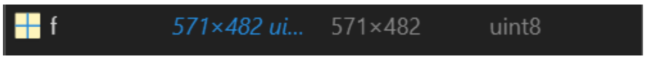
Notes and Outputs - Lab 3

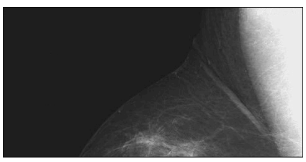
Task 1 - Contrast enhancement

```
imfinfo('assets/breastXray.tif')
f = imread('assets/breastXray.tif');
imshow(f)
```



```
f(3,10)              % print the intensity of pixel(3,10)
imshow(f(1:241,:))   % display only top half of the image
```

Output:
ans =
28

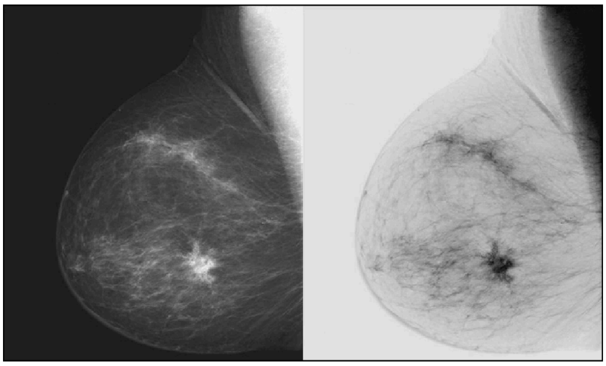


```
[fmin, fmax] = bounds(f(:))
```

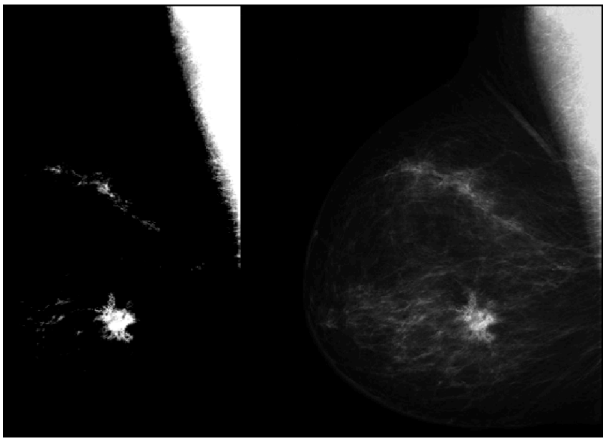
Output:
fmin =
21

fmax =
255

```
g1 = imadjust(f, [0 1], [1 0])
montage({f, g1})
```



```
g2 = imadjust(f, [0.5 0.75], [0 1]); % gray scale range between 0.5 and 0.75
mapped to the full range.
g3 = imadjust(f, [ ], [ ], 2); gamma correct with gamma = 2.0, [ ] is the
same as [0 1] by default
montage({g2,g3})
```

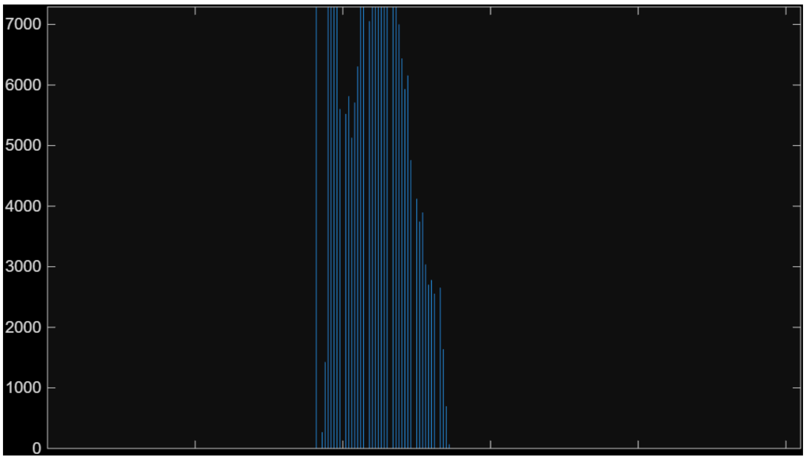


Task 2: Contrast-stretching transformation

```
f = imread('assets/bonescan-front.tif');
r = double(f);  % uint8 to double conversion
k = mean2(r);   % find mean intensity of image
E = 0.9;
s = 1 ./ (1.0 + (k ./ (r + eps)) .^ E);
g = uint8(255*s);
imshowpair(f, g, "montage")
```

Contrast Enhancement using Histogram

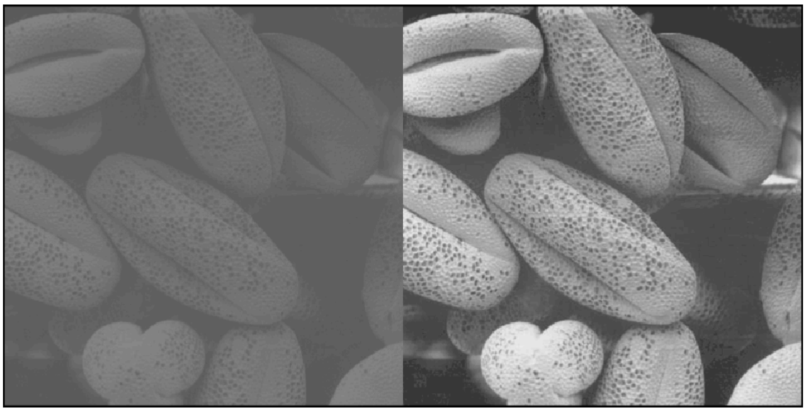
```
f=imread('assets/pollen.tif');
imhist(f);      % calculate and plot the histogram
```

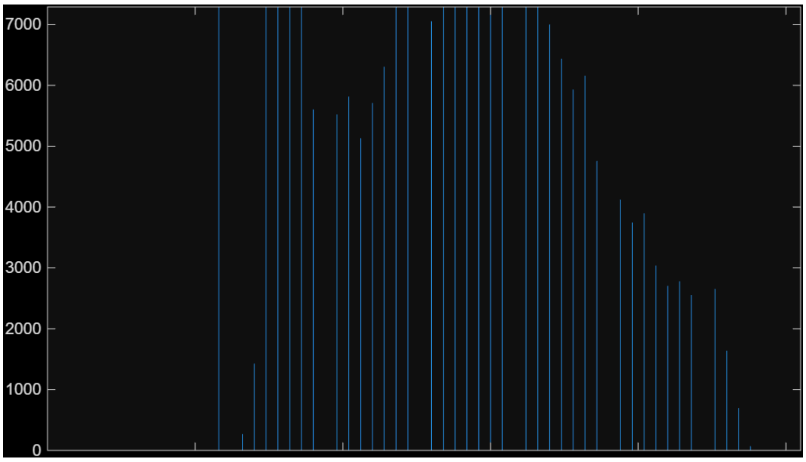



```
g=imadjust(f,[0.3 0.55]); % stretch the intensity between 0.3 and 0.55
montage({f, g})     % display list of images side-by-side

imhist(g);
```

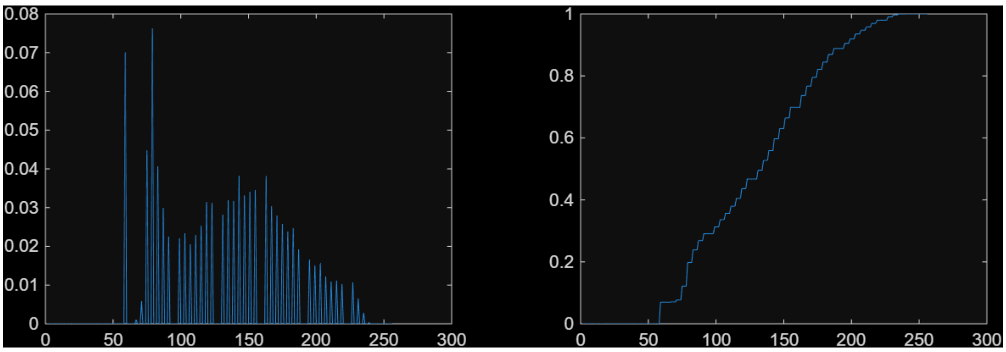
Task 3: Contrast Enhancement using Histogram





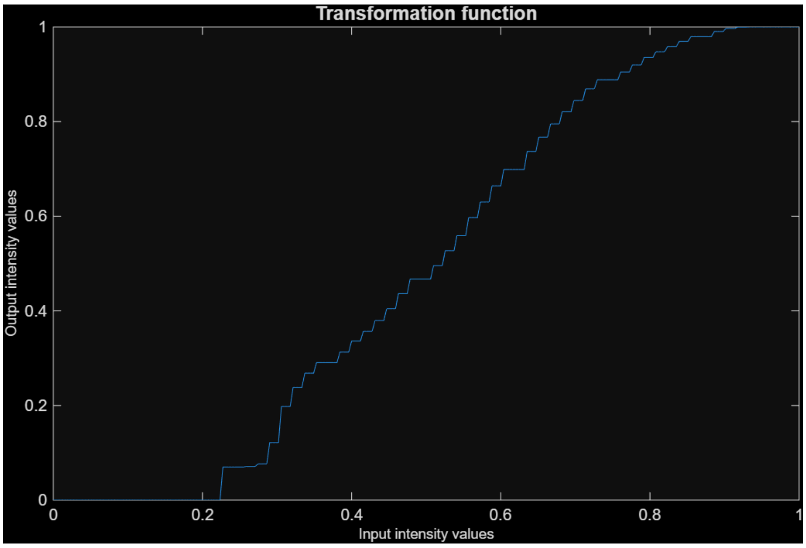

```
g_pdf = imhist(g) ./ numel(g);  % compute PDF
g_cdf = cumsum(g_pdf);          % compute CDF
```


```
subplot(1,2,1)                  % plot 1 in a 1x2 subplot
plot(g_pdf)
subplot(1,2,2)                  % plot 2 in a 1x2 subplot
plot(g_cdf)
```

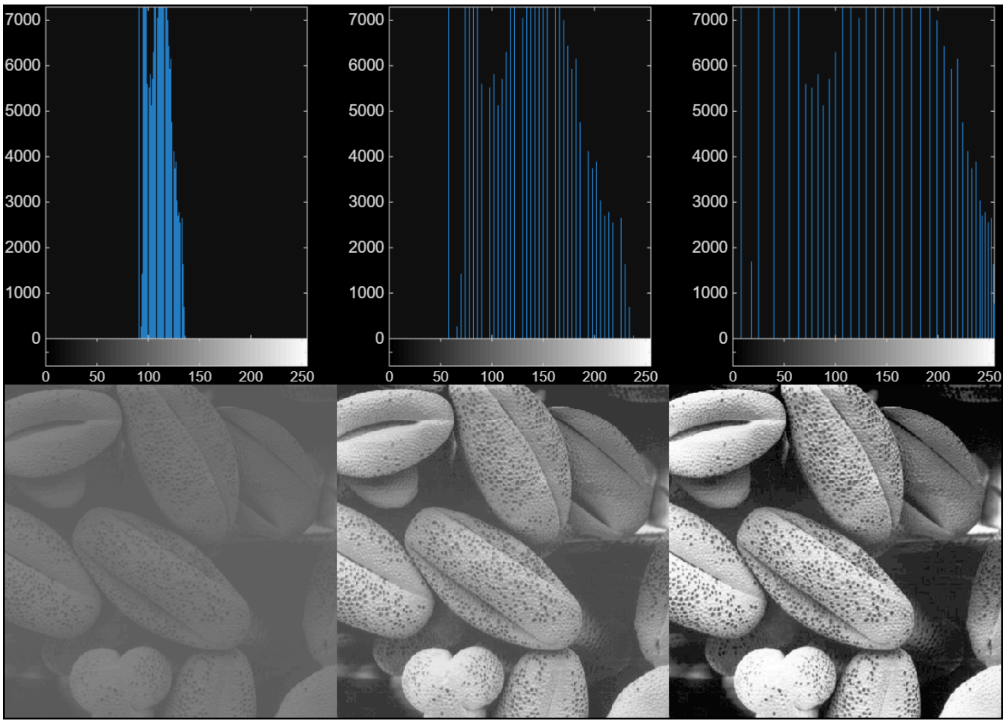



```
x = linspace(0, 1, 256);      % x has 256 values equally spaced
                              %  .... between 0 and 1
figure
plot(x, g_cdf)
axis([0 1 0 1])               % graph x and y range is 0 to 1
```

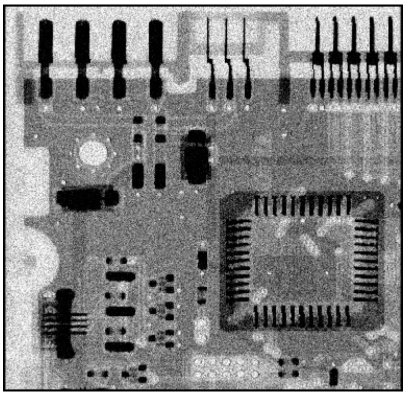
```
set(gca, 'xtick', 0:0.2:1)  % x tick marks are in steps of 0.2
set(gca, 'ytick', 0:0.2:1)
xlabel('Input intensity values', 'fontsize', 9)
ylabel('Output intensity values', 'fontsize', 9)
title('Transformation function', 'fontsize', 12)
```




```
h = histeq(g,256);              % histogram equalize g
close all
montage({f, g, h},'Size',[1 3])
figure;
subplot(1,3,1); imhist(f);
subplot(1,3,2); imhist(g);
subplot(1,3,3); imhist(h);
```



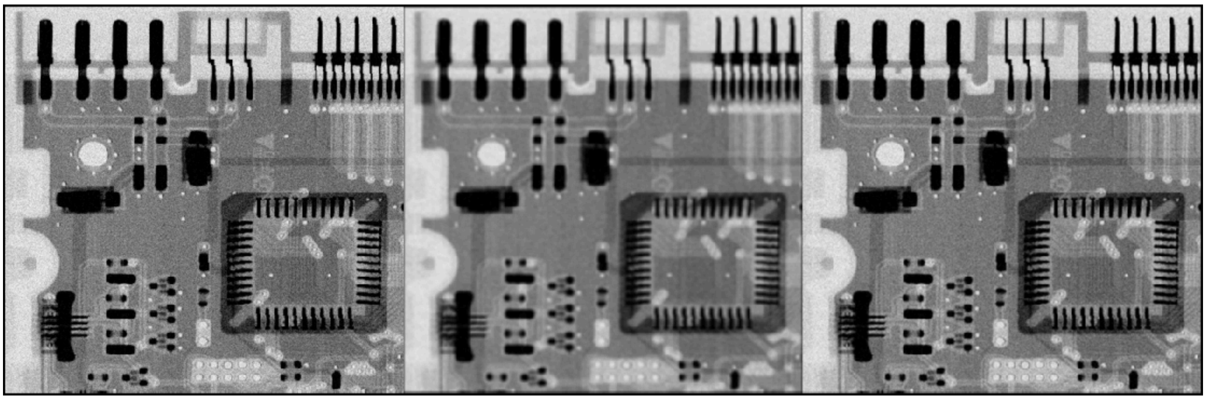
Task 4 - Noise reduction with lowpass filter



```
w_box = fspecial('average', [9 9])
w_gauss = fspecial('Gaussian', [7 7], 1.0)
```

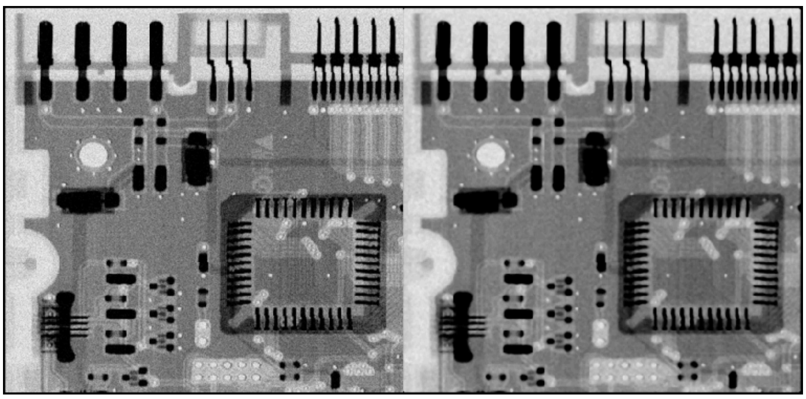
w_box	*9×9 double*	9×9	double
w_gauss	*7×7 double*	7×7	double

```
g_box = imfilter(f, w_box, 0);
g_gauss = imfilter(f, w_gauss, 0);
figure
montage({f, g_box, g_gauss})
```



Task 5 - Median Filtering

```
g_median = medfilt2(f, [7 7], 'zero');
figure; montage({f, g_median})
```



Understanding the Additional filters

```
% r and c - row and column are natural numbers
% sig > 0, likely 0.5
% 0 < alpha < 1
% length > 0, natural, default is 9
% theta, from -180 to 180 or 0 to 360
--------------------------------------------------------------
f_average = fspecial('average', [r c])
f_disk = fspecial('disk', r)
f_gauss = fspecial('Gaussian', [r c], sig)
f_laplacian = fspecial('laplacian', alpha)
f_log = fspecial('log', [r c], sig)
f_motion = fspecial('motion', len, theta)
f_prewitt = fspecial('prewitt')
f_sobel = fspecial('sobel')
f_unsharp = fspecial('unsharp', alpha)
```

Task 6 - Sharpening the image with Laplacian, Sobel and Unsharp filters

```
f = imread('moon.tif');
imshow(f)
```

```
f_moon = imread('assets/moon.tif');
w_lap = fspecial('laplacian', 0.2);
edges = imfilter(f_moon, w_lap);
g_sharp = f_moon - edges;
imshowpair(f_moon, g_sharp, 'montage');
```

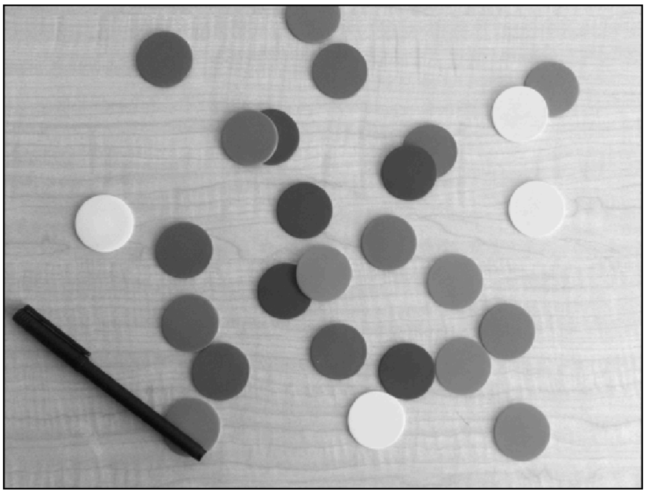
Task 7a - Contrast Improvement

```
f_tree = imread('assets/lake&tree.png');
img = imread('assets/lake&tree.png');
g_enhanced = adapthisteq(img);
imshowpair(f_tree,g_enhanced,'montage');
```

Task 7b - Edge Detection

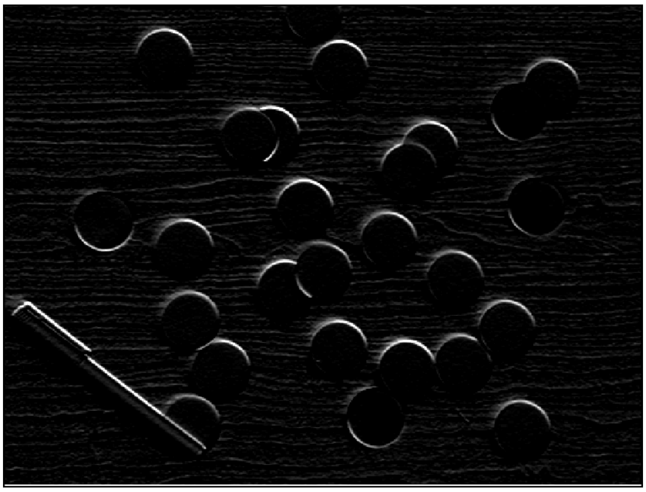
original image:

```
c = imread('assets\circles.tif');
imshow(c)
```



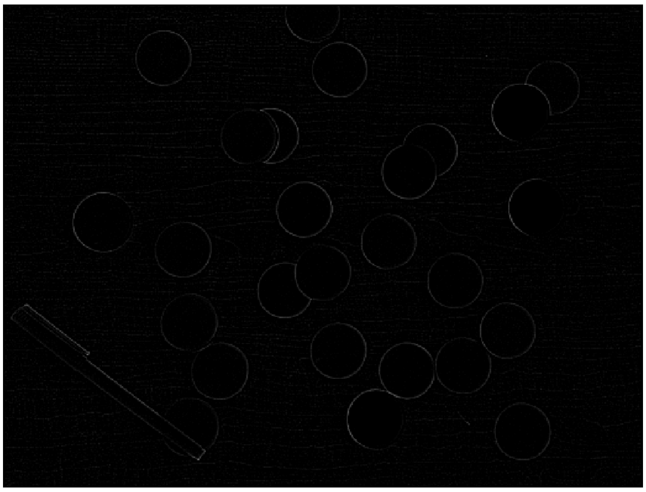
Attempt 1: Using only sobel:

```
w_sobel = fspecial('sobel')
imshow(imfilter(c, w_sobel, 0))
```



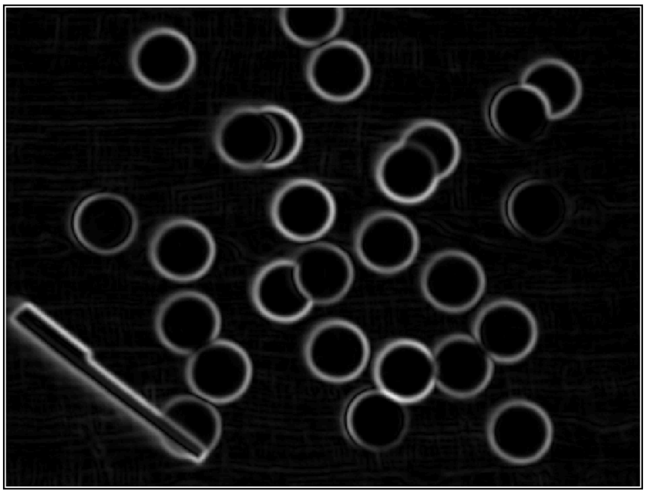
Attempt 2: Using only laplacian

```
w_laplacian = fspecial('laplacian', 0.5);
imshow(imfilter(c, w_laplacian, 0))
```



Attempt 3: Using a combination of sobel and and gaussian smoothing

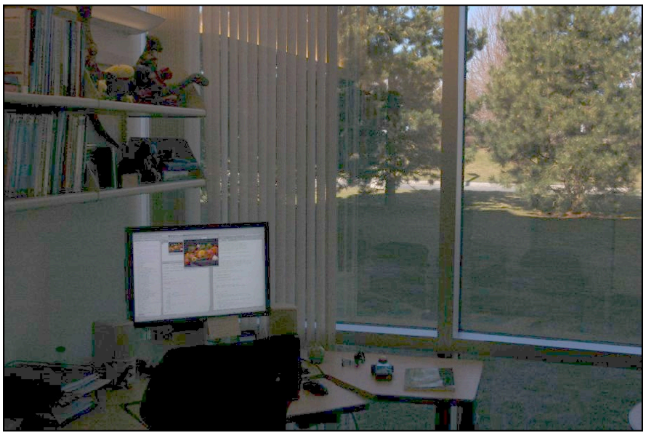
```
w_smooth = imgaussfilt(c, 2);
w_sobel = fspecial('sobel');
edges_v = imfilter(double(w_smooth), w_sobel);
edges_h = imfilter(double(w_smooth), w_sobel');
magnitude = sqrt(edges_v.^2 + edges_h.^2);
imshow(uint8(magnitude));
```



Task 7c - Sobel Filter

```
rgb = imread('assets/office.jpg');
imshow(rgb)
```

Original Image

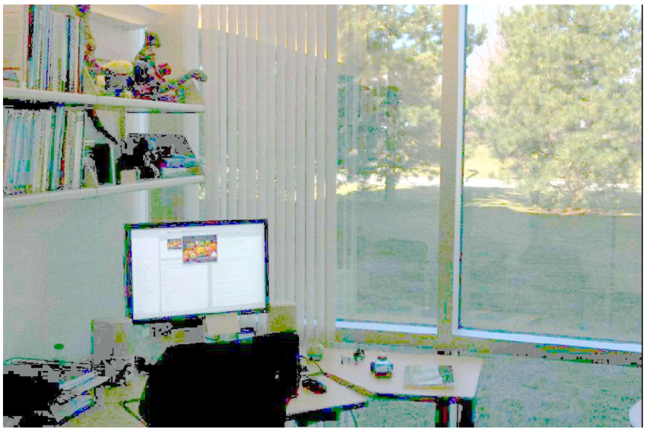


Attempt 1:

```
lab = rgb2lab(rgb);
lab(:,:,1) = adapthisteq(lab(:,:,1), 'ClipLimit', 0.02, 'Distribution',
'rayleigh');
saturation_factor = 1.3;
lab(:,:,2) = lab(:,:,2) * saturation_factor;
lab(:,:,3) = lab(:,:,3) * saturation_factor;
enhanced_rgb = lab2rgb(lab);-
figure;
imshow(enhanced_rgb)
```

Attempt 2:

```
f = im2double(imread('office.jpg'));
f_denoised = f;
for i = 1:3
    f_denoised(:,:,i) = medfilt2(f(:,:,i), [3 3]);
end
w_gauss = fspecial('Gaussian', [5 5], 0.5);
f_smooth = imfilter(f_denoised, w_gauss, 'replicate');
lab = rgb2lab(f_smooth);
L = lab(:,:,1) / 100; % Normalize L to 0-1
L_final = imadjust(L, stretchlim(L), [], 0.4);
lab(:,:,1) = L_final * 100;
g = lab2rgb(lab);
% 7. Final Safety Clamp to prevent glitches
g = max(0, min(1, g));
figure;
montage({f, g})
title('Original (Left) vs Denoised, Smoothened, and High Exposure (Right)')
```



Relevance for Design Engineers

I'm fascinated by how these simple functions can be used practically in medical design. Medical sensors often operate in high-noise environments (such as low-dose radiation scans meant to protect the patient).

- **Salt-and-Pepper Noise**: Just `medfilt2` was used for the PCB, median filtering is used in medical imaging to remove "shot noise" caused by faulty detector pixels without blurring the sharp edges of bones or organs.
- **Tissue Smoothing**: Gaussian blurring is used to smooth out the grain in ultrasound images, making it easier for automated software to trace the boundaries of an organ or a developing fetus.