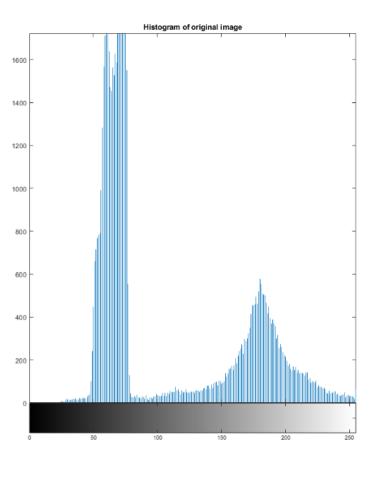
Digital image processing and vision systems – lab #5

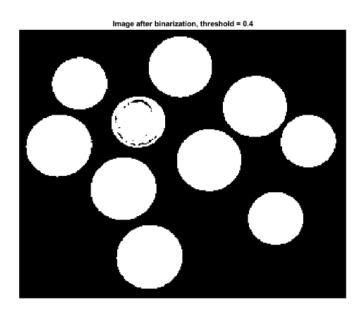
Date performed: 20.04.2021	Group 2
Author name: Krzysztof Klimczyk	

1. Source codes and screenshots:

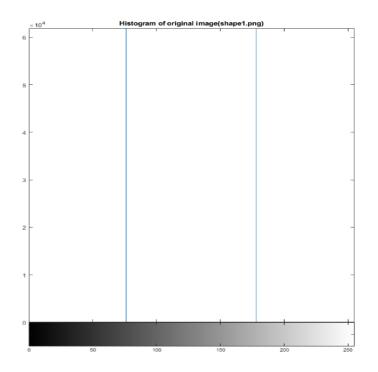
Task 6.3. Histogram based binarization:

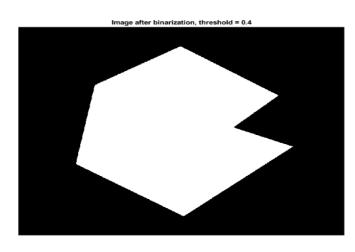
```
1. image = imread("coins.png");
2.
3. figure('Name','Histogram and binarization','NumberTitle','off');
4. subplot(1,2,1)
5. imhist(image);
6. title("Histogram of original image");
7. subplot(1,2,2)
8. bw = im2bw(image,0.4);
9. imshow(bw);
10. title("Image after binarization, threshold = 0.4");
```

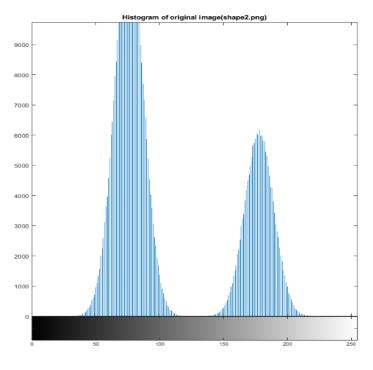


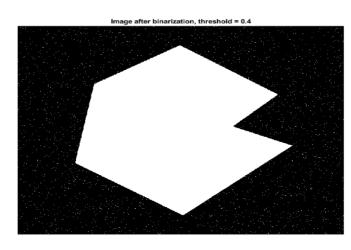


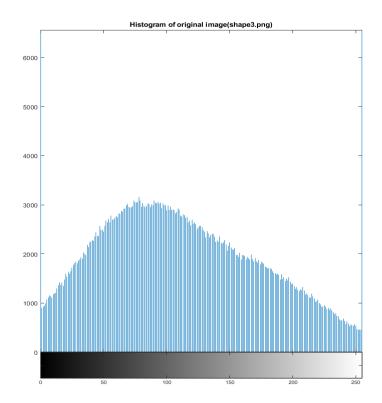
```
1. shape1 = imread("shape1.png");
2. shape2 = imread("shape2.png");
3. shape3 = imread("shape3.png");
4. shape4 = imread("shape4.png");
5.
6. figure('Name','Shape 1','NumberTitle','off');
7. subplot(1,2,1)
8. imhist(shape1);
9. title("Histogram of original image(shape1.png)");
10. subplot(1,2,2)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

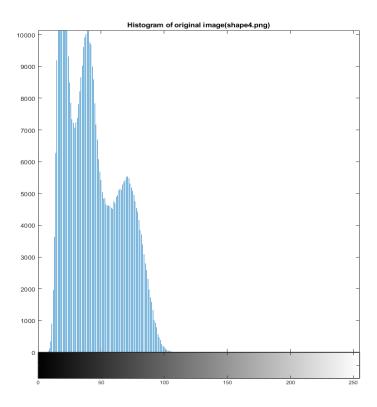


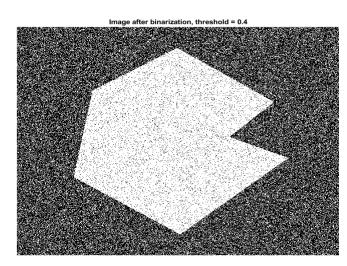


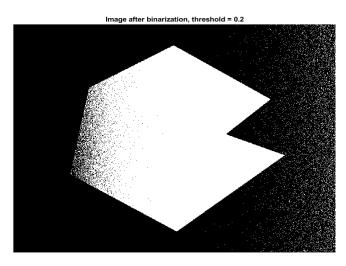




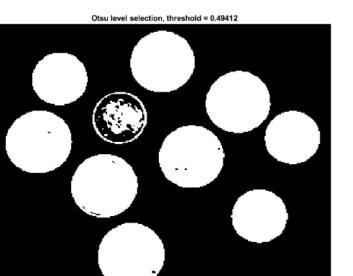


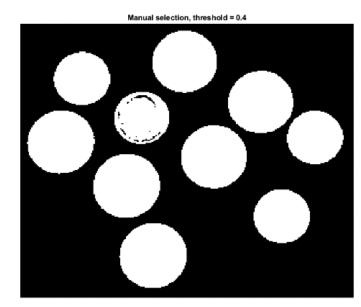






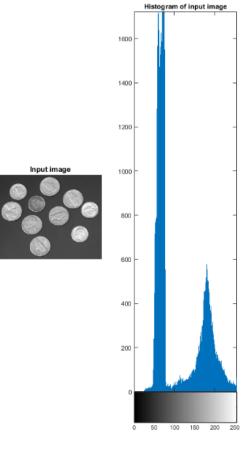
```
1. figure('Name','Otsu and manually selection','NumberTitle','off');
2. subplot(1,2,1)
3. level = graythresh(image);
4. bw = im2bw(image,level);
5. imshow(bw);
6. title("Otsu level selection, threshold = " + level);
7. subplot(1,2,2)
8. bw = im2bw(image,0.4);
9. imshow(bw);
10. title("Manual selection, threshold = 0.4");
```





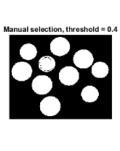
```
1. image = imread("catalogue.bmp");
2.
3. figure('Name','Kittle/Yen','NumberTitle','off');
5. imshow(image)
6. title("Input image");
7. subplot(1, 6, 2)
8. imhist(image)
9. title("Histogram of input image");
10. subplot(1, 6, 3)
11. level = 0.4;
12. bw = im2bw(image, level);
13. imshow(bw);
14. title("Manual selection, threshold = " + level);
15. subplot (1, 6, 4)
16. level = graythresh(image);
17. bw = im2bw(image, level);
18. imshow(bw);
19. title("Otsu level selection, threshold = " + level);
20. subplot(1, 6, 5)
21. Kit = clusterKittler(image);
22. bw = im2bw (image, Kit/255);
23. imshow(bw);
24. title("Kittler, threshold = " + Kit);
```

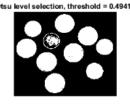
```
25. subplot(1,6,6)
26. Yen = entropyYen(image);
27. bw = im2bw(image,Yen/255);
28. imshow(bw);
29. title("Yen, threshold = " + Yen);
```

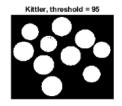


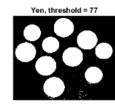
1000

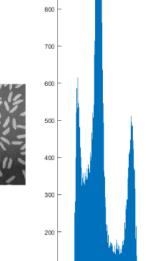
900











100

Histogram of input image

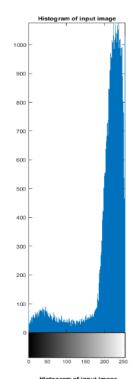






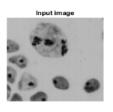






lanual selection, threshold = 0.4 Non - destruction is a simed of of manufacand mainte Fiber and octnotor abonding an interlayer of massive and impact level selection, threshold = 0.5 Non-destru is aimed o of manufac and mainle Fiber and actuator a bonding an interlayer of massive and impact





Input image

DM L21 9%-X 50K

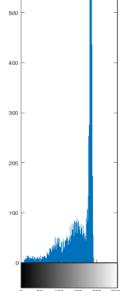
Minister-Region Defined Region Bases Instruction Region Regi

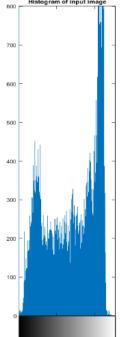
0.43 0.43

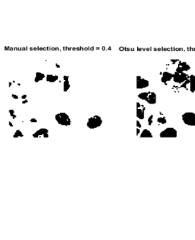
Input image

Non-destris aimed of manufa and maint Fiber and actuator bonding a interlaye of massiv and impac

u o c e a n r e t



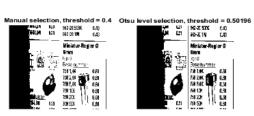








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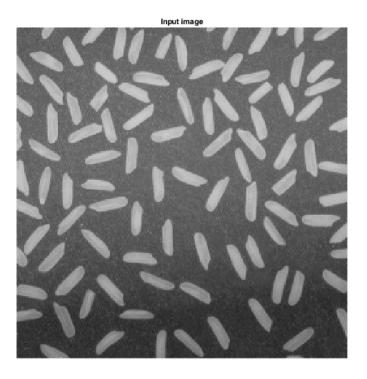




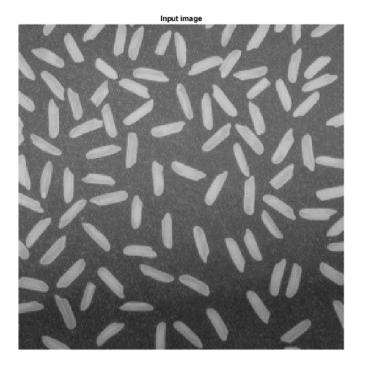


Task 6.4. Local binarization:

```
1. image = imread("rice.png");
2. imageBW = image;
3. figure('Name','Local binarization','NumberTitle','off');
4. [X, Y] = size(image);
5. W2 = 128;
6.
7. for i = 1:X
     for j = 1:Y
8.
9.
           if imageBW(i,j) > meanLT(i,j,W2,image,X,Y)
10.
                imageBW(i,j) = 255;
11.
12.
                 imageBW(i,j) = 0;
13.
            end
14.
        end
15. end
16.
17. subplot(1,2,1)
18. imshow(image);
19. title("Input image");
20. subplot(1,2,2)
21. imshow(imageBW);
22. title("Image after local binarization, W2 = " + W2);
```

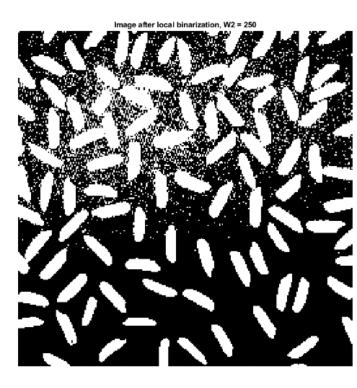










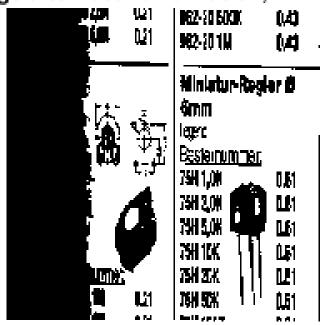


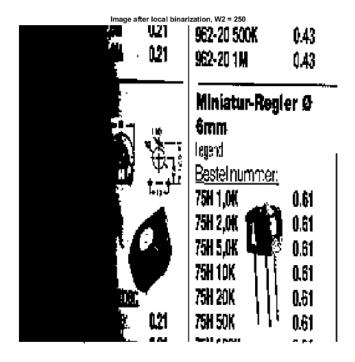
Input image

141 962-20 500K 0.43 FI15/85,0M 021 962-21 1M 0.43 Miniatur-Regler 0 6mm legand Bestelnummer. 75H 1,4K 0.61 75H 2,0K 0.61 75H 5,0K 0.61 75H 10K 0.81 75E 20K 0.61 0.21 MIRL 100 75H 50K 0.61

15-5 5,0M	0.21 0.21	962-20 500K 962-20 1M	0.43 0.43
A STATE OF THE PARTY OF THE PAR	0.21	Miniatur-Re 6mm legend Bestelnumme 75H 1,0K 75H 2,0K 75H 5,0K 75H 10K 75H 20K 75H 50K	

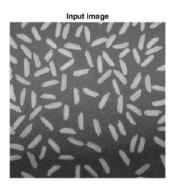
Image after local binarization, W2 = 128



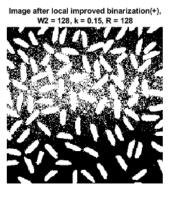


Sauvola method:

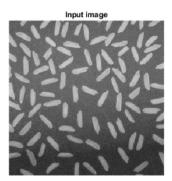
```
1. image = imread("rice.png");
2. imageBW = image;
3. p_imageBW_improved = image;
4. m imageBW improved = image;
5.
6. figure('Name','Improved local binarization','NumberTitle','off');
7. [X, Y] = size(image);
8. W2 = 128;
9. k = 0.15;
10. R = 128;
11. for i = 1:X
12.
         for j = 1:Y
13.
             mean = meanLT(i,j,W2,image,X,Y);
14.
             stddev = stddevLT(i,j,W2,image,mean,X,Y);
15.
             T p = mean * (1 + k*(stddev/R - 1));
16.
             T m = mean * (1 - k*(stddev/R - 1));
17.
18.
             if image(i,j) > T p
19.
                 p_imageBW_improved(i,j) = 255;
20.
             else
21.
                  p_{imageBW_improved(i,j)} = 0;
22.
             end
23.
24.
             if image(i,j) > T m
25.
                 m imageBW improved(i,j) = 255;
26.
             else
27.
                 m imageBW improved(i,j) = 0;
28.
             end
29.
             if image(i,j) > mean
30.
31.
                  imageBW(i,j) = 255;
32.
             else
33.
                  imageBW(i,j) = 0;
34.
             end
         end
35.
36. end
37. subplot(1, 4, 1)
38. imshow(image);
39. title("Input image");
40. subplot (1, 4, 2)
41. imshow(imageBW);
42. title("Image after local binarization, W2 = " + W2);
43. subplot(1,4,3)
44. imshow(p_imageBW_improved);
45. title("Image after local improved binarization(+)," + newline + "W2
   = " + W2 + ", k = " + k + ", R = " + R);
46. subplot(1, 4, 4)
47. imshow(m_imageBW_improved);
48. title("Image after local improved binarization(-)," + newline + "W2
   = " + W2 + ", k = " + k + ", R = " + R);
```



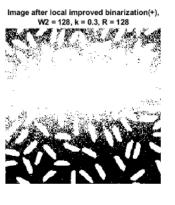




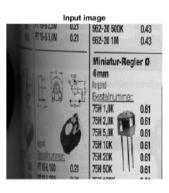












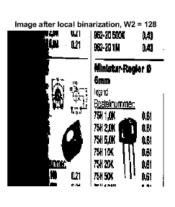


Image after loca W2 = 12		oved binariz 0.15, R = 128	
745,3H	0.21	962-20 500K 962-20 1 M	0.43 0.43
		Ministur Re 6mm leged Bestelnummer 758 1,0M 758 2,0M 758 10X 758 20X 758 50X	-

Image after local improved binarization(-), W2 = 128, k = 0.15, R = 128 W2 98/20500K 0.4)				
	962-23 PM 0.43 Miniatur-Regier Ø 6mm leged			
	Bestelnummer: 75H 1,0K 0.61 75H 2,0K 0.61 75H 5,0K 0.61 75H 1,0K 0.61			
0.21	75H 20K 0.61 75H 50K 0.61	ĺ		

Input image				
	BSIAN	021	962-20 500K 962-20 1M	0.43 0.43
	E G	021	Miniatur-Ref 6mm legard Eesteinummer 75H 1,0K 75H 2,0K 75H 5,0K 75H 10K 75H 20K 75H 50K	e de la compa

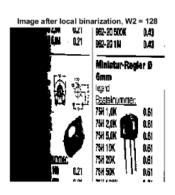
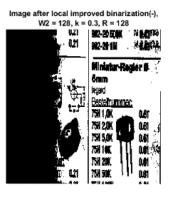


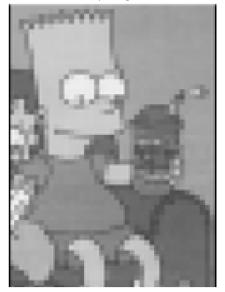
Image after local improved binarization(+), W2 = 128, k = 0.3, R = 128			
1 166 S.J.M	021 021	962-20 500K 962-20 1M	0.43 0.43
E G		Miniatur-Reg Genm legral Bestelnummen 75H 1,0H 75H 2,0K 75H 10K 75H 20K 75H 50K	

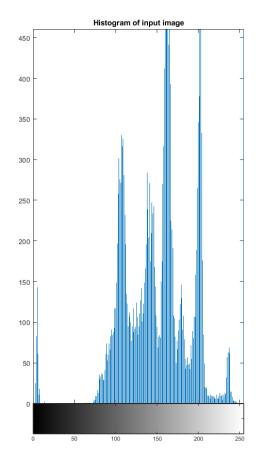


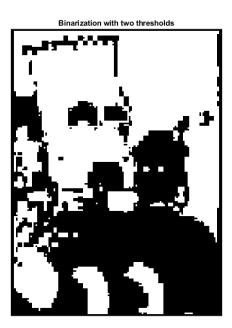
Task 6.5. Binarization with two thresholds:

```
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");
```

Input image







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.