Przetwarzanie Obrazów Cyfrowych

**Raport z ćwiczenia nr. 2:
Przetwarzanie obrazów w dziedzinie
częstotliwości - transformata Fouriera**

Raport opracował:
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Data wykonania ćwiczenia: xx.xx.xxxx
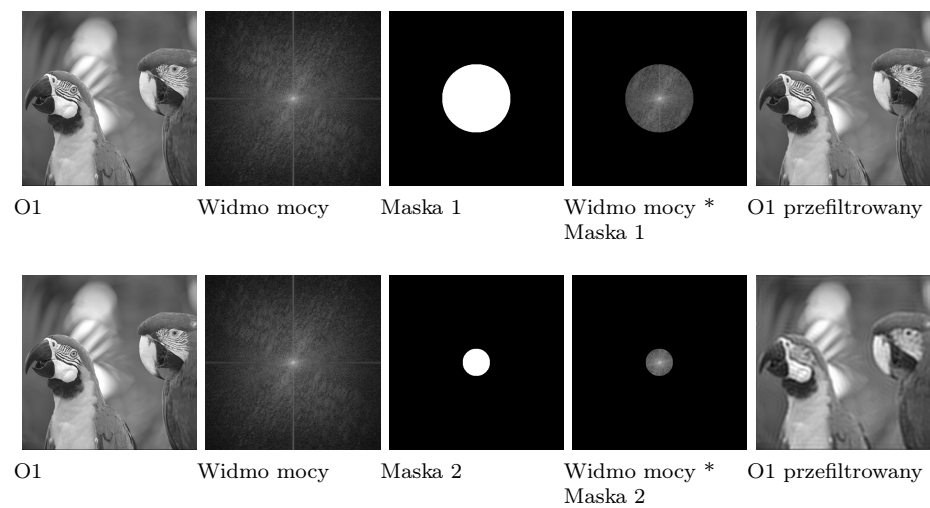
Zadanie 4. Wpływ filtracji przestrzennej na TF

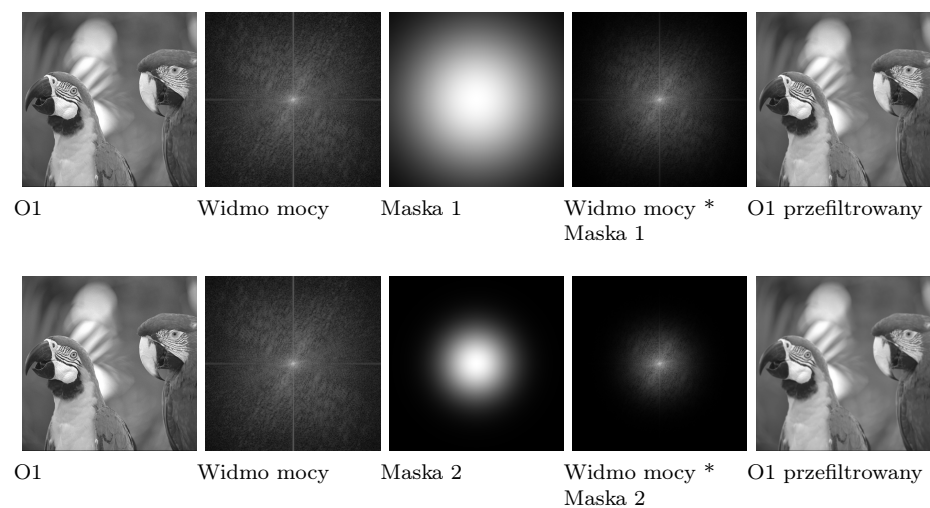| O1 | Widmo mocy | Maska 1 | Widmo mocy * Maska 1 | O1 przefiltrowany |

| O1 | Widmo mocy | Maska 2 | Widmo mocy * Maska 2 | O1 przefiltrowany |

Figure 1: Porownanie

| O1 | Widmo mocy | Maska 1 | Widmo mocy * Maska 1 | O1 przefiltrowany |

| O1 | Widmo mocy | Maska 2 | Widmo mocy * Maska 2 | O1 przefiltrowany |

Figure 2: Porownanie

| O1 | Widmo mocy | Maska 1 | Widmo mocy * Maska 1 | O1 przefiltrowany |

| O1 | Widmo mocy | Maska 2 | Widmo mocy * Maska 2 | O1 przefiltrowany |

Figure 3: Porownanie

| O1 | Widmo mocy | Maska 1 | Widmo mocy * Maska 1 | O1 przefiltrowany |

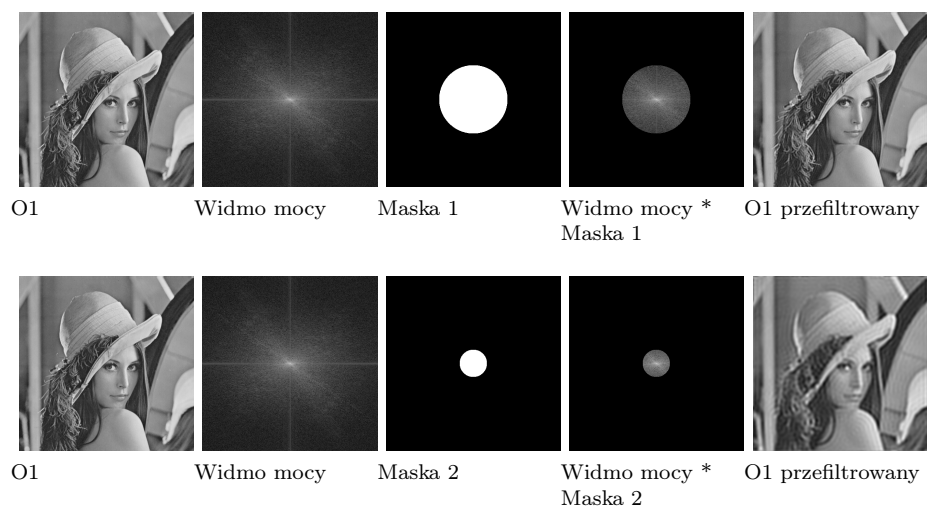| O1 | Widmo mocy | Maska 2 | Widmo mocy * Maska 2 | O1 przefiltrowany |

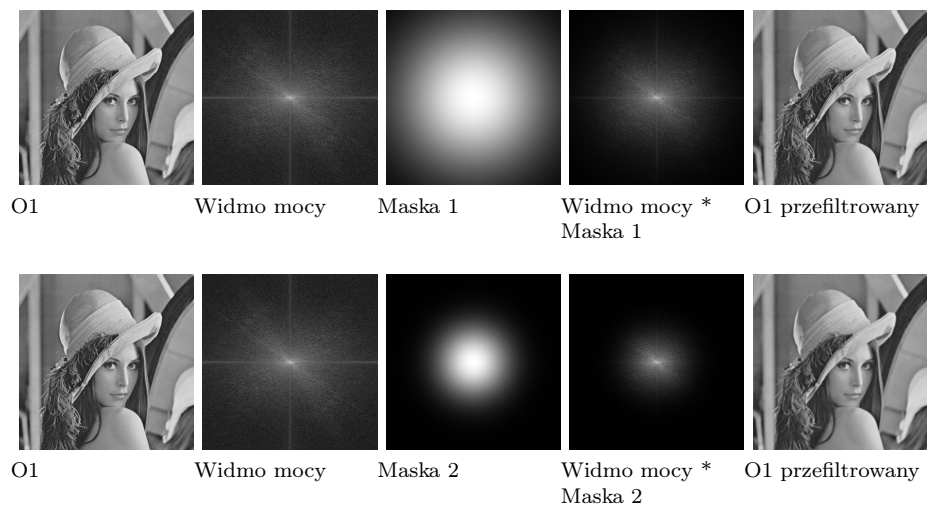Figure 4: Porownanie

Kody programów

image_fft.m

```matlab
function [im_level, im_angle, L1] = image_fft(I1)

    L1 = fftshift(fft2(I1));
    im_level = log(1+abs(L1));
    im_angle = angle(L1);

end
```

image_ifft.m

```matlab
function I1 = image_ifft(L1)

    I1 = ifft2(ifftshift(L1));
    I1 = abs(I1);

end
```

zad2.m

```matlab
clear all
close all
clc




images_triangle_rot = [
%                    path,  rotation, translation, scale
{"../images/triangle.png",         0,      [0 0],     1 }
{'../images/triangle.png',        15,      [0 0],     1 }
{'../images/triangle.png',        29,      [0 0],     1 }
{'../images/triangle.png',        50,      [0 0],     1 }
]

images_triangle_pos = [
%                    path,  rotation,  translation,  scale
{"../images/triangle.png",         0,        [0 0],     1 }
{'../images/triangle.png',         0,      [30 30],     1 }
{'../images/triangle.png',         0,    [100 100],     1 }
{'../images/triangle.png',         0,   [-100 -20],     1 }
]

images_circle_pos = [
%                  path,  rotation, translation,    scale
{"../images/circle.png",         0,       [0 0],     1 }
{'../images/circle.png',         0,     [30 30],     1 }
{'../images/circle.png',         0,   [100 100],     1 }
{'../images/circle.png',         0,  [-100 -20],     1 }
]


images_circle_scale = [
%                  path, rotation, translation, scale
{"../images/circle.png",         0,      [0 0],     1 }
{'../images/circle.png',         0,      [0 0],    .5 }
{'../images/circle.png',         0,      [0 0],     2 }
{'../images/circle.png',         0,      [0 0],     3 }
]


images_line_rot = [
%                 path,  rotation,  translation, scale
{"../images/lines.png",         0,       [0 0],     1 }
{'../images/lines.png',        15,       [0 0],     1 }
{'../images/lines.png',        29,       [0 0],     1 }
{'../images/lines.png',        50,       [0 0],     1 }
]

images_sine = [
%           path, rotation,    translation,   scale
{       [.20 .20],         0,         [0 0],       1 }
{      [.05 .005],         0,         [0 0],       1 }
{        [1  .01],         0,         [0 0],       1 }
{        [.01 1],          0,         [0 0],       1 }
```

```matlab
56  ]
57
58
59  figure;
60  show_images(images_triangle_rot, "../zad2/triangle_rot");
61
62  figure;
63  show_images(images_triangle_pos, "../zad2/triangle_pos");
64
65  figure;
66  show_images(images_circle_pos, "../zad2/circle_pos");
67
68  figure;
69  show_images(images_circle_scale, "../zad2/circle_scale");
70
71  figure;
72  show_images(images_line_rot, "../zad2/line_rot");
73
74  figure;
75  show_images(images_sine, "../zad2/sine");
76
77
78
79  function show_images(images, dest_folder)
80
81      mkdir(dest_folder);
82
83
84      tiledlayout(3,size(images, 1), 'TileSpacing','none');
85
86      tile_indexes = 1:(3*size(images, 1));
87      tile_indexes = reshape(tile_indexes,[],3)';
88
89
90      for tile_index = tile_indexes
91
92          image = images(tile_index(1),:);
93
94          src   = image{1};
95          rot   = image{2};
96          trans = image{3};
97          scale = image{4};
98
99          if isa(src, 'string') || isa(src, 'char')
100             I1 = imread(src);
101             I1 = double(I1)./256;
102             I1 = rgb2gray(I1);
103
104
105             orig_size = size(I1);
106
107             I1 = imrotate(I1, rot);
108             I1 = imtranslate(I1, trans);
109             I1 = imresize(I1, scale);
110
111             if (orig_size - size(I1)) >= 0
112                 w = (orig_size - size(I1)) /2;
```

```matlab
113                 w = w + [.1, -.1];
114                 w = round(w);
115                 I1 = padarray(I1, w, 0);
116             else
117                 I1 = imcrop(I1, centerCropWindow2d(size(I1),
    orig_size));
118             end
119
120         elseif isa(src, 'double')
121             [X,Y] = meshgrid(1:512, 1:512);
122             I1 = sin(X*src(1) + Y*src(2));
123             I1 = (1 + I1)./2;
124         end
125
126
127
128         [im_level, im_angle] = image_fft(I1);
129
130         % scale values
131         im_level = rescale(im_level);
132         im_angle = rescale(im_angle);
133
134         nexttile(tile_index(1))
135         imshow(I1);
136
137         nexttile(tile_index(2))
138         imshow(im_level);
139         xlabel('Widmo mocy');
140
141         nexttile(tile_index(3))
142         imshow(im_angle);
143         xlabel('Faza');
144
145         imwrite(I1, dest_folder + "/I" + tile_index(1) + ".png")
146         imwrite(im_level, dest_folder + "/I" + tile_index(1) + "
    _mag.png")
147         imwrite(im_angle, dest_folder + "/I" + tile_index(1) + "
    _angle.png")
148
149     end
150
151
152     trans2str = @(tran) "(" + tran(1) + ", " + tran(1) + ")"
153
154     Latex = [
155 "\newcommand{\ww}{0.24} "
156 "\begin{figure}[H] "
157 "    \captionsetup[subfloat]{justification=raggedright,
    singlelinecheck=false, position=bottom,labelformat=empty} % "
158 "    "
159 "     \subfloat[O1 \\ rot = " + string(images{1,2}) + " \\ trans = "
     + trans2str(images{1,3}) + " \\ scale = " + string(images
    {1,4}) + "]{"
160 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I1.png}}  \hfill% "
161 "     \subfloat[O1 \\ rot = " + string(images{2,2}) + " \\ trans = "
     + trans2str(images{2,3}) + " \\ scale = " + string(images
```

```
        {2,4}) + "]{"
162 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I2.png}}  \hfill% "
163 "    \subfloat[O1 \\ rot = " + string(images{3,2}) + " \\ trans = "
     + trans2str(images{3,3}) + " \\ scale = " + string(images
    {3,4}) + "]{"
164 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I3.png}}  \hfill%"
165 "    \subfloat[O1 \\ rot = " + string(images{4,2}) + " \\ trans = "
     + trans2str(images{4,3}) + " \\ scale = " + string(images
    {4,4}) + "]{"
166 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I4.png}}  \hfill"
167 ""
168 "    \subfloat[Widmo mocy]{"
169 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I1_mag.png}}  \hfill% "
170 "    \subfloat[Widmo mocy]{"
171 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I2_mag.png}}  \hfill% "
172 "    \subfloat[Widmo mocy]{"
173 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I3_mag.png}}  \hfill%"
174 "    \subfloat[Widmo mocy]{"
175 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I4_mag.png}} \hfill"
176 ""
177 "    \subfloat[Faza]{"
178 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I1_angle.png}}  \hfill% "
179 "    \subfloat[Faza]{"
180 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I2_angle.png}}  \hfill% "
181 "    \subfloat[Faza]{"
182 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I3_angle.png}}  \hfill%"
183 "    \subfloat[Faza]{"
184 "         \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I4_angle.png}}"
185 ""
186 "\caption{Porownanie}  "
187 " "
188 "\end{figure} "
189 "\let\ww\undefined "
190     ]
191
192     Latex = join(Latex,[''],2);
193     Latex = join(Latex,[newline],1);
194
195     fid = fopen(dest_folder + "/result.tex",'wt');
196     fprintf(fid,"%s", Latex);
197     fclose(fid);
198
199
200 end
```

zad3.m

```matlab
1  clear all
2  close all
3  clc
4
5
6
7
8  images = [
9  %              src              ,      iterations,
       filter
10 {"../images/lena_512x512.bmp",      [1 2 5 10], @(I1) imfilter(I1,
       fspecial('average',5)) ,"../zad3/lena_smooth"    }
11 {"../images/lena_512x512.bmp",      [1 2 5 10], @(I1) imsharpen(I1)
                              ,"../zad3/lena_sharp"    }
12 {"../images/kodim23_512x512.png",  [1 2 5 10], @(I1) imfilter(I1,
       fspecial('average',5)) ,"../zad3/kodim_smooth"    }
13 {"../images/kodim23_512x512.png",  [1 2 5 10], @(I1) imsharpen(I1)
                              ,"../zad3/kodim_sharp"    }
14 ]
15
16
17
18
19 for image = images'
20
21     figure
22     show_images(image)
23
24 end
25
26
27
28 function show_images(image)
29
30     tiledlayout(2,1 + length(image{2}));
31
32     tile_indexes = 1:(2*length(image{2}) + 2);
33     tile_indexes = reshape(tile_indexes,[],2)';
34
35
36     src = image{1};
37     filter_iters = image{2};
38     %filte_mat = image{3};
39     filter_func = image{3};
40     dest_folder = image{4};
41
42
43     I1 = imread(src);
44     I1 = double(I1)./256;
45     I1 = rgb2gray(I1);
46
47     [im_level, ~] = image_fft(I1);
48     im_level = rescale(im_level);
49
50
```

```matlab
    nexttile(tile_indexes(1,1))
    imshow(I1);

    nexttile(tile_indexes(2,1))
    imshow(im_level,[]);
    xlabel('Widmo mocy');



    mkdir(dest_folder)
    imwrite(I1, dest_folder + "/I1.png");
    imwrite(im_level, dest_folder + "/I1_mag.png");



    % filtering
    x = 1;
    for iter = filter_iters

        I2 = I1;
        for i = 1:iter
            I2 = filter_func(I2);
        end

        [im_level, ~] = image_fft(I2);
        im_level = rescale(im_level);

        nexttile(tile_indexes(1,x + 1))
        imshow(I2);

        nexttile(tile_indexes(2,x + 1))
        imshow(im_level,[]);
        xlabel('Widmo mocy');


        imwrite(I2, dest_folder + "/I1_iter" + iter + ".png");
        imwrite(im_level, dest_folder + "/I1_iter" + iter + "_mag.
    png");

        x = x + 1;

    end


    Latex = [
"\newcommand{\ww}{0.19} "
"\begin{figure}[H] "
"    \captionsetup[subfloat]{justification=raggedright,
    singlelinecheck=false, position=bottom,labelformat=empty} % "
"    "
"    \subfloat[O1]{"
"        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I1.png}}  \hfill% "
"    \subfloat[O1]{"
"        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
    I1_iter" + filter_iters(1) + ".png}}  \hfill% "
"    \subfloat[O1]{"
```

```
104 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(2) + ".png}}  \hfill%"
105 "    \subfloat[01]{"
106 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(3) + ".png}}  \hfill"
107 "    \subfloat[01]{"
108 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(4) + ".png}}  \hfill"
109 ""
110 "    \subfloat[Widmo mocy]{"
111 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_mag.png}}  \hfill% "
112 "    \subfloat[Widmo mocy]{"
113 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(1) + "_mag.png}}  \hfill% "
114 "    \subfloat[Widmo mocy]{"
115 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(2) + "_mag.png}}  \hfill%"
116 "    \subfloat[Widmo mocy]{"
117 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(3) + "_mag.png}} \hfill"
118 "    \subfloat[Widmo mocy]{"
119 "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
        I1_iter" + filter_iters(4) + "_mag.png}} \hfill"
120 ""
121 "\caption{Porownanie}  "
122 " "
123 "\end{figure} "
124 "\let\ww\undefined "
125     ]

126
127     Latex = join(Latex,[''],2);
128     Latex = join(Latex,[newline],1);

129
130     fid = fopen(dest_folder + "/result.tex",'wt');
131     fprintf(fid,"%s", Latex);
132     fclose(fid);

133

134

135
136 end
```

zad4.m

```matlab
1  clear all
2  close all
3  clc
4
5
6  images = [
7  %              src                  ,   mask
8  {"../images/lena_512x512.bmp",    { "circle", 100,   40}, "../zad4/
      lena_circ"  }
9  {"../images/kodim23_512x512.png", { "circle", 100,   40}, "../zad4/
      kodim_circ"  }
10 {"../images/lena_512x512.bmp",    { "gauss",  150,   70}, "../zad4/
      lena_gauss"  }
11 {"../images/kodim23_512x512.png", { "gauss",  150,   70}, "../zad4/
      kodim_gauss"  }
12 ]
13
14
15
16
17
18 for image = images'
19     show_images(image)
20 end
21
22
23 function show_images(image)
24
25
26     tiledlayout(2, 5, 'TileSpacing','none');
27
28     src = image{1};
29     mask = image{2};
30     dest_folder = image{3};
31
32
33     I1 = imread(src);
34     I1 = double(I1)./256;
35     I1 = rgb2gray(I1);
36
37
38     [im_level, ~, L1] = image_fft(I1);
39     im_level = rescale(im_level);
40
41     if mask{1} == "circle"
42         im_mask1 = MaskCircle(size(I1), mask{2});
43         im_mask2 = MaskCircle(size(I1), mask{3});
44     elseif mask{1} == "gauss"
45         im_mask1 = MaskGauss(size(I1), mask{2});
46         im_mask2 = MaskGauss(size(I1), mask{3});
47     end
48
49     % mask 1
50     nexttile
51     imshow(I1);
```

```matlab
    nexttile
    imshow(im_level,[]);

    nexttile
    imshow(im_mask1);

    nexttile
    imshow(im_level .* im_mask1 , []);

    nexttile
    imshow(image_ifft(L1 .* im_mask1));

    % mask 1
    nexttile
    imshow(I1);

    nexttile
    imshow(im_level,[]);

    nexttile
    imshow(im_mask2);

    nexttile
    imshow(im_level .* im_mask2  , []);

    nexttile
    imshow(image_ifft(L1 .* im_mask2));

    mkdir(dest_folder)
    imwrite(I1,                     dest_folder + "/I1.png");
    imwrite(im_level,               dest_folder + "/I1_mag.png"
    );
    imwrite(im_mask1,               dest_folder + "/I1_mask1.
    png");
    imwrite(im_level .* im_mask1,       dest_folder + "/
    I1_mag_mask1.png");
    imwrite(image_ifft(L1 .* im_mask1), dest_folder + "/I1_1.png");

    % imwrite(I1,                       dest_folder + "/I1.png");
    % imwrite(im_level,                 dest_folder + "/I1_mag.
    png");
    imwrite(im_mask2,               dest_folder + "/I1_mask2.
    png");
    imwrite(im_level .* im_mask2,       dest_folder + "/
    I1_mag_mask2.png");
    imwrite(image_ifft(L1 .* im_mask2), dest_folder + "/I1_2.png");




    Latex = [
"\newcommand{\ww}{0.19} "
"\begin{figure}[H] "
"   \captionsetup[subfloat]{justification=raggedright,
    singlelinecheck=false, position=bottom,labelformat=empty} % "
"   "
```

```
102  "    \subfloat[O1]{"
103  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1.png}}  \hfill% "
104  "    \subfloat[Widmo mocy]{"
105  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_mag.png}}  \hfill% "
106  "    \subfloat[Maska 1]{"
107  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_mask1.png}}  \hfill%"
108  "    \subfloat[Widmo mocy * Maska 1]{"
109  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_mag_mask1.png}}  \hfill"
110  "    \subfloat[O1 przefiltrowany]{"
111  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_1.png}}  \hfill"
112  ""
113  "    \subfloat[O1]{"
114  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1.png}}  \hfill% "
115  "    \subfloat[Widmo mocy]{"
116  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_mag.png}}  \hfill% "
117  "    \subfloat[Maska 2]{"
118  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_mask2.png}}  \hfill%"
119  "    \subfloat[Widmo mocy * Maska 2]{"
120  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_mag_mask2.png}} \hfill"
121  "    \subfloat[O1 przefiltrowany]{"
122  "        \includegraphics[width=\ww\linewidth]{" + dest_folder + "/
     I1_2.png}} \hfill"
123  ""
124  "\caption{Porownanie}   "
125  " "
126  "\end{figure} "
127  "\let\ww\undefined "
128      ]
129
130      Latex = join(Latex,[''],2);
131      Latex = join(Latex,[newline],1);
132
133      fid = fopen(dest_folder + "/result.tex",'wt');
134      fprintf(fid,"%s", Latex);
135      fclose(fid);
136
137
138
139  end
140
141
142
143
144
145
146  function M = MaskCircle(dim, r)
147
148      x = (1:dim(1)) - dim(1)/2;
```

```matlab
149      y = (1:dim(2)) - dim(2)/2;
150      [X, Y] = meshgrid(x, y);
151
152      R2 = X.*X + Y.*Y;
153      r2 = r.*r;
154
155      M = R2 < r2;
156      M = double(M);
157
158  end
159
160
161
162  function M = MaskGauss(dim, sigma)
163
164      x = (1:dim(1)) - dim(1)/2;
165      y = (1:dim(2)) - dim(2)/2;
166      [X, Y] = meshgrid(x, y);
167
168      R = sqrt(X.*X + Y.*Y);
169
170      M = normpdf(R, 1,sigma);
171      M = M ./ max(M, [], "all");
172
173  end
```