Silesian
University
of Technology

Faculty of Automatic Control,
Electronics and Computer Science

PRZETWARZANIE OBRAZÓW CYFROWYCH

Lab. 4 – CECHY NIEZMIENNICZE I KLASYFIKACJA OBIEKTÓW

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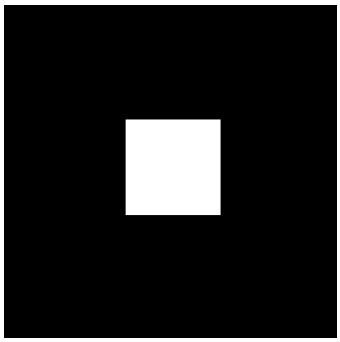
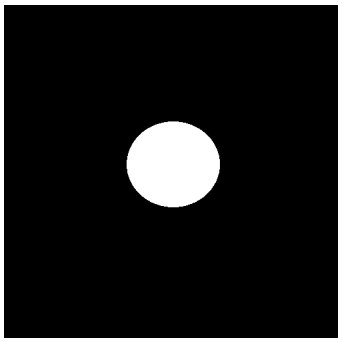
Contents

Chapter 1

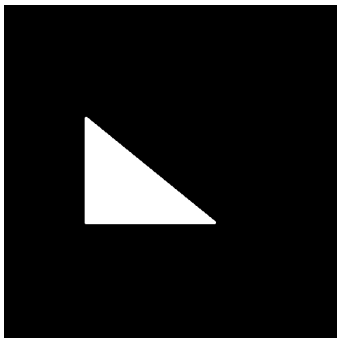
Przygotowanie obrazów testowych



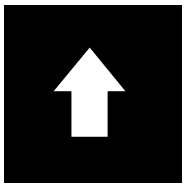
(a) Kwadrat



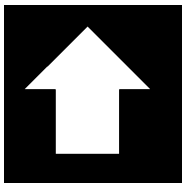
(b) Kolo



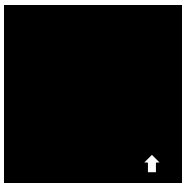
(c) Trojkat



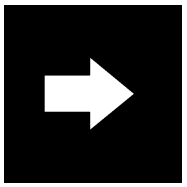
(a) Strzalka



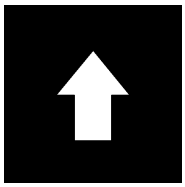
(b) StrzalkaD



(c) Strzalkam



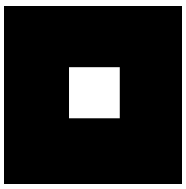
(d) StrzalkaP



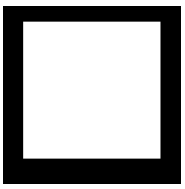
(e) StrzalkaT

Chapter 2

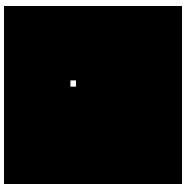
Zad2



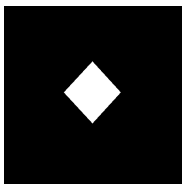
(a) M=0.0976
Mz=0.9111
K=0.8301



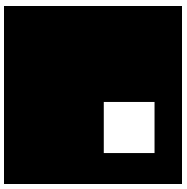
(b) M3=0.1027
Mz3=0.9068
K3=0.8223



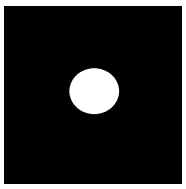
(c) M4=0.0365
Mz4=0.9648
K4=0.9308



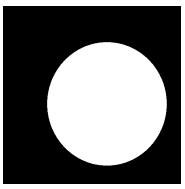
(d) M2=0.1237
Mz2=1.0678
K2=0.7919



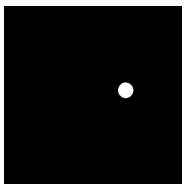
(e) M1=0.0976
Mz1=0.9111
K1=0.8301



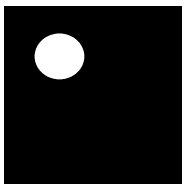
(a) M9=-0.0058
Mz9=1.0058
K9=1.0117



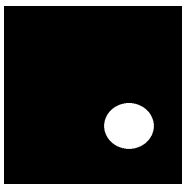
(b) M5=-0.0022
Mz5=1.0022
K5=1.0043



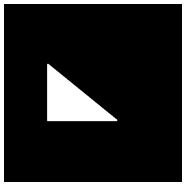
(c) M6=-0.0211
Mz6=1.0216
K6=1.0436



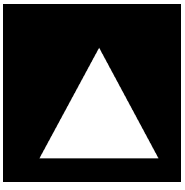
(d) M7=-0.0058
Mz7=1.0058
K7=1.0117



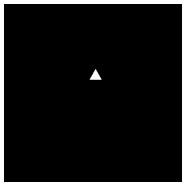
(e) M8=-0.0058
Mz8=1.0058
K8=1.0117



(a) M14=0.3229
Mz14=0.7559
K14=0.5714

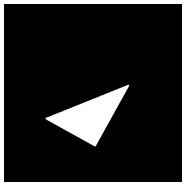


(b) M10=0.2657
Mz10=0.7900
K10=0.6242



(c) M11=0.2144
Mz11=0.8235
K11=0.6781

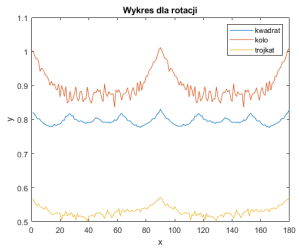
(d) M12=0.3229
Mz12=0.7559
K12=0.5714



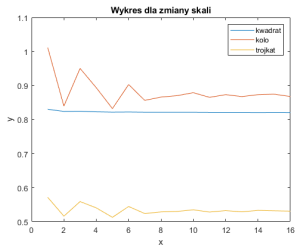
(e) M13=0.3700
Mz13=0.7299
K13=0.5328

Chapter 3

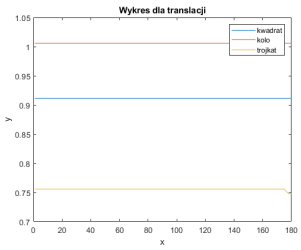
Zad2kolejne2



(a) Wykres w wyniku rotacji



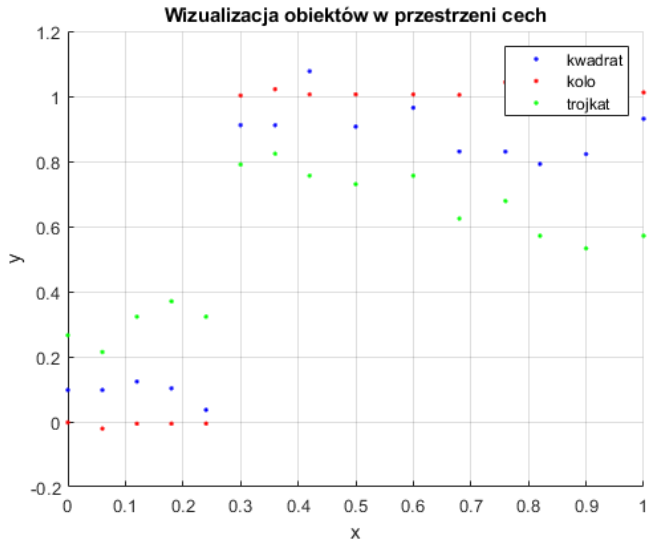
(b) Wykres w wyniku zmiany skali



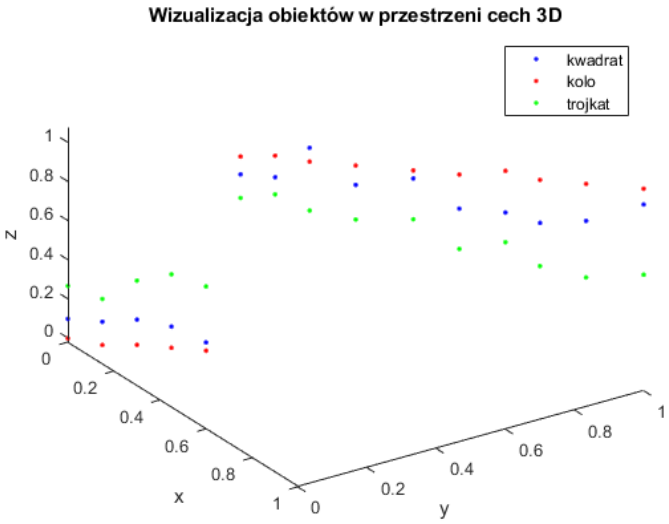
(c) Wykres w wyniku translacji

Chapter 4

Zad3



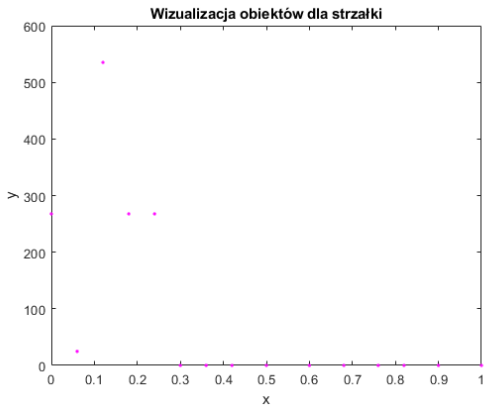
(a) Wizualizacja obiektów 2d



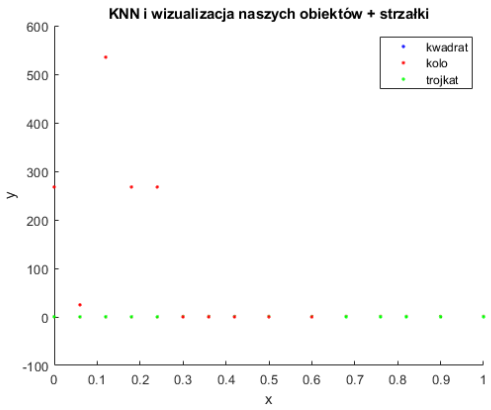
(b) Wizualizacja obiektów 3d

Chapter 5

Zad5

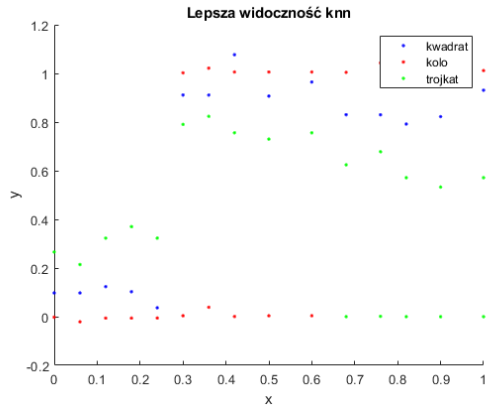


(a) Wizualizacja dla strzalki



(b) Knn

(c) Lepsza widocznosc dla strzalki



(d) Knn lepsza widocznosc

Chapter 6

Wnioski

1. Czy wszystkie klasy obietków mogą być rozróżnione za pomocą jednej cechy?
Zapewne nie, iż może wystąpić podobieństwo między jedną cechą obiektów i przydałaby się inna cecha.

2. Oceń jak na wynik klasyfikacji wpływa dobór wartości k i rodzaj stosowanej metryki(np. używając funkcję pdist)
Im większe k tym lepsza klasyfikacja. Jeśli k jest duże, koszt obliczenia jest większy $\rightarrow$ algorytm jest czasochłonny. Zastosowaliśmy Euklidesową metrykę i zadziałała prawidłowo.

Zabrane z innego angielskiego pdfa: Wyniki pokazały, że Manhattan, Minkowski, Chebychev, Euclidean, Mahalanobis i standaryzowane pomiary odległości euklidesowych osiągnęły podobne wyniki dokładności i przewyższyły wyniki inne testowane odległości.

Chapter 7

Zad4Kod

function wynik=knnmoje(nowy$_p unkt_x, nowy_p unkt_y, zestawdanych1, zestawdanych2, zestawdanych3$)
$x = [00.060.120.180.240.300.360.420.500.60.680.760.820.91];$
$classb =' b.';$
$classr =' r.';$
$classg =' g.';$
$iloscb = 0;$
$iloscr = 0;$
$iloscg = 0;$

plot(nowy$_p unkt_x, nowy_p unkt_y,' m.');$

dystans=[];
dystans2=[];
dystans3=[];
punkt1=[];
punkt22=[];
punkt33=[];

for i=1:length(zestawdanych1)
e=sqrt((zestawdanych1(i)-nowy$_p unkt_y)^2 + (x(i) - nowy_p unkt_x)^2);$
$e2 = sqrt((zestawdanych2(i) - nowy_p unkt_y)^2 + (x(i) - nowy_p unkt_x)^2);$
$e3 = sqrt((zestawdanych3(i) - nowy_p unkt_y)^2 + (x(i) - nowy_p unkt_x)^2);$
$punkt = [x(i), zestawdanych1(i)];$
$punkt2 = [x(i), zestawdanych2(i)];$
$punkt3 = [x(i), zestawdanych3(i)];$

$punkt1 = [punkt1; punkt];$
$punkt22 = [punkt22; punkt2];$
$punkt33 = [punkt33; punkt3];$
$dystans = [dystanse];$
$dystans2 = [dystans2e2];$
$dystans3 = [dystans3e3];$
end

```
    punkt1
dystans
najmniejszydystans=sort(dystans)
najmniejszydystans2=sort(dystans2)
najmniejszydystans3=sort(dystans3)

    k=7;
for i=1:k
for j=1:k
if najmniejszydystans(i)<najmniejszydystans2(j)
if najmniejszydystans(i)<najmniejszydystans3(j)
iloscb=iloscb+1;
end
end
end

end

    for i=1:k
for j=1:k
if najmniejszydystans2(i)<najmniejszydystans(j)
if najmniejszydystans2(i)<najmniejszydystans3(j)
iloscr=iloscr+1;
end
end
end
end
```

```
    for i=1:k
for j=1:k
if najmniejszydystans3(i)<najmniejszydystans(j)
if najmniejszydystans3(i)<najmniejszydystans2(j);
iloscg=iloscg+1;
end
end
end
end

    iloscb
iloscr
iloscg

    if iloscb>iloscr
if iloscb>iloscg
end
end
if iloscr>iloscb
if iloscr>iloscg
end
end
if iloscg>iloscb
if iloscg>iloscr
end
end

    if iloscb>iloscr
if iloscb>iloscg
wynik=classb;
end
end
if iloscr>iloscb
if iloscr>iloscg
wynik=classr;
end
```

```
end
if iloscg>iloscb
if iloscg>iloscr
wynik=classg;
end
end

    end
```

Chapter 8

Kod

```
clear all;
clc;

    I=imread('kwadratS.png');
IO=imread('kolkoS.png');
Itroj=imread('trojkatS.png');
I1=imread('kwadratS100.png');
I2=imread('romb.png');
I3=imread('kwadratD.png');
I4=imread('kwadratm.png');
I5=imread('koloD.png');
I6=imread('koloM.png');
I7=imread('kolkoSminus100.png');
I8=imread('kolkoS100.png');
I9=imread('trojkatD.png');
I10=imread('trojkatm.png');
I11=imread('translacja71.png');
I12=imread('rotacja61.png');

    I=imbinarize(I);
I1=imbinarize(I1);
I2=imbinarize(I2);
I3=imbinarize(I3);
I4=imbinarize(I4);
IO=imbinarize(IO);
```

```
Itroj=imbinarize(Itroj);
I5=imbinarize(I5);
I6=imbinarize(I6);
I7=imbinarize(I7);
I8=imbinarize(I8);
I9=imbinarize(I9);
I10=imbinarize(I10);
I11=imbinarize(I11);
I12=imbinarize(I12);

    cent = regionprops(I,'perimeter');
L = cat(1, cent.Perimeter);

    Area = regionprops(I,'Area');
S = cat(1, Area.Area);

    cent1 = regionprops(I1,'perimeter');
L1 = cat(1, cent1.Perimeter);

    Area1 = regionprops(I1,'Area');
S1 = cat(1, Area1.Area);

    cent2 = regionprops(I2,'perimeter');
L2 = cat(1, cent2.Perimeter);

    Area2 = regionprops(I2,'Area');
S2 = cat(1, Area2.Area);

    cent3 = regionprops(I3,'perimeter');
L3 = cat(1, cent3.Perimeter);

    Area3 = regionprops(I3,'Area');
S3 = cat(1, Area3.Area);

    cent4 = regionprops(I4,'perimeter');
L4 = cat(1, cent4.Perimeter);
```

```
    Area4 = regionprops(I4,'Area');
S4 = cat(1, Area4.Area);

    cent5 = regionprops(I5,'perimeter');
L5 = cat(1, cent5.Perimeter);

    Area5 = regionprops(I5,'Area');
S5 = cat(1, Area5.Area);

    cent6 = regionprops(I6,'perimeter');
L6 = cat(1, cent6.Perimeter);

    Area6 = regionprops(I6,'Area');
S6 = cat(1, Area6.Area);

    cent7 = regionprops(I7,'perimeter');
L7 = cat(1, cent7.Perimeter);

    Area7 = regionprops(I7,'Area');
S7 = cat(1, Area7.Area);

    cent8 = regionprops(I8,'perimeter');
L8 = cat(1, cent8.Perimeter);

    Area8 = regionprops(I8,'Area');
S8 = cat(1, Area8.Area);

    cent9 = regionprops(IO,'perimeter');
L9 = cat(1, cent9.Perimeter);

    Area9 = regionprops(IO,'Area');
S9 = cat(1, Area9.Area);

    cent10 = regionprops(I9,'perimeter');
L10 = cat(1, cent10.Perimeter);
```

```
    Area10 = regionprops(I9,'Area');
S10 = cat(1, Area10.Area);

    cent11 = regionprops(I10,'perimeter');
L11 = cat(1, cent11.Perimeter);

    Area11 = regionprops(I10,'Area');
S11 = cat(1, Area11.Area);

    cent12 = regionprops(I11,'perimeter');
L12 = cat(1, cent12.Perimeter);

    Area12 = regionprops(I11,'Area');
S12 = cat(1, Area12.Area);

    cent13 = regionprops(I12,'perimeter');
L13 = cat(1, cent13.Perimeter);

    Area13 = regionprops(I12,'Area');
S13 = cat(1, Area13.Area);

    cent14 = regionprops(Itroj,'perimeter');
L14 = cat(1, cent14.Perimeter);

    Area14 = regionprops(Itroj,'Area');
S14 = cat(1, Area14.Area);

    Mz=2*sqrt(pi*S)/L

    M=(L/(2*sqrt(pi*S)))-1

    K=(4*pi*S)/(L*L)

    Mz1=2*sqrt(pi*S1)/L1
```

M1=(L1/(2*sqrt(pi*S1)))-1

K1=(4*pi*S1)/(L1*L1)

Mz2=2*sqrt(pi*S1)/L2

M2=(L2/(2*sqrt(pi*S2)))-1

K2=(4*pi*S2)/(L2*L2)

Mz3=2*sqrt(pi*S3)/L3

M3=(L3/(2*sqrt(pi*S3)))-1

K3=(4*pi*S3)/(L3*L3)

Mz4=2*sqrt(pi*S4)/L4

M4=(L4/(2*sqrt(pi*S4)))-1

K4=(4*pi*S4)/(L4*L4)

Mz5=2*sqrt(pi*S5)/L5

M5=(L5/(2*sqrt(pi*S5)))-1

K5=(4*pi*S5)/(L5*L5)

Mz6=2*sqrt(pi*S6)/L6

M6=(L6/(2*sqrt(pi*S6)))-1

K6=(4*pi*S6)/(L6*L6)

Mz7=2*sqrt(pi*S7)/L7

M7=(L7/(2*sqrt(pi*S7)))-1

K7=(4*pi*S7)/(L7*L7)

Mz8=2*sqrt(pi*S8)/L8

M8=(L8/(2*sqrt(pi*S8)))-1

K8=(4*pi*S8)/(L8*L8)

Mz9=2*sqrt(pi*S9)/L9

M9=(L9/(2*sqrt(pi*S9)))-1

K9=(4*pi*S9)/(L9*L9)

Mz10=2*sqrt(pi*S10)/L10

M10=(L10/(2*sqrt(pi*S10)))-1

K10=(4*pi*S10)/(L10*L10)

Mz11=2*sqrt(pi*S11)/L11

M11=(L11/(2*sqrt(pi*S11)))-1

K11=(4*pi*S11)/(L11*L11)

Mz12=2*sqrt(pi*S12)/L12

M12=(L12/(2*sqrt(pi*S12)))-1

K12=(4*pi*S12)/(L12*L12)

Mz13=2*sqrt(pi*S13)/L13

```
M13=(L13/(2*sqrt(pi*S13)))-1

K13=(4*pi*S13)/(L13*L13)

Mz14=2*sqrt(pi*S14)/L14

M14=(L14/(2*sqrt(pi*S14)))-1

K14=(4*pi*S14)/(L14*L14)

otoczenie=bwarea(I);

CT=bwperim(I);

for i=1:180
IT=imtranslate(I, [0 i]);
centT = regionprops(IT,'perimeter');
LT = cat(1, centT.Perimeter);

AreaT = regionprops(IT,'Area');
ST = cat(1, AreaT.Area);

MzT(i)=2*sqrt(pi*ST)/LT;

MT(i)=(LT/(2*sqrt(pi*ST)))-1;

KT(i)=(4*pi*ST)/(LT*LT);
end

j=[1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90
91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114
115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136
137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158
159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180];
```

```
    plot(j,MzT(1:180));
hold on;

    for i=1:180
ITO=imtranslate(IO, [0 i]);
centTO = regionprops(ITO,'perimeter');
LTO = cat(1, centTO.Perimeter);

    AreaTO = regionprops(ITO,'Area');
STO = cat(1, AreaTO.Area);

    MzTO(i)=2*sqrt(pi*STO)/LTO;

    MTO(i)=(LTO/(2*sqrt(pi*STO)))-1;

    KTO(i)=(4*pi*STO)/(LTO*LTO);
end

    plot(j,MzTO(1:180));

    for i=1:180
ITT=imtranslate(Itroj, [0 i]);
centTT = regionprops(ITT,'perimeter');
LTT = cat(1, centTT.Perimeter);

    AreaTT = regionprops(ITT,'Area');
STT = cat(1, AreaTT.Area);

    MzTT(i)=2*sqrt(pi*STT)/LTT;

    MTT(i)=(LTT/(2*sqrt(pi*STT)))-1;

    KTT(i)=(4*pi*STT)/(LTT*LTT);
end
```

```
    plot(j,MzTT(1:180));
legend('kwadrat','kolo', 'trojkat');
hold off;
figure;

    for i=1:180
IR=imrotate(I, i);
centR = regionprops(IR,'perimeter');
LR = cat(1, centR.Perimeter);

    AreaR = regionprops(IR,'Area');
SR = cat(1, AreaR.Area);

    MzR(i)=2*sqrt(pi*SR)/LR;

    MR(i)=(LR/(2*sqrt(pi*SR)))-1;

    KR(i)=(4*pi*SR)/(LR*LR);
end

    plot(j,KR(1:180));

    hold on;

    for i=1:180
IRO=imrotate(IO, i);
centRO = regionprops(IRO,'perimeter');
LRO = cat(1, centRO.Perimeter);

    AreaRO = regionprops(IRO,'Area');
SRO = cat(1, AreaRO.Area);


    MzRO(i)=2*sqrt(pi*SRO)/LRO;

    MRO(i)=(LRO/(2*sqrt(pi*SRO)))-1;
```

```
    KRO(i)=(4*pi*SRO)/(LRO*LRO);
end

    plot(j,KRO(1:180));

    for i=1:180
IRT=imrotate(Itroj, i);
centRT = regionprops(IRT,'perimeter');
LRT = cat(1, centRT.Perimeter);

    AreaRT = regionprops(IRT,'Area');
SRT = cat(1, AreaRT.Area);

    MzRT(i)=2*sqrt(pi*SRT)/LRT;

    MRT(i)=(LRT/(2*sqrt(pi*SRT)))-1;

    KRT(i)=(4*pi*SRT)/(LRT*LRT);
end

    plot(j,KRT(1:180));
legend('kwadrat','kolo', 'trojkat');
hold off;

    figure;

    for i=1:16
IRE=imresize(I, i);
centRE = regionprops(IRE,'perimeter');
LRE = cat(1, centRE.Perimeter);

    AreaRE = regionprops(IRE,'Area');
SRE = cat(1, AreaRE.Area);

    MzRE(i)=2*sqrt(pi*SRE)/LRE;
```

```
    MRE(i)=(LRE/(2*sqrt(pi*SRE)))-1;

    KRE(i)=(4*pi*SRE)/(LRE*LRE);
end jdlaresize=[1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16];
plot(jdlaresize,KRE(1:16));

    hold on;

    for i=1:16
IROE=imresize(IO, i);
centROE = regionprops(IROE,'perimeter');
LROE = cat(1, centROE.Perimeter);

    AreaROE = regionprops(IROE,'Area');
SROE = cat(1, AreaROE.Area);

    MzROE(i)=2*sqrt(pi*SROE)/LROE;

    MROE(i)=(LROE/(2*sqrt(pi*SROE)))-1;

    KROE(i)=(4*pi*SROE)/(LROE*LROE);
end

    plot(jdlaresize,KROE(1:16));

    for i=1:16
IRTE=imresize(Itroj, i);
centRTE = regionprops(IRTE,'perimeter');
LRTE = cat(1, centRTE.Perimeter);

    AreaRTE = regionprops(IRTE,'Area');
SRTE = cat(1, AreaRTE.Area);

    MzRTE(i)=2*sqrt(pi*SRTE)/LRTE;
```

```
    MRTE(i)=(LRTE/(2*sqrt(pi*SRTE)))-1;

    KRTE(i)=(4*pi*SRTE)/(LRTE*LRTE);
end

    plot(jdlaresize,KRTE(1:16));
legend('kwadrat','kolo', 'trojkat');
hold off;
figure;

    hold on;
grid
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M M1 M2 M3 M4 Mz Mz1 Mz2 Mz3 Mz4 K K1 K2 K3 K4], 'b.');
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M5 M6 M7 M8 M9 Mz5 Mz6 Mz7 Mz8 Mz9 K5 K6 K7 K8 K9], 'r.');
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M10 M11 M12 M13 M14 Mz10 Mz11 Mz12 Mz13 Mz14 K10 K11 K12 K13 K14], 'g.');
legend('kwadrat','kolo', 'trojkat');
hold off;
figure;
hold on;
plot3([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1],[0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1],[M M1 M2 M3 M4 Mz Mz1 Mz2 Mz3 Mz4 K K1 K2 K3 K4], 'b.')
plot3([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1],[0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1],[M5 M6 M7 M8 M9 Mz5 Mz6 Mz7 Mz8 Mz9 K5 K6 K7 K8 K9], 'r.')
plot3([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1],[0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1],[M10 M11 M12 M13 M14 Mz10 Mz11 Mz12 Mz13 Mz14 K10 K11 K12 K13 K14], 'g.')
legend('kwadrat','kolo', 'trojkat');
hold off;
figure;

    ISd=imread("strzalka.png");
```

```
ISd=imbinarize(ISd);
IMd=imread("strzalkaM.png");
IMd=imbinarize(IMd);
IDd=imread("strzalkaD.png");
IDd=imbinarize(IDd);
IPd=imread("strzalkaP.png");
IPd=imbinarize(IPd);

    ITs=imtranslate(ISd, [10 10]);
imwrite(ITs, 'strzalkatranslate.png');

    cent = regionprops(ISd,'perimeter');
Sd = cat(1, cent.Perimeter);

    Area = regionprops(ISd,'Area');
Ld = cat(1, Area.Area);

    cent = regionprops(IMd,'perimeter');
S1d = cat(1, cent.Perimeter);

    Area = regionprops(IMd,'Area');
L1d = cat(1, Area.Area);

    cent = regionprops(IDd,'perimeter');
S2d = cat(1, cent.Perimeter);

    Area = regionprops(IDd,'Area');
L2d = cat(1, Area.Area);

    cent = regionprops(IPd,'perimeter');
S3d = cat(1, cent.Perimeter);

    Area = regionprops(IPd,'Area');
L3d = cat(1, Area.Area);

    cent = regionprops(ITs,'perimeter');
```

```
S4d = cat(1, cent.Perimeter);

    Area = regionprops(ITs,'Area');
L4d = cat(1, Area.Area);

    Mzd=2*sqrt(pi*Sd)/Ld

    Md=(Ld/(2*sqrt(pi*Sd)))-1

    Kd=(4*pi*Sd)/(Ld*Ld)

    Mz1d=2*sqrt(pi*S1d)/L1d

    M1d=(L1d/(2*sqrt(pi*S1d)))-1

    K1d=(4*pi*S1d)/(L1d*L1d)

    Mz2d=2*sqrt(pi*S1d)/L2d

    M2d=(L2d/(2*sqrt(pi*S2d)))-1

    K2d=(4*pi*S2d)/(L2d*L2d)

    Mz3d=2*sqrt(pi*S3d)/L3d

    M3d=(L3d/(2*sqrt(pi*S3d)))-1

    K3d=(4*pi*S3d)/(L3d*L3d)

    Mz4d=2*sqrt(pi*S4d)/L4d

    M4d=(L4d/(2*sqrt(pi*S4d)))-1

    K4d=(4*pi*S4d)/(L4d*L4d)

    X=[0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1]
```

```
Y=[Md M1d M2d M3d M4d Mzd Mz1d Mz2d Mz3d Mz4d Kd K1d K2d K3d K4d]

    zestawdanych1=[M M1 M2 M3 M4 Mz Mz1 Mz2 Mz3 Mz4 K K1 K2 K3 K4];
zestawdanych2=[M5 M6 M7 M8 M9 Mz5 Mz6 Mz7 Mz8 Mz9 K5 K6 K7 K8 K9];
zestawdanych3=[M10 M11 M12 M13 M14 Mz10 Mz11 Mz12 Mz13 Mz14 K10 K11 K12 K13
K14];
color=[];
for i=1:15
c=knnmoje(X(i),Y(i), zestawdanych1,zestawdanych2,zestawdanych3)
color=[color c];
end

    plot(X,Y, 'm.');
figure;
hold on;
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M M1 M2 M3 M4
Mz Mz1 Mz2 Mz3 Mz4 K K1 K2 K3 K4], 'b.');
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M5 M6 M7 M8 M9
Mz5 Mz6 Mz7 Mz8 Mz9 K5 K6 K7 K8 K9], 'r.');
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M10 M11 M12 M13
M14 Mz10 Mz11 Mz12 Mz13 Mz14 K10 K11 K12 K13 K14], 'g.');
plot(X(1),Y(1), strcat(color(1),color(2)));
plot(X(2),Y(2), strcat(color(3),color(4)));
plot(X(3),Y(3), strcat(color(5),color(6)));
plot(X(4),Y(4), strcat(color(7),color(8)));
plot(X(5),Y(5), strcat(color(9),color(10)));
plot(X(6),Y(6), strcat(color(11),color(12)));
plot(X(7),Y(7), strcat(color(13),color(14)));
plot(X(8),Y(8), strcat(color(15),color(16)));
plot(X(9),Y(9), strcat(color(17),color(18)));
plot(X(10),Y(10), strcat(color(19),color(20)));
plot(X(11),Y(11), strcat(color(21),color(22)));
plot(X(12),Y(12), strcat(color(23),color(24)));
plot(X(13),Y(13), strcat(color(25),color(26)));
plot(X(14),Y(14), strcat(color(27),color(28)));
plot(X(15),Y(15), strcat(color(29),color(30)));
```

```
legend('kwadrat','kolo', 'trojkat');
hold off;
figure;
hold on;
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M M1 M2 M3 M4
Mz Mz1 Mz2 Mz3 Mz4 K K1 K2 K3 K4], 'b.');
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M5 M6 M7 M8 M9
Mz5 Mz6 Mz7 Mz8 Mz9 K5 K6 K7 K8 K9], 'r.');
plot([0 0.06 0.12 0.18 0.24 0.30 0.36 0.42 0.50 0.6 0.68 0.76 0.82 0.9 1], [M10 M11 M12 M13
M14 Mz10 Mz11 Mz12 Mz13 Mz14 K10 K11 K12 K13 K14], 'g.');
plot(X(6),Y(6), strcat(color(11),color(12)));
plot(X(7),Y(7), strcat(color(13),color(14)));
plot(X(8),Y(8), strcat(color(15),color(16)));
plot(X(9),Y(9), strcat(color(17),color(18)));
plot(X(10),Y(10), strcat(color(19),color(20)));
plot(X(11),Y(11), strcat(color(21),color(22)));
plot(X(12),Y(12), strcat(color(23),color(24)));
plot(X(13),Y(13), strcat(color(25),color(26)));
plot(X(14),Y(14), strcat(color(27),color(28)));
plot(X(15),Y(15), strcat(color(29),color(30)));
legend('kwadrat','kolo', 'trojkat');
hold off;
figure;
hold on;
plot(X(6),Y(6), 'm.');
plot(X(7),Y(7), 'm.');
plot(X(8),Y(8), 'm.');
plot(X(9),Y(9), 'm.');
plot(X(10),Y(10), 'm.');
plot(X(11),Y(11), 'm.');
plot(X(12),Y(12),'m.' );
plot(X(13),Y(13),'m.' );
plot(X(14),Y(14), 'm.');
plot(X(15),Y(15),'m.' );
```

Bibliography