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FACULTY OF ENGINEERING AND ARCHITECTURE
DEPARTMENT OF COMPUTER ENGINEERING
152112011 COMPUTER PROGRAMMING LAB
HOMEWORK

		Grade
Writing input image to file	:	15
Writing filter to file	:	15
Writing input grid to file	:	25
Writing output grid to file	:	25
Writing output image to file	:	20
TOTAL	**:**	**100**

PROBLEM

In this study, you will perform a filter operation on an image (matrix). Pixel values in this image vary between 0 and 255 and 0 is black, 255 is white etc. Filter operation is used in image processing to remove noise (denoising) on the image. For this purpose, various noise removal methods are available in the literature. The program consists of the followings;

1. There is an input file (**inputs.txt**) which contains four parameters ***image size (odd number), filter size (odd number), white pixel value*** and ***black pixel value***, respectively. The program must read these four parameters and make the necessary calculations. When we change these values, the output results should also change.

2. Your program must generate a input image (Red border matrix in Figure 1) of pixel values of random data and a gaussian filter (Blue border matrix in Figure 1). Gaussian filter is also another matrix and you may use given "**makeKernel.cpp"** to create it. You will need to adapt this code to your own code.

3. It would be incorrect to apply the filter on the input image directly. Because, in this case the size of the output image will decrease. For instance, when a 5x5 filter is applied to a 7x7 size input image, the output image size will decrease to 7 - 5 + 1, that is 3x3. To eliminate this undesired situation, edges of image are mirrored (Yellow parts on input grid in Figure 1) and image is placed on the **input grid** of zeros. Thus, dimension of the input image and the dimension of the output image will be equal.

4. Filtering is applied for each pixel value of the input image shown in Figure 1 with blue dashed lines. **As you see, size of edge mirror is equal to half of the filter size**. For example, if the filter size is 5 mirror size is equal to 5/2=2. In this figure, image size and filter size is 5x5 and 3x3, respectively. The calculation for the first pixel value 41 of the image is made with the following equation.

$$2.7325 = \frac{(0,0370 \ast 41 + 0,0370 \ast 41 + 0,0370 \ast 35 + 0,0370 \ast 41 + 0,0370 \ast 41 + 0,0370 \ast 35 + 0,0370 \ast 108 + 0,0370 \ast 108 + 0,0370 \ast 214)}{9}$$

   The number 9 in the denominator is the number of element of the filter and the weighted average of each pixel value is calculated with gaussian filter parameters.

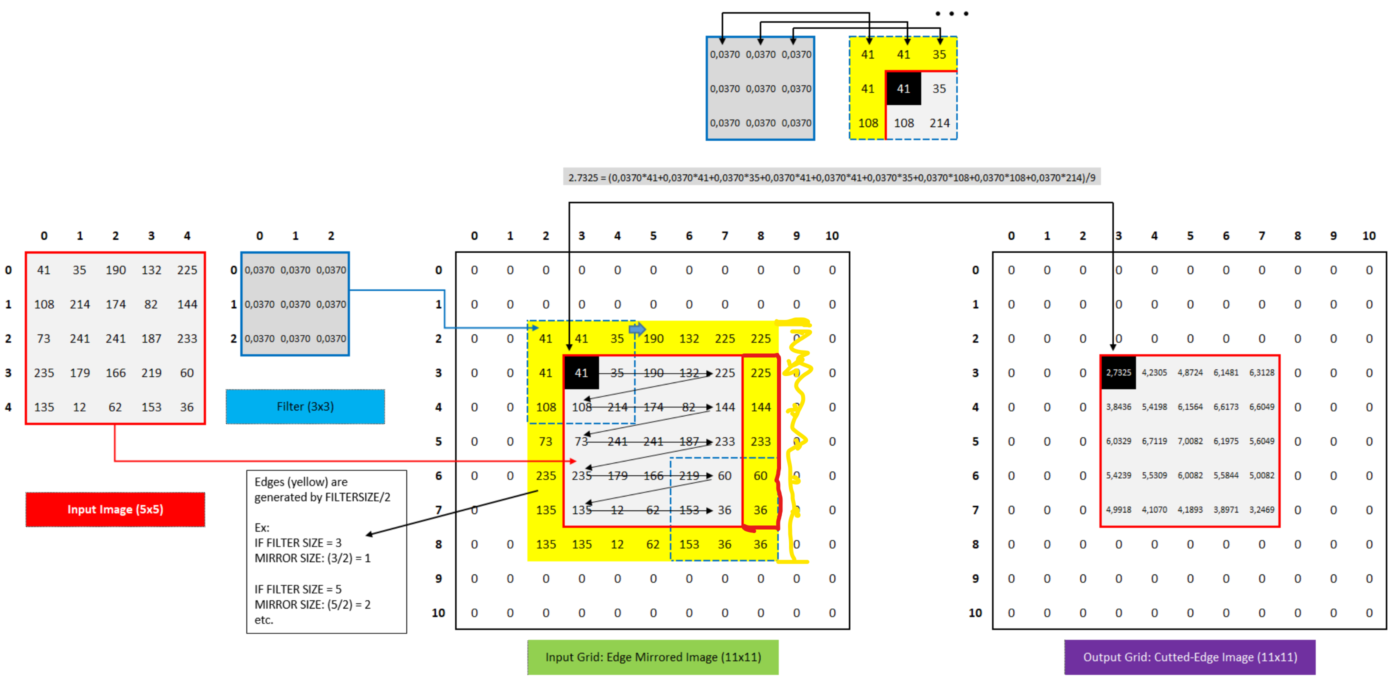
5. The edges of the mirrored image in the defined **output grid**, which is the same size as the input grid,

are cut off.

6. The output image is obtained by extracting from the output grid, thus it is the same size with the input image.

7. As a result, your program should generate an output file (**output.txt**) containing the followings;

   i. input image,
   ii. gaussian filter,
   iii. input grid,
   iv. output grid and
   v. filtered output image.



Input Image (5x5)

	0	1	2	3	4
0	41	35	190	132	225
1	108	214	174	82	144
2	73	241	241	187	233
3	235	179	166	219	60
4	135	12	62	153	36

Filter (3x3)

	0	1	2
0	0,0370	0,0370	0,0370
1	0,0370	0,0370	0,0370
2	0,0370	0,0370	0,0370

Input Grid: Edge Mirrored Image (11x11)

	0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	41	41	35	190	132	225	225	0	0
3	0	0	41	41	35	190	132	225	225	0	0
4	0	0	108	108	214	174	82	144	144	0	0
5	0	0	73	73	241	241	187	233	233	0	0
6	0	0	235	235	179	166	219	60	60	0	0
7	0	0	135	135	12	62	153	36	36	0	0
8	0	0	135	135	12	62	153	36	36	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0

Output Grid: Cutted-Edge Image (11x11)

	0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	2,7325	4,2305	4,8724	6,1481	6,3128	0	0	0
4	0	0	0	3,8436	5,4198	6,1564	6,6173	6,6049	0	0	0
5	0	0	0	6,0329	6,7119	7,0082	6,1975	5,6049	0	0	0
6	0	0	0	5,4239	5,5309	6,0082	5,5844	5,0082	0	0	0
7	0	0	0	4,9918	4,1070	4,1893	3,8971	3,2469	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0

Figure 1. Filter operation example

Output formats

Numeric values in the output file must be 4 floating points and at least 9 characters must be reserved for them.

Limits of matrices

	Max
Input image	9x9
Gaussian filter	9x9
Input grid	21x21
Output grid	21x21

WARNING!

YOUR PROGRAM WILL BE CHECKED FOR PLAGIARISM WITH A 3rd PARTY SOFTWARE. THEREFORE, YOU SHOULD DEVELOP YOUR ALGORITHM AND CODE COMPLETELY BY YOURSELF.