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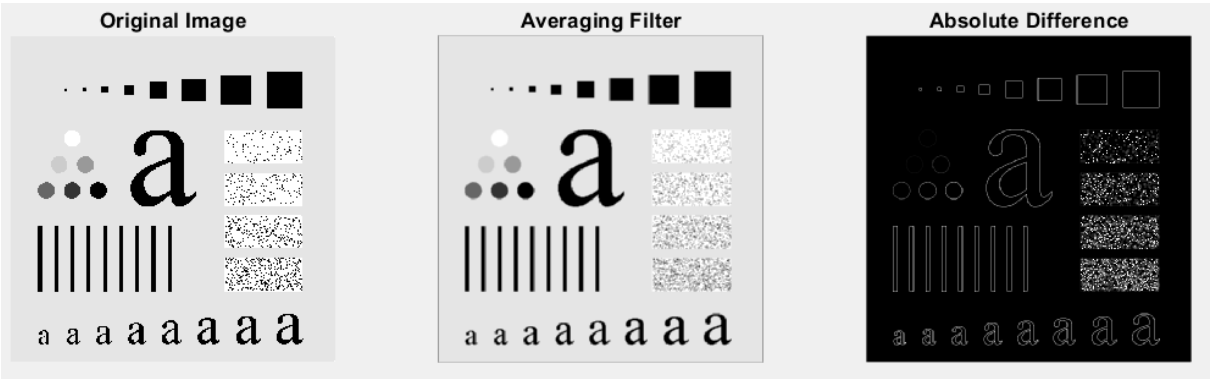
Linear filtering

LF-1. Linear low-pass filters

Task 1a Filtering with the averaging filter

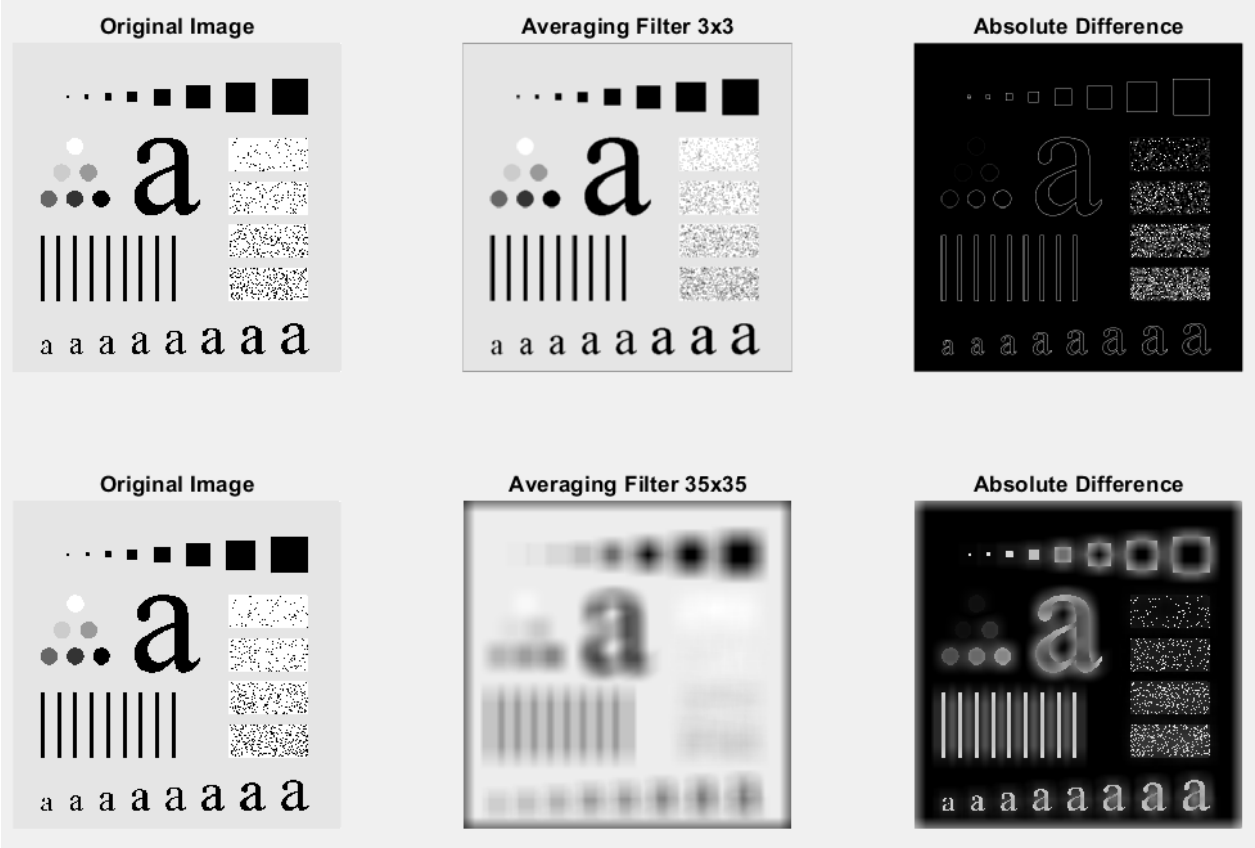
```
%% Task 1a

clearvars;
close all;
clc;

image = imread('board.png');

filter_size = 3;
averaging_filter = fspecial('average', [filter_size filter_size]);

convolved_image = filter2(averaging_filter, image, 'same');
convolved_image = uint8(convolved_image);

absolute_difference = imabsdiff(image, convolved_image);

% Display
figure('Position', [100, 100, 1000, 300]);

subplot(1, 3, 1);
imshow(image, []);
title('Original Image');

subplot(1, 3, 2);
imshow(convolved_image, []);
title('Averaging Filter');

subplot(1, 3, 3);
imshow(absolute_difference, []);
title('Absolute Difference');
```

Result of the code:



```
% Analyse the impact of the kernel size on the result.

filter_size2 = 35;
averaging_filter2 = fspecial('average', [filter_size2 filter_size2]);

convolved_image2 = filter2(averaging_filter2, image, 'same');
convolved_image2 = uint8(convolved_image2);

absolute_difference2 = imabsdiff(image, convolved_image2);

% Display
figure('Position', [100, 100, 1000, 600]);

subplot(2, 3, 1);
imshow(image, []);
title('Original Image');

subplot(2, 3, 2);
imshow(convolved_image, []);
title('Averaging Filter 3x3');

subplot(2, 3, 3);
imshow(absolute_difference, []);
title('Absolute Difference');

subplot(2, 3, 4);
imshow(image, []);
title('Original Image');

subplot(2, 3, 5);
imshow(convolved_image2, []);
title('Averaging Filter 35x35');

subplot(2, 3, 6);
imshow(absolute_difference2, []);
title('Absolute Difference');
```

Result of the code:

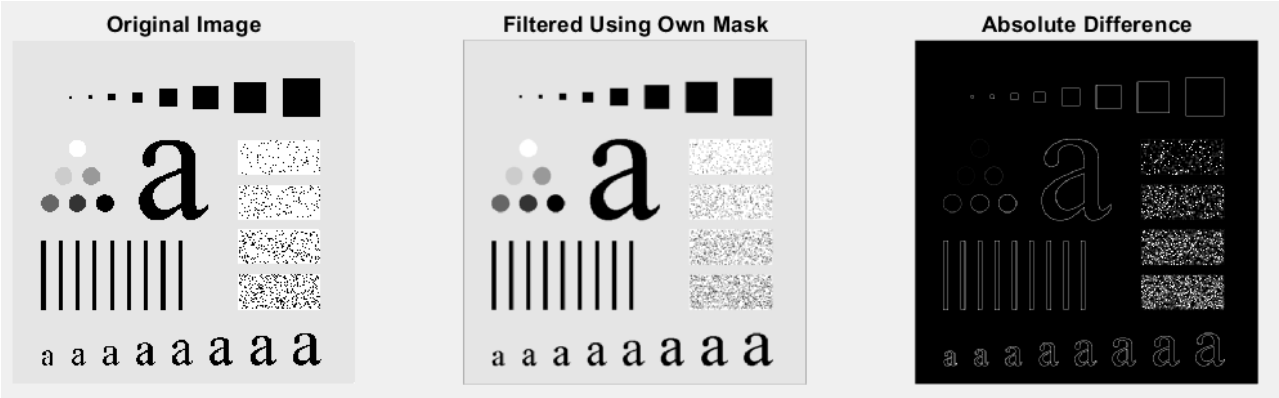


Task 1b User-defined mask

```
%% Task 1b

clearvars;
close all;
clc;

image = imread('board.png');

% Kernel (mask)
M = [1 2 1; 2 4 2; 1 2 1];
M = M/sum(sum(M));

convolved_image = filter2(M, image, 'same');
convolved_image = uint8(convolved_image);

absolute_difference = imabsdiff(image, convolved_image);

% Display
figure('Position', [100, 100, 1000, 400]);

subplot(1, 3, 1);
imshow(image, []);
title('Original Image');

subplot(1, 3, 2);
imshow(convolved_image, []);
title('Filtered Using Own Mask');
```

```
subplot(1, 3, 3);
imshow(absolute_difference, []);
title('Absolute Difference');
```

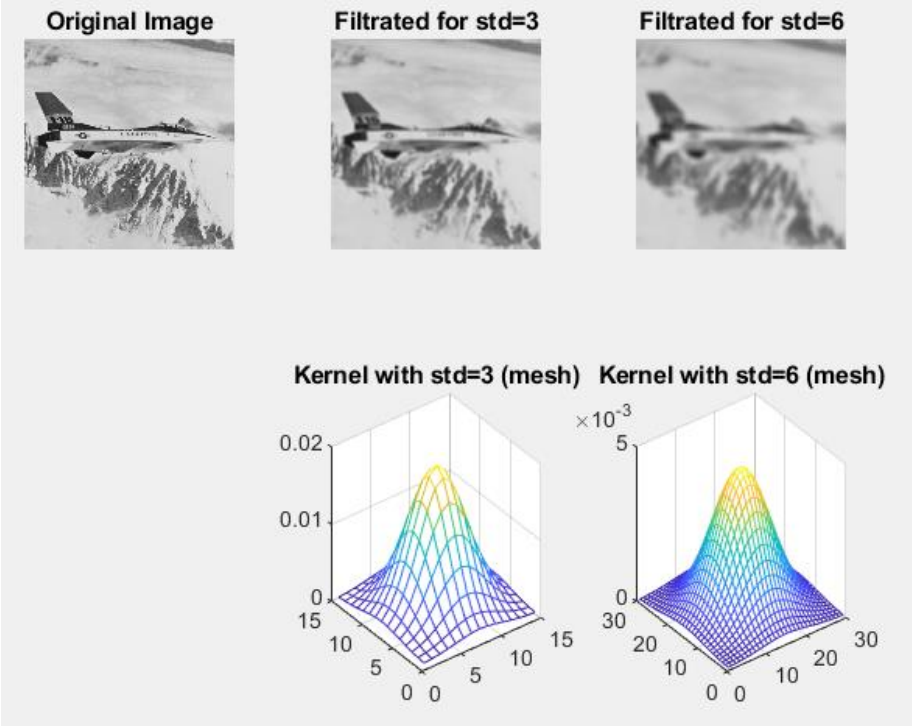
Result of the code:



Task 1c Gaussian filter

```
image = imread('jet.bmp');

filter1 = fspecial('gaussian', [15, 15], 3);
filter2 = fspecial('gaussian', [30, 30], 6);

filteredImage1 = imgaussfilt(image, 3);
filteredImage2 = imgaussfilt(image, 6);

% Display
figure;

subplot(2, 3, 1);
imshow(image);
title('Original Image');

subplot(2, 3, 2);
imshow(filteredImage1);
title('Filtrated for std=3');

subplot(2, 3, 3);
imshow(filteredImage2);
title('Filtrated for std=6');

subplot(2, 3, 5);
mesh(filter1);
title('Kernel with std=3 (mesh)');

subplot(2, 3, 6);
mesh(filter2);
title('Kernel with std=6 (mesh)');
```

Result of the code:

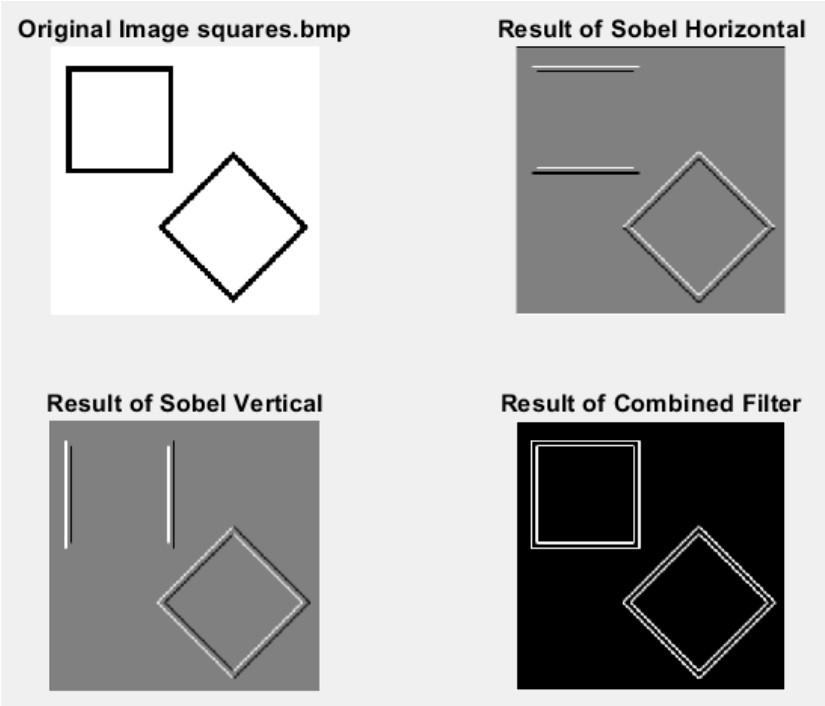


LF-2. Filters based on gradient (first derivative) approximation

```
clearvars;
close all;
clc;

originalImage = imread('squares.bmp');
originalImage = double(originalImage);

% Sobel filters
sobelHorizontal = fspecial('sobel');
sobelVertical = sobelHorizontal';

% Convolution
sobelHorizontalResult = imfilter(originalImage, sobelHorizontal);
sobelVerticalResult = imfilter(originalImage, sobelVertical);

combinedFilter = sqrt(sobelHorizontalResult.^2 + sobelVerticalResult.^2);

% Display
figure;

subplot(2, 2, 1);
imshow(uint8(originalImage));
title('Original Image squares.bmp');


subplot(2, 2, 2);
imshow(sobelHorizontalResult, []);
title('Result of Sobel Horizontal');
```

```
subplot(2, 2, 3);
imshow(sobelVerticalResult, []);
title('Result of Sobel Vertical');

subplot(2, 2, 4);
imshow(combinedFilter, []);
title('Result of Combined Filter');
```

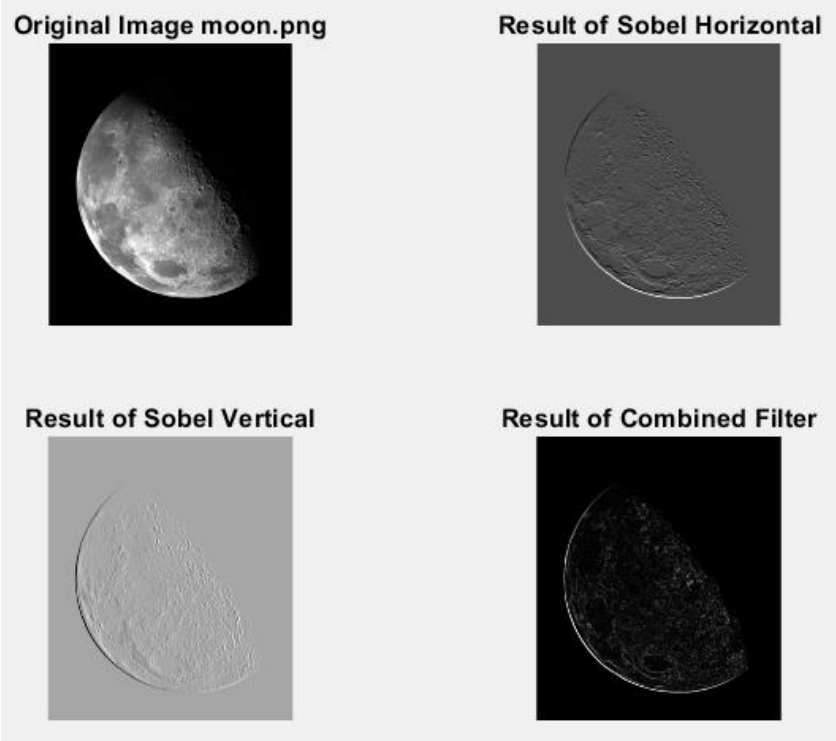
Result of the code:




```
%%
% Change filename to moon.png and present the results:
clearvars;
close all;
clc;

originalImage = imread('moon.png');
originalImage = double(originalImage);

% Sobel filters
sobelHorizontal = fspecial('sobel');
sobelVertical = sobelHorizontal';

% Convolution
sobelHorizontalResult = imfilter(originalImage, sobelHorizontal);
sobelVerticalResult = imfilter(originalImage, sobelVertical);

combinedFilter = sqrt(sobelHorizontalResult.^2 + sobelVerticalResult.^2);

% Display
figure;

subplot(2, 2, 1);
imshow(uint8(originalImage));
title('Original Image moon.png');
```

```
subplot(2, 2, 2);
imshow(sobelHorizontalResult, []);
title('Result of Sobel Horizontal');

subplot(2, 2, 3);
imshow(sobelVerticalResult, []);
title('Result of Sobel Vertical');

subplot(2, 2, 4);
imshow(combinedFilter, []);
title('Result of Combined Filter');
```

Result of the code:

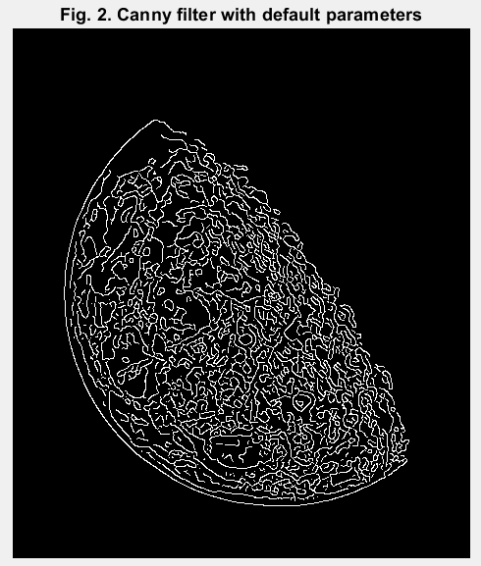


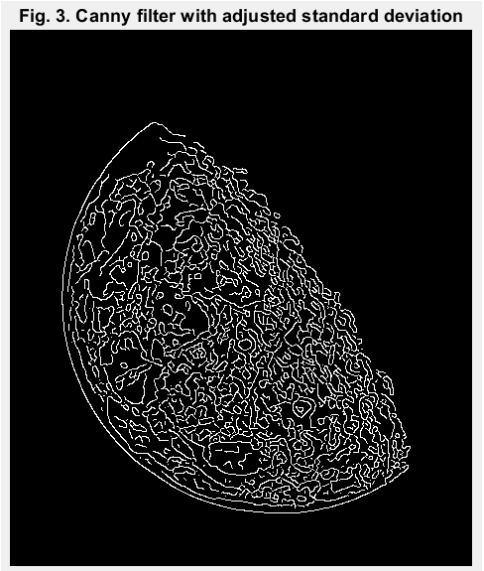
LF-3. Canny filter

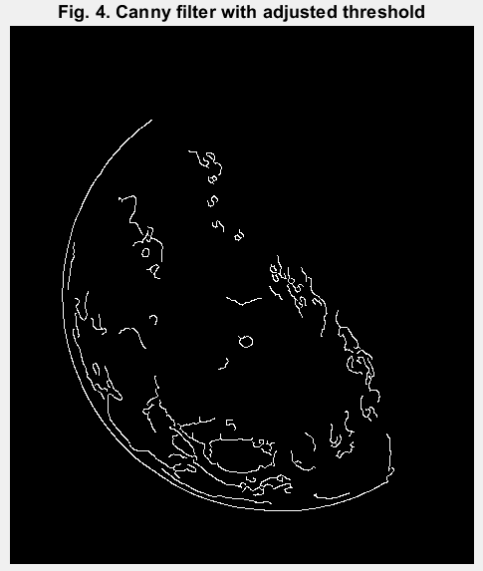
```
clearvars;
close all;
clc;

originalImage = imread('moon.png');

edgesDefault = edge(originalImage, 'canny');

sigmaAdjusted = 1.5;
edgesSigmaAdjusted = edge(originalImage, 'canny', [], sigmaAdjusted);

thresholdAdjusted = 0.2;
edgesThresholdAdjusted = edge(originalImage, 'canny', thresholdAdjusted);
```

```
% Display
figure;
imshow(originalImage);
title('Fig. 1. Original Image moon.png');

figure;
imshow(edgesDefault);
title('Fig. 2. Canny filter with default parameters');


figure;
imshow(edgesSigmaAdjusted);
title('Fig. 3. Canny filter with adjusted standard deviation');

figure;
imshow(edgesThresholdAdjusted);
title('Fig. 4. Canny filter with adjusted threshold');
```

Result of the code:







LF-4. Laplacian (second derivative of the image)

```
clearvars;
close all;
clc;

originalImage = imread('moon.png');

% Laplacian mask
laplacianMask = fspecial('laplacian', 0);

% Convolution
laplacianFiltered = filter2(laplacianMask, double(originalImage), 'same');

% Normalizing
laplacianFilteredAbs = abs(laplacianFiltered);
maxValue = max(laplacianFilteredAbs(:));
laplacianFilteredNormalized = (laplacianFilteredAbs / maxValue) * 255;

% Display
figure;

subplot(1, 2, 1);
imshow(uint8(originalImage));
title('Original Image');

subplot(1, 2, 2);
imshow(uint8(laplacianFilteredNormalized));
title('Laplacian Filtered Image');
```

Result of the code: