

Original image in grayscale: -



Image after it has been run through the smearing routine: -



***Do you notice any particular differences? Do you notice anything odd about the resulting image?
How would you modify this to use an arbitrary [n by m] sized filter?***

After zooming on characters, I observed the characters of original image had noise on black color as it was not smooth after applying smoothing filter the characters become smooth.

For converting the filter into an N by M filter we will make below changes in logical block of the code:

```
for row = floor(m/2)+1 : (dimensions(1) - floor(m/2)+1)
    for col = floor(n/2)+1 : (dimensions(2) - floor(n/2)+1 )
        sum = 0;
        for ii = - floor(m/2) : floor(m/2)
            for kk = - floor(n/2) : floor(n/2)
                sum = sum + input_image( row + kk , col + ii);
            end
        end
        output_image( row, col ) = sum / m*n;
    end
end
```

Description : -

Each pixel of the input image has accessed by outer nested for loops and for each pixel $m \times n - 1$ neighbouring pixels values were accessed using inner nested for loops. Then the average of pixel intensity was calculated with its' neighbouring $m \times n$ pixels. Then calculated average value was assigned to the pixel itself.

Outer nested loops start from row number $\text{floor}(m/2)+1$, col number $\text{floor}(n/2)+1$ and go up to row number = number of rows - $\text{floor}(m/2)+1$ and col = number of col - $\text{floor}(n/2)+1$, because inner nested loop while accessing neighbouring pixels access the previous and next $\text{floor}(m/2)$ rows and col for each pixel. Hence by running outer nested loop between row number $\text{floor}(m/2)+1$, col number $\text{floor}(n/2)+1$ and row number = number of row - $\text{floor}(n/2)$ and col number = number of col - $\text{floor}(n/2)$ we avoided array/matrix out of index run time exception.

2.

Input image: -



Discuss the results that you get with different sized blurring amounts that were applied in part a. I tried various value of sigma for .001 to 50, best results I have received with value of .001



What impact does larger standard deviations cause?

Higher SD make input image bluer, due to smoothing and we lost edge details in image

What do smaller standard deviations cause?

Small SD does not provide proper smoothing to the input image due to which noise remain in input image.