# ECE 438 Digital Signal Processing
# Week 14: Image Processing (Lab 10a)

Date 4/29/2020

Section 2

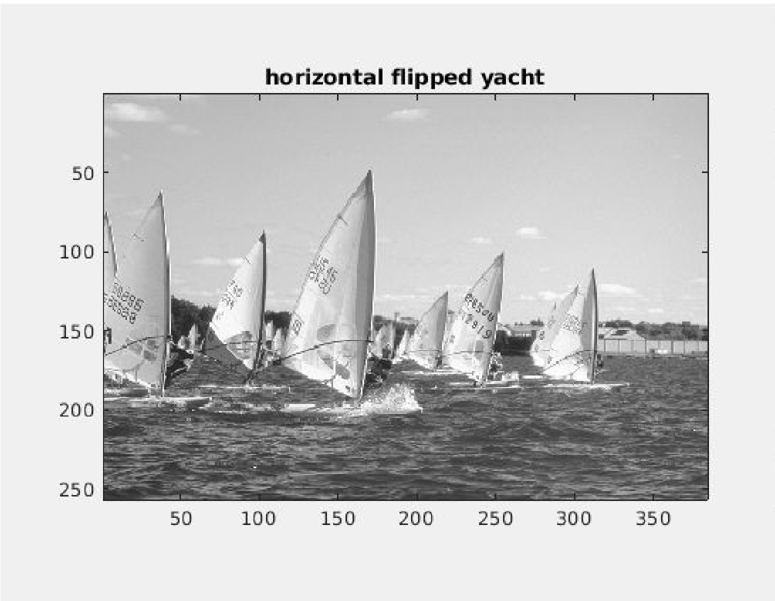
| Name | Sign | Time spent outside lab |
|---|---|---|
| David Dang [ %] | David Dang | 19 hrs |
| Benedict Lee [ %] | Benedict Lee | 24 hrs |

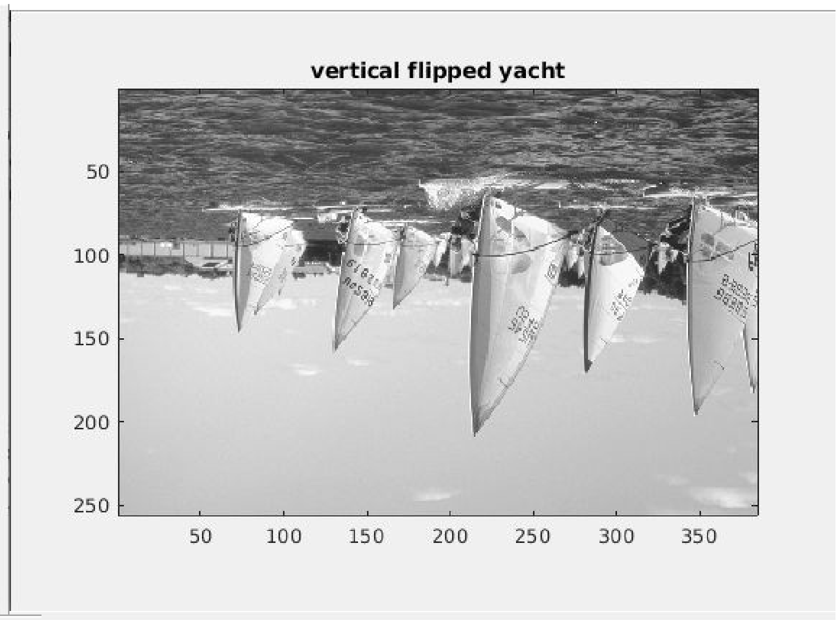
## Grading Rubric (Spring 2020)

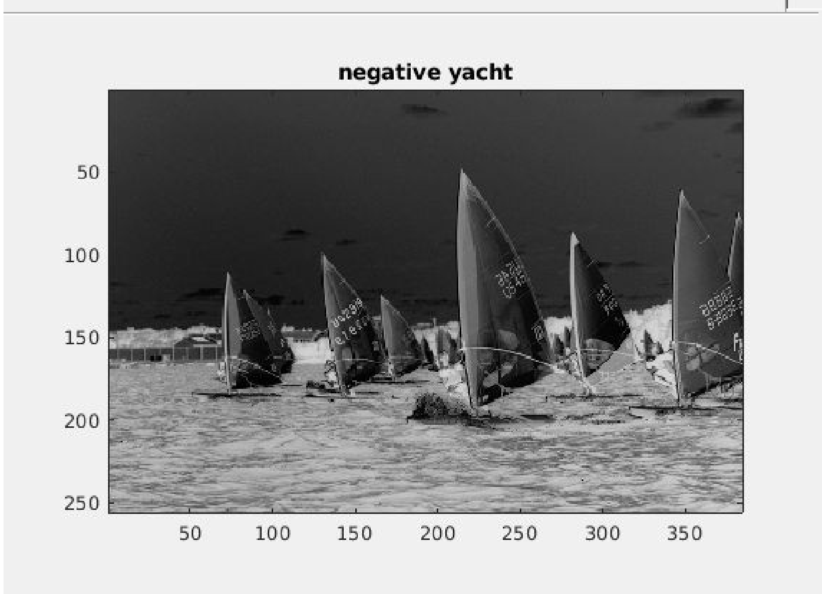
| | below expectations | lacks in some respect | meets all expectations |
|---|---|---|---|
| Completeness of the report | | | |
| Organization of the report<br>*One-sided, with cover sheet, answers are in the same order as questions in the lab, copies of the questions* | | | |
| Quality of figures<br>*Correctly labeled with title, x-axis, y-axis, and name(s)* | | | |
| Ability to process images with simple operations (15 pts)<br>*Output images, question* | | | |
| Understanding of pixel distribution and linear transformation (25 pts)<br>*Output images, histograms, code(pointTrans), questions* | | | |
| Understanding of gamma correction (15 pts)<br>*Output image, code(gammCorr), questions* | | | |
| Understanding of image smoothing and sharpening (45 pts)<br>*Output images, codes(gaussFilter, medianFilter), frequency response, questions* | | | |

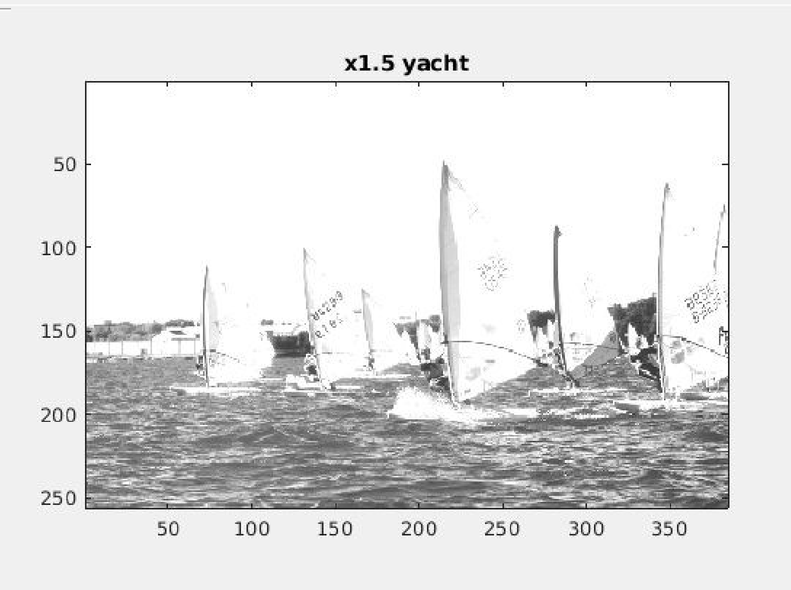
ECE 438 Lab 10a
David Dang & Benedict Lee

**2.1 Exercise**
**INLAB REPORT:**
1. Hand in two flipped images.
2. Hand in the negative image.
3. Hand in the image multiplied by factor of 1.5. What effect did this have?



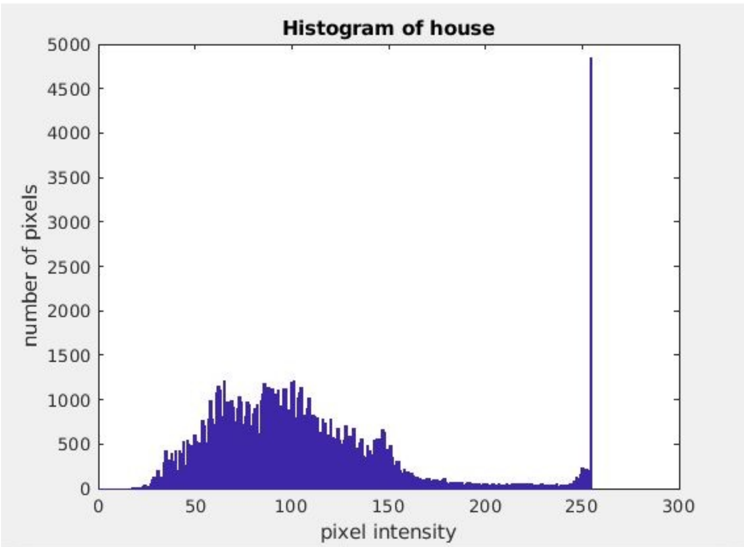




- Multiplying the image by 1.5 caused the image to become brighter by increasing the pixel values

## 3.1 Histogram of an Image

**INLAB REPORT:**

Hand in your labeled histogram. Comment on the distribution of the pixel intensities.



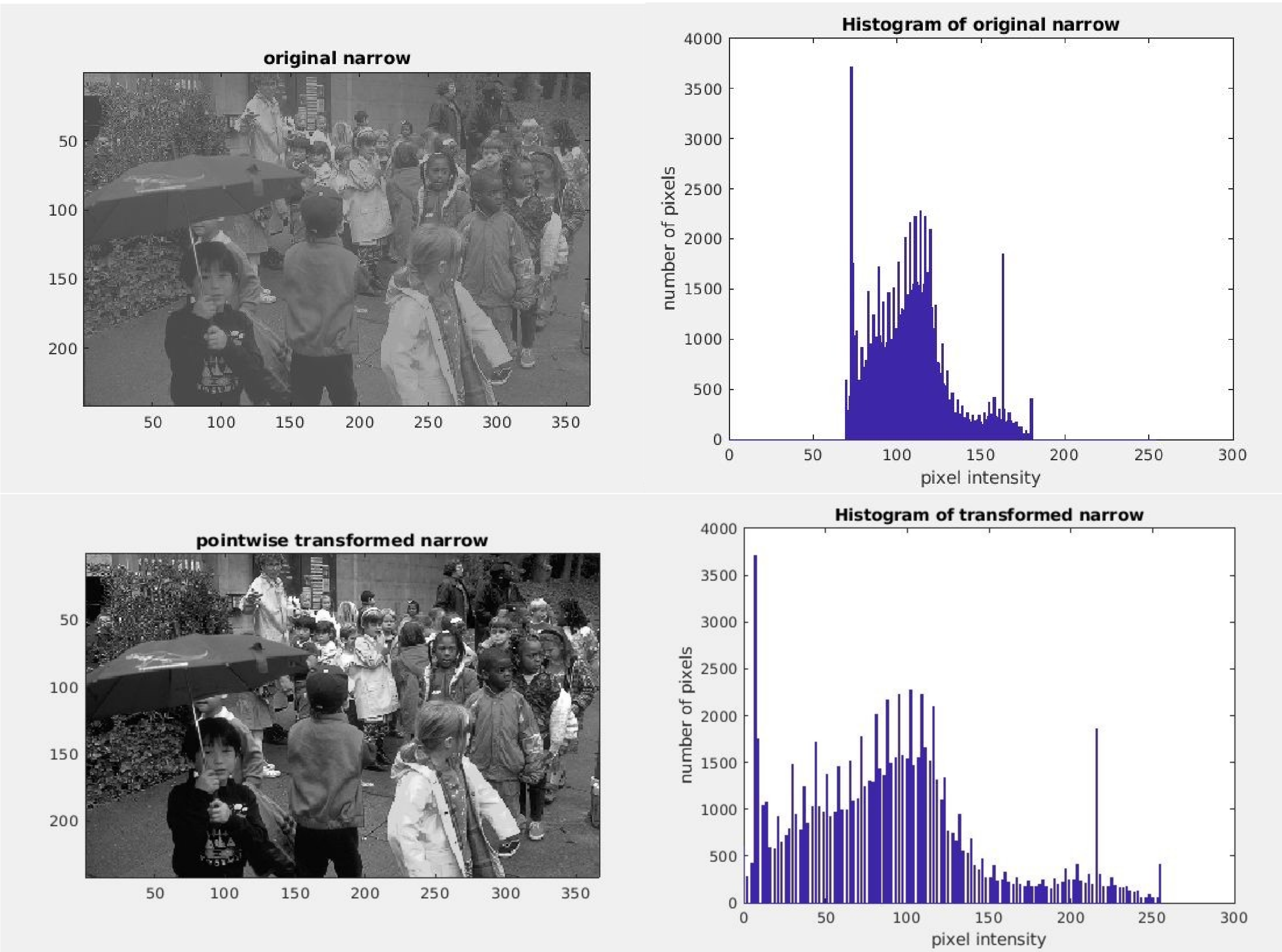

- A sizeable portion of the pixels lie in the lower range of pixel values, which makes sense due to the varying shades of grey in the picture. There appears to be a high amount of white in the picture indicated by the high number of pixels in bin 255.

## 3.2 Pointwise Transformations

**INLAB REPORT:**

1. Hand in your code for pointTrans.
2. Hand in the original image and its histogram.
3. Hand in the transformed image and its histogram.
4. What qualitative effect did the transformation have on the original image? Do you observe any negative effects of the transformation?
5. Compare the histograms of the original and transformed images. Why are there zeros in the output histogram?

```
function output = pointTrans(input, T1, T2)
output = input;
for m=1:size(input,1)
    for n=1:size(input,2)
        if(input(m,n)<=T1)
            output(m,n) = 0;
        elseif(input(m,n)>=T2)
            output(m,n) = 255;
        else
            output(m,n) = double((input(m,n)-T1))/(T2-T1)*255;
        end
    end
end
```




- The image became lighter and less cloudy. No obvious negative effects of pointwise transformation on the image were observed.
- The histogram of the pointwise transformed image is more spread out. It contains zeros because some pixels had their value reassigned and that caused the frequency of the pixel's former value to decrease.

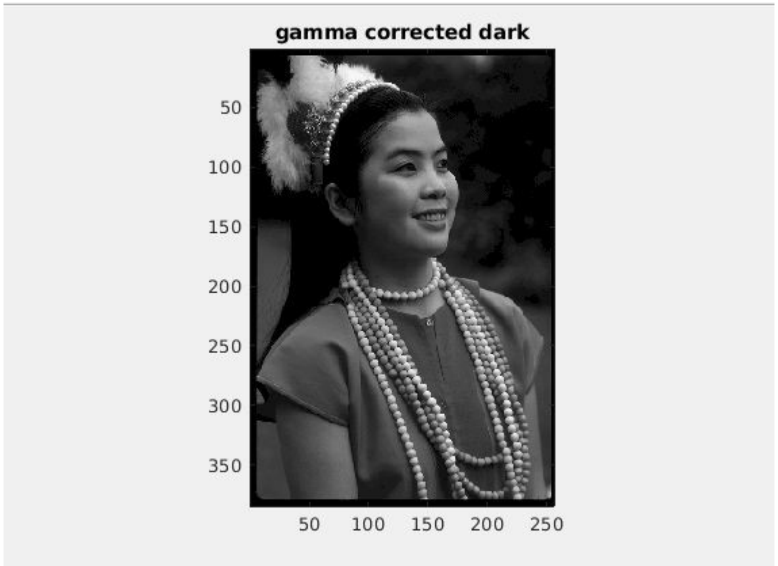
## 4 Gamma(γ) Correction

**INLAB REPORT:**

1. Hand in your code for gammCorr.
2. Hand in the γ corrected image.
3. How did the correction affect the image? Does this appear to be the correct value for γ ?

```
function B = gammCorr(A, gamma)
B = 255 * (double(A)/255).^(1/gamma);
```

- The gamma correction brightened the image. 2.2 appears to be the correct value for gamma



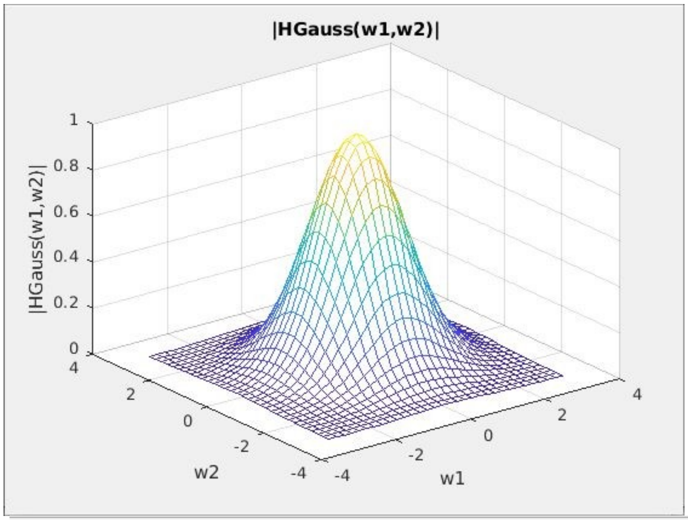

## 5.2 Smoothing Exercise

**INLAB REPORT:**

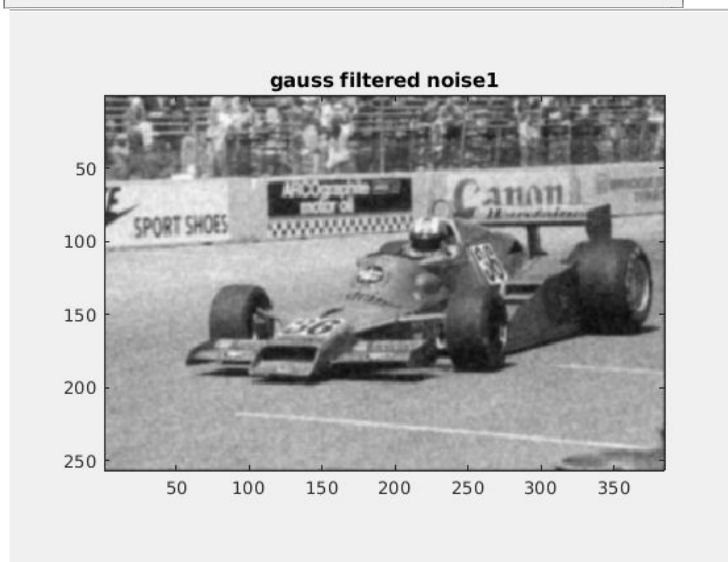
1. Hand in your code for gaussFilter and medianFilter.
2. Hand in the plot of |HGauss(ω1, ω2)|.
3. Hand in the results of filtering the noisy images (4 pictures).
4. Discuss the effectiveness of each filter for the case of additive white Gaussian noise. Discuss both positive and negative effects that you observe for each filter.
5. Discuss the effectiveness of each filter for the case of “salt & pepper” noise. Again, discuss both positive and negative effects that you observe for each filter.

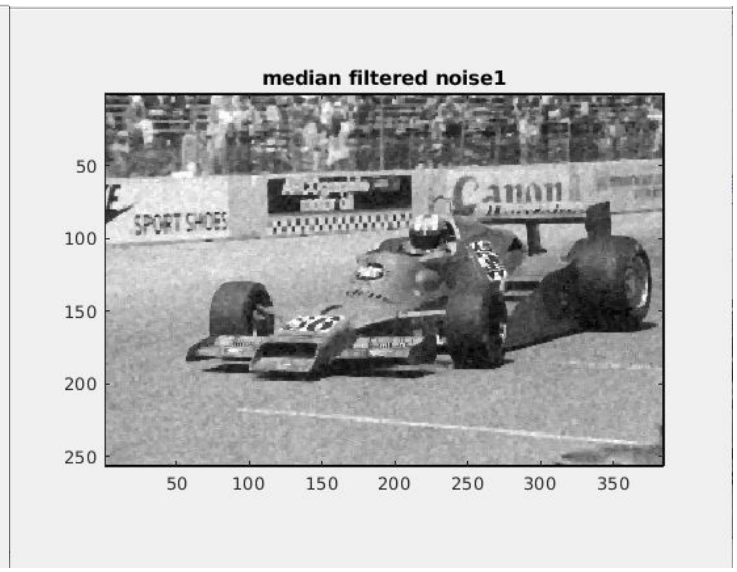
```
function h = gaussFilter(N, var)
h = fspecial('gaussian',N,sqrt(var));
```

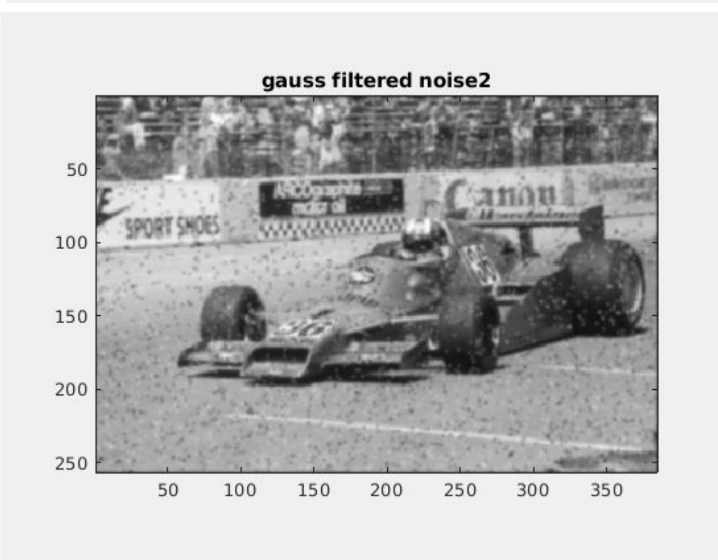
```
function Y = medianFilter(X)
[rows, cols] = size(X);
Y = zeros(rows, cols);
for a = 2:(rows-1)
    for b = 2:(cols-1)
        temp = X((a-1:a+1), (b-1:b+1));
        Y(a, b) = median(median(temp));
    end
end
```

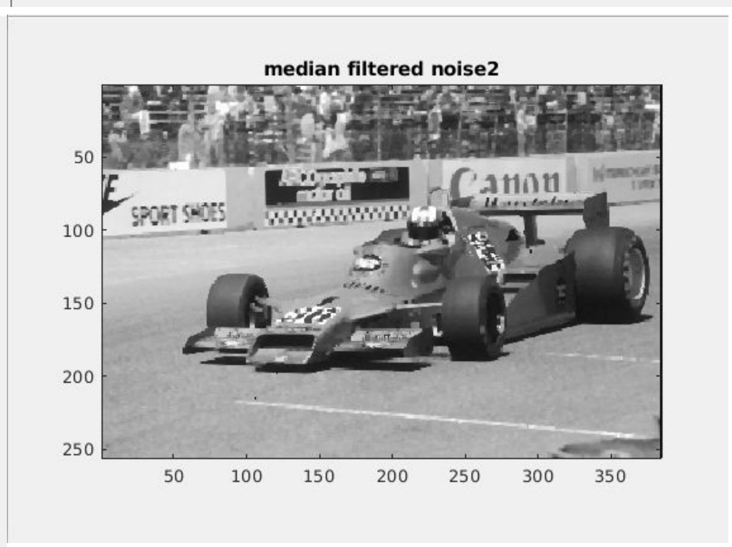



- For the case of additive white Gaussian noise, both filters seemed to remove the graininess from the photo, but resolution was lost with the median filter applied. The gaussian filter did a better job overall, but the resulting image was blurrier than the original.
- For the case of “salt and pepper” noise, the median filter did a much better job of removing the interference than the gaussian filter, but resolution was lost. The gaussian filter still had traces of noise in it.



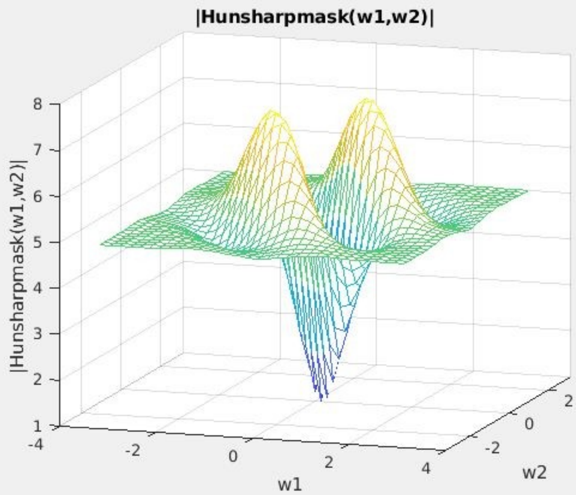



## 5.4 Sharpening Exercise

**INLAB REPORT:**

1. Hand in your derivation for the frequency response of the unsharp mask.
2. Hand in the labeled plot of the magnitude response. Compare this plot to the highpass responses of Fig. 10. In what ways is it similar to these frequency responses?
3. Hand in the two processed images.
4. Describe any positive and negative effects of the filtering that you observe. Discuss the influence of the α and β parameters.






Derivation

- Fourier transform both sides of

$g(i, j) = \alpha f(i, j) - \beta[f(i, j) ** h(i, j)]$ to get

$G = \alpha F - \beta[FH]$

- $G/F = \alpha - \beta H$

- The magnitude response of the unsharp mask filter was similar to the other high-pass responses in that it had a trough in the middle of the plot.
- A positive effect of the unsharp mask was its ability to unblur the blurred image. One negative effect of the unsharp mask was that it seemed to shrink the image a bit after it was applied. Higher values of alpha and beta appear to increase the image's contrast.