corr')
```

```
h =

     0     0     0     5     4     3     2     1     0     0     0

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```

The results from the previous step should confirm that convolution is related to correlation by a reflection of the filter matrix, regardless of the number of dimensions involved. Let us see how correlation works on a small window of size 3 × 3. Consider the window of values extracted from a larger image in Figure 9.1. The correlation of two matrices is a sum of products. Numerically, the calculation would be as follows:

$$(140)(-1) + (108)(0) + (94)(1) + (89)(-2) + (99)(0) + (125)(2) + (121)(-1) + (134)(0) + (221)(1) = 126$$

Here, we specify the image (which in our case will be the image region as in Figure 9.1) and the mask from Figure 9.2. We will also explicitly tell the function to use correlation, as it can perform both correlation and convolution.

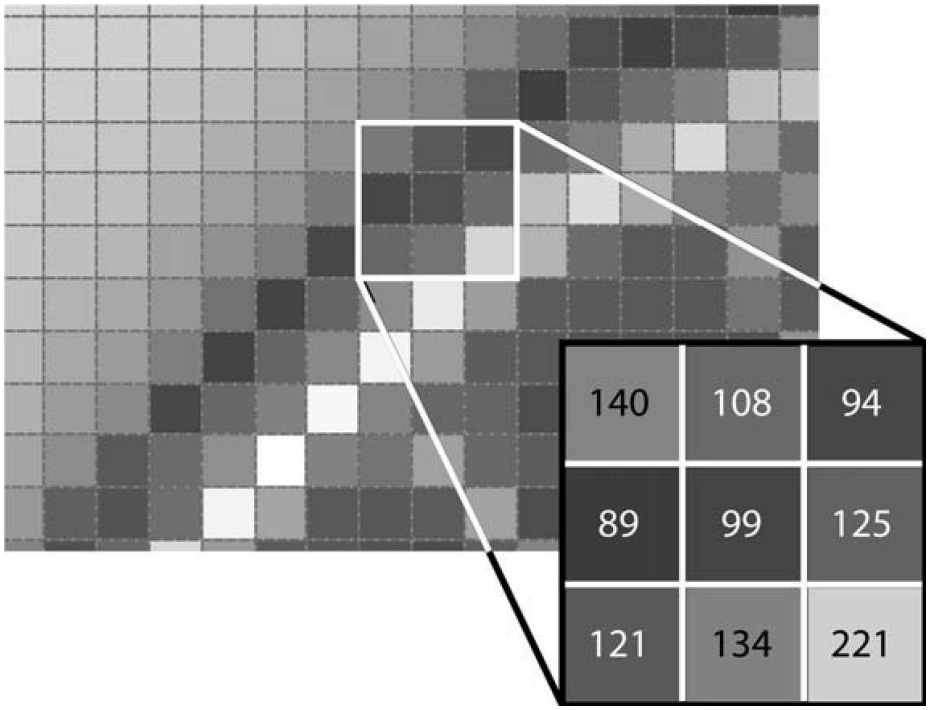

FIGURE 9.1 A 3 × 3 image region.

−1	0	1
−2	0	2
−1	0	1

FIGURE 9.2 A 3 × 3 mask.

4. Clear all workspace variables.
5. Use `imfilter` to perform a correlation of the two matrices.

```
x = [140 108 94;89 99 125;121 134 221]
y = [-1 0 1;-2 0 2;-1 0 1]
z = imfilter(x,y,'corr')
```

```
>> x = [ 140 108 94; 89 99 125; 121 131 221]
y = [-1 0 1; -2 0 2; -1 0 1]
z = imfilter(x,y,'corr')

x =

   140   108    94
    89    99   125
   121   131   221


y =

    -1     0     1
    -2     0     2
    -1     0     1


z =

   315   -56  -315
   437   126  -437
   361   236  -361

>> %valencio arjun
```

Question 3 In the resulting matrix (z), we are interested only in the center value. How does this value compare with our calculation illustrated above?

Centervalue=(−1)∗140+0∗108+1∗94+(−2)∗89+0∗99+2∗125+(−1)∗121+0∗131+1∗221 =−140+0+94+(−178)+0+250+(−121)+0+221= -140 + 0 + 94+(-178)+0+250+(-121)+0+221=−140+0+94+(−178)+0+250+(−121)+0+221=(−140+94)+(−178+250)+(−121+221)=(−46)+72+100=126= (-140 + 94) + (-178 + 250) + (-121 + 221) = (-46) + 72 + 100 = 126=(−140+94)+(−178+250)+(−121+221)=(−46)+72+100=126

Question 4 What are the other values in the resulting matrix?

The other values are the results of applying the same correlation filter centered over each pixel in x, including the edges.

Question 5 Note in the last step we did not specify if the output should be `'full'` or `'same'`. What is the default for this setting if it is not specified?

'same'

To perform convolution,weuse the same technique as in correlation. The difference here is that the filter matrix is rotated 180◦ before performing the sum of products. Again, the calculation of the convolution of the given image region and mask is performed as follows:

$$(140)(1) + (108)(0) + (94)(-1) + (89)(2) + (99)(0) + (125)(-2) + (121)(1) + (134)(0) + (221)(-1) = -126$$

6. Use `imfilter` to perform a convolution of the two matrices.

```
z2 = imfilter(x,y,'conv')
```

```
>> z2 = imfilter(x,y,'conv')

z2 =

  -315    56   315
  -437  -126   437
  -361  -236   361

>> %valencio arjun
```

Question 6 How does the center value of the resulting matrix compare with our calculation above?

imfilter(..., 'corr') applies correlation: uses the kernel as-is. imfilter(..., 'conv') applies convolution: flips the kernel both horizontally and vertically before applying.