Difference of Gaussians

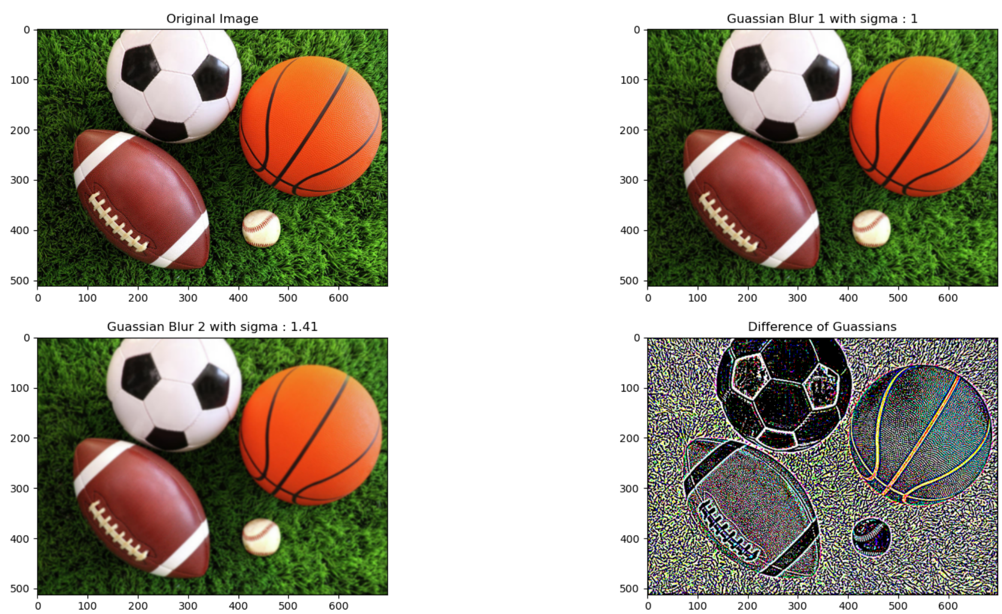
Task-a

Q : To prove that the difference of gaussians acts like a bandpass filter.

As we know gaussian filtering blurs the image. In blurring some of the crisp spatial information(edges,corners etc) will be lost. By blurring with different σ values the smoothing of the image varies. A high σ has more blurring.

In the difference of gaussians we subtract one gaussian blurred image with another gaussian blurred image. By such an operation we remove high frequency components like edges, corners etc. What will be removed depends upon again σ.

Both smoothed images contain low freq components and lower σ smoothed additionally contains some high frequency components also. When subtracted we will get components starting from a certain frequency and ending at a certain frequency. So DOG is Band pass filter.



Note : Please refer to high quality images provided in the submission folder.

Task b:

Q : Observation on blob detection, edge detection and edge localization

Since we can vary the $\sigma1$ *and* $\sigma2$ a variety of cases will be possible with different bandpass frequencies. We will see three cases out of them.

Case 1: $\sigma1 << \sigma2$, $\sigma1$ is small

$\sigma1 = 1 \quad and \quad \sigma2 = 2.5 \quad and \quad window\ size = 15$

By using this sort of standard deviation in gaussian kernel, the DoG will lead

1. Low frequency noise edge will be present in output
2. Small and minor changes appear
3. Overall noise is bit compared to all three cases
4. Edge detection is bit bulky not very clear/precise edges
5. Edge localization is also bulky and spread around. Additional algorithms have to be employed for clear edges.
6. Blob detection is also not good. Good amount of noise is present, reducing SNR.

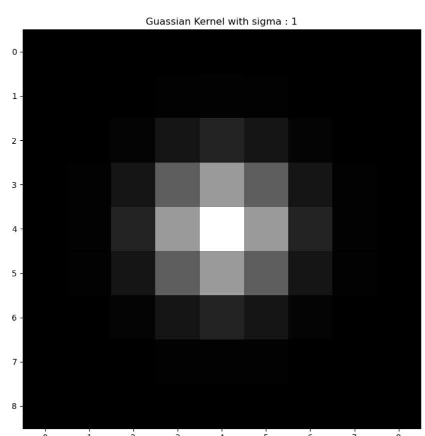
Case 2: $\sigma1 \sim = \sigma2$, $\sigma1$ is large
$\sigma1 = 5 \quad and \quad \sigma2 = 5.5 \quad and \quad window\ size = 33$

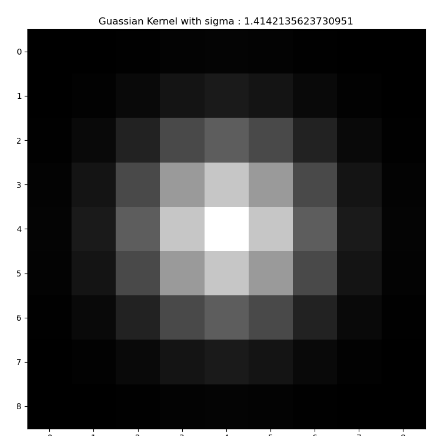
1. High amount of noise is present.
2. Edge localization is also very bulky and not very precise to locations.
3. Edge detection is also not good with all unwanted edges(low frequency components)
4. Blob detection is also not good with high pixel width on the edges. But necessary blobs are detected.

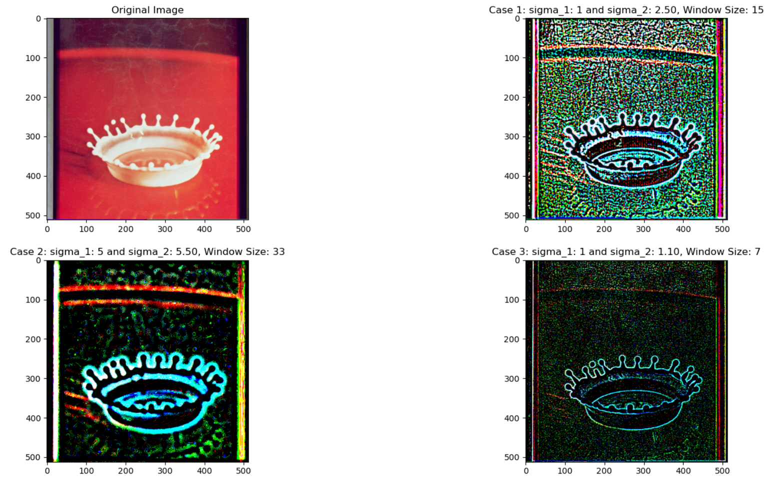
Case 3: $\sigma1 \sim = \sigma2$, $\sigma1$ is small
$\sigma1 = 1 \quad and \quad \sigma2 = 1.1 \quad and \quad window\ size = 7$

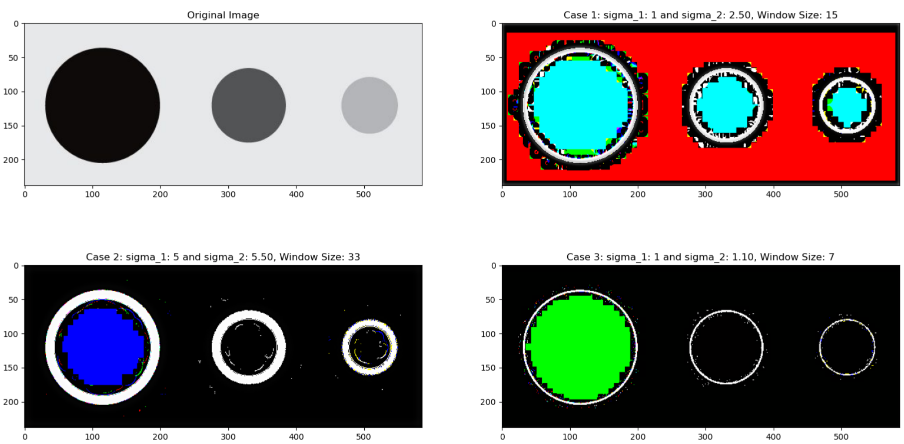
1. Low noise in the difference of gaussian.
2. Edge detection is good with all prominent edges.
3. Edge localization is precise and sharp. This is crucial for most of the tasks.
4. Blob detection is also good with original clear shapes

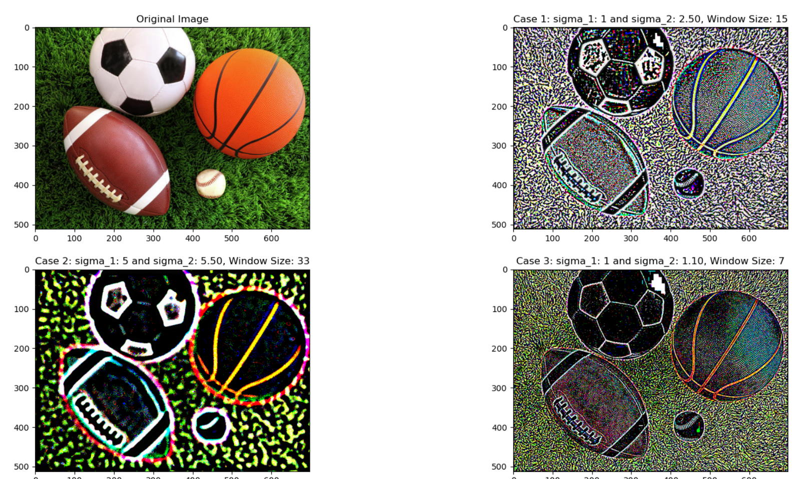
Resultant Images:






Original Image
Case 1: sigma_1: 1 and sigma_2: 2.50, Window Size: 15
Case 2: sigma_1: 5 and sigma_2: 5.50, Window Size: 33
Case 3: sigma_1: 1 and sigma_2: 1.10, Window Size: 7


Original Image
Case 1: sigma_1: 1 and sigma_2: 2.50, Window Size: 15
Case 2: sigma_1: 5 and sigma_2: 5.50, Window Size: 33
Case 3: sigma_1: 1 and sigma_2: 1.10, Window Size: 7


Original Image
Case 1: sigma_1: 1 and sigma_2: 2.50, Window Size: 15
Case 2: sigma_1: 5 and sigma_2: 5.50, Window Size: 33
Case 3: sigma_1: 1 and sigma_2: 1.10, Window Size: 7