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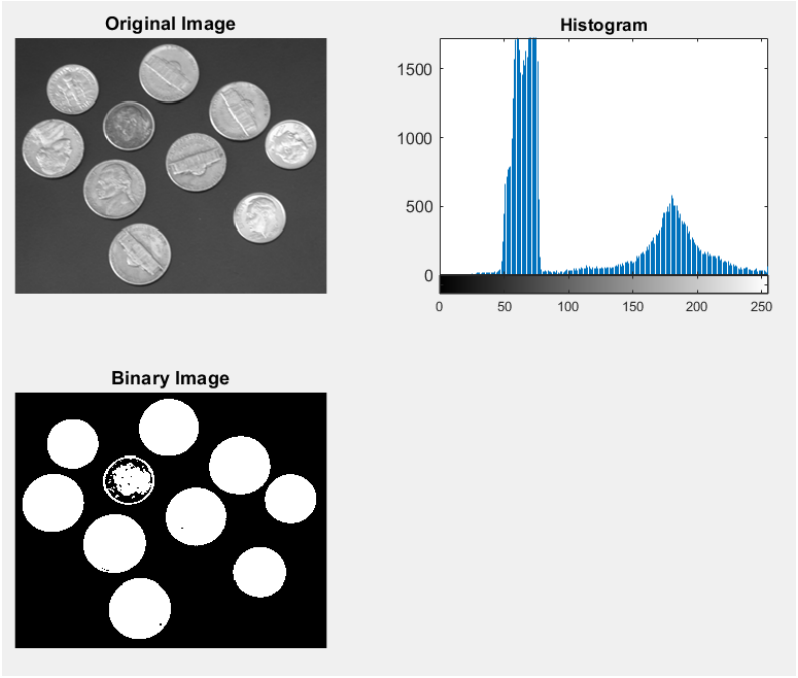
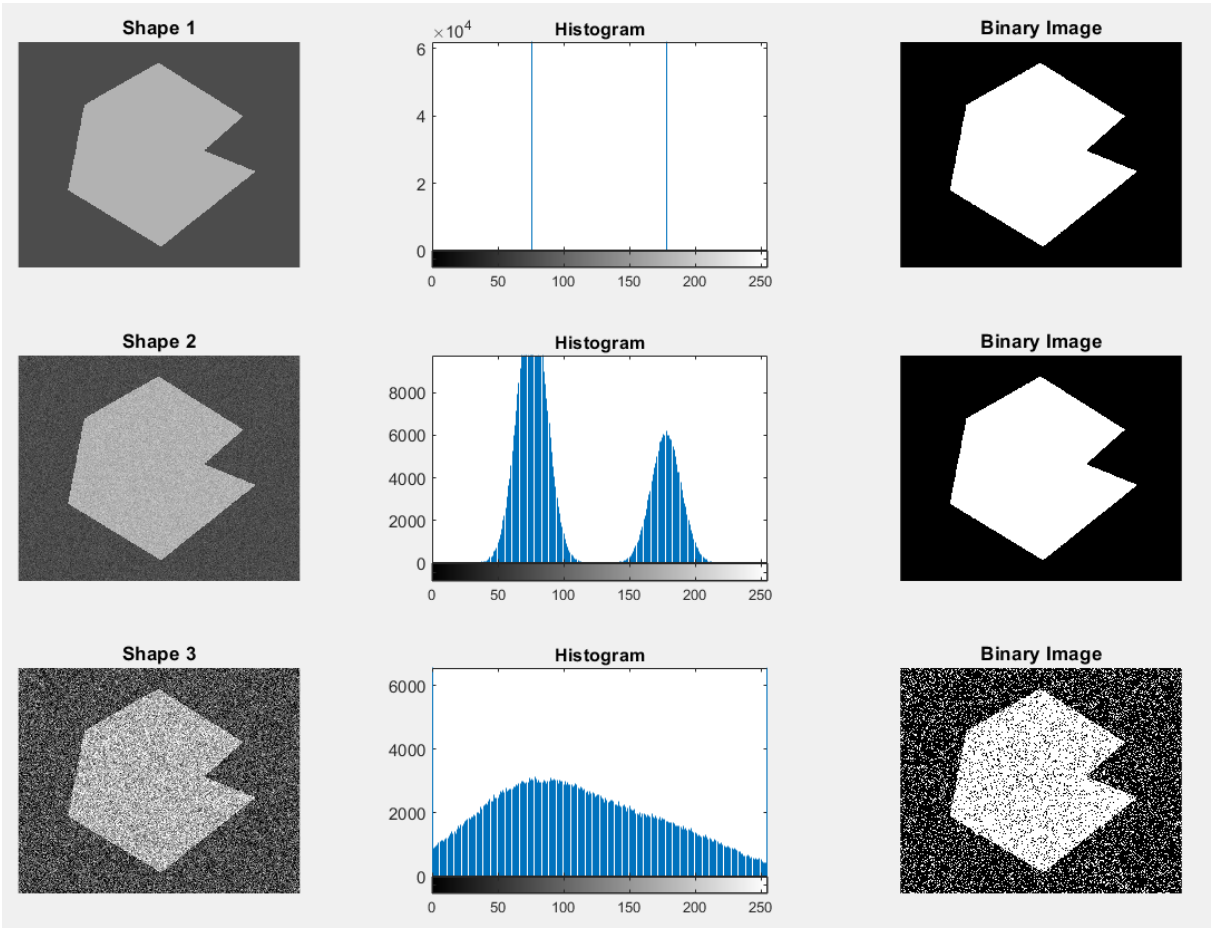
Binarization

Bin-1. Binarization based on histogram

```
coins_image = imread('coins.png');

% Display
figure;

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

subplot(2, 2, 2);
imhist(coins_image);
title('Histogram');

threshold = 120;
binary_coins = imbinarize(coins_image, threshold / 255);

subplot(2, 2, 3);
imshow(binary_coins);
title('Binary Image');

shape1_image = imread('shape1.png');
shape2_image = imread('shape2.png');
shape3_image = imread('shape3.png');

% Display
figure;
images = {shape1_image, shape2_image, shape3_image};
for i = 1:3

    subplot(3, 4, (i - 1) * 4 + 1);
    imshow(images{i});
    title(['Shape ' num2str(i)]);

    subplot(3, 4, (i - 1) * 4 + 2);
    imhist(images{i});
    title('Histogram');

    threshold = 120;
    binary_shape = imbinarize(images{i}, threshold / 255);

    subplot(3, 4, (i - 1) * 4 + 3);
    imshow(binary_shape);
    title('Binary Image');
end
```

Result of the code:



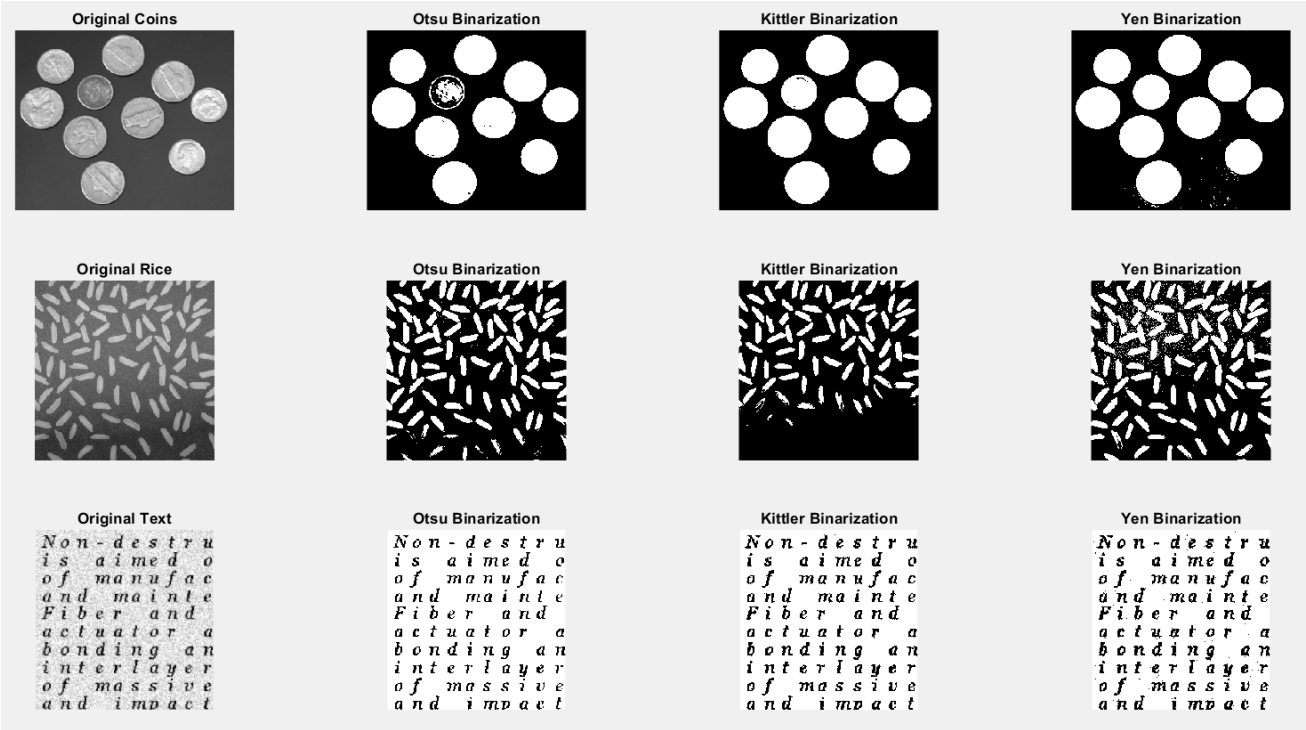


Bin-2. Automatic binarization methods

```
coins_image = imread('coins.png');
rice_image = imread('rice.png');
text_image = imread('text.bmp');

% Binarization using Otsu method
otsu_coins = imbinarize(coins_image, graythresh(coins_image));
otsu_rice = imbinarize(rice_image, graythresh(rice_image));
otsu_text = imbinarize(text_image, graythresh(text_image));

% Binarization using Kittler method
threshold_kittler_coins = clusterKittler(coins_image);
kittler_coins = imbinarize(coins_image, threshold_kittler_coins / 255);
threshold_kittler_rice = clusterKittler(rice_image);
kittler_rice = imbinarize(rice_image, threshold_kittler_rice / 255);
threshold_kittler_text = clusterKittler(text_image);
kittler_text = imbinarize(text_image, threshold_kittler_text / 255);

% Binarization using Yen method
threshold_yen_coins = entropyYen(coins_image);
yen_coins = imbinarize(coins_image, threshold_yen_coins / 255);
threshold_yen_rice = entropyYen(rice_image);
yen_rice = imbinarize(rice_image, threshold_yen_rice / 255);
threshold_yen_text = entropyYen(text_image);
yen_text = imbinarize(text_image, threshold_yen_text / 255);

% Display
figure;

% Coins image
subplot(3, 4, 1);
imshow(coins_image);
title('Original Coins');
subplot(3, 4, 2);
imshow(otsu_coins);
title('Otsu Binarization');
subplot(3, 4, 3);
imshow(kittler_coins);
title('Kittler Binarization');
subplot(3, 4, 4);
imshow(yen_coins);
title('Yen Binarization');

% Rice image
subplot(3, 4, 5);
imshow(rice_image);
title('Original Rice');
subplot(3, 4, 6);
imshow(otsu_rice);
title('Otsu Binarization');
subplot(3, 4, 7);
imshow(kittler_rice);
title('Kittler Binarization');
subplot(3, 4, 8);
imshow(yen_rice);
title('Yen Binarization');
```

```
% Text image
subplot(3, 4, 9);
imshow(text_image);
title('Original Text');
subplot(3, 4, 10);
imshow(otsu_text);
title('Otsu Binarization');
subplot(3, 4, 11);
imshow(kittler_text);
title('Kittler Binarization');
subplot(3, 4, 12);
imshow(yen_text);
title('Yen Binarization');
```

Result of the code:

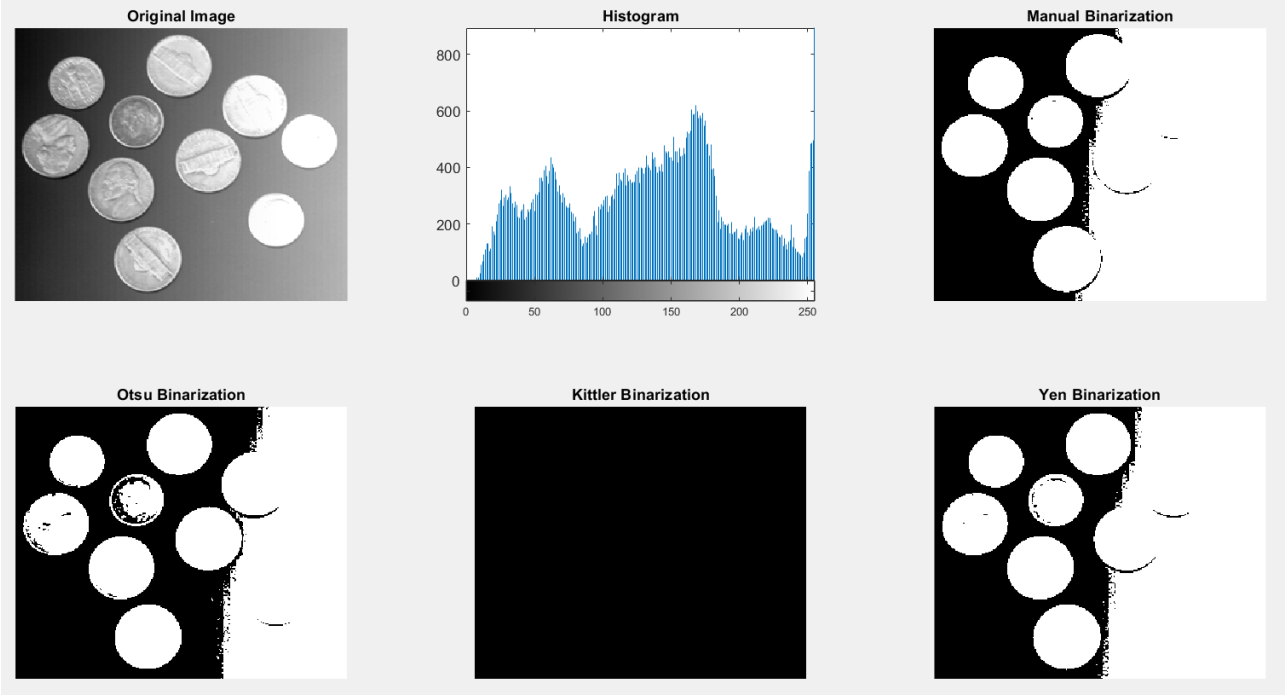


Bin-3. Adaptive threshold

```
coins_grad_image = imread('coins_grad.png');

figure;

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

subplot(2, 3, 2);
imhist(coins_grad_image);
title('Histogram');

manual_threshold = 100;
manual_binary_image = imbinarize(coins_grad_image, manual_threshold / 255);
```

```
% Otsu, Kittler, and Yen binarization
otsu_binary_image = imbinarize(coins_grad_image, graythresh(coins_grad_image));
kittler_threshold = clusterKittler(coins_grad_image);
kittler_binary_image = imbinarize(coins_grad_image, kittler_threshold / 255);
yen_threshold = entropyYen(coins_grad_image);
yen_binary_image = imbinarize(coins_grad_image, yen_threshold / 255);

% Display
subplot(2, 3, 3);
imshow(manual_binary_image);
title('Manual Binarization');

subplot(2, 3, 4);
imshow(otsu_binary_image);
title('Otsu Binarization');

subplot(2, 3, 5);
imshow(kittler_binary_image);
title('Kittler Binarization');

subplot(2, 3, 6);
imshow(yen_binary_image);
title('Yen Binarization');

adaptive_threshold = adaptthresh(coins_grad_image, 'NeighborhoodSize', 21,
'Statistic', 'Mean');
adaptive_binary_image = imbinarize(coins_grad_image, adaptive_threshold);

% Display
figure;
subplot(1, 3, 1);
imshow(adaptive_threshold);
title('Adaptive Threshold');

filled_image = imfill(adaptive_binary_image, 'holes');
opened_image = imopen(filled_image, strel('disk', 5));

subplot(1, 3, 2);
imshow(filled_image);
title('Filled Image');

subplot(1, 3, 3);
imshow(opened_image);
title('Corrected Image');
```

Result of the code:



Bin-4. Binarization with two thresholds

```
bart_image = imread('bart.bmp');

figure;

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

subplot(2, 3, 2);
imhist(bart_image);
title('Histogram');

lower_threshold = 130;
upper_threshold = 190;

binary_image = (bart_image > lower_threshold) & (bart_image < upper_threshold);
```

```
subplot(2, 3, 3);
imshow(binary_image);
title('Binarized Image');

skin_color_image = bart_image;
skin_color_image(~binary_image) = 0;

subplot(2, 3, [4, 5, 6]);
imshow(skin_color_image);
title('Skin Color Areas');
```

Result of the code: