Assignment 1

Solution 1(a).

Gaussian Kernel using f(x,y) = 1/sqrt(2*pi*sigma^2) * exp(-(X^2+Y^2)/2*sigma^2) where -4<X,Y<4 and Normalized using divide every element by sum of all element of Kernel.

(1). Gaussian filter Kernel of size 9x9 with standard deviation of 1.

9x9 double

	1	2	3	4	5	6	7	8	9
1	1.7911e-...	5.9312e-...	7.2257e-...	3.2383e-...	5.3391e-...	3.2383e-...	7.2257e-...	5.9312e-...	1.7911e-...
2	5.9312e-...	1.9641e-...	2.3928e-...	0.0011	0.0018	0.0011	2.3928e-...	1.9641e-...	5.9312e-...
3	7.2257e-...	2.3928e-...	0.0029	0.0131	0.0215	0.0131	0.0029	2.3928e-...	7.2257e-...
4	3.2383e-...	0.0011	0.0131	0.0586	0.0965	0.0586	0.0131	0.0011	3.2383e-...
5	5.3391e-...	0.0018	0.0215	0.0965	0.1592	0.0965	0.0215	0.0018	5.3391e-...
6	3.2383e-...	0.0011	0.0131	0.0586	0.0965	0.0586	0.0131	0.0011	3.2383e-...
7	7.2257e-...	2.3928e-...	0.0029	0.0131	0.0215	0.0131	0.0029	2.3928e-...	7.2257e-...
8	5.9312e-...	1.9641e-...	2.3928e-...	0.0011	0.0018	0.0011	2.3928e-...	1.9641e-...	5.9312e-...
9	1.7911e-...	5.9312e-...	7.2257e-...	3.2383e-...	5.3391e-...	3.2383e-...	7.2257e-...	5.9312e-...	1.7911e-...

(2). Gaussian filter Kernel of size 9x9 with standard deviation of 3.

9x9 double

	1	2	3	4	5	6	7	8	9
1	0.0040	0.0059	0.0077	0.0091	0.0096	0.0091	0.0077	0.0059	0.0040
2	0.0059	0.0086	0.0114	0.0135	0.0142	0.0135	0.0114	0.0086	0.0059
3	0.0077	0.0114	0.0150	0.0178	0.0188	0.0178	0.0150	0.0114	0.0077
4	0.0091	0.0135	0.0178	0.0210	0.0222	0.0210	0.0178	0.0135	0.0091
5	0.0096	0.0142	0.0188	0.0222	0.0235	0.0222	0.0188	0.0142	0.0096
6	0.0091	0.0135	0.0178	0.0210	0.0222	0.0210	0.0178	0.0135	0.0091
7	0.0077	0.0114	0.0150	0.0178	0.0188	0.0178	0.0150	0.0114	0.0077
8	0.0059	0.0086	0.0114	0.0135	0.0142	0.0135	0.0114	0.0086	0.0059
9	0.0040	0.0059	0.0077	0.0091	0.0096	0.0091	0.0077	0.0059	0.0040

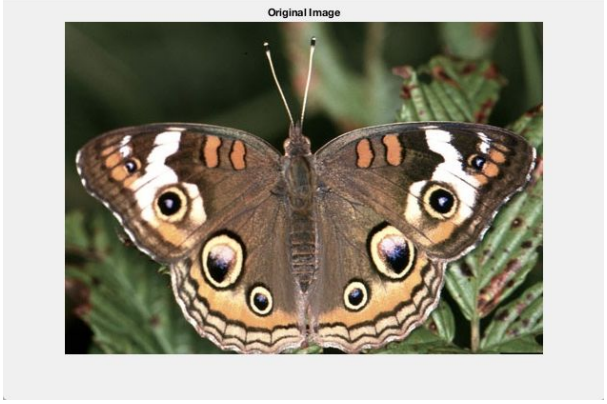
(3). Gaussian filter Kernel of size 9x9 with standard deviation of 20.

9x9 double

	1	2	3	4	5	6	7	8	9
1	0.0121	0.0122	0.0122	0.0123	0.0123	0.0123	0.0122	0.0122	0.0121
2	0.0122	0.0123	0.0124	0.0124	0.0124	0.0124	0.0124	0.0123	0.0122
3	0.0122	0.0124	0.0124	0.0125	0.0125	0.0125	0.0124	0.0124	0.0122
4	0.0123	0.0124	0.0125	0.0125	0.0125	0.0125	0.0125	0.0124	0.0123
5	0.0123	0.0124	0.0125	0.0125	0.0126	0.0125	0.0125	0.0124	0.0123
6	0.0123	0.0124	0.0125	0.0125	0.0125	0.0125	0.0125	0.0124	0.0123
7	0.0122	0.0124	0.0124	0.0125	0.0125	0.0125	0.0124	0.0124	0.0122
8	0.0122	0.0123	0.0124	0.0124	0.0124	0.0124	0.0124	0.0123	0.0122
9	0.0121	0.0122	0.0122	0.0123	0.0123	0.0123	0.0122	0.0122	0.0121

Solution 1(b).

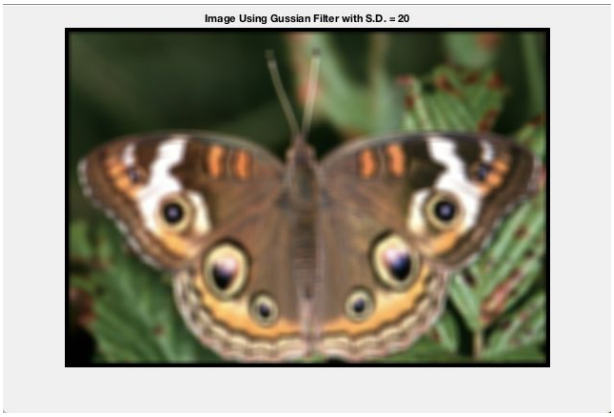
As we increase the standard deviation of Gaussian filter 1,3 and 20 the image becomes more blurry. So as the sigma increases means more variance allowed around mean and we are looking for broad scene information without paying attention to the detail exits.



(1). Original Image

(2). Image Using Gaussian Filter S=1

(3). Image Using Gaussian Filter S=3



(3). Image Using Gaussian Filter S=20

Solution 2(a).

i). Difference of Gaussian (DoG) filter of size 11x11 where sigma1>sigma2>1.

ii). DoG(x,y) = Gs1(X,Y) - Gs2(X,Y) where -5<X,Y<5 and s1=4 and s2=2.

Gs(X,Y) with standard deviation 4.

m1

11x11 double

	1	2	3	4	5	6	7	8	9	10	11
1	0.0030	0.0040	0.0050	0.0058	0.0064	0.0066	0.0064	0.0058	0.0050	0.0040	0.0030
2	0.0040	0.0053	0.0066	0.0077	0.0084	0.0087	0.0084	0.0077	0.0066	0.0053	0.0040
3	0.0050	0.0066	0.0082	0.0096	0.0105	0.0108	0.0105	0.0096	0.0082	0.0066	0.0050
4	0.0058	0.0077	0.0096	0.0112	0.0123	0.0127	0.0123	0.0112	0.0096	0.0077	0.0058
5	0.0064	0.0084	0.0105	0.0123	0.0135	0.0139	0.0135	0.0123	0.0105	0.0084	0.0064
6	0.0066	0.0087	0.0108	0.0127	0.0139	0.0144	0.0139	0.0127	0.0108	0.0087	0.0066
7	0.0064	0.0084	0.0105	0.0123	0.0135	0.0139	0.0135	0.0123	0.0105	0.0084	0.0064
8	0.0058	0.0077	0.0096	0.0112	0.0123	0.0127	0.0123	0.0112	0.0096	0.0077	0.0058
9	0.0050	0.0066	0.0082	0.0096	0.0105	0.0108	0.0105	0.0096	0.0082	0.0066	0.0050
10	0.0040	0.0053	0.0066	0.0077	0.0084	0.0087	0.0084	0.0077	0.0066	0.0053	0.0040
11	0.0030	0.0040	0.0050	0.0058	0.0064	0.0066	0.0064	0.0058	0.0050	0.0040	0.0030

Gs(X,Y) with standard deviation 2.

m2

11x11 double

	1	2	3	4	5	6	7	8	9	10	11
1	7.7655e-...	2.3920e-...	5.7380e-...	0.0011	0.0016	0.0018	0.0016	0.0011	5.7380e-...	2.3920e-...	7.7655e-...
2	2.3920e-...	7.3677e-...	0.0018	0.0033	0.0048	0.0054	0.0048	0.0033	0.0018	7.3677e-...	2.3920e-...
3	5.7380e-...	0.0018	0.0042	0.0079	0.0115	0.0131	0.0115	0.0079	0.0042	0.0018	5.7380e-...
4	0.0011	0.0033	0.0079	0.0148	0.0215	0.0244	0.0215	0.0148	0.0079	0.0033	0.0011
5	0.0016	0.0048	0.0115	0.0215	0.0313	0.0355	0.0313	0.0215	0.0115	0.0048	0.0016
6	0.0018	0.0054	0.0131	0.0244	0.0355	0.0402	0.0355	0.0244	0.0131	0.0054	0.0018
7	0.0016	0.0048	0.0115	0.0215	0.0313	0.0355	0.0313	0.0215	0.0115	0.0048	0.0016
8	0.0011	0.0033	0.0079	0.0148	0.0215	0.0244	0.0215	0.0148	0.0079	0.0033	0.0011
9	5.7380e-...	0.0018	0.0042	0.0079	0.0115	0.0131	0.0115	0.0079	0.0042	0.0018	5.7380e-...
10	2.3920e-...	7.3677e-...	0.0018	0.0033	0.0048	0.0054	0.0048	0.0033	0.0018	7.3677e-...	2.3920e-...
11	7.7655e-...	2.3920e-...	5.7380e-...	0.0011	0.0016	0.0018	0.0016	0.0011	5.7380e-...	2.3920e-...	7.7655e-...

DoG(x,y) = Gs1(X,Y) - Gs2(X,Y) where -5<X,Y<5 and s1=4 and s2=2.

11x11 double

	1	2	3	4	5	6	7	8	9	10	11
1	0.0029	0.0038	0.0044	0.0047	0.0048	0.0048	0.0048	0.0047	0.0044	0.0038	0.0029
2	0.0038	0.0045	0.0048	0.0044	0.0036	0.0033	0.0036	0.0044	0.0048	0.0045	0.0038
3	0.0044	0.0048	0.0039	0.0017	-0.0010	-0.0022	-0.0010	0.0017	0.0039	0.0048	0.0044
4	0.0047	0.0044	0.0017	-0.0036	-0.0092	-0.0117	-0.0092	-0.0036	0.0017	0.0044	0.0047
5	0.0048	0.0036	-0.0010	-0.0092	-0.0178	-0.0216	-0.0178	-0.0092	-0.0010	0.0036	0.0048
6	0.0048	0.0033	-0.0022	-0.0117	-0.0216	-0.0259	-0.0216	-0.0117	-0.0022	0.0033	0.0048
7	0.0048	0.0036	-0.0010	-0.0092	-0.0178	-0.0216	-0.0178	-0.0092	-0.0010	0.0036	0.0048
8	0.0047	0.0044	0.0017	-0.0036	-0.0092	-0.0117	-0.0092	-0.0036	0.0017	0.0044	0.0047
9	0.0044	0.0048	0.0039	0.0017	-0.0010	-0.0022	-0.0010	0.0017	0.0039	0.0048	0.0044
10	0.0038	0.0045	0.0048	0.0044	0.0036	0.0033	0.0036	0.0044	0.0048	0.0045	0.0038
11	0.0029	0.0038	0.0044	0.0047	0.0048	0.0048	0.0048	0.0047	0.0044	0.0038	0.0029

Solution 2(b).

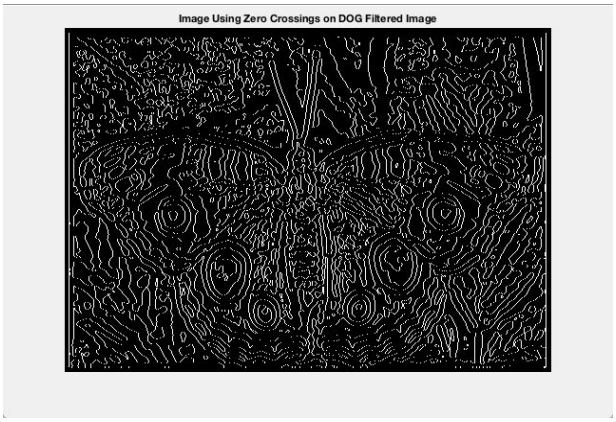
In DoG filter we are subtracting one blurred image obtained by convolving the original image with Gaussian kernel with less blurred version of original image.It is used for feature enhancement algorithm such as increase the visibility of edges, smooth of sample image and blob detection in the scale-invariant feature transform.

(1). Original Gray Image

(2) Image using DOG Filter

Solution 2(c). Zero crossing looks for places in the Laplacian of an image where the slope changes its sign(+ive to -ive or -ive to +ive). Such points frequently occurs at edges in image.
Kernel : m3=[0 1 0;1 -4 1;0 1 0];

(1). Image using DOG Filter(Input)



(2). Binary Image detecting Zero Crossing