Digital image processing and vision systems – lab #5

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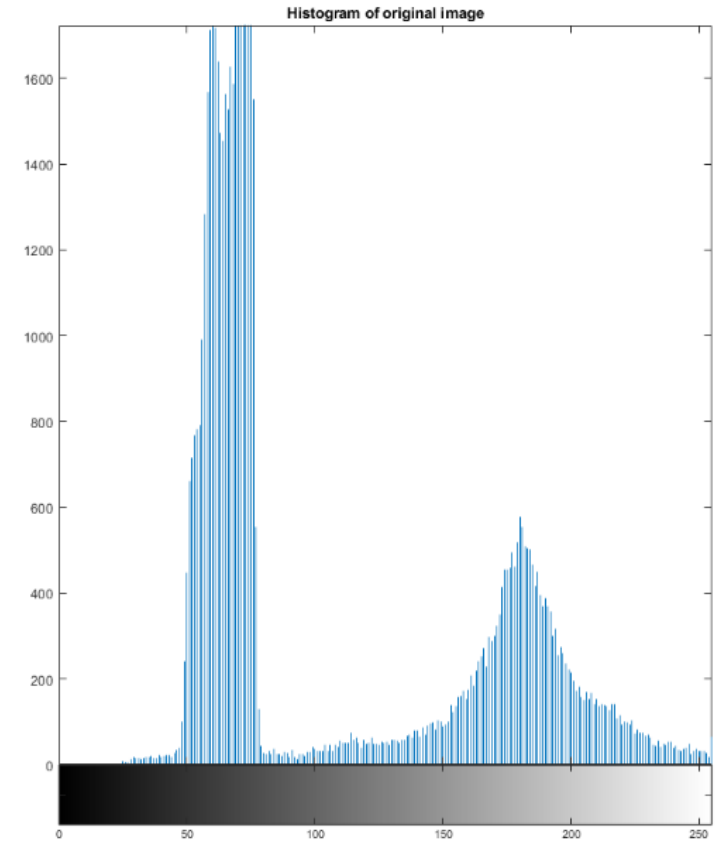
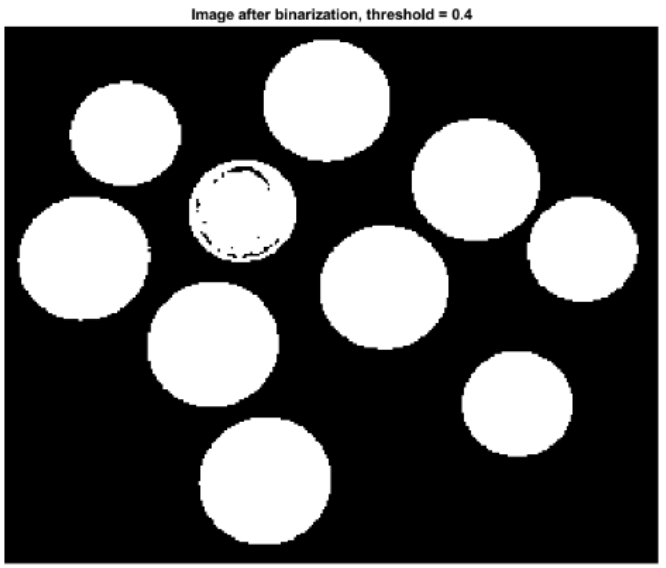
1. **Source codes and screenshots:**

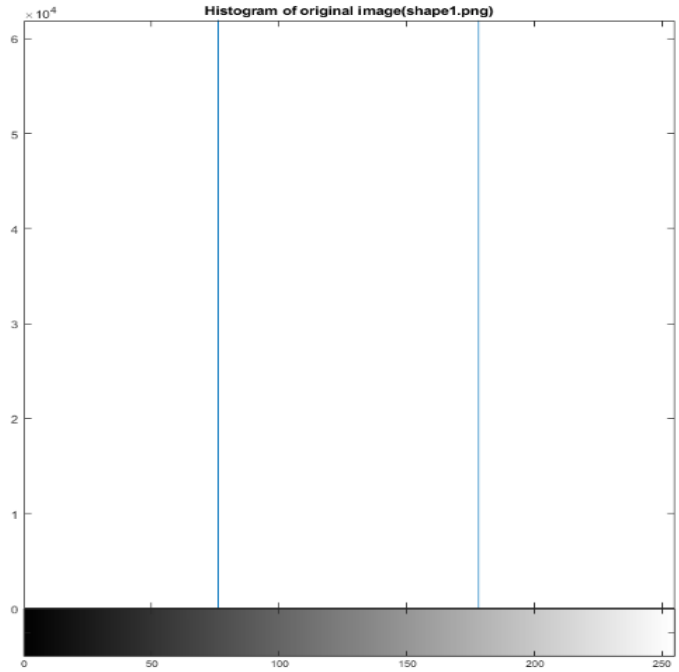
   Task 6.3. Histogram based binarization:

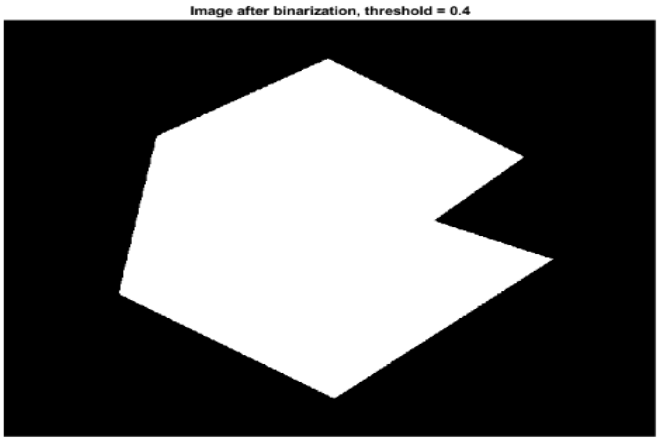
```
1. image = imread("coins.png");
2.
3. figure('Name','Histogram and binarization','NumberTitle','off');
4. subplot(1,2,1)
5. imhist(image);
6. title("Histogram of original image");
7. subplot(1,2,2)
8. bw = im2bw(image,0.4);
9. imshow(bw);
10.  title("Image after binarization, threshold = 0.4");
```

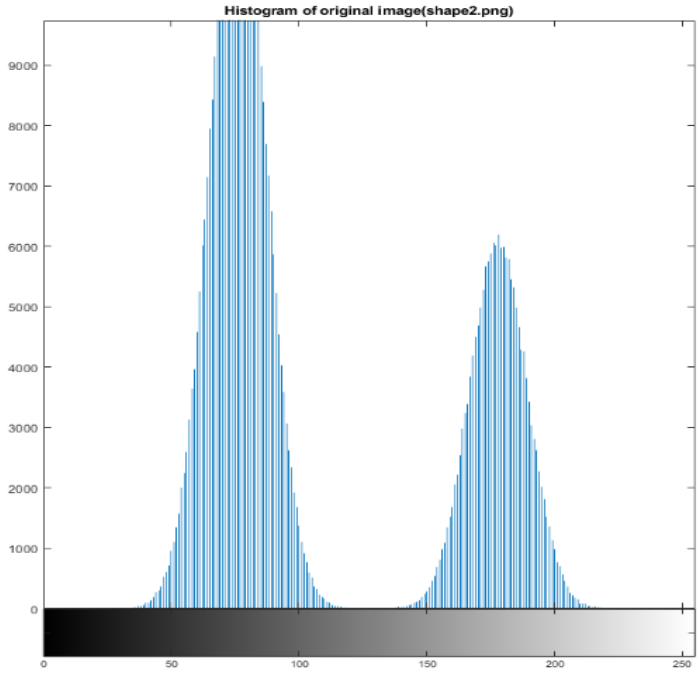


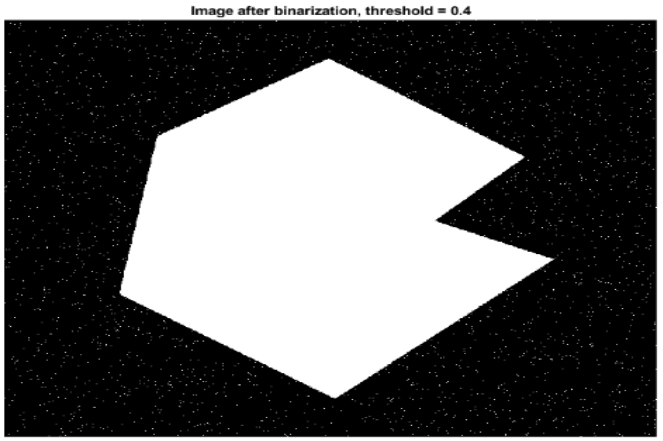


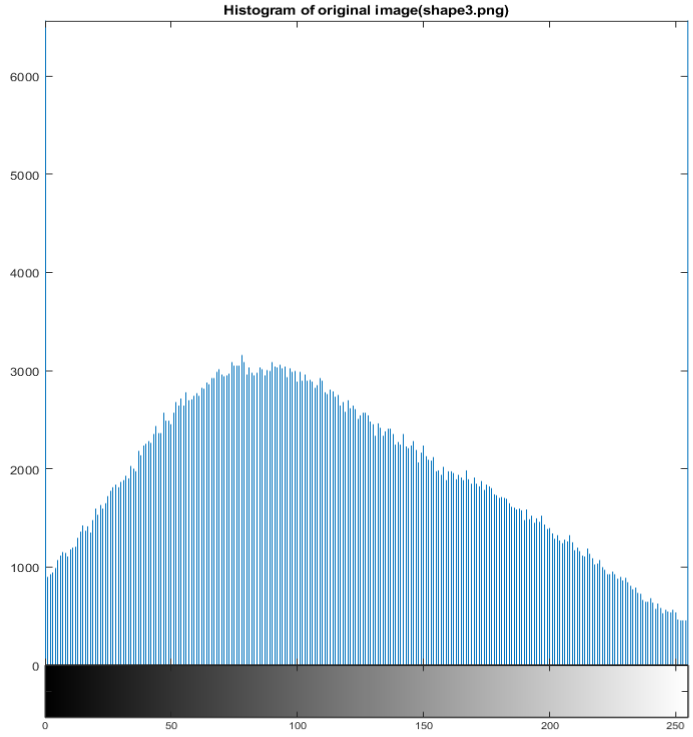
```
1. shape1 = imread("shape1.png");
2. shape2 = imread("shape2.png");
3. shape3 = imread("shape3.png");
4. shape4 = imread("shape4.png");
5.
6. figure('Name','Shape 1','NumberTitle','off');
7. subplot(1,2,1)
8. imhist(shape1);
9. title("Histogram of original image(shape1.png)");
10.  subplot(1,2,2)
11.  bw = im2bw(shape1,0.4);
12.  imshow(bw);
13.  title("Image after binarization, threshold = 0.4");
```










Histogram of original image(shape3.png)
6000
5000
4000
3000
2000
1000
0
0
50
100
150
200
250

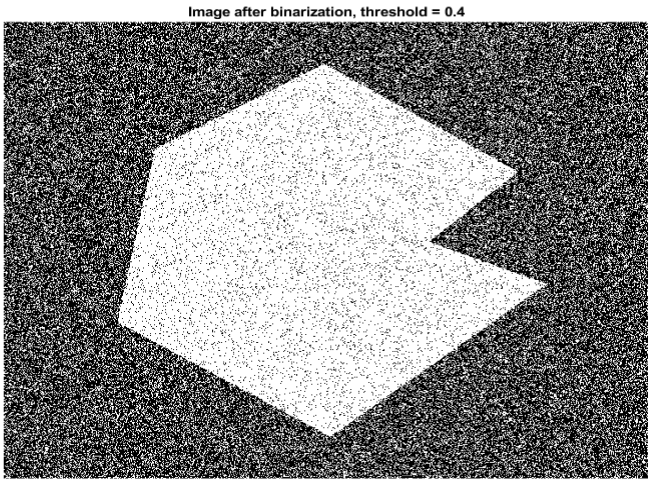
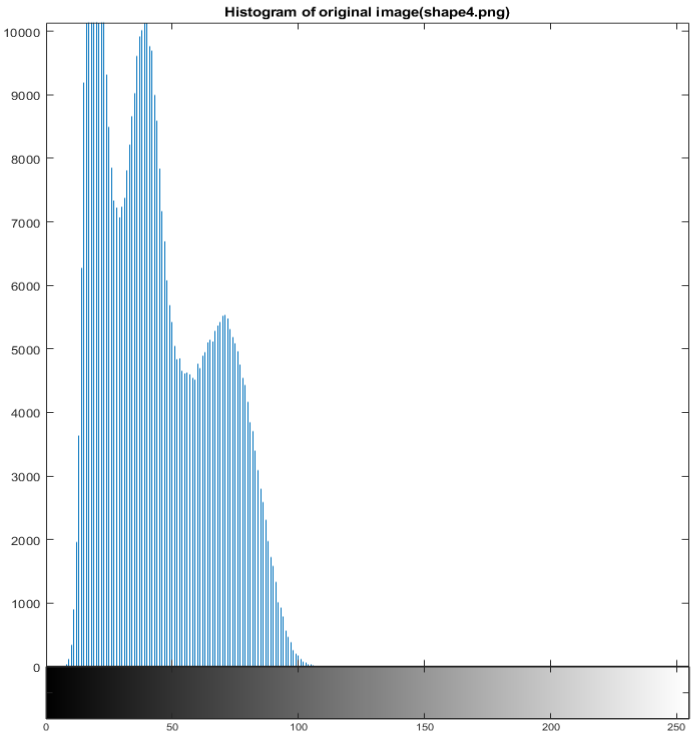


Image after binarization, threshold = 0.4


Histogram of original image(shape4.png)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
50
100
150
200
250

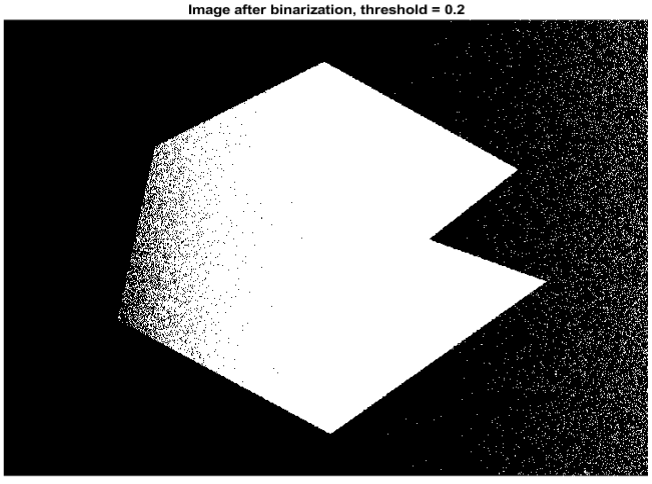
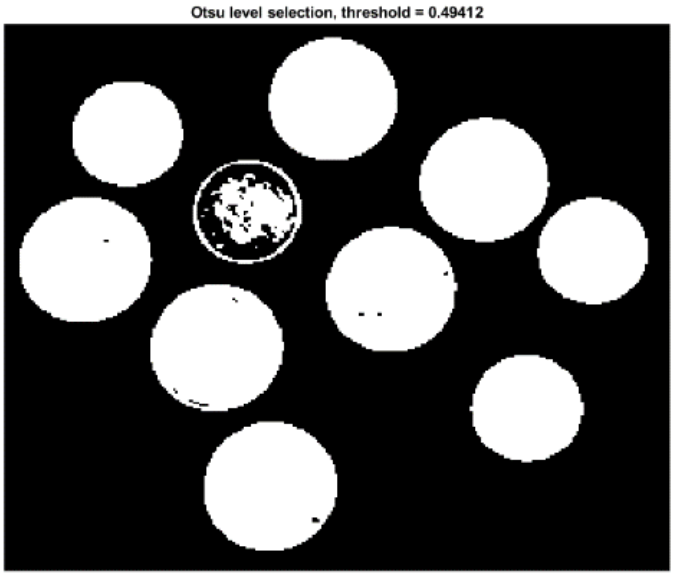
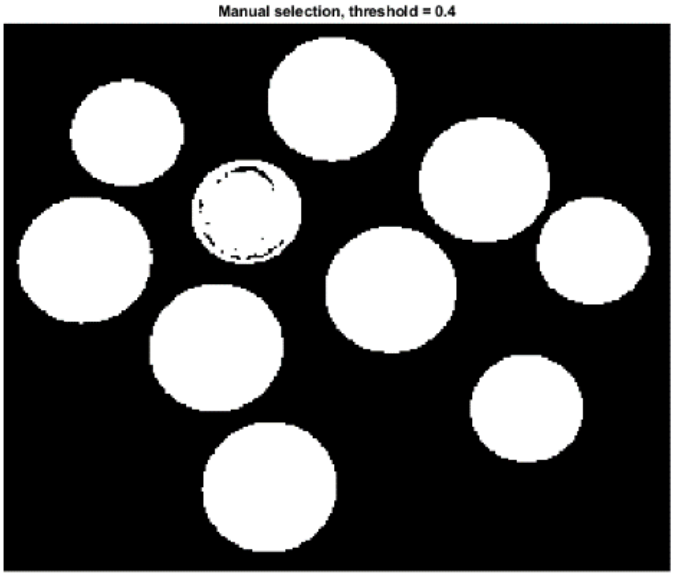


Image after binarization, threshold = 0.2

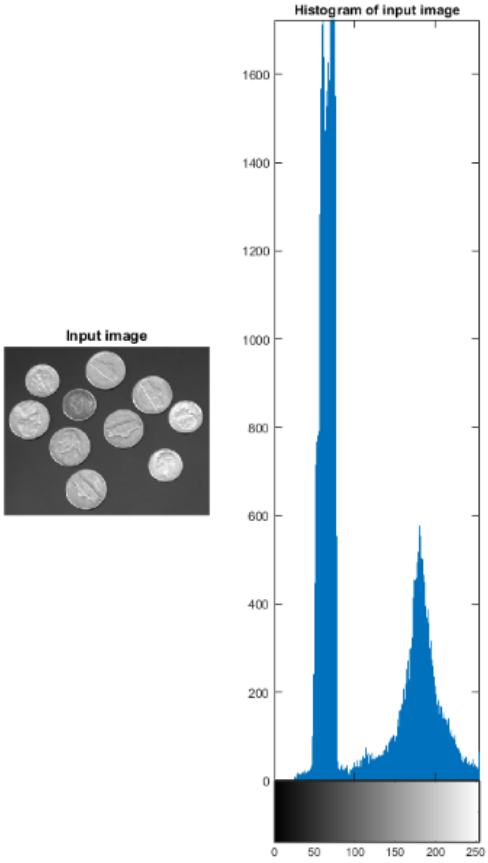
```
figure('Name','Otsu and manually selection','NumberTitle','off');
subplot(1,2,1)
level = graythresh(image);
bw = im2bw(image,level);
imshow(bw);
title("Otsu level selection, threshold = " + level);
subplot(1,2,2)
bw = im2bw(image,0.4);
imshow(bw);
 title("Manual selection, threshold = 0.4");
```

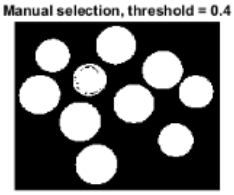


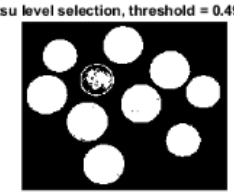


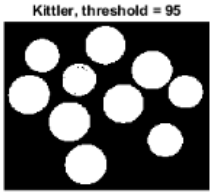

```
image = imread("catalogue.bmp");

figure('Name','Kittle/Yen','NumberTitle','off');
subplot(1,6,1)
imshow(image)
title("Input image");
subplot(1,6,2)
imhist(image)
title("Histogram of input image");
 subplot(1,6,3)
 level = 0.4;
 bw = im2bw(image,level);
 imshow(bw);
 title("Manual selection, threshold = " + level);
 subplot(1,6,4)
 level = graythresh(image);
 bw = im2bw(image,level);
 imshow(bw);
 title("Otsu level selection, threshold = " + level);
 subplot(1,6,5)
 Kit = clusterKittler(image);
 bw = im2bw(image,Kit/255);
 imshow(bw);
 title("Kittler, threshold = " + Kit);
```

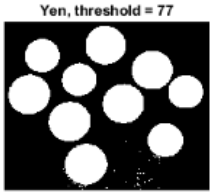
```
25.  subplot(1,6,6)
26.  Yen = entropyYen(image);
27.  bw = im2bw(image,Yen/255);
28.  imshow(bw);
29.  title("Yen, threshold = " + Yen);
```

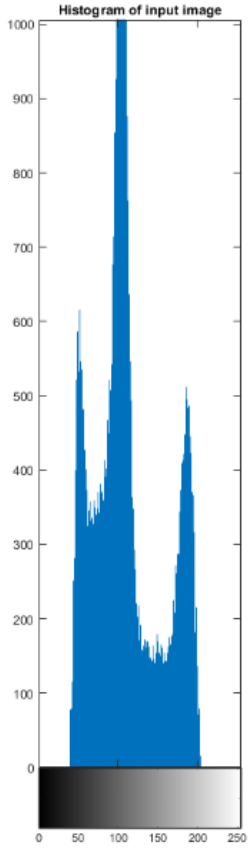


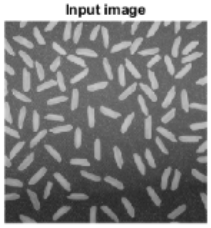




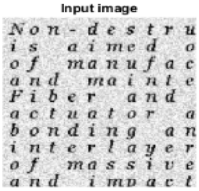




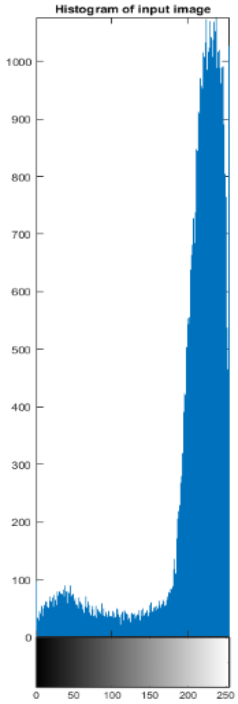




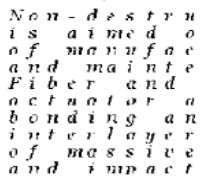
Input image



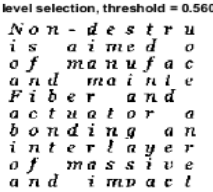
Histogram of input image



Manual selection, threshold = 0.4

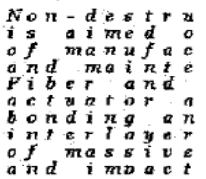


Otsu level selection, threshold = 0.56078

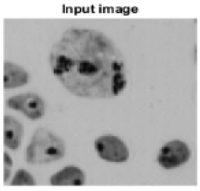


Kittler, threshold = 168

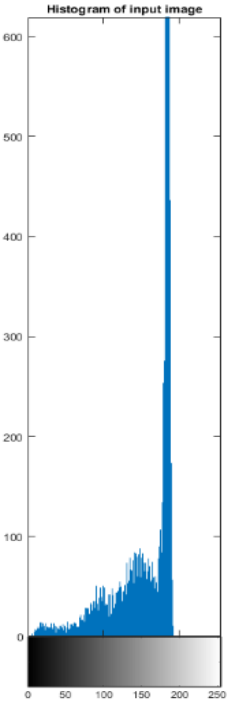
Yen, threshold = 180



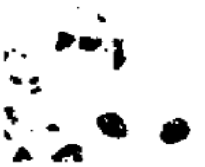
Input image



Histogram of input image



Manual selection, threshold = 0.4

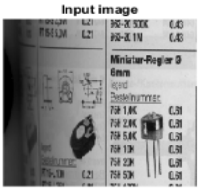


Otsu level selection, threshold = 0.53725

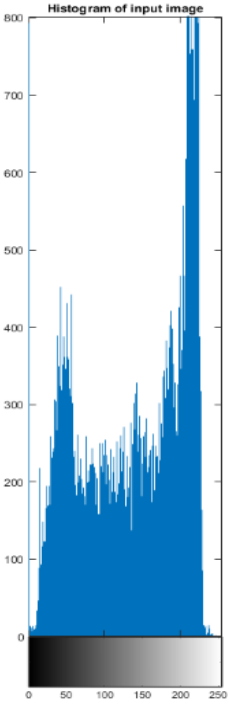
Kittler, threshold = 178

Yen, threshold = 130

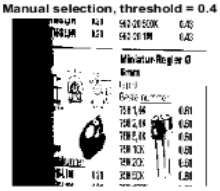
Input image



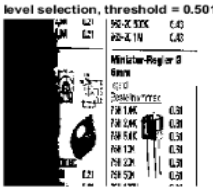
Histogram of input image



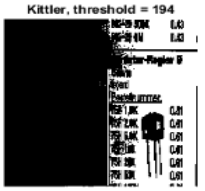
Manual selection, threshold = 0.4



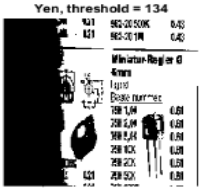
Otsu level selection, threshold = 0.50196



Kittler, threshold = 194

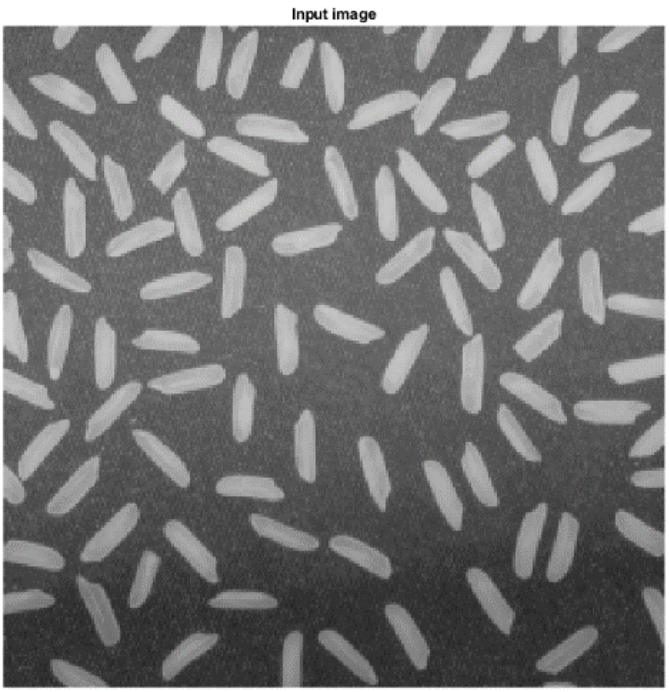


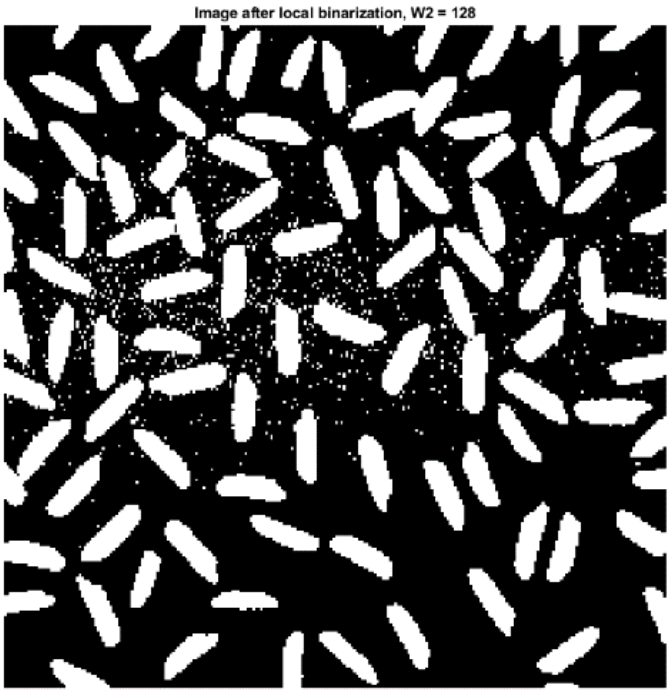
Yen, threshold = 134



Task 6.4. Local binarization:

```
image = imread("rice.png");
imageBW = image;
figure('Name','Local binarization','NumberTitle','off');
[X, Y] = size(image);
W2 = 128;

for i = 1:X
    for j = 1:Y
        if imageBW(i,j) > meanLT(i,j,W2,image,X,Y)
            imageBW(i,j) = 255;
        else
            imageBW(i,j) = 0;
        end
    end
end

subplot(1,2,1)
imshow(image);
title("Input image");
subplot(1,2,2)
imshow(imageBW);
title("Image after local binarization, W2 = " + W2);
```





Input image

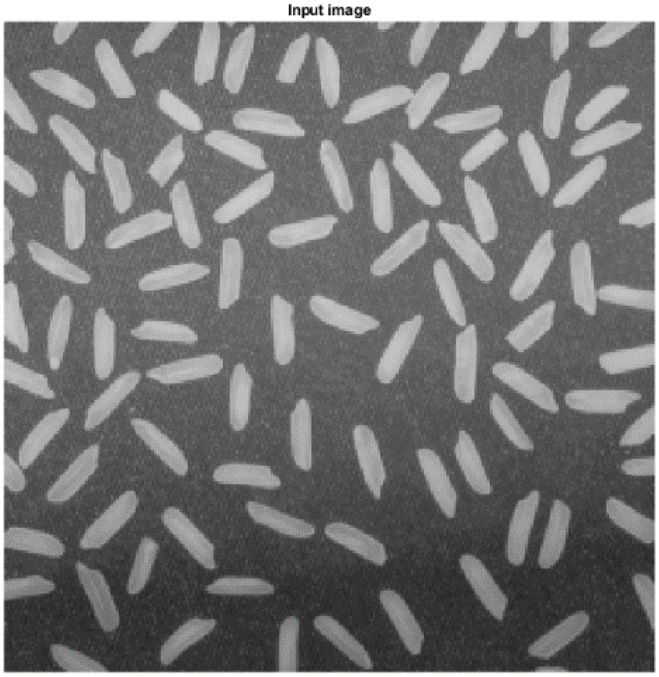
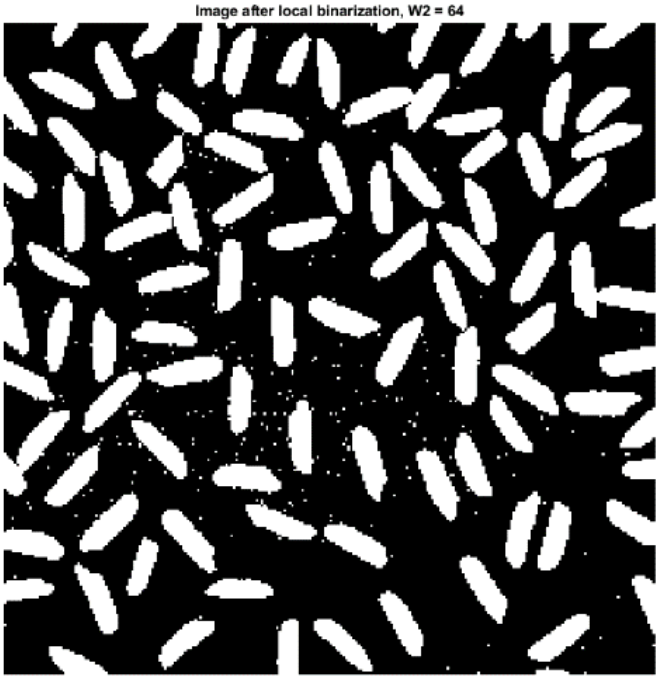


Image after local binarization, W2 = 64



Input image

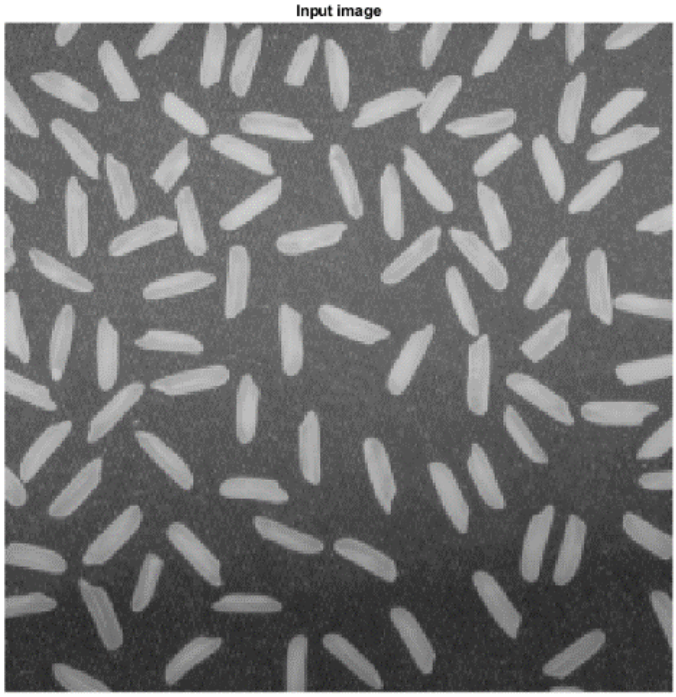
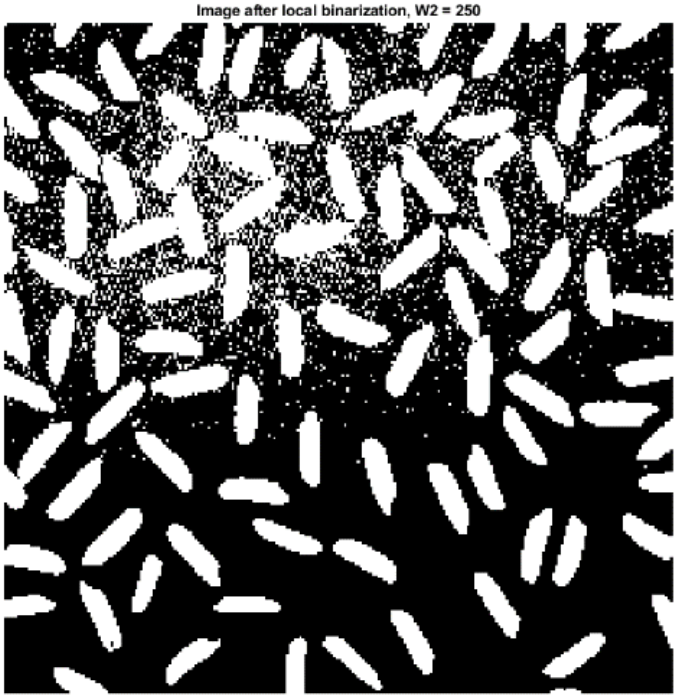


Image after local binarization, W2 = 250



Input image

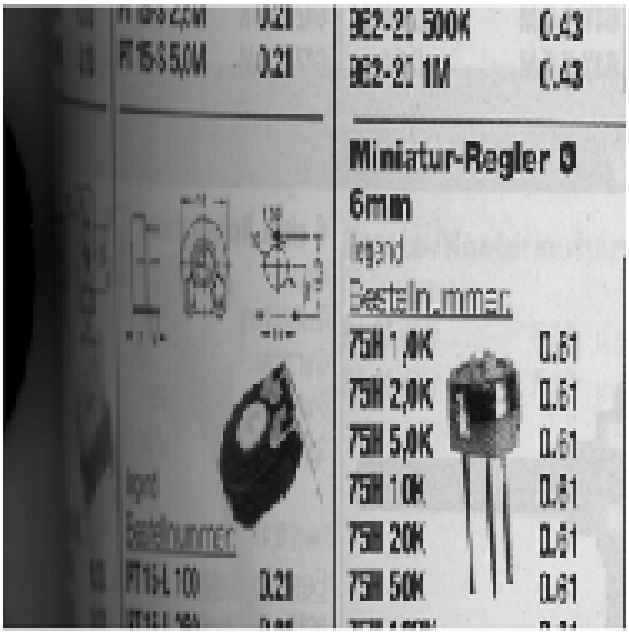
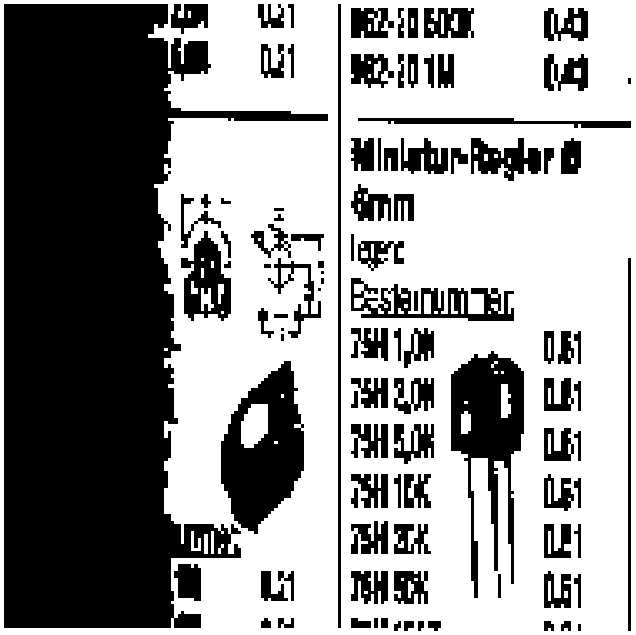


Image after local binarization, W2 = 128



Input image

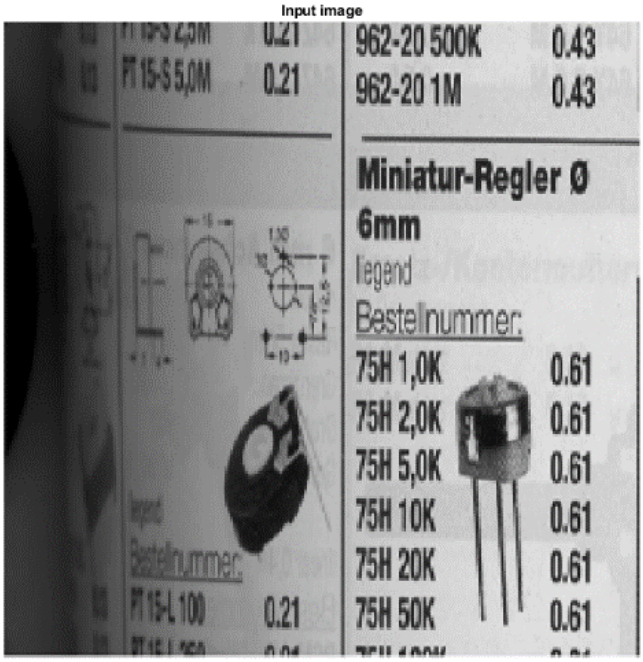
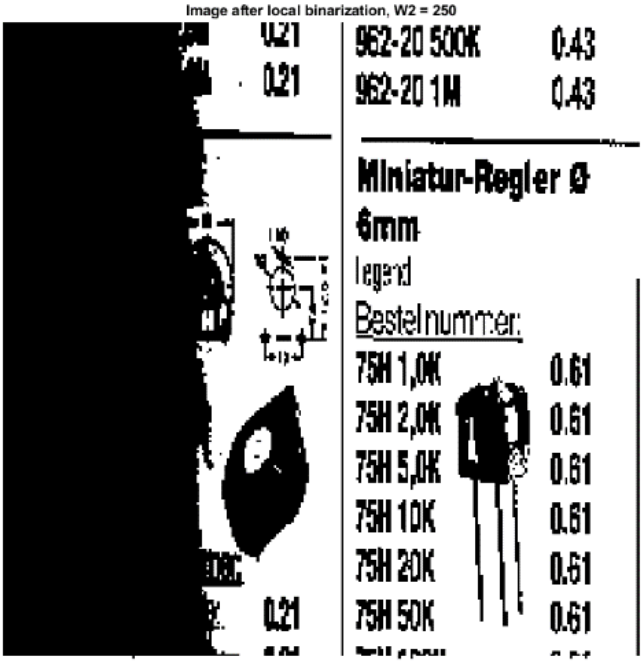


Image after local binarization, W2 = 250



Sauvola method:

```
image = imread("rice.png");
imageBW = image;
p_imageBW_improved = image;
m_imageBW_improved = image;

figure('Name','Improved local binarization','NumberTitle','off');
[X, Y] = size(image);
W2 = 128;
k = 0.15;
 R = 128;
 for i = 1:X
     for j = 1:Y
         mean = meanLT(i,j,W2,image,X,Y);
         stddev = stddevLT(i,j,W2,image,mean,X,Y);
         T_p = mean * (1 + k*(stddev/R - 1));
         T_m = mean * (1 - k*(stddev/R - 1));

         if image(i,j) > T_p
             p_imageBW_improved(i,j) = 255;
         else
             p_imageBW_improved(i,j) = 0;
         end

         if image(i,j) > T_m
             m_imageBW_improved(i,j) = 255;
         else
             m_imageBW_improved(i,j) = 0;
         end

         if image(i,j) > mean
             imageBW(i,j) = 255;
         else
             imageBW(i,j) = 0;
         end
     end
 end
 subplot(1,4,1)
 imshow(image);
 title("Input image");
 subplot(1,4,2)
 imshow(imageBW);
 title("Image after local binarization, W2 = " + W2);
 subplot(1,4,3)
 imshow(p_imageBW_improved);
 title("Image after local improved binarization(+)," + newline + "W2
   = " + W2 + ", k = " + k + ", R = " + R);
 subplot(1,4,4)
 imshow(m_imageBW_improved);
 title("Image after local improved binarization(-)," + newline + "W2
   = " + W2 + ", k = " + k + ", R = " + R);
```

Input image

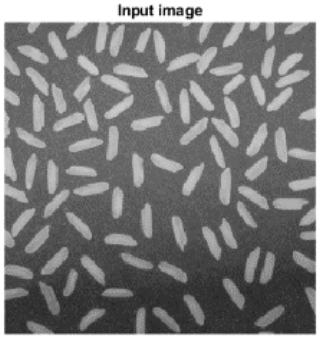


Image after local binarization, W2 = 128

Image after local improved binarization(+), W2 = 128, k = 0.15, R = 128

Image after local improved binarization(-), W2 = 128, k = 0.15, R = 128

Input image

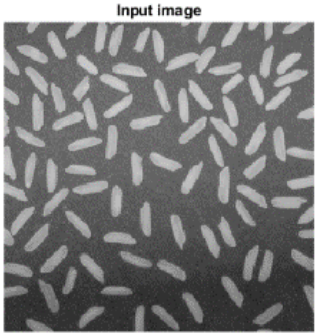


Image after local binarization, W2 = 128

Image after local improved binarization(+), W2 = 128, k = 0.3, R = 128

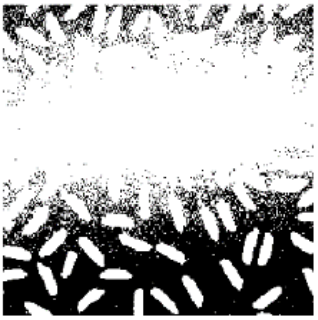


Image after local improved binarization(-), W2 = 128, k = 0.3, R = 128

Input image

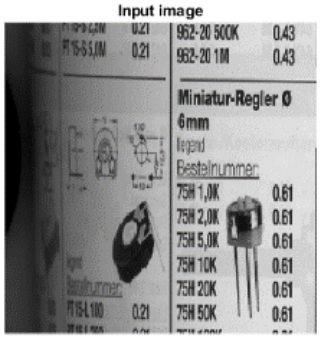


Image after local binarization, W2 = 128

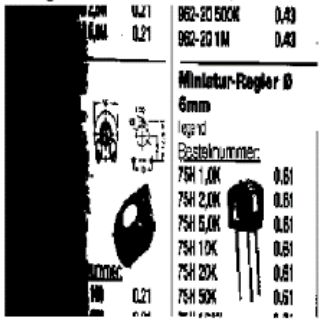


Image after local improved binarization(+), W2 = 128, k = 0.15, R = 128

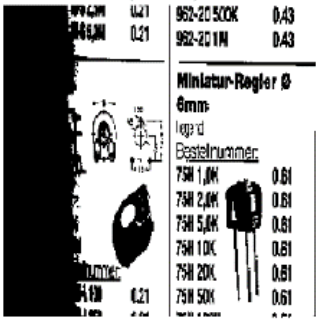
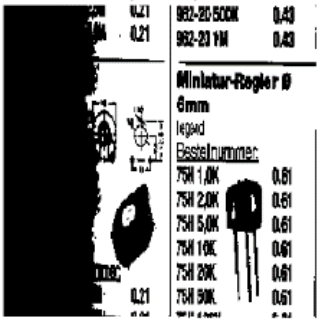


Image after local improved binarization(-), W2 = 128, k = 0.15, R = 128



Input image

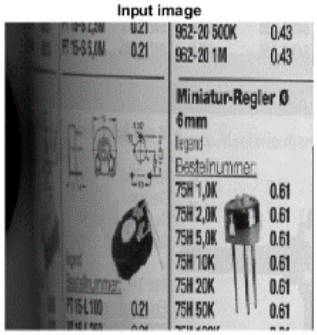


Image after local binarization, W2 = 128

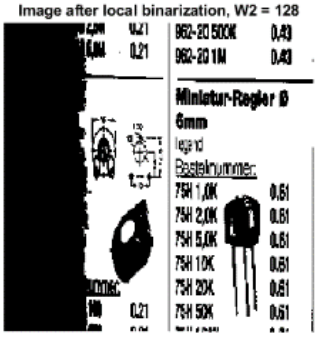


Image after local improved binarization(+), W2 = 128, k = 0.3, R = 128

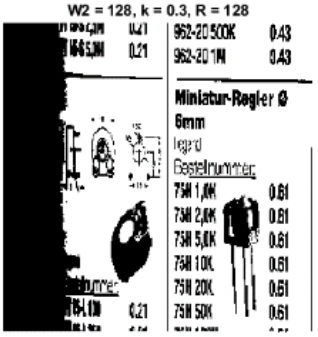
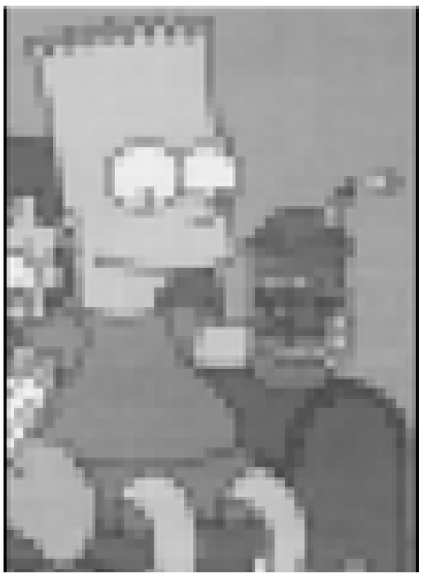
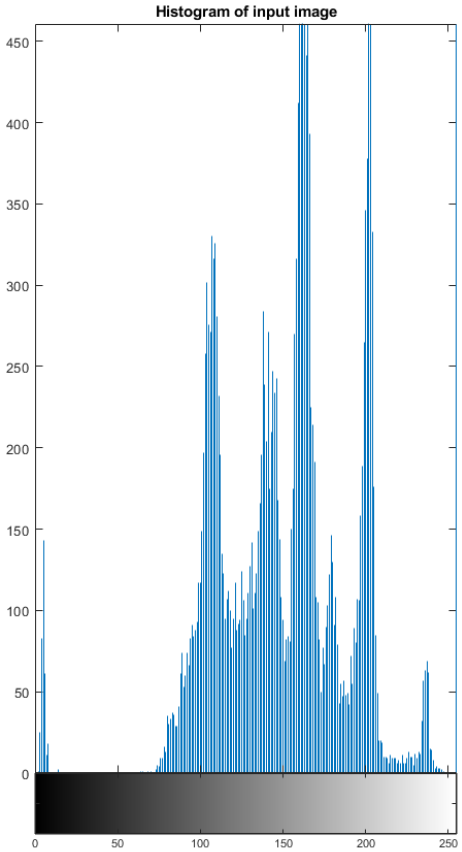


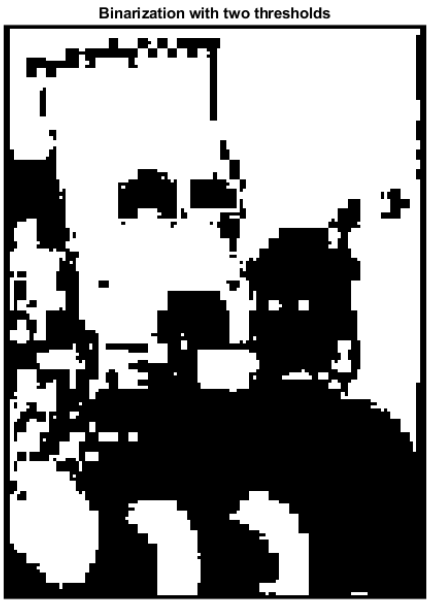
Image after local improved binarization(-), W2 = 128, k = 0.3, R = 128

Task 6.5. Binarization with two thresholds:

```
1. image = imread("bart.bmp");
2.
3. figure('Name','Binarization with two
   thresholds','NumberTitle','off');
4. subplot(1,3,1);
5.
6. imshow(image);
7. title("Input image");
8. subplot(1,3,2);
9. imhist(image);
10.  title("Histogram of input image");
11.
12.  subplot(1,3,3);
13.  lowerThreshold = 145;
14.  upperThreshold = 225;
15.  imageBW = image > lowerThreshold & image < upperThreshold;
16.  imageBW = uint8(imageBW);
17.  imshow(imageBW, []);
18.  title("Binarization with two thresholds");
```







2. Conclusions:

Considering the picture of coins, the threshold with a value of 0.4 gives the best result of the simple binarization effect. The shape of white circles is similar to real coins in the input image and only one shape has a bit of black noise inside.

The output image after binarization by im2bw() method has a clear and sharp shape but there is no build-in algorithm to remove the noise.

The Otsu method gives a little bigger threshold (0.49412) than the manually selected (0.4). Comparing the binary images, the otsu version has more black pixels inside the white circles, and the shape of these circles is less round.

The Yen method gives the best result if the lighting is not uniform. Kittler method has a problem with darker areas of an image and after processing there are black spots on the resulting picture. The most readable output of text pictures is given by Kittle and Otsu methods, the text is sharp and letter shapes are not distorted.

Local binarization with meanLT method can handle with non-uniform lighting. In a picture called rice.png, the value of the W2 parameter affects noise in the brightened area so the higher value means more disturbance. But on the other image called catalogue.bmp the higher value of this parameter affects text sharpness.

The equation in the Sauvola method has two versions. One is with "+" symbol and it gives better results with brightened images and the second with "-"symbol should be used in dimmed images.

Binarization with two thresholds gives more control of image processing because we can define the range of greyscale we want to separate from the rest of the image.