



**Politechnika  
Śląska**

# Przetwarzanie Obrazów Cyfrowych

**Raport z ćwiczenia nr. 3:  
Metody segmentacji obrazów**

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## Zadanie 2

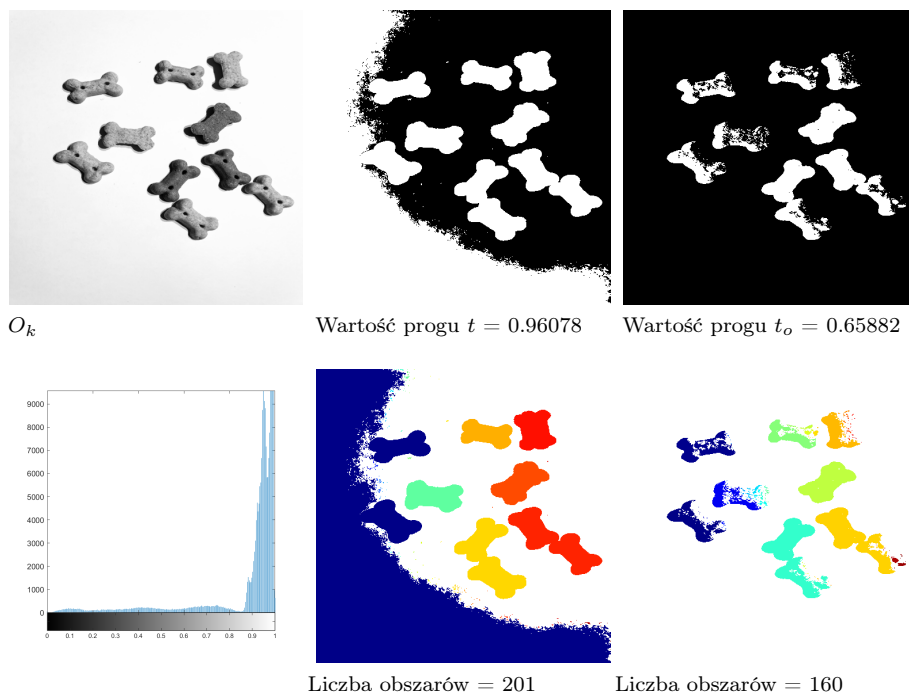
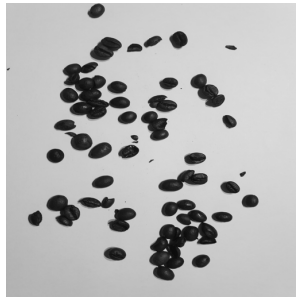
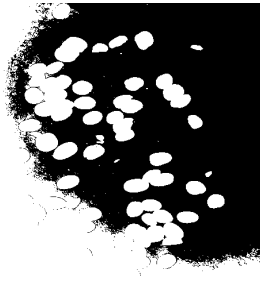


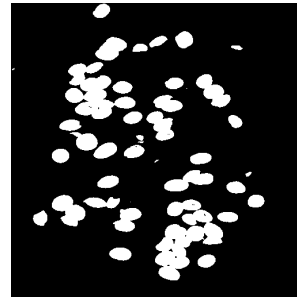
Figure 1: Porównanie



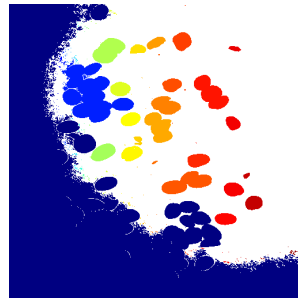
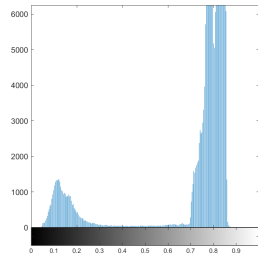
$O_k$



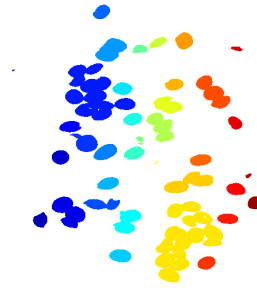
Wartość progu  $t = 0.78824$



Wartość progu  $t_o = 0.47451$



Liczba obszarów = 258



Liczba obszarów = 39

Figure 2: Porównanie

### Zadanie 3

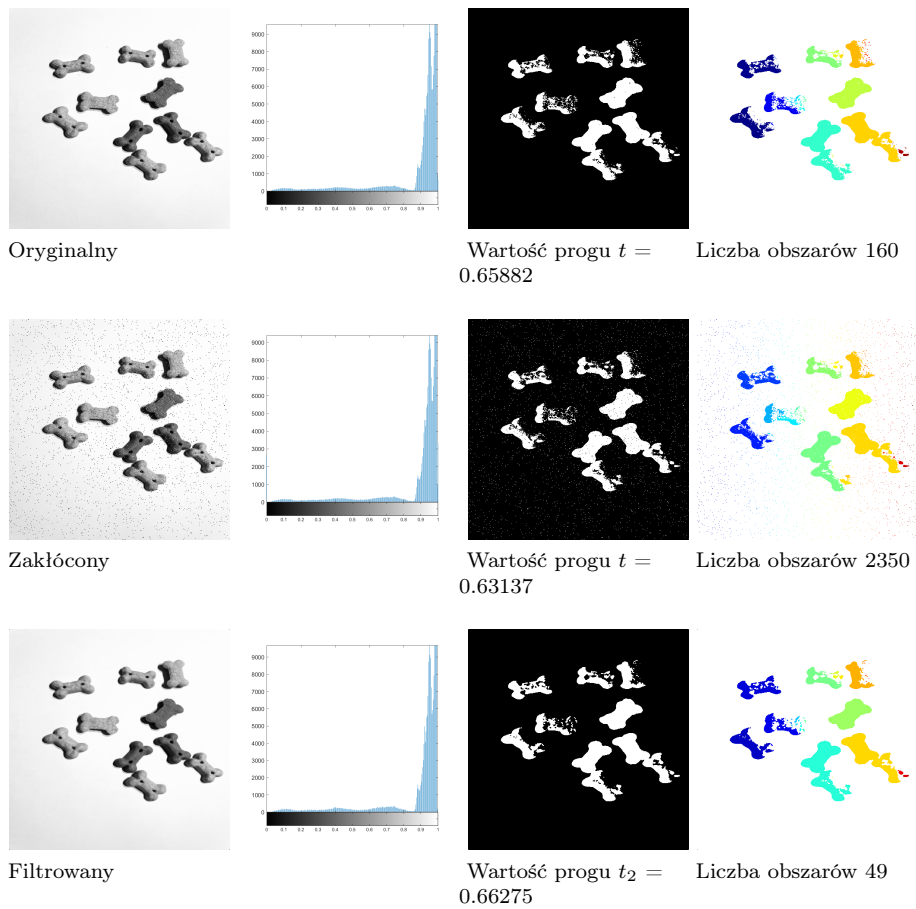


Figure 3: Porównanie

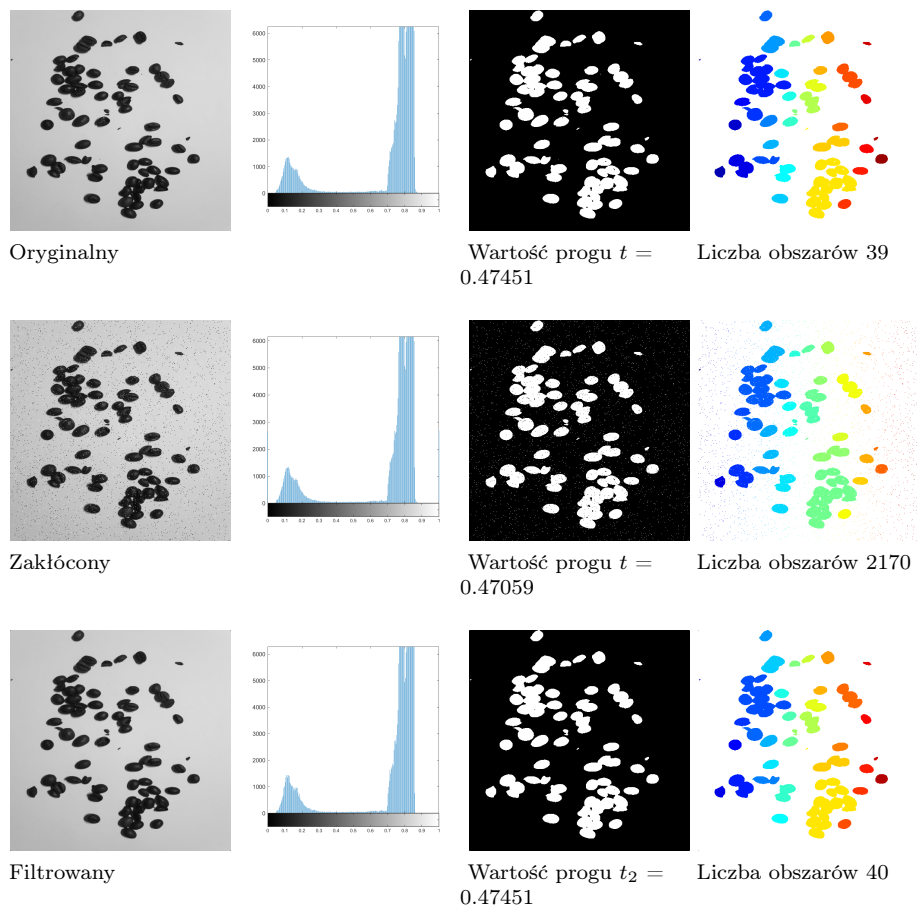


Figure 4: Porównanie

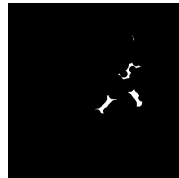
## Zadanie 4



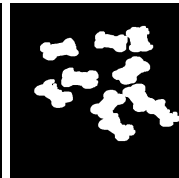
Wartość progu  $t$   
= 160



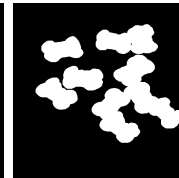
$s = \text{offset-}$   
 $\text{strel('ball', 5, 5);}$   
 $\text{imerode(I, s);}$



$s = \text{offset-}$   
 $\text{strel('ball', 10, 10);}$   
 $\text{imerode(I, s);}$



$s = \text{offset-}$   
 $\text{strel('ball', 5, 5);}$   
 $\text{imdilate(I, s);}$



$s = \text{offset-}$   
 $\text{strel('ball', 10, 10);}$   
 $\text{imdilate(I, s);}$



Liczba obszarów  
= 160



Liczba obszarów  
= 22



Liczba obszarów  
= 6

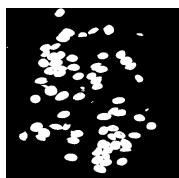
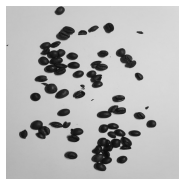


Liczba obszarów  
= 6

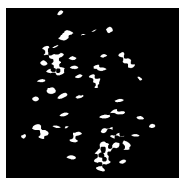


Liczba obszarów  
= 5

Figure 5: Porównanie



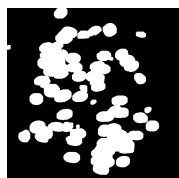
Wartość progu  $t$   
= 39



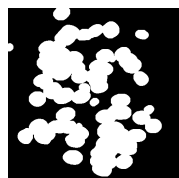
$s = \text{offset-}$   
 $\text{strel('ball', 5, 5);}$   
 $\text{imerode(I, s);}$



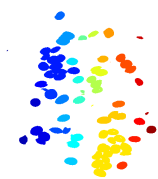
$s = \text{offset-}$   
 $\text{strel('ball', 10, 10);}$   
 $\text{imerode(I, s);}$



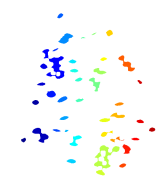
$s = \text{offset-}$   
 $\text{strel('ball', 5, 5);}$   
 $\text{imdilate(I, s);}$



$s = \text{offset-}$   
 $\text{strel('ball', 10, 10);}$   
 $\text{imdilate(I, s);}$



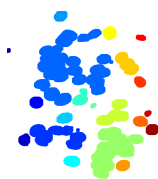
Liczba obszarów  
= 39



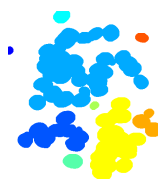
Liczba obszarów  
= 42



Liczba obszarów  
= 42



Liczba obszarów  
= 20



Liczba obszarów  
= 9

Figure 6: Porównanie

# Kody programów

## zad2.m

```
1 clear all
2 close all
3
4
5 disp("Zad 2")
6
7 disp("    Img 1")
8 ProcessImages("../images/20191121_072040.jpg", "../zad2/Img1");
9
10 disp("    Img 2")
11 ProcessImages("../images/20191121_072227.jpg", "../zad2/Img2");
12
13
14
15
16 function ProcessImages(image_path, dest_folder)
17
18
19     I = imread(image_path);
20     I = rgb2gray(I);
21     I = double(I) / 255;
22     I = imresize(I, [512 512]);
23
24     [I1, t1] = ImageBinarize(I, "hist");
25     [I2, t2] = ImageBinarize(I, "otsu");
26
27     I1 = -I1 + 1;
28     I2 = -I2 + 1;
29
30     [~, n1] = bwlabel(I1);
31     [~, n2] = bwlabel(I2);
32
33     I1_col = label2rgb(bwlabel(I1));
34     I2_col = label2rgb(bwlabel(I2));
35
36     % figure; imshow(I);
37     % figure; imshow(I1); title("wartosc progu t1 = " + string(t1))
38     % figure; imshow(I2); title("wartosc progu t2 = " + string(t2))
39     %
40     % figure; imhist(I);
41     % figure; imshow(I1_col); title("Liczba obszarow = " + string(
42     n1))
43     % figure; imshow(I2_col); title("Liczba obszarow = " + string(
44     n2))
45
46     mkdir(dest_folder);
47
48     imwrite(cropToSquare(I), dest_folder + "/I.png");
49     imwrite(cropToSquare(I1), dest_folder + "/I1.png");
50     imwrite(cropToSquare(I2), dest_folder + "/I2.png");
51
52     HistSave(I, dest_folder + "/I_hist.png")
```



```

52     imwrite(cropToSquare(I1_col), dest_folder + "/I1_col.png");
53     imwrite(cropToSquare(I2_col), dest_folder + "/I2_col.png");
54
55
56     Latex = [
57         "\newcommand{\ww}{0.32} "
58         "\begin{figure}[H] "
59         "    \captionsetup[subfloat]{justification=raggedright,
60         singlelinecheck=false, position=bottom,labelformat=empty} % "
61         "    \subfloat[ $0_k$ ]{"
62         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
63         + "/I.png}} \hfill% "
64         "    \subfloat[ śĆWarto progu $t$ = " + string(t1) + " ]{"
65         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
66         + "/I1.png}} \hfill% "
67         "    \subfloat[ śĆWarto progu $t_o$ = " + string(t2) + " ]{"
68         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
69         + "/I2.png}} \hfill%"
70         " "
71         "    \subfloat["
72         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
73         + "/I_hist.png}} \hfill% "
74         "    \subfloat[Liczba óbszarw = " + string(n1) + " ]{"
75         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
76         + "/I1_col.png}} \hfill% "
77         "    \subfloat[Liczba óbszarw = " + string(n2) + " ]{"
78         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
79         + "/I2_col.png}} \hfill%"
80         " "
81         "\caption{Porownanie}"
82         " "
83         "\end{figure} "
84         "\let\ww\undefined "
85     ];
86
87     Latex = join(Latex,['\n'],2);
88     Latex = join(Latex,['\n'],1);
89
90     fid = fopen(dest_folder + "/result.tex",'wt');
91     fprintf(fid,"%s", Latex);
92     fclose(fid);
93
94 end
95
96 function HistSave(I, dest)
97     f = figure;
98     f.Position = [0,0,512,512];
99     imhist(I);
100     saveas(gcf, dest)
101     close(gcf);
102 end

```

## zad3.m

```
1 clear all
2 close all
3
4
5 disp("Zad 3")
6
7 disp("    Img 1")
8 ProcessImages("../images/20191121_072040.jpg", "../zad3/Img1");
9
10 disp("    Img 2")
11 ProcessImages("../images/20191121_072227.jpg", "../zad3/Img2");
12
13
14
15 function ProcessImages(image_path, dest_folder)
16
17
18     I = imread(image_path);
19     I = rgb2gray(I);
20     I = double(I) / 255;
21     I = imresize(I, [512, 512]);
22
23     I1 = imnoise(I, "salt & pepper", .02);
24     %I2 = imfilter(I, fspecial("gaussian", 3, 1));
25     I2 = medfilt2(I,[3 3]);
26
27     [I_b, t] = ImageBinarize(I, "otsu");
28     [I1_b, t1] = ImageBinarize(I1, "otsu");
29     [I2_b, t2] = ImageBinarize(I2, "otsu");
30
31     I_b = -I_b + 1;
32     I1_b = -I1_b + 1;
33     I2_b = -I2_b + 1;
34
35     [~, n] = bwlabel(I_b);
36     [~, n1] = bwlabel(I1_b);
37     [~, n2] = bwlabel(I2_b);
38
39     I_col = label2rgb(bwlabel(I_b));
40     I1_col = label2rgb(bwlabel(I1_b));
41     I2_col = label2rgb(bwlabel(I2_b));
42
43
44     mkdir(dest_folder);
45
46     imwrite(cropToSquare(I), dest_folder + "/I.png");
47     imwrite(cropToSquare(I1), dest_folder + "/I1.png");
48     imwrite(cropToSquare(I2), dest_folder + "/I2.png");
49
50     HistSave(I, dest_folder + "/H.png")
51     HistSave(I1, dest_folder + "/H1.png")
52     HistSave(I2, dest_folder + "/H2.png")
53
54     imwrite(cropToSquare(I_b), dest_folder + "/I_b.png");
55     imwrite(cropToSquare(I1_b), dest_folder + "/I1_b.png");
```

```

56     imwrite(cropToSquare(I2_b), dest_folder + "/I2_b.png");
57
58     imwrite(cropToSquare(I_col), dest_folder + "/I_col.png");
59     imwrite(cropToSquare(I1_col), dest_folder + "/I1_col.png");
60     imwrite(cropToSquare(I2_col), dest_folder + "/I2_col.png");
61
62
63     Latex = [
64         "\newcommand{\ww}{0.24} "
65         "\begin{figure}[H] "
66         "    \captionsetup[subfloat]{justification=raggedright,
67         singlelinecheck=false, position=bottom,labelformat=empty} % "
68         "    "
69         "    \subfloat[ Oryginalny ]{"
70         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
71         + "/I.png}} \hfill% "
72         "    \subfloat[ ]{"
73         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
74         + "/H.png}} \hfill% "
75         "    \subfloat[ \acute{e}Warto programu $t$ = " + string(t) + " ]{"
76         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
77         + "/I_b.png}} \hfill%"
78         "    \subfloat[ Liczba \acute{o}bszarw " + string(n) + " ]{"
79         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
80         + "/I_col.png}} \hfill%"
81         "    "
82         "    \subfloat[ \acute{e}Warto programu $t_1$ = " + string(t1) + " ]{"
83         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
84         + "/I1_b.png}} \hfill%"
85         "    \subfloat[ Liczba \acute{o}bszarw " + string(n1) + " ]{"
86         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
87         + "/I1_col.png}} \hfill%"
88         "    "
89         "    \subfloat[ Filtrowany ]{"
90         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
91         + "/I2.png}} \hfill% "
92         "    \subfloat[ ]{"
93         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
94         + "/H2.png}} \hfill% "
95         "    \subfloat[ \acute{e}Warto programu $t_2$ = " + string(t2) + " ]{"
96         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
97         + "/I2_b.png}} \hfill%"
98         "    \subfloat[ Liczba \acute{o}bszarw " + string(n2) + " ]{"
99         "        \includegraphics[width=\ww\linewidth]{" + dest_folder
100        + "/I2_col.png}} \hfill%"
101        "    "
102        "    "
103        "\caption{Porownanie}"
104        ""
105        "\end{figure} "
106        "\let\ww\undefined "

```

```

100     ];
101
102     Latex = join(Latex,[''],2);
103     Latex = join(Latex,[newline],1);
104
105     fid = fopen(dest_folder + "/result.tex",'wt');
106     fprintf(fid,"%s", Latex);
107     fclose(fid);
108
109
110
111
112
113 end
114
115
116
117 function HistSave(I, dest)
118     f = figure;
119     f.Position = [0,0,512,512];
120     imhist(I);
121     saveas(gcf, dest)
122     close(gcf);
123 end

```

## zad4.m

```
1 clear all
2 close all
3
4
5 disp("Zad 4")
6
7 disp("    Img 1")
8 ProcessImages("../images/20191121_072040.jpg", "../zad4/Img1");
9
10 disp("    Img 2")
11 ProcessImages("../images/20191121_072227.jpg", "../zad4/Img2");
12
13
14
15 function ProcessImages(image_path, dest_folder)
16
17
18     I = imread(image_path);
19     I = rgb2gray(I);
20     I = double(I) / 255;
21     I = imresize(I, [512, 512]);
22
23     [I_b, t] = ImageBinarize(I, "otsu");
24
25     I_b = -I_b + 1;
26
27     I_b_u8 = uint8(I_b*255);
28
29     Ib1 = imerode(I_b_u8, offsetstrel('ball',5,5)) > 127;
30     Ib2 = imerode(I_b_u8, offsetstrel('ball',10,10)) > 127;
31     Ib3 = imdilate(I_b_u8, offsetstrel('ball',5,5)) > 127;
32     Ib4 = imdilate(I_b_u8, offsetstrel('ball',10,10)) > 127;
33
34     [~, n] = bwlabel(I_b_u8);
35     [~, n1] = bwlabel(Ib1);
36     [~, n2] = bwlabel(Ib2);
37     [~, n3] = bwlabel(Ib3);
38     [~, n4] = bwlabel(Ib4);
39
40     I_col = label2rgb(bwlabel(I_b_u8));
41     I1_col = label2rgb(bwlabel(Ib1));
42     I2_col = label2rgb(bwlabel(Ib2));
43     I3_col = label2rgb(bwlabel(Ib3));
44     I4_col = label2rgb(bwlabel(Ib4));
45
46
47     mkdir(dest_folder);
48
49     imwrite(cropToSquare(I), dest_folder + "/I.png");
50
51     imwrite(cropToSquare(I_b), dest_folder + "/I_b.png");
52     imwrite(cropToSquare(Ib1), dest_folder + "/Ib1.png");
53     imwrite(cropToSquare(Ib2), dest_folder + "/Ib2.png");
54     imwrite(cropToSquare(Ib3), dest_folder + "/Ib3.png");
55     imwrite(cropToSquare(Ib4), dest_folder + "/Ib4.png");
```

```

56 imwrite(cropToSquare(I_col), dest_folder + "/I_col.png");
57 imwrite(cropToSquare(I1_col), dest_folder + "/I1_col.png");
58 imwrite(cropToSquare(I2_col), dest_folder + "/I2_col.png");
59 imwrite(cropToSquare(I3_col), dest_folder + "/I3_col.png");
60 imwrite(cropToSquare(I4_col), dest_folder + "/I4_col.png");
61
62
63
64
65 Latex = [
66 "\newcommand{\ww}{0.19} "
67 "\begin{figure}[H] "
68 " \captionsetup[subfloat]{justification=raggedright,
69 singlelinecheck=false, position=bottom,labelformat=empty} % "
70 " \subfloat[]{"
71 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/I.png}} \hfill% "
72 " \subfloat[]{"
73 " \includegraphics[width=\ww\linewidth]{../other/Empty.
png}} \hfill% "
74 " \subfloat[]{"
75 " \includegraphics[width=\ww\linewidth]{../other/Empty.
png}} \hfill%"
76 " \subfloat[]{"
77 " \includegraphics[width=\ww\linewidth]{../other/Empty.
png}} \hfill% "
78 " \subfloat[]{"
79 " \includegraphics[width=\ww\linewidth]{../other/Empty.
png}} \hfill%"
80 " "
81 " \subfloat[śĆWarto programu t = " + string(n) + "]{ "
82 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/I_b.png}} \hfill% "
83 " \subfloat[ s = offsetstrel('ball',5,5); \\\imerode(I, s)
; ]{ "
84 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/Ib1.png}} \hfill% "
85 " \subfloat[ s = offsetstrel('ball',10,10); \\\imerode(I,
s); ]{ "
86 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/Ib2.png}} \hfill%"
87 " \subfloat[ s = offsetstrel('ball',5,5); \\\imdilate(I, s)
; ]{ "
88 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/Ib3.png}} \hfill% "
89 " \subfloat[ s = offsetstrel('ball',10,10); \\\imdilate(I,
s); ]{ "
90 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/Ib4.png}} \hfill%"
91 " "
92 " \subfloat[Liczba 60bszarw = " + string(n) + "]{ "
93 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/I_col.png}} \hfill% "
94 " \subfloat[Liczba 60bszarw = " + string(n1) + "]{ "
95 " \includegraphics[width=\ww\linewidth]{" + dest_folder
+ "/I1_col.png}} \hfill% "

```

```

96     "\subfloat[Liczba óbszarw = " + string(n2) + "]{\"
97     "\includegraphics[width=\ww\linewidth]{\" + dest_folder
+ "/I2_col.png}} \hfill\"
98     "\subfloat[Liczba óbszarw = " + string(n3) + "]{\"
99     "\includegraphics[width=\ww\linewidth]{\" + dest_folder
+ "/I3_col.png}} \hfill\"
100     "\subfloat[Liczba óbszarw = " + string(n4) + "]{\"
101     "\includegraphics[width=\ww\linewidth]{\" + dest_folder
+ "/I4_col.png}} \hfill\"
102     \"
103     \"
104     \"\caption{Porownanie}\"
105     \"
106     \"\end{figure}\"
107     \"\let\ww\undefined \"
108     ];
109
110     Latex = join(Latex,[''],2);
111     Latex = join(Latex,[newline],1);
112
113     fid = fopen(dest_folder + "/result.tex",'wt');
114     fprintf(fid,"%s", Latex);
115     fclose(fid);
116
117
118
119
120
121 end
122
123
124
125 function HistSave(I, dest)
126     f = figure;
127     f.Position = [0,0,512,512];
128     imhist(I);
129     saveas(gcf, dest)
130     close(gcf);
131 end

```

## ImageBinarize.m

```
1 function [I1, level] = ImageBinarize(I, method)
2
3     if method == "hist"
4         level = HistogramHalf(I);
5     elseif method == "otsu"
6         level = OtsuTreshhold(I);
7     end
8
9     I1 = double( I > level );
10 end
11
12
13
14
15 function level = HistogramHalf(I)
16
17     [counts,binLocations] = imhist(I);
18     count_and_bin = [counts, binLocations]';
19
20     all = numel(I);
21     half = all/2;
22
23     accumulator = 0;
24
25     for cb = count_and_bin
26         accumulator = accumulator + cb(1);
27
28         if(accumulator >= half)
29             level = cb(2);
30             return;
31         end
32     end
33
34     % function should never reach this
35     level = 1;
36
37 end
38
39
40
41
42 function level = OtsuTreshhold(I)
43
44     N = numel(I);
45
46     [n_all, k_all] = imhist(I);
47
48
49     p_all = n_all/N;
50
51
52     selected_k = 0;
53     max_sigma2_B = 0;
54
55     for i = 1:numel(k_all)-1
```



```

56
57     k = k_all(i);
58
59     I_L = [1:i]';
60     I_H = [i+1:numel(p_all)]';
61
62     w0 = sum( p_all(I_L) );
63     w1 = sum( p_all(I_H) );
64
65     u0 = sum( I_L .* p_all(I_L) / w0 );
66     u1 = sum( I_H .* p_all(I_H) / w1 );
67
68     sigma2_B = w0*w1*(u1-u0)^2;
69
70     if( max_sigma2_B < sigma2_B)
71         max_sigma2_B = sigma2_B;
72         selected_k = k;
73     end
74
75 end
76
77 level = selected_k;
78
79
80 end

```

## run\_all.m

```
1 clear all
2 close all
3 clc
4
5 zad2
6 zad3
7 zad4
```

## cropToSquare.m

```
1 function I1 = cropToSquare(I)
2
3     s1 = size(I,1);
4     s2 = size(I,2);
5
6
7     if s1 == s2
8         I1 = I;
9
10    elseif( s1 > s2 )
11
12        diff2 = round((s1 - s2)/2);
13        v1 = (1:s2) + diff2;
14        v2 = 1:s2;
15
16        I1 = I(v1,v2, :);
17
18    elseif( s1 < s2 )
19
20        diff2 = round((s2 - s1)/2);
21        v1 = 1:s1;
22        v2 = (1:s1) + diff2;
23
24        I1 = I(v1,v2, :);
25
26    end
27
28
29 end
```