Programming Design Writeup for Assignment 2:

Scale Space using Laplacian of Gaussian operator;

Unsharp Masking, and Sobel Operator;

Tim Hung <thung1@binghamton.edu>

CS 455/555

Professor Lijun Yin

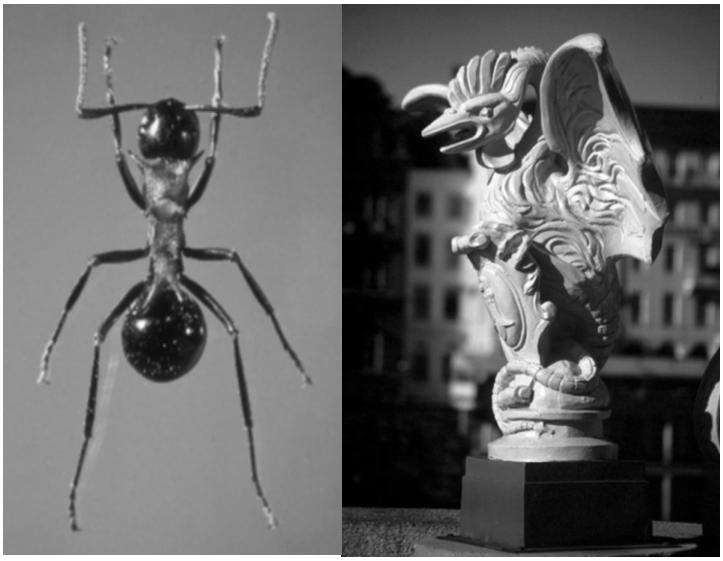
11 October 2016

1. Obtaining images

I first obtain the two provided images, “ant” and “basel,” in TIFF format.

2. Unsharp Masking

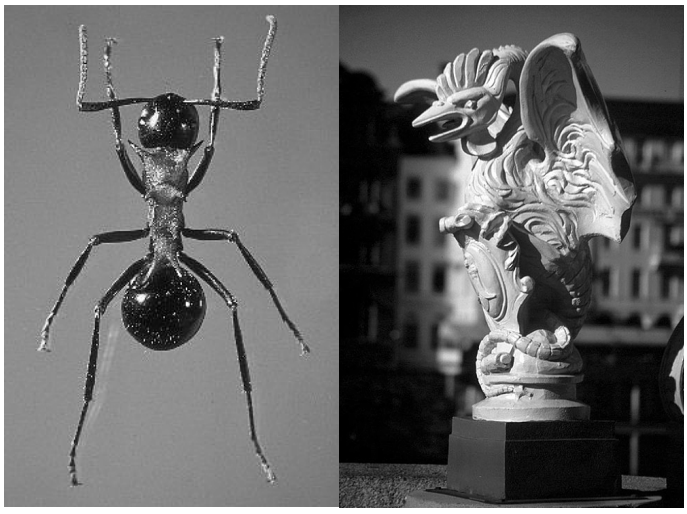
To apply the Unsharp Masking method to create an enhanced edge image, I first run a Gaussian Blur over the images.



Blurred Images

Next, I added the original image with the difference of the original image and the blurred image to obtain the enhanced image.

$$enhanced = original + (original - blurred)$$



Enhanced Edge Image

3. Sobel Operator

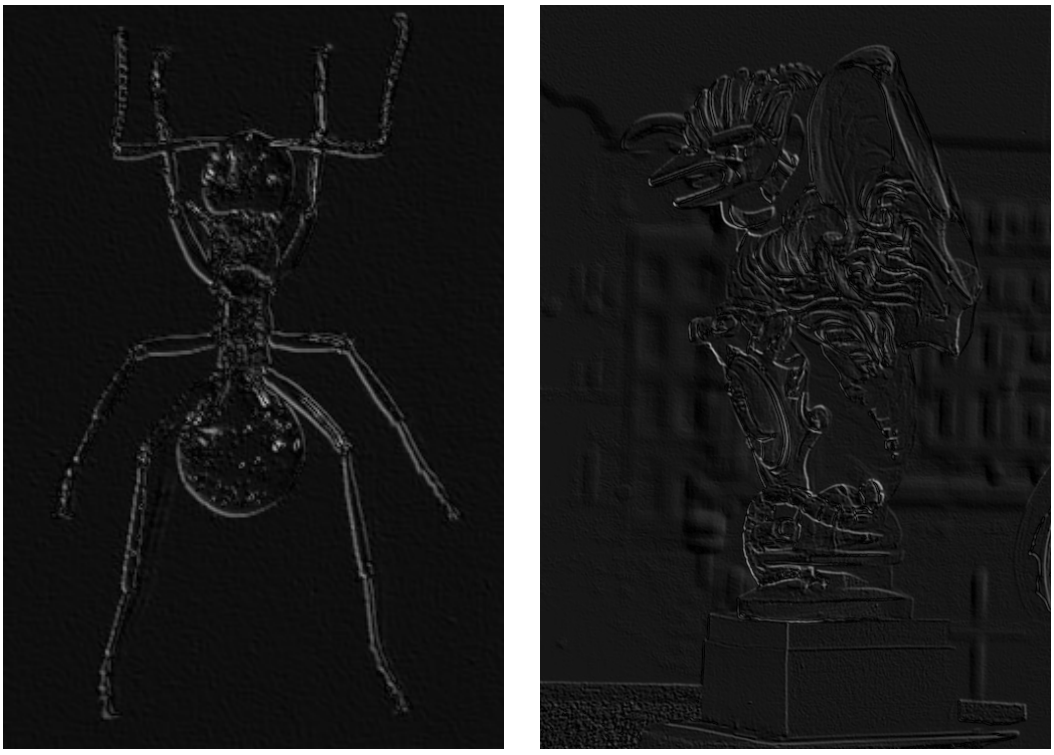
I apply two 3x3 kernels to accentuate horizontal and vertical changes in intensity, to generate two gradient images, Gx and Gy. Next, I combine the two gradient images using the Pythagorean Theorem to generate the edge image.

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

Horizontal Kernel

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

Vertical Kernel



Edge Image from Sobel Operator application

4. Laplacian of Gaussian Mask

Using the following function:

$$L(x,y)=\left(\frac{1}{\sqrt{2\pi\sigma^2}}\right)^2\left(\frac{x^2y^2}{\sigma^2}-2\right)e^{\frac{-x^2y^2}{2\sigma^2}}$$

I generate the two Laplacian of Gaussian masks.

5	11	16	18	16	11	5
11	18	10	1	10	18	11
16	10	-40	-78	-40	10	16
18	1	-78	-136	-78	1	18
16	10	-40	-78	-40	10	16
11	18	10	1	10	18	11
5	11	16	18	16	11	5

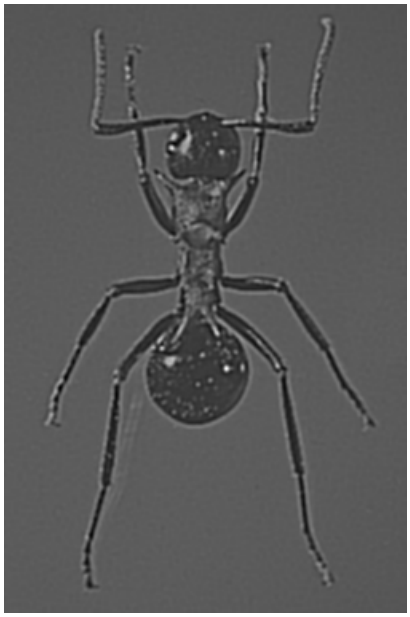
Laplacian of Gaussian of size 7x7 with σ=1.4

0	-1	-2	-3	-4	-4	-4	-3	-2	-1	0
-1	-2	-4	-5	-6	-6	-6	-5	-4	-2	-1
-2	-4	-6	-7	-8	-9	-8	-7	-6	-4	-2
-3	-5	-7	-9	-10	-11	-10	-9	-7	-5	-3
-4	-6	-8	-10	-12	-12	-12	-10	-8	-6	-4
-4	-6	-9	-11	-12	-13	-12	-11	-9	-6	-4
-4	-6	-8	-10	-12	-12	-12	-10	-8	-6	-4
-3	-5	-7	-9	-10	-11	-10	-9	-7	-5	-3
-2	-4	-6	-7	-8	-9	-8	-7	-6	-4	-2
-1	-2	-4	-5	-6	-6	-6	-5	-4	-2	-1
0	-1	-2	-3	-4	-4	-4	-3	-2	-1	0

Laplacian of Gaussian of size 11x11 with σ=5.0

5. Applying L.o.G. Masks

I apply the two generated Laplacian of Gaussian masks to our original images.




Applying 7x7, σ=1.4 mask


Applying 11x11, σ=5.0 mask

It is clear that the application of the 7x7 mask results in far more edge detail. This is because the 11x11 mask has a very large σ value of 5.0, while the 7x7 only has a σ of 1.4.