Lab4-Methods

August 23, 2020

[1]:
```
pkg load image
```

Funcion de Binarizacion

[2]:
```
function bin=toGray(img)
    bin = uint8(rgb2gray(img));
end
```

[3]:
```
function output = Binarization(imD,threshold);

    [fBin,cBin]=size(imD);

    for i=1:fBin
        for j=1:cBin
            if imD(i,j)<=threshold
                imageBin(i,j) = 0;
            else
                imageBin(i,j) = 255;
            end
        end
    end

    output = imageBin;
end
```

Funcion Histograma e Histograma Normalizado

[4]:
```
function hist=Histograma(img)
    %El histograma va desde los tonos negros hasta tonos blancos.
    imD = double(img);
    [f,c]=size(imD);

    for i=1:256
        h(i) = 0;
    end

    for i=1:f
           for j=1:c
```

```
               k = imD(i,j);
               h(k+1) = h(k+1)+1;
           end
    end
    %Plotear el Histograma
    %plot(h);
    hist = h;
end
```

[5]:

```
function hN=histNormalizado(matrix)

hist = Histograma(matrix);
[f,c]=size(matrix);

hN = hist / (f * c);
end
```

Metodo Otsu

[6]:

```
function umbral=otsu(matrix)
    [f,c] = size(matrix);
    hN = histNormalizado(matrix);

    mayor = -1;
    umbral = -1;

    for t=1:256
        w1 = 1e-16;
        u1 = 1e-16; u2 = 1e-16;
        for i=1:t
            w1 = w1 + double(hN(i));
        end
        w2 = 1 - w1;

        if w2 == 0
            w2 = 1e-16;
        end

        for i=1:t
            c1 = (hN(i)/w1);
            u1 = u1 + c1*i;
        end
        for i=t+1:256
            c2 = (hN(i)/w2);
            u2 = u2 + c2*i;
        end
        ut = w1*u1 + w2*u2;
        B = w1*(u1 - ut)^2 + w2*(u2 - ut)^2;
        if(B > mayor)
            mayor = B;
            umbral = t;
        end
    end
end
```

Metodo Kappur

[7]:

```
function umbral=kapurMethod(imD);
    [f,c]=size(imD);
    mayor = -1;
    umbral = 0;

    hn = histNormalizado(imD);

    for t=1:256
        pt = 0;
        pr = 0;
        s1 = 0;
        s2 = 0;
        eObjeto = 0;
        eFondo = 0;
        entropiaT = 0;
        %CALCULO PARA EL OBJETO
        for j=1:t
            pt = pt + hn(j);
        end
        for i=1:t
            if pt~=0
                s1 = hn(i)/pt;
            end
            if s1~=0
                eObjeto = eObjeto + (s1)*log2(s1);
            end
        end
        %CALCULO PARA EL FONDO
        pr = 1 - pt;
        for i=t+1:256
            if pr~=0 && pt~=0
                s2 = hn(i)/pr;
            end
            if s2~=0
                eFondo = eFondo + (s2)*log2(s2);
            end
        end

        entropiaT = -eObjeto + -eFondo;
        if (entropiaT > mayor )
            mayor = entropiaT;
            umbral = t-1;
        end
    end
end
```

Metodo Isodata

[8]:

```
function salida = kernel_isodata(t,h)

    hP = zeros(1,256);

    for j = 1:256
         hP(j) = h(j)*(j);
    end

    shN = 0;
    shP = 0;
    shNL = 0;
    shPL = 0;

    for i = 1:t
       shN = shN + h(i);
       shP = shP + hP(i);
    end

    for i = t+1:256
       shNL = shNL + h(i);
       shPL = shPL + hP(i);
    end

    if (shN == 0 || shNL == 0)
        uj = 1;
    else
        uj = ((shP/shN) + (shPL/shNL))/2;
    end

    salida = uj;
end
```

[9]:

```
function umbral = isodata(imagen)
    hn = histNormalizado(imagen);
    u = zeros(1,256);
    for i=1:256
        u(i) = kernel_isodata(i,hn);
    end

    i = 2;
    while (abs(u(i)-u(i-1)) >= 1 || u(i)==1)
        i = i+1;
    end

    umbral = u(i);
end
```

Filtro de Promediacion

[10]:
```
function image=averagefilter(image, varargin)
    numvarargs = length(varargin);
    if numvarargs > 2
        error('myfuns:somefun2Alt:TooManyInputs', ...
            'requires at most 2 optional inputs');
    end

    optargs = {[3 3] 0};            % set defaults for optional inputs
    optargs(1:numvarargs) = varargin;
    [window, padding] = optargs{:}; % use memorable variable names
    m = window(1);
    n = window(2);
    if ~mod(m,2) m = m-1; end       % check for even window sizes
    if ~mod(n,2) n = n-1; end
    if (ndims(image)~=2)            % check for color pictures
        display('The input image must be a two dimensional array.')
        display('Consider using rgb2gray or similar function.')
        return
    end
    % Initialization.
    [rows columns] = size(image);   % size of the image
    % Pad the image.
    imageP  = padarray(image, [(m+1)/2 (n+1)/2], padding, 'pre');
    imagePP = padarray(imageP, [(m-1)/2 (n-1)/2], padding, 'post');
    % Always use double because uint8 would be too small.
    imageD = double(imagePP);
    % Matrix 't' is the sum of numbers on the left and above the current cell.
    t = cumsum(cumsum(imageD),2);
    % Calculate the mean values from the look up table 't'.
    imageI = t(1+m:rows+m, 1+n:columns+n) + t(1:rows, 1:columns)...
        - t(1+m:rows+m, 1:columns) - t(1:rows, 1+n:columns+n);
    % Now each pixel contains sum of the window. But we want the average value.
    imageI = imageI/(m*n);
    % Return matrix in the original type class.
    image = cast(imageI, class(image));
end
```

Metodo Sauvola

[11]:
```
function output=sauvola(imagen, varargin)
    image=imagen;
    % Initialization
    numvarargs = length(varargin);      % only want 3 optional inputs at most
    if numvarargs > 3
        error('myfuns:somefun2Alt:TooManyInputs', ...
         'Possible parameters are: (image, [m n], threshold, padding)');
    end

    optargs = {[3 3] 0.34 'replicate'}; % set defaults

    optargs(1:numvarargs) = varargin;   % use memorable variable names
    [window, k, padding] = optargs{:};
    if ndims(image) ~= 2
        error('The input image must be a two-dimensional array.');
    end
    % Convert to double
    image = double(image);
    % Mean value
    mean = averagefilter(image, window, padding);
    % Standard deviation
    meanSquare = averagefilter(image.^2, window, padding);
    deviation = (meanSquare - mean.^2).^0.5;
    % Sauvola
    R = max(deviation(:));
    threshold = mean.*(1 + k * (deviation / R-1));
    output = (image > threshold);
end
```

Metodo Niblack

[12]:
```
function output = niblack(image, varargin)
    % Initialization
    numvarargs = length(varargin);      % only want 4 optional inputs at most
    if numvarargs > 4
        error('myfuns:somefun2Alt:TooManyInputs', ...
         'Possible parameters are: (image, [m n], k, offset, padding)');
    end

    optargs = {[3 3] -0.2 0 'replicate'};    % set defaults

    optargs(1:numvarargs) = varargin;   % use memorable variable names
    [window, k, offset, padding] = optargs{:};
    if ndims(image) ~= 2
        error('The input image must be a two-dimensional array.');
    end
    % Convert to double
    image = double(image);
    % Mean value
    mean = averagefilter(image, window, padding);
    % Standard deviation
    meanSquare = averagefilter(image.^2, window, padding);
    deviation = (meanSquare - mean.^2).^0.5;
    % Initialize the output
    output = zeros(size(image));
    % Niblack
    output(image > mean + k * deviation - offset) = 1;
end
```

Lineazadores

[13]:

```
function [S, shape] = parse_inputsFILT(varargin)
    shape = 'same';
    flag = [0 0]; % size shape
    for i = 1 : nargin
       t = varargin{i};
       if strcmp(t,'full') && flag(2) == 0
          shape = 'full';
          flag(2) = 1;
       elseif strcmp(t,'same') && flag(2) == 0
          shape = 'same';
          flag(2) = 1;
       elseif strcmp(t,'valid') && flag(2) == 0
          shape = 'valid';
          flag(2) = 1;
       elseif flag(1) == 0
          S = t;
          flag(1) = 1;
       else
          error(['Too many / Unkown parameter : ' t ])
       end
    end
    if flag(1) == 0
       S = [3 3];
    end
    if length(S) == 1;
       S(2) = S(1);
    end
    if length(S) ~= 2
       error('Wrong window size parameter.')
    end
end
```

[14]:

```
function [direc, shape] = parse_inputsVAR(varargin)
    direc = 'lin';
    shape = 'same';
    flag = [0 0]; % [dir shape]
    for i = 1 : nargin
       t = varargin{i};
       if strcmp(t,'col') && flag(1) == 0
          direc = 'col';
          flag(1) = 1;
       elseif strcmp(t,'full') && flag(2) == 0
          shape = 'full';
          flag(2) = 1;
       elseif strcmp(t,'same') && flag(2) == 0
          shape = 'same';
          flag(2) = 1;
       elseif strcmp(t,'valid') && flag(2) == 0
          shape = 'valid';
          flag(2) = 1;
       else
          error(['Too many / Unkown parameter : ' t ])
       end
    end
end
```

Kernel Optimizado de aplicacion de mascaras

[15]:

```
function Y = vanherk(X,N,TYPE,varargin)
    % Initialization
    [direc, shape] = parse_inputsVAR(varargin{:});
    if strcmp(direc,'col')
       X = X';
    end
    if strcmp(TYPE,'max')
       maxfilt = 1;
    elseif strcmp(TYPE,'min')
       maxfilt = 0;
    else
       error([ 'TYPE must be ' char(39) 'max' char(39) ' or ' char(39) 'min'␣
 ↪char(39) '.'])
    end
    % Correcting X size
    fixsize = 0;
```

```
addel = 0;
if mod(size(X,2),N) ~= 0
   fixsize = 1;
   addel = N-mod(size(X,2),N);
   if maxfilt
      f = [ X zeros(size(X,1), addel) ];
   else
      f = [X repmat(X(:,end),1,addel)];
   end
else
   f = X;
end
lf = size(f,2);
lx = size(X,2);
clear X
% Declaring aux. mat.
g = f;
h = g;
% Filling g & h (aux. mat.)
ig = 1:N:size(f,2);
ih = ig + N - 1;
g(:,ig) = f(:,ig);
h(:,ih) = f(:,ih);
if maxfilt
   for i = 2 : N
      igold = ig;
      ihold = ih;

      ig = ig + 1;
      ih = ih - 1;

      g(:,ig) = max(f(:,ig),g(:,igold));
      h(:,ih) = max(f(:,ih),h(:,ihold));
   end
else
   for i = 2 : N
      igold = ig;
      ihold = ih;

      ig = ig + 1;
      ih = ih - 1;

      g(:,ig) = min(f(:,ig),g(:,igold));
      h(:,ih) = min(f(:,ih),h(:,ihold));
   end
end
clear f
```

```
   % Comparing g & h
   if strcmp(shape,'full')
      ig = [ N : 1 : lf ];
      ih = [ 1 : 1 : lf-N+1 ];
      if fixsize
         if maxfilt
            Y = [ g(:,1:N-1)  max(g(:,ig), h(:,ih))  h(:,end-N+2:end-addel) ];
         else
            Y = [ g(:,1:N-1)  min(g(:,ig), h(:,ih))  h(:,end-N+2:end-addel) ];
         end
      else
         if maxfilt
            Y = [ g(:,1:N-1)  max(g(:,ig), h(:,ih))  h(:,end-N+2:end) ];
         else
            Y = [ g(:,1:N-1)  min(g(:,ig), h(:,ih))  h(:,end-N+2:end) ];
         end
      end

   elseif strcmp(shape,'same')
      if fixsize
         if addel > (N-1)/2
            ig = [ N : 1 : lf - addel + floor((N-1)/2) ];
            ih = [ 1 : 1 : lf-N+1 - addel + floor((N-1)/2)];
            if maxfilt
               Y = [ g(:,1+ceil((N-1)/2):N-1)  max(g(:,ig), h(:,ih)) ];
            else
               Y = [ g(:,1+ceil((N-1)/2):N-1)  min(g(:,ig), h(:,ih)) ];
            end
         else
            ig = [ N : 1 : lf ];
            ih = [ 1 : 1 : lf-N+1 ];
            if maxfilt
               Y = [ g(:,1+ceil((N-1)/2):N-1)  max(g(:,ig), h(:,ih))  h(:
↪,lf-N+2:lf-N+1+floor((N-1)/2)-addel) ];
            else
               Y = [ g(:,1+ceil((N-1)/2):N-1)  min(g(:,ig), h(:,ih))  h(:
↪,lf-N+2:lf-N+1+floor((N-1)/2)-addel) ];
            end
         end
      else % not fixsize (addel=0, lf=lx)
         ig = [ N : 1 : lx ];
         ih = [ 1 : 1 : lx-N+1 ];
         if maxfilt
            Y = [  g(:,N-ceil((N-1)/2):N-1) max( g(:,ig), h(:,ih) )  h(:
↪,lx-N+2:lx-N+1+floor((N-1)/2)) ];
         else
```

```
             Y = [  g(:,N-ceil((N-1)/2):N-1) min( g(:,ig), h(:,ih) )  h(:
↪,lx-N+2:lx-N+1+floor((N-1)/2)) ];
          end
       end

    elseif strcmp(shape,'valid')
       ig = [ N : 1 : lx];
       ih = [ 1 : 1: lx-N+1];
       if maxfilt
          Y = [ max( g(:,ig), h(:,ih) ) ];
       else
          Y = [ min( g(:,ig), h(:,ih) ) ];
       end
    end
    if strcmp(direc,'col')
       Y = Y';
    end
end
```

Filtrado de Minimos

[16]:

```
function Y = minfilt2(X,varargin)
    % Initialization
    [S, shape] = parse_inputsFILT(varargin{:});
    % filtering
    Y = vanherk(X,S(1),'min',shape);
    Y = vanherk(Y,S(2),'min','col',shape);
end
```

Filtrado de Maximos

[17]:

```
function Y = maxfilt2(X,varargin)
    % Initialization
    [S, shape] = parse_inputsFILT(varargin{:});
    % filtering
    Y = vanherk(X,S(1),'max',shape);
    Y = vanherk(Y,S(2),'max','col',shape);
end
```

Metodo Bernsen

[18]:

```
function output = bernsen(image, varargin)

    % Initialization
    numvarargs = length(varargin);      % only want 3 optional inputs at most
    if numvarargs > 3
        error('myfuns:somefun2Alt:TooManyInputs', ...
         'Possible BERNSEN parameters are: (image, [m n], contrast, padding)');
    end

    optargs = {[3 3] 15 'replicate'};    % set defaults

    optargs(1:numvarargs) = varargin;    % use memorable variable names
    [window, contrast_threshold, padding] = optargs{:};
    if ndims(image) ~= 2
        error('The input image must be a two-dimensional array.');
    end
    if sum(mod(window,2))~=2
        error('Sorry, only odd valued window dimensions are supported');
    end
    % Convert to double
    image = double(image);
    % Mean value
    mean = averagefilter(image, window, padding);
    % Local contrast
    local_contrast = maxfilt2(image, window) - minfilt2(image, window);
    % Initialize the output
    output = zeros(size(image));
    % Whenever contrast in the window is low assume homogenous area
    mask = local_contrast < contrast_threshold;
    output(mask && image>=128) = 1;
    % Otherwise compare to the mean value
    output(~mask) = (image(~mask) >= mean(~mask));
end
```

Comparativa y Ejecucion de los Metodos

[19]:

```
!ls "../images" | cut -f 1 -d " " | awk '{print "\"" $1 "\"" ","}'
```

```
"boat.png",
"cameraman.png",
"coins.png",
"hands1.png",
"house.png",
"imagen1.png",
"imagen2.png",
"parrot.png",
"pout.png",
"westconcordorthophoto.png",
```

[20]:

```
PATH = "../images";
IMGS = {
"boat.png",
"cameraman.png",
"coins.png",
"hands1.png",
"house.png",
"imagen1.png",
"imagen2.png",
"parrot.png",
"pout.png",
"westconcordorthophoto.png"
}';
```

[21]:

```
results = zeros(size(IMGS)(2), (3 + (3 * 3)));
```

[22]:

```
for ii = [1:size(IMGS)(2)]
    filename = IMGS{ii};

    current = strcat(PATH, strcat("/", filename));
    imCurrent = imread(current);

    [a,b,c]=size(imCurrent);
    if c~=1
        imCurrent=toGray(imCurrent);
    end

    % Metodos Globales
    %
    % OTSU

    tic;
    OTSU_T = otsu(imCurrent);
    OTSU_IMG = Binarization(imCurrent, OTSU_T);
    OTSU_t = toc;
    OTSU_LABEL = strjoin({"OTSU", num2str(OTSU_t), int2str(OTSU_T)}, " | ");

    partial_results = [OTSU_t];

    % Kappur

    tic;
    KAPPUR_T = kapurMethod(imCurrent);
    KAPPUR_IMG = Binarization(imCurrent, KAPPUR_T);
    KAPPUR_t = toc;
    KAPPUR_LABEL = strjoin({"KAPPUR", num2str(KAPPUR_t), int2str(KAPPUR_T)}, "␣
↪| ");

    partial_results = [partial_results, KAPPUR_t];

    % Isodata
    tic;
    ISODATA_T = isodata(imCurrent);
    ISODATA_IMG = Binarization(imCurrent, ISODATA_T);
    ISODATA_t = toc;
    ISODATA_LABEL = strjoin({"ISODATA", num2str(ISODATA_t),␣
↪int2str(ISODATA_T)}, " | ");

    partial_results = [partial_results, ISODATA_t];

    % Metodos Locales
    %

    ref = 1;
    for jj = [3:2:7]
        % Sauvola
        filterShape = [jj jj];
        filterSTR = strjoin({"[ ", int2str(jj), " x ", int2str(jj), " ]"});

        tic;
        SAUVOLA_IMG = sauvola(imCurrent, filterShape);
        SAUVOLA_t = toc;
        SAUVOLA_LABEL = strjoin({"SAUVOLA", num2str(SAUVOLA_t), filterSTR}, " |␣
↪");

        partial_results = [partial_results, SAUVOLA_t];

        % Niblack

        tic;
        NIBLACK_IMG = niblack(imCurrent, filterShape);
        NIBLACK_t = toc;
        NIBLACK_LABEL = strjoin({"NIBLACK", num2str(NIBLACK_t), filterSTR}, " |␣
↪");

        partial_results = [partial_results, NIBLACK_t];

        % Bernsen

        tic;
        BERSEN_IMG = bernsen(imCurrent, filterShape);
        BERSEN_t = toc;
        BERSEN_LABEL = strjoin({"BERSEN", num2str(BERSEN_t), filterSTR}, " | ");

        partial_results = [partial_results, BERSEN_t];

        % SHOWING
        figure;

        subplot(3,3,2); imshow(imCurrent); title(current);

        subplot(3,3,4); imshow(OTSU_IMG); title(OTSU_LABEL);

        subplot(3,3,5); imshow(KAPPUR_IMG); title(KAPPUR_LABEL);

        subplot(3,3,6); imshow(ISODATA_IMG); title(ISODATA_LABEL);

        subplot(3,3,7); imshow(SAUVOLA_IMG); title(SAUVOLA_LABEL);

        subplot(3,3,8); imshow(NIBLACK_IMG); title(NIBLACK_LABEL);

        subplot(3,3,9); imshow(BERSEN_IMG); title(BERSEN_LABEL);

        saveas((ii - 1) * 3 + ref, strjoin({"./results/RE_FA", int2str(ii), "-", int2str(jj), "_", filename}, ""), "png");

        ref = ref + 1;
    end

    results(ii, :) = partial_results;
end
```

```
DEBUG: FC_WEIGHT didn't match
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```
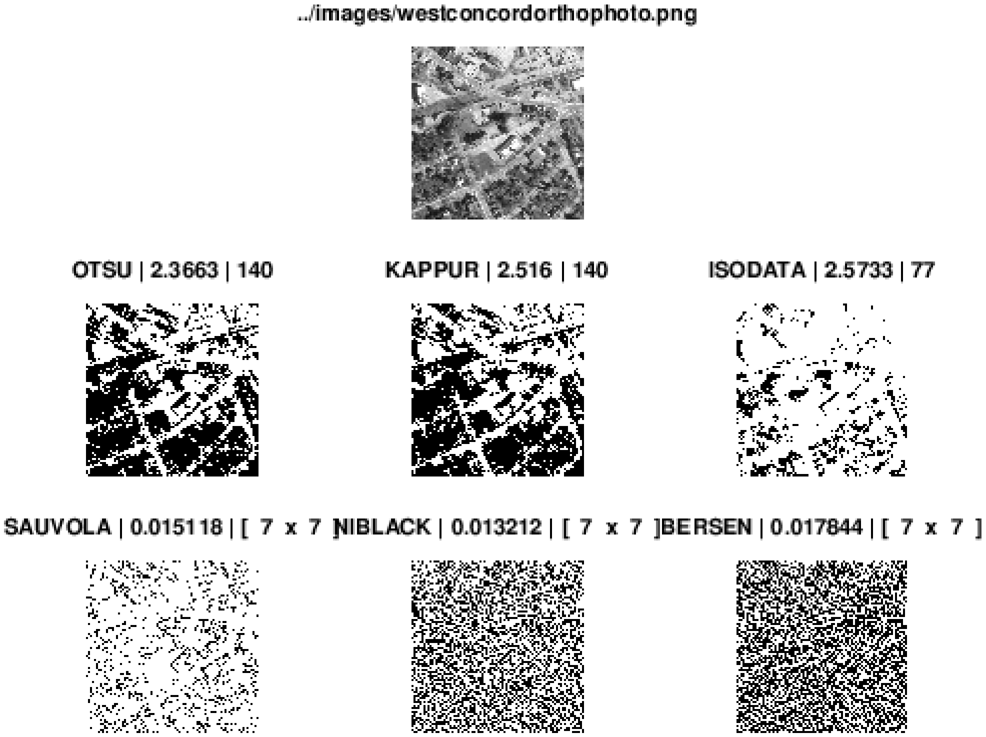
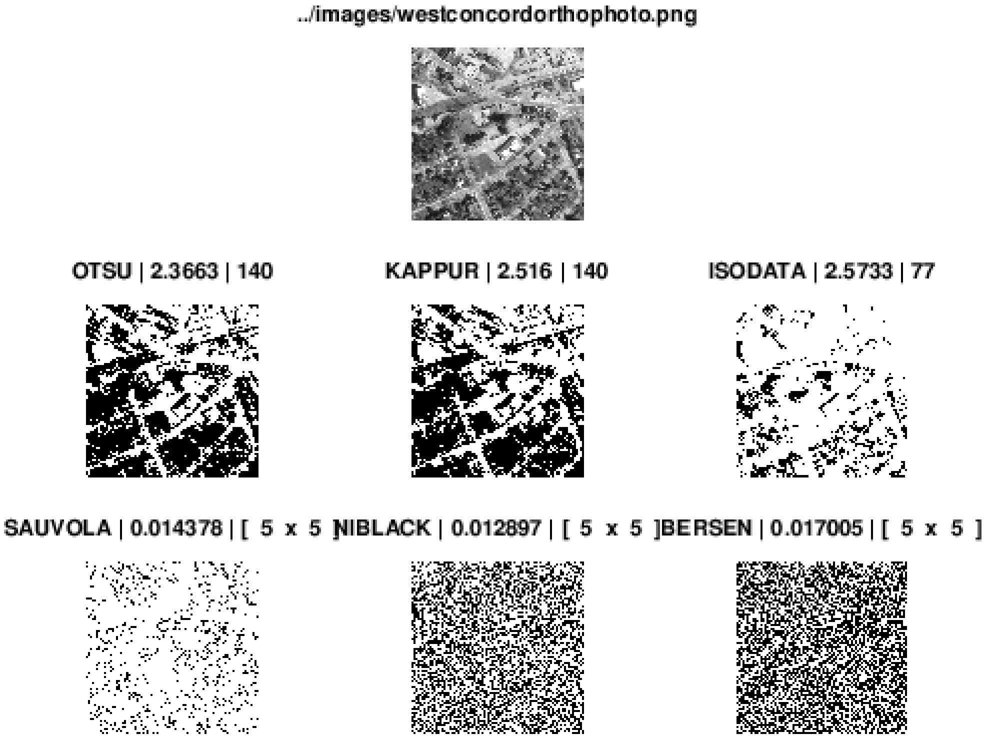


../images/westconcordorthophoto.png
OTSU | 2.3663 | 140
KAPPUR | 2.516 | 140
ISODATA | 2.5733 | 77
SAUVOLA | 0.015118 | [7 x 7]
NIBLACK | 0.013212 | [7 x 7]
BERSEN | 0.017844 | [7 x 7]



../images/westconcordorthophoto.png

OTSU | 2.3663 | 140

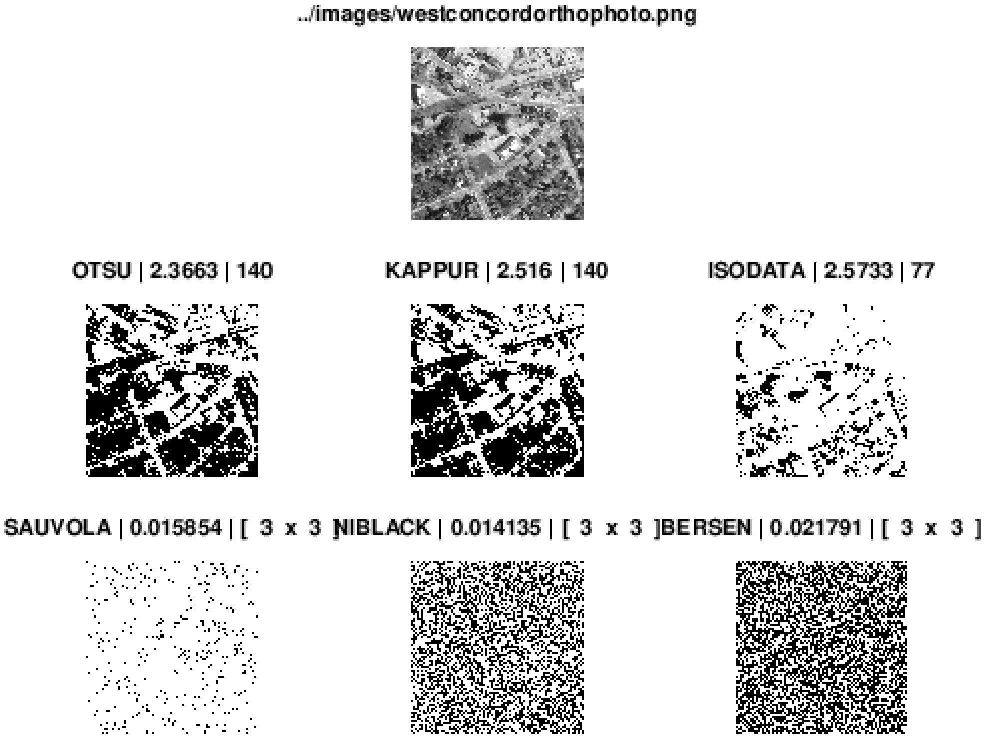
KAPPUR | 2.516 | 140

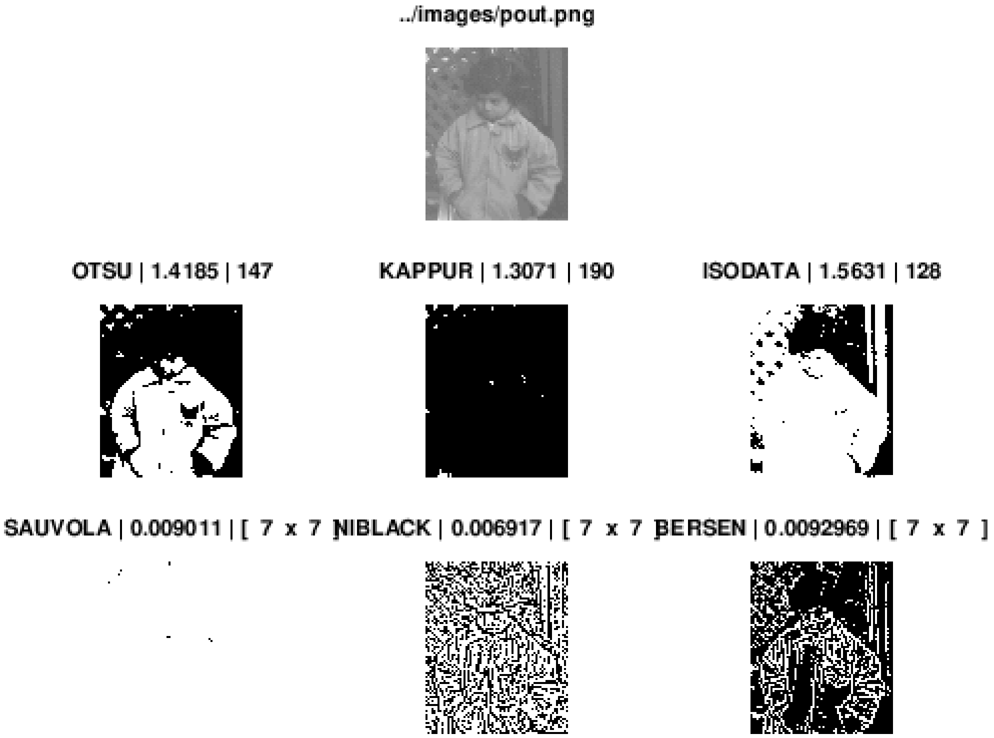
ISODATA | 2.5733 | 77

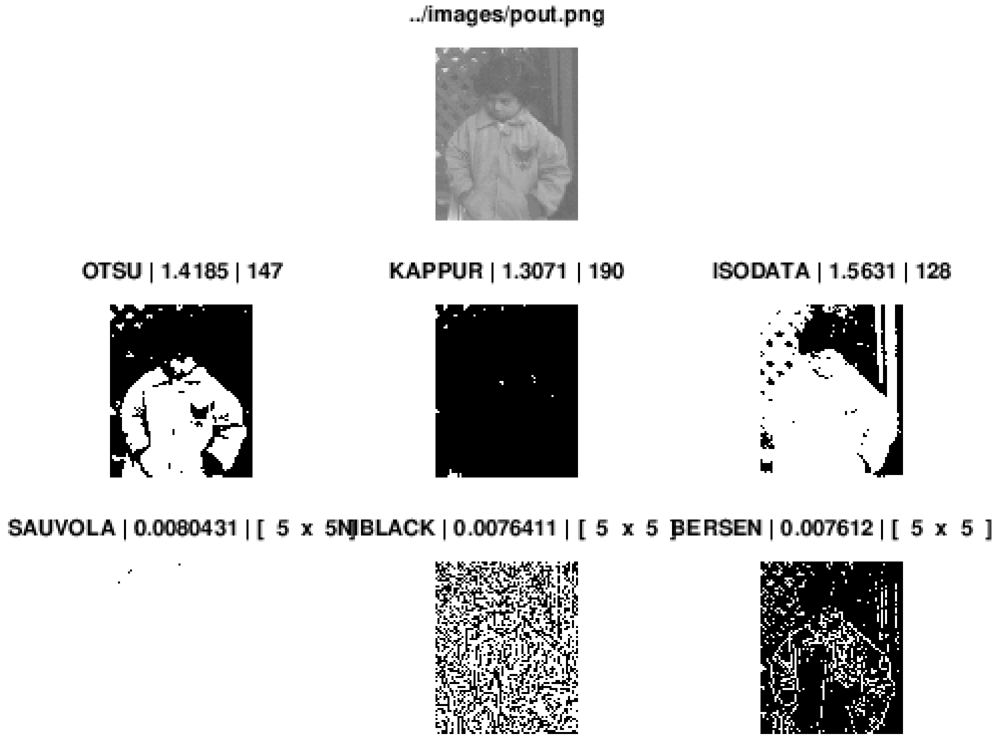
SAUVOLA | 0.014378 | [5 x 5]

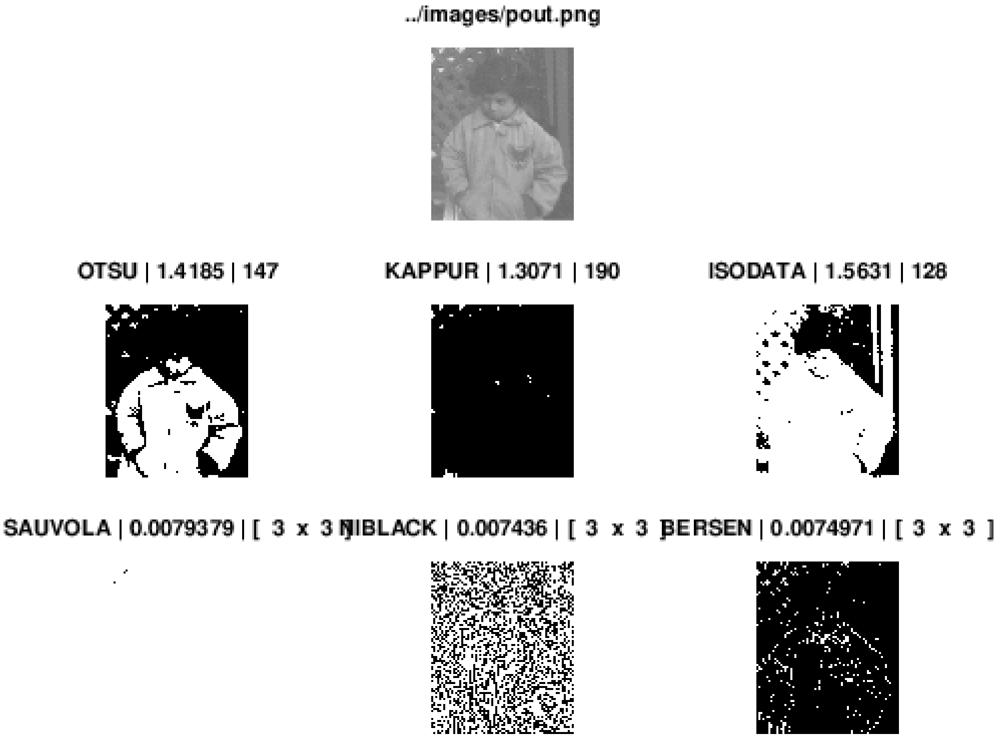
NIBLACK | 0.012897 | [5 x 5]

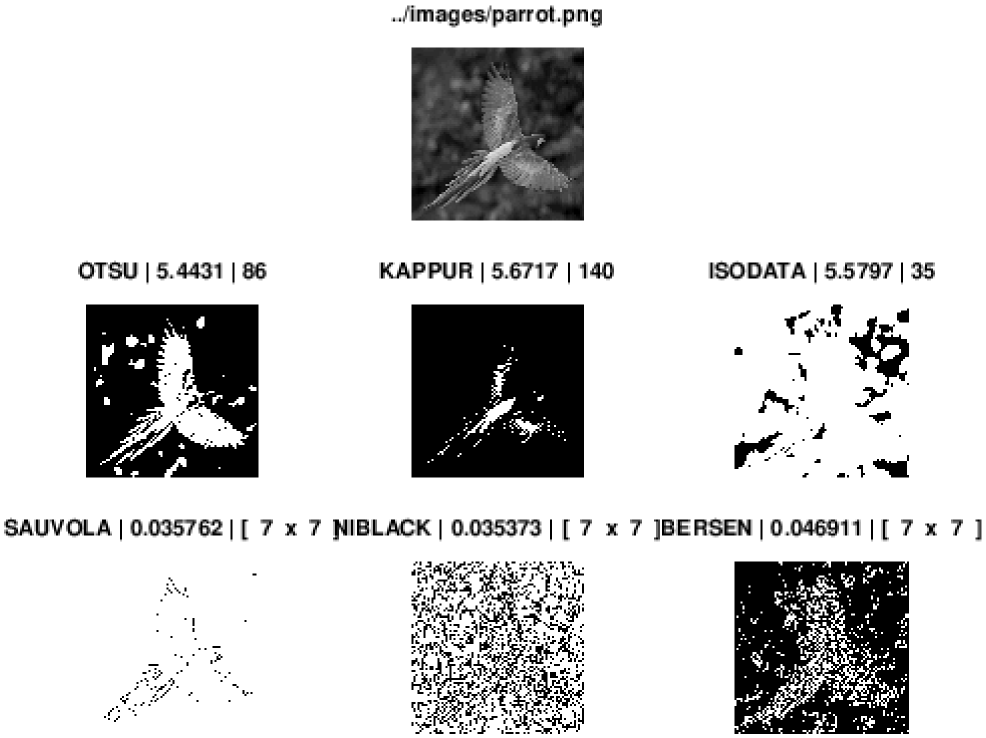
BERSEN | 0.017005 | [5 x 5]

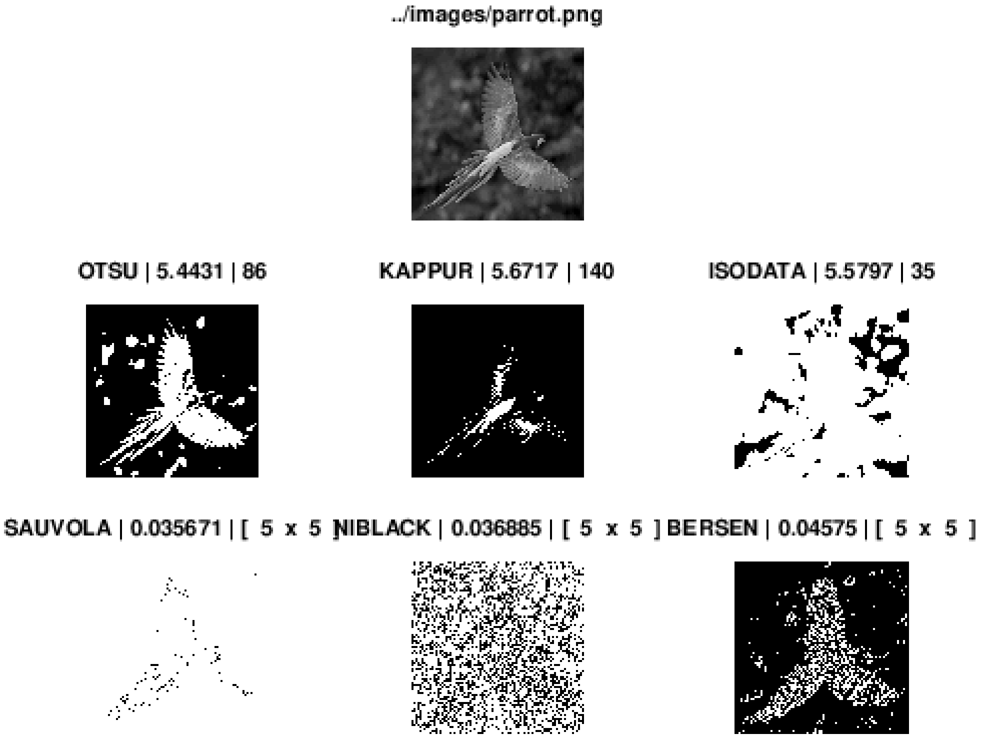

../images/westconcordorthophoto.png
OTSU | 2.3663 | 140
KAPPUR | 2.516 | 140
ISODATA | 2.5733 | 77
SAUVOLA | 0.015854 | [3 x 3]
NIBLACK | 0.014135 | [3 x 3]
BERSEN | 0.021791 | [3 x 3]

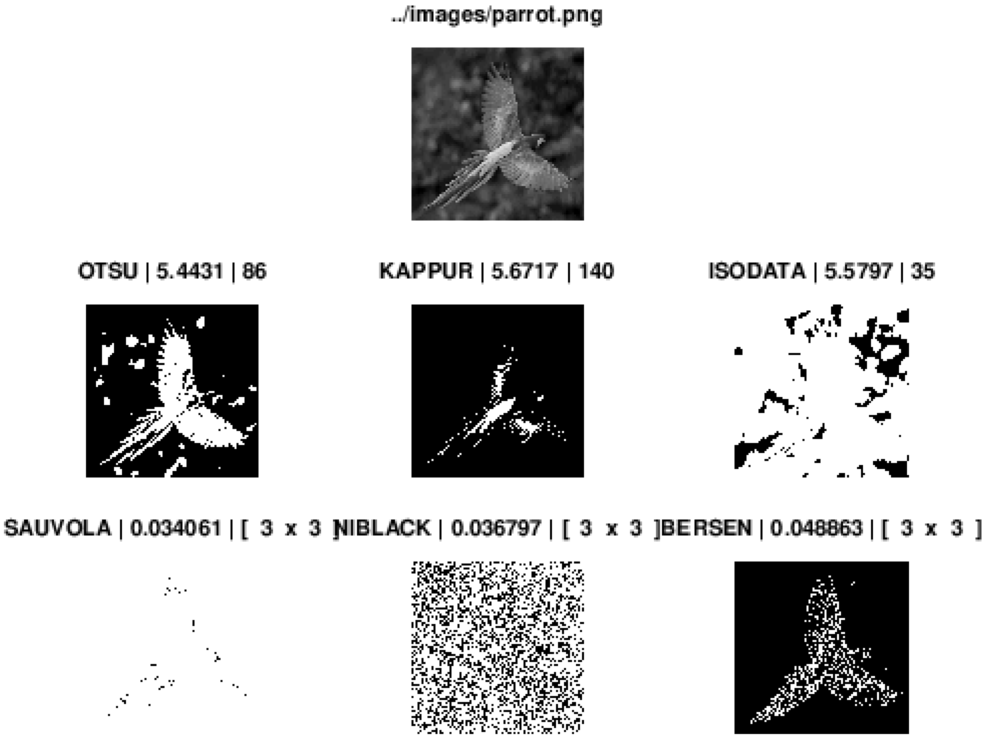

../images/pout.png
OTSU | 1.4185 | 147
KAPPUR | 1.3071 | 190
ISODATA | 1.5631 | 128
SAUVOLA | 0.009011 | [7 x 7]
NIBLACK | 0.006917 | [7 x 7]
BERSEN | 0.0092969 | [7 x 7]

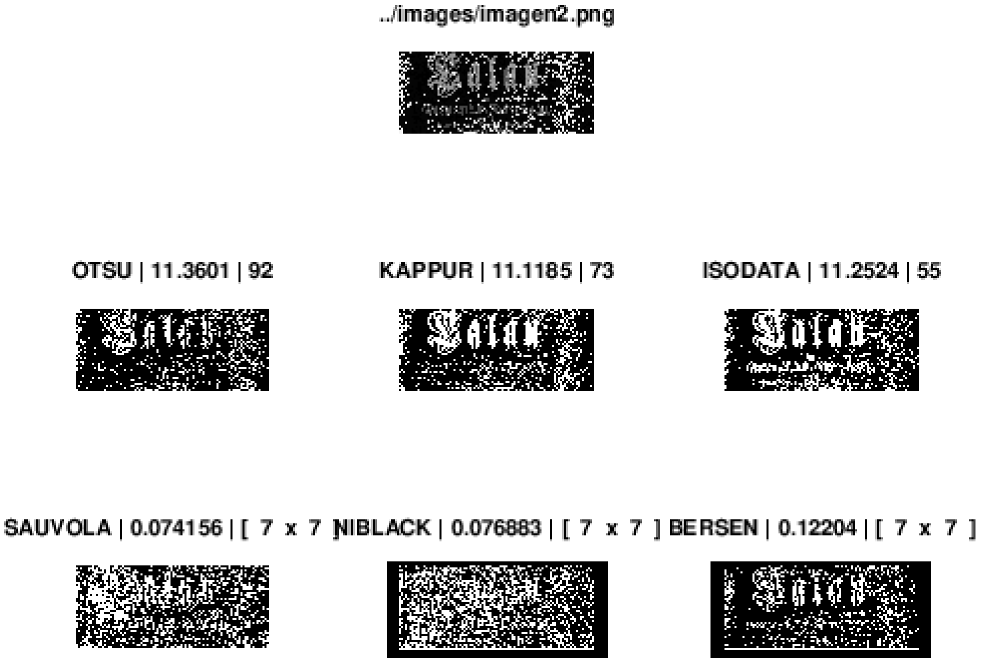

../images/pout.png
OTSU | 1.4185 | 147
KAPPUR | 1.3071 | 190
ISODATA | 1.5631 | 128
SAUVOLA | 0.0080431 | [5 x 5]
NIBLACK | 0.0076411 | [5 x 5]
BERSEN | 0.007612 | [5 x 5]

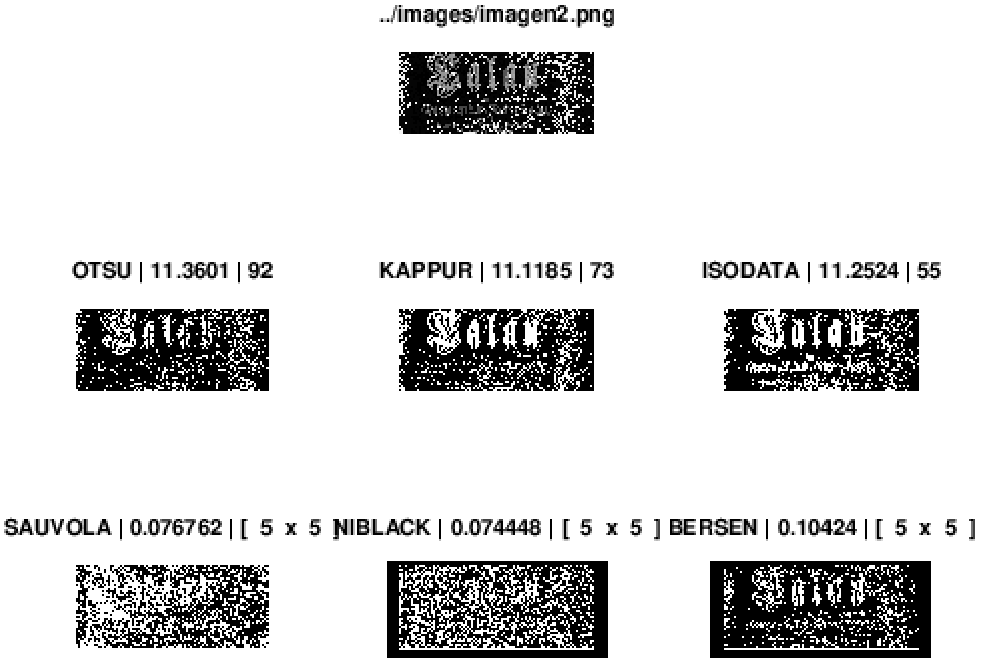

../images/pout.png
OTSU | 1.4185 | 147
KAPPUR | 1.3071 | 190
ISODATA | 1.5631 | 128
SAUVOLA | 0.0079379 | [3 x 3]
NIBLACK | 0.007436 | [3 x 3]
BERSEN | 0.0074971 | [3 x 3]


../images/parrot.png
OTSU | 5.4431 | 86
KAPPUR | 5.6717 | 140
ISODATA | 5.5797 | 35
SAUVOLA | 0.035762 | [7 x 7]
NIBLACK | 0.035373 | [7 x 7]
BERSEN | 0.046911 | [7 x 7]


../images/parrot.png
OTSU | 5.4431 | 86
KAPPUR | 5.6717 | 140
ISODATA | 5.5797 | 35
SAUVOLA | 0.035671 | [5 x 5]
NIBLACK | 0.036885 | [5 x 5]
BERSEN | 0.04575 | [5 x 5]


../images/parrot.png
OTSU | 5.4431 | 86
KAPPUR | 5.6717 | 140
ISODATA | 5.5797 | 35
SAUVOLA | 0.034061 | [3 x 3]
NIBLACK | 0.036797 | [3 x 3]
BERSEN | 0.048863 | [3 x 3]


../images/imagen2.png
OTSU | 11.3601 | 92
KAPPUR | 11.1185 | 73
ISODATA | 11.2524 | 55
SAUVOLA | 0.074156 | [7 x 7]
NIBLACK | 0.076883 | [7 x 7]
BERSEN | 0.12204 | [7 x 7]



../images/imagen2.png

OTSU | 11.3601 | 92

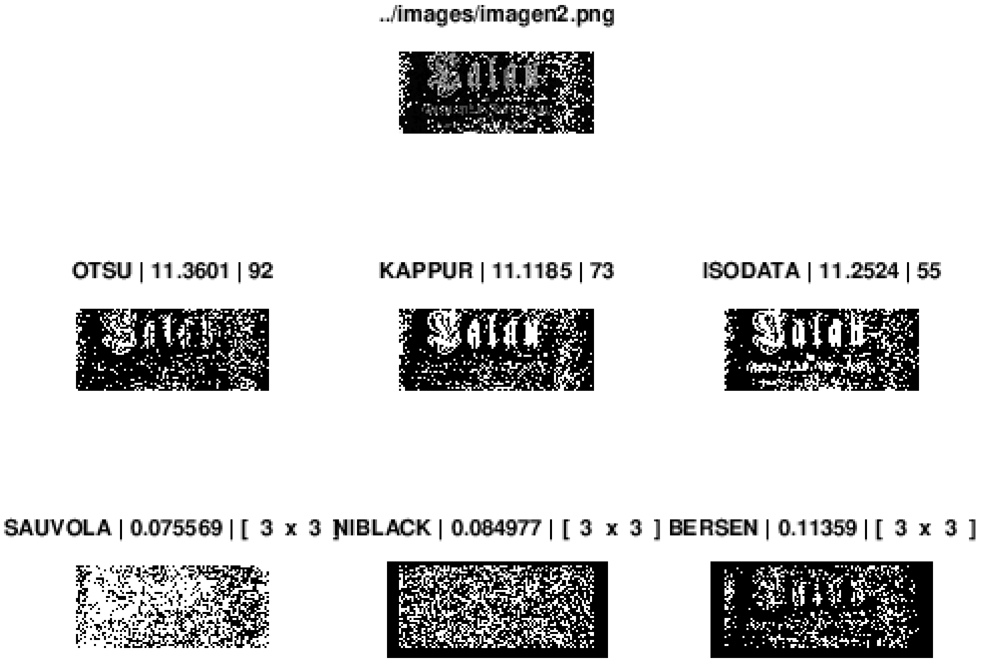
KAPPUR | 11.1185 | 73

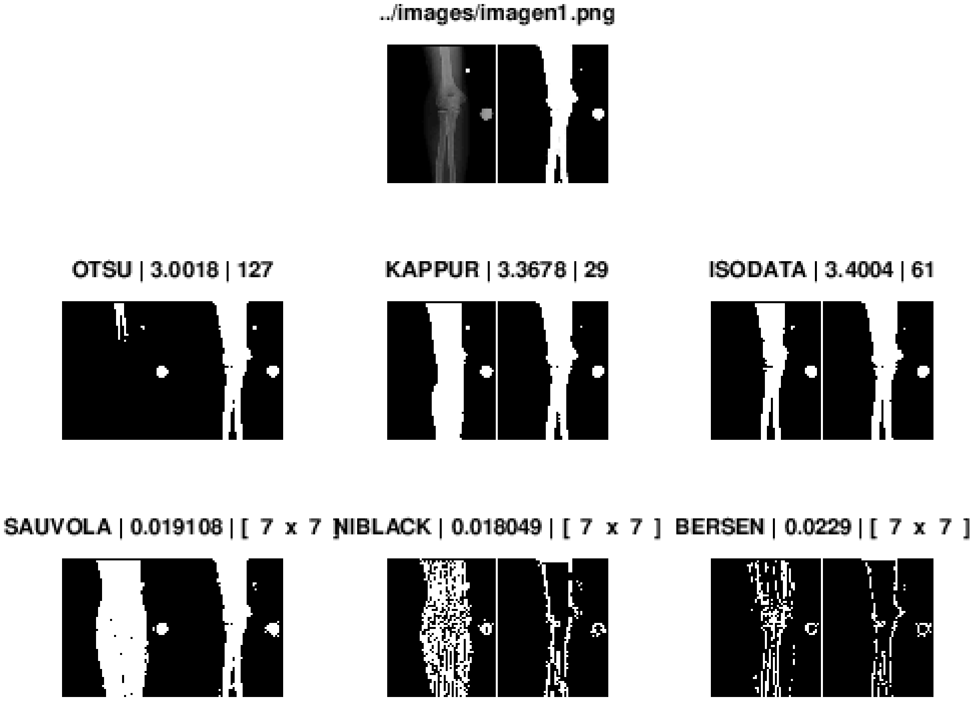
ISODATA | 11.2524 | 55

SAUVOLA | 0.076762 | [5 x 5]

NIBLACK | 0.074448 | [5 x 5]

BERSEN | 0.10424 | [5 x 5]


../images/imagen2.png
OTSU | 11.3601 | 92
KAPPUR | 11.1185 | 73
ISODATA | 11.2524 | 55
SAUVOLA | 0.075569 | [3 x 3]
NIBLACK | 0.084977 | [3 x 3]
BERSEN | 0.11359 | [3 x 3]



../images/imagen1.png

OTSU | 3.0018 | 127

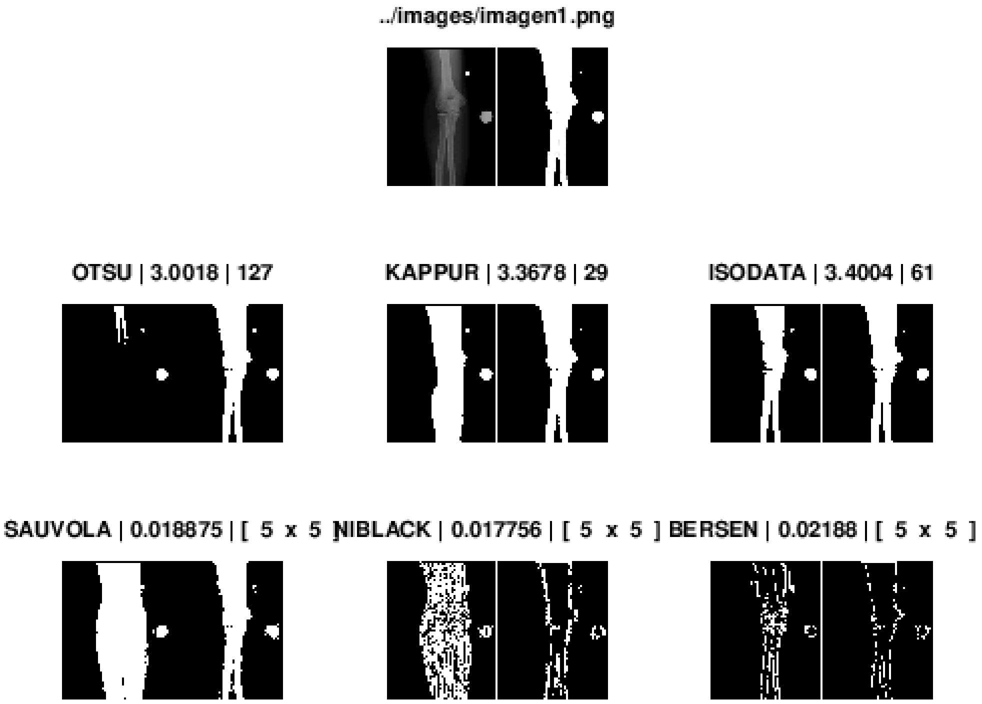
KAPPUR | 3.3678 | 29

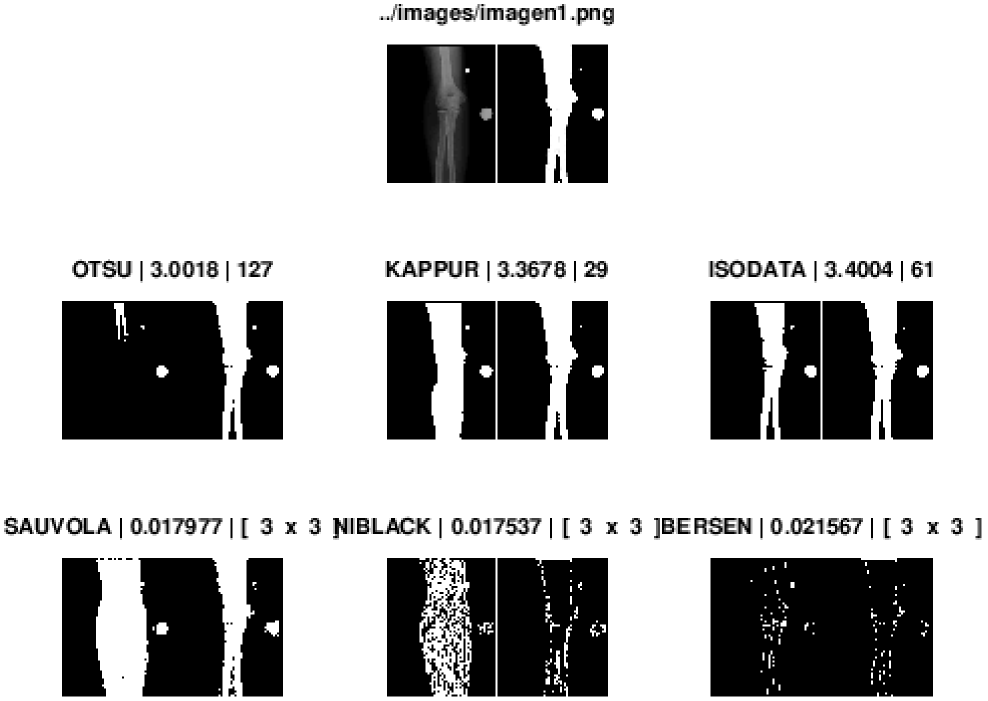
ISODATA | 3.4004 | 61

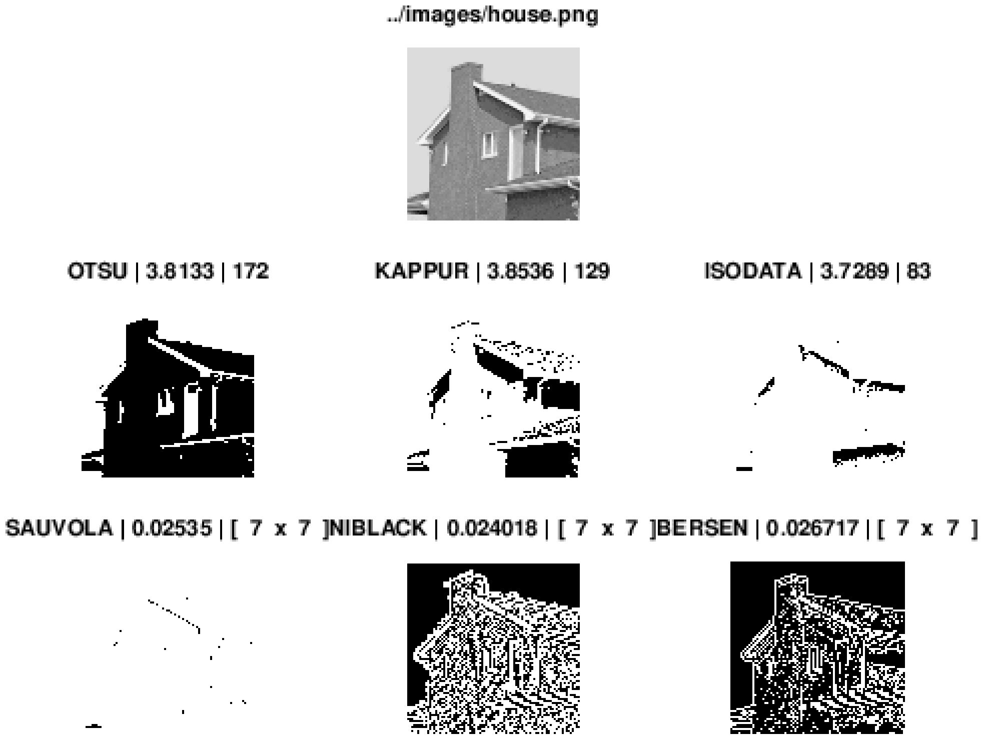
SAUVOLA | 0.019108 | [7 x 7]

NIBLACK | 0.018049 | [7 x 7]

BERSEN | 0.0229 | [7 x 7]


../images/imagen1.png
OTSU | 3.0018 | 127
KAPPUR | 3.3678 | 29
ISODATA | 3.4004 | 61
SAUVOLA | 0.018875 | [5 x 5]
NIBLACK | 0.017756 | [5 x 5]
BERSEN | 0.02188 | [5 x 5]


../images/imagen1.png
OTSU | 3.0018 | 127
KAPPUR | 3.3678 | 29
ISODATA | 3.4004 | 61
SAUVOLA | 0.017977 | [3 x 3]NIBLACK | 0.017537 | [3 x 3]BERSEN | 0.021567 | [3 x 3]



../images/house.png

OTSU | 3.8133 | 172

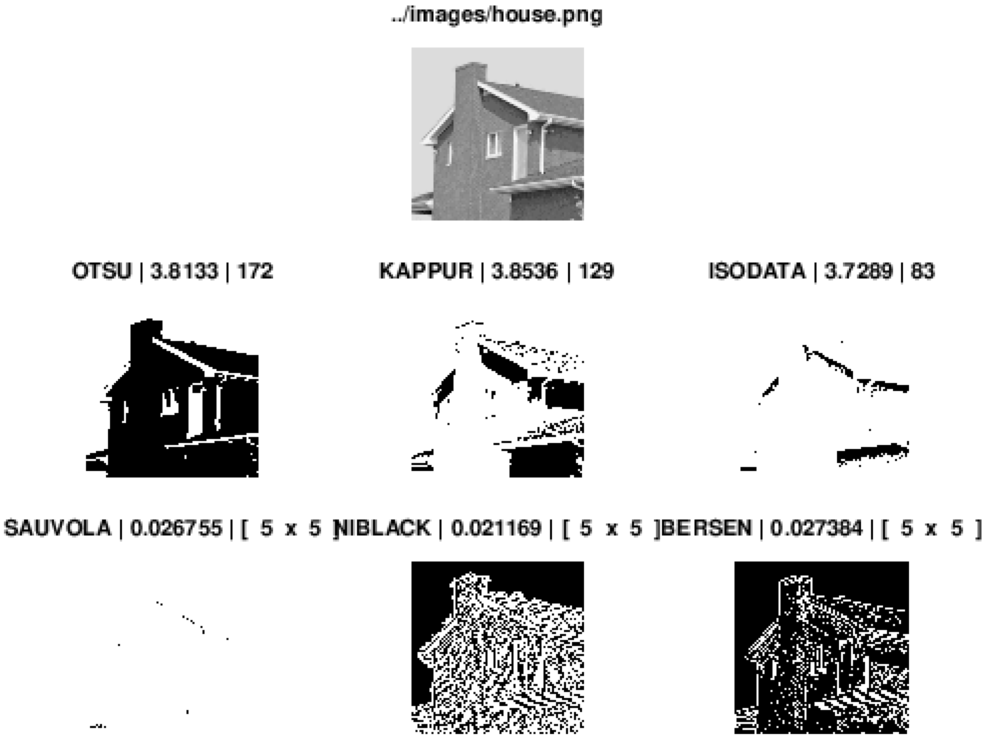
KAPPUR | 3.8536 | 129

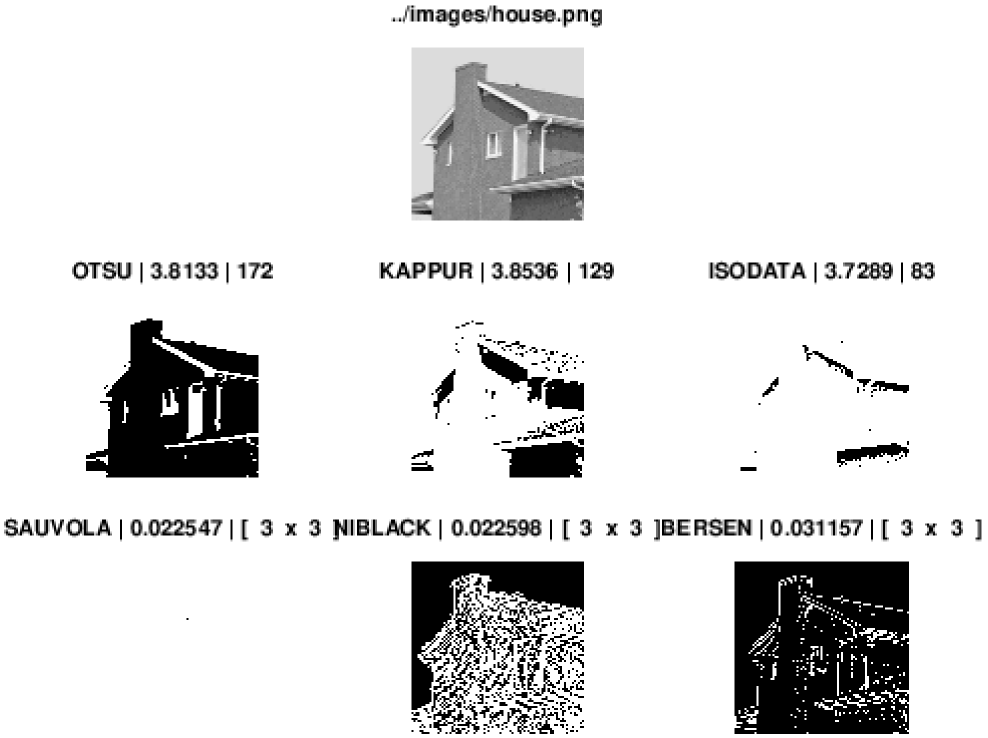
ISODATA | 3.7289 | 83

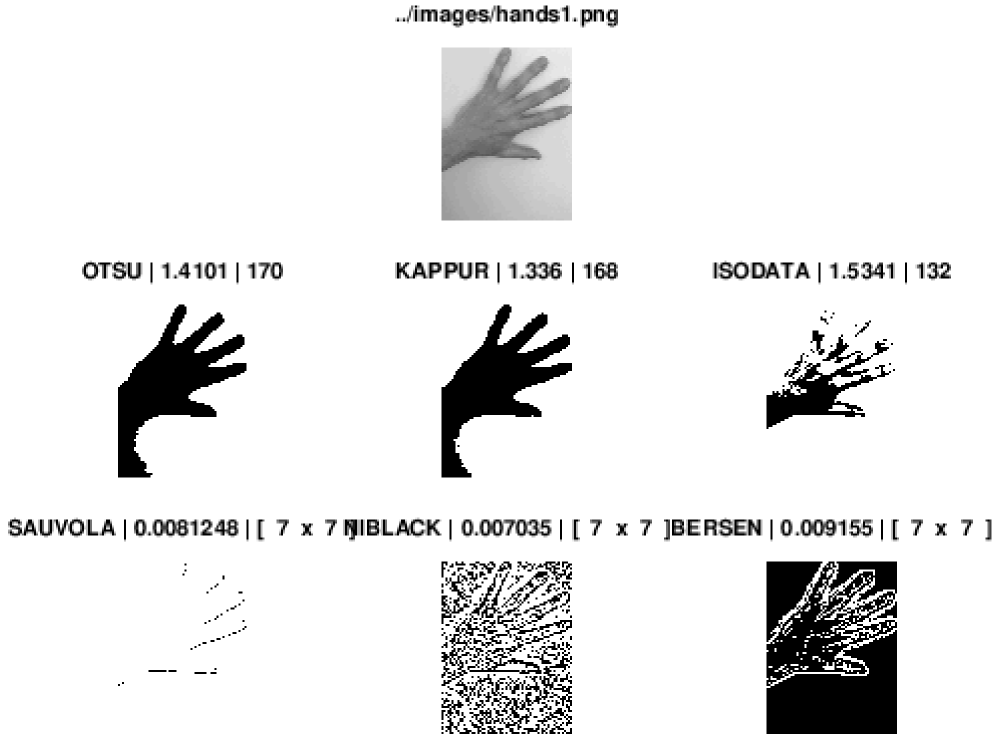
SAUVOLA | 0.02535 | [7 x 7]

NIBLACK | 0.024018 | [7 x 7]

BERSEN | 0.026717 | [7 x 7]


../images/house.png
OTSU | 3.8133 | 172
KAPPUR | 3.8536 | 129
ISODATA | 3.7289 | 83
SAUVOLA | 0.026755 | [5 x 5]
NIBLACK | 0.021169 | [5 x 5]
BERSEN | 0.027384 | [5 x 5]


../images/house.png
OTSU | 3.8133 | 172
KAPPUR | 3.8536 | 129
ISODATA | 3.7289 | 83
SAUVOLA | 0.022547 | [3 x 3]
NIBLACK | 0.022598 | [3 x 3]
BERSEN | 0.031157 | [3 x 3]



../images/hands1.png

OTSU | 1.4101 | 170

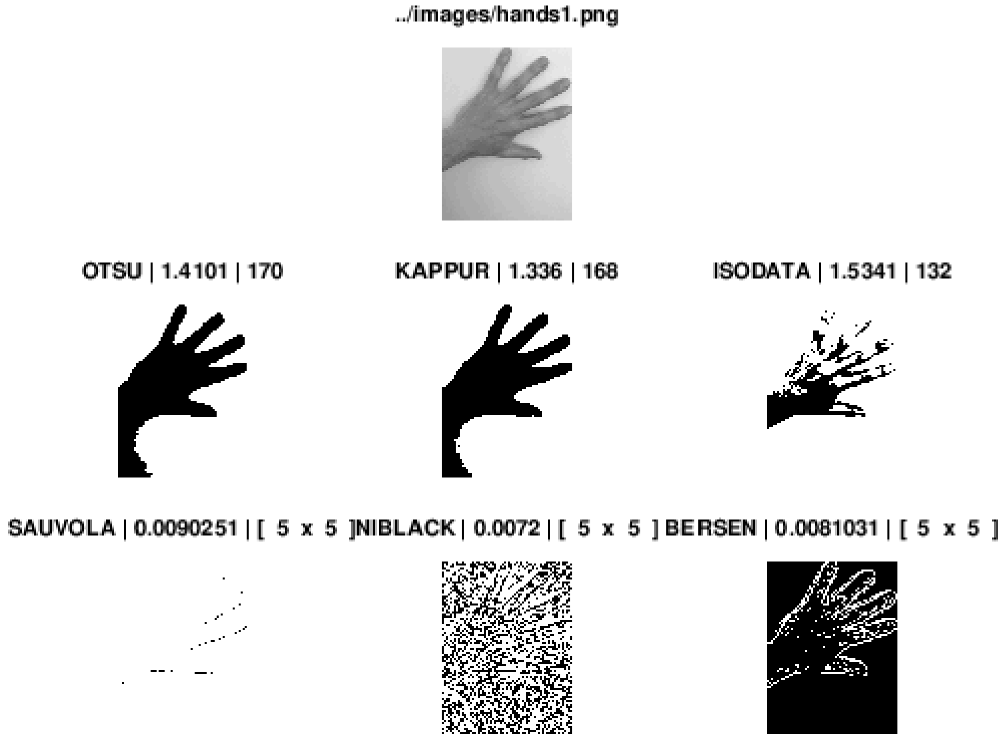
KAPPUR | 1.336 | 168

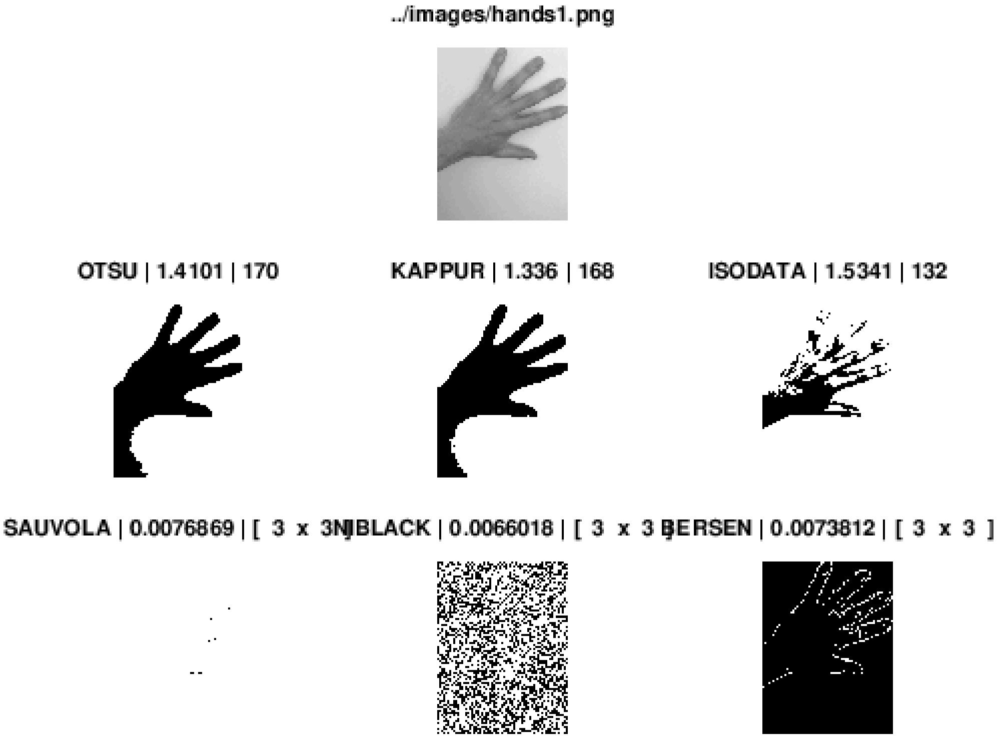
ISODATA | 1.5341 | 132

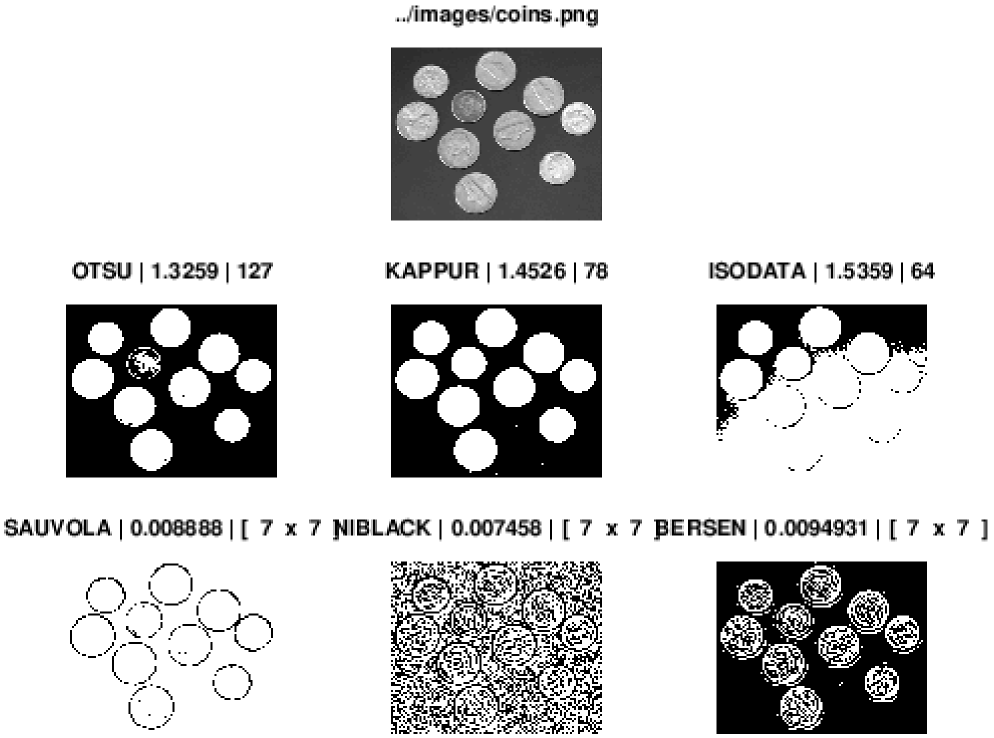
SAUVOLA | 0.0081248 | [7 x 7]

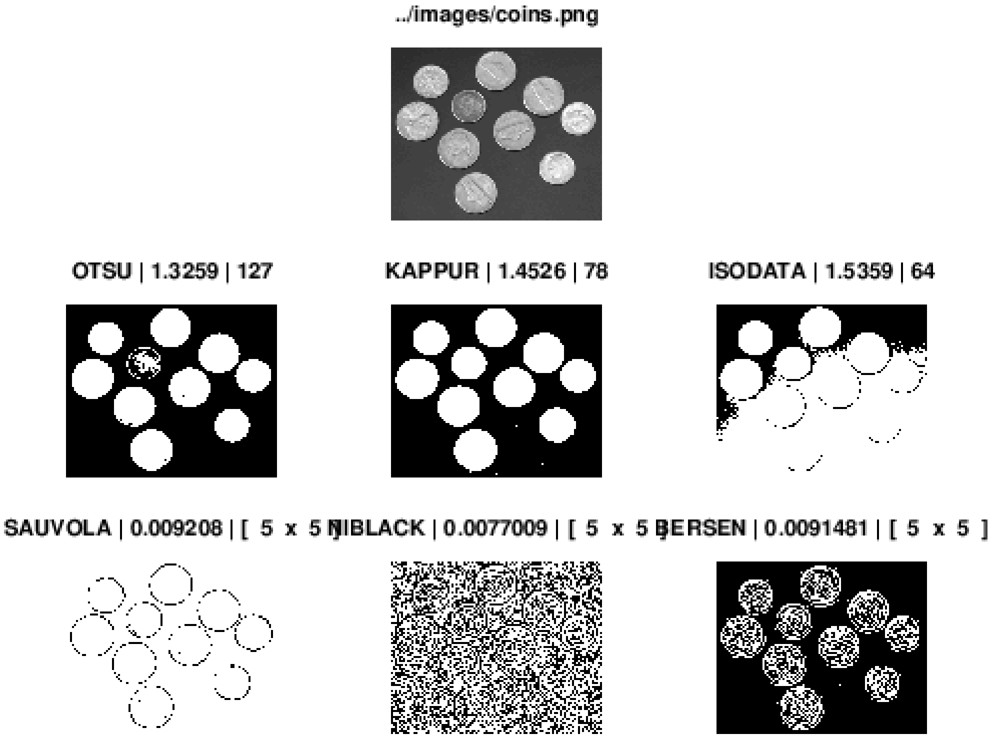
NIBLACK | 0.007035 | [7 x 7]

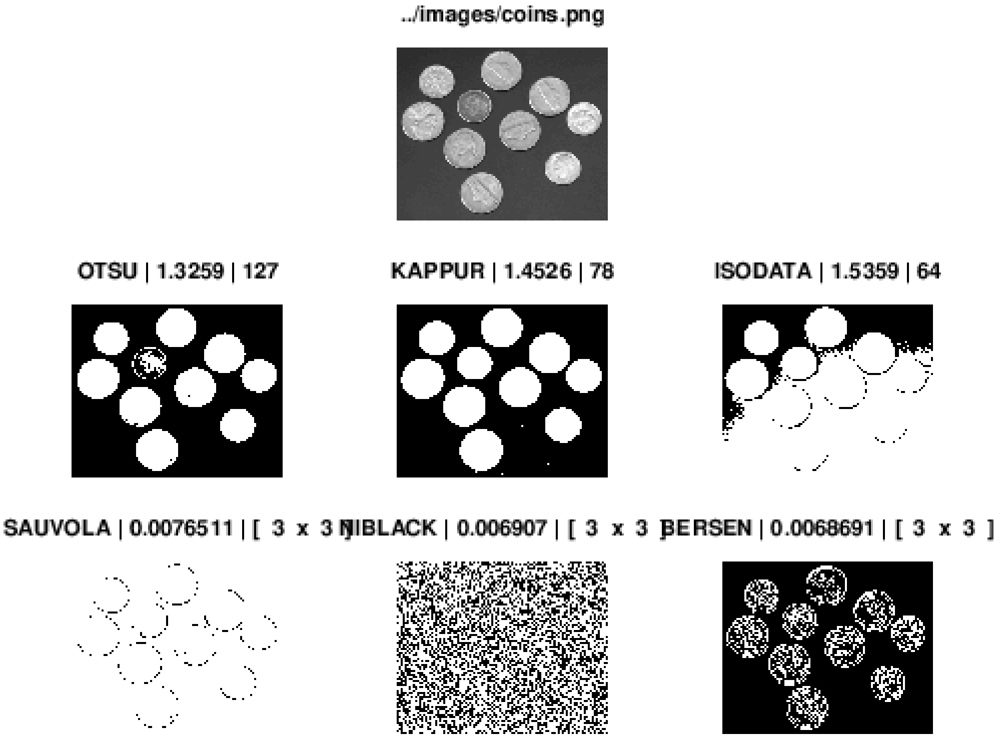
BERSEN | 0.009155 | [7 x 7]

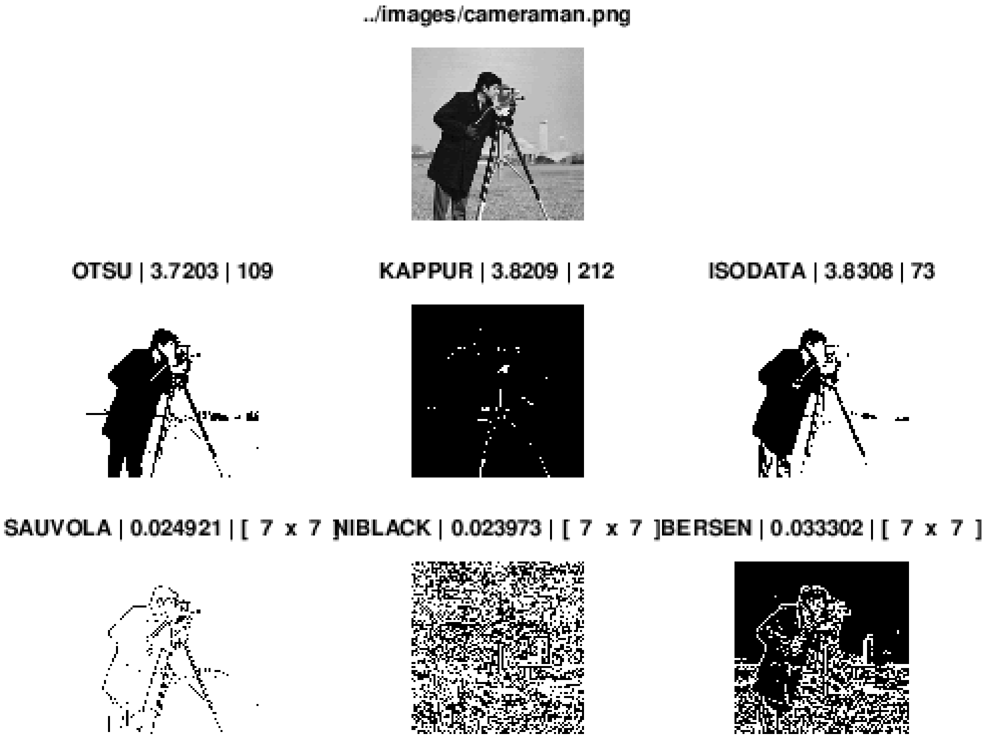

../images/hands1.png
OTSU | 1.4101 | 170
KAPPUR | 1.336 | 168
ISODATA | 1.5341 | 132
SAUVOLA | 0.0090251 | [5 x 5]
NIBLACK | 0.0072 | [5 x 5]
BERSEN | 0.0081031 | [5 x 5]

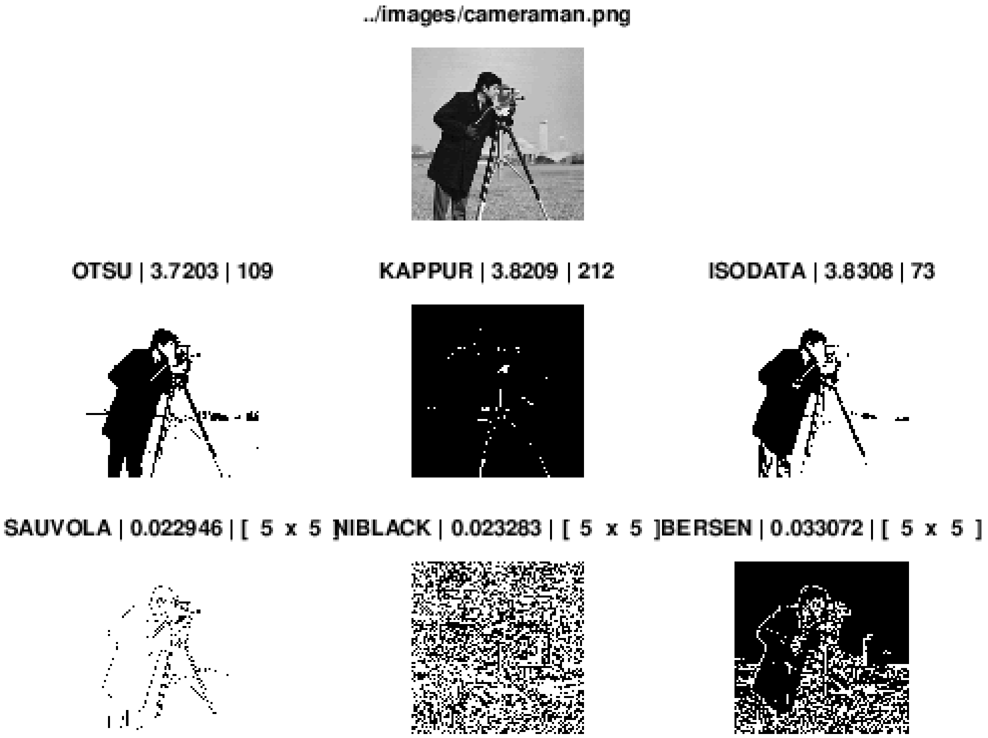

../images/hands1.png
OTSU | 1.4101 | 170
KAPPUR | 1.336 | 168
ISODATA | 1.5341 | 132
SAUVOLA | 0.0076869 | [3 x 3]
NIBLACK | 0.0066018 | [3 x 3]
BERSEN | 0.0073812 | [3 x 3]

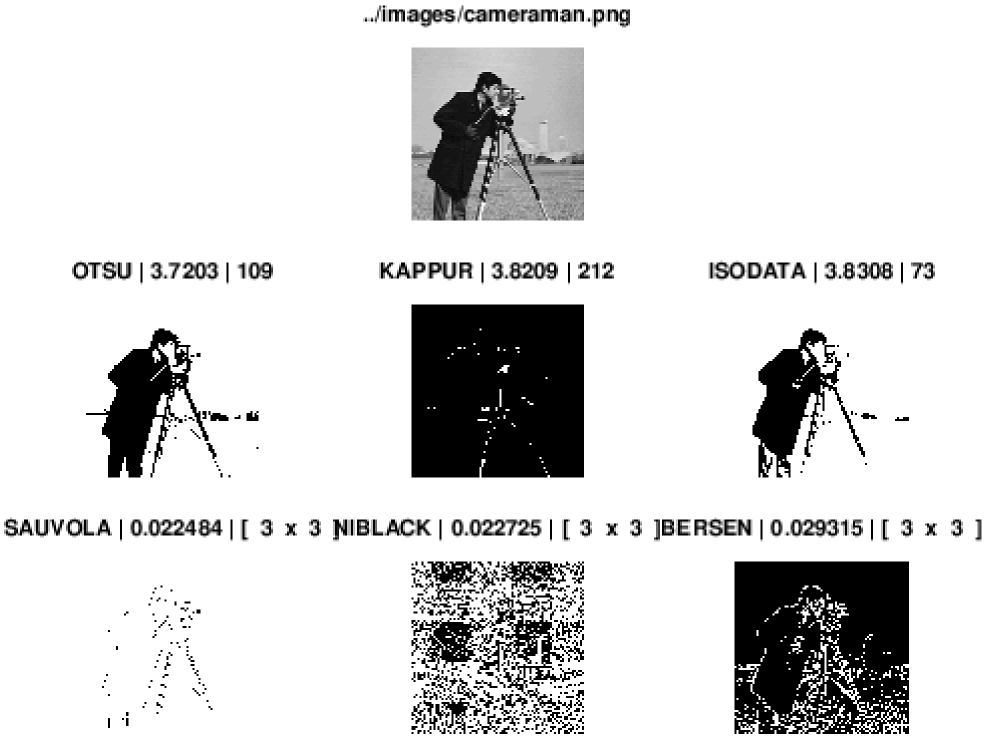

../images/coins.png
OTSU | 1.3259 | 127
KAPPUR | 1.4526 | 78
ISODATA | 1.5359 | 64
SAUVOLA | 0.008888 | [7 x 7]
NIBLACK | 0.007458 | [7 x 7]
BERSEN | 0.0094931 | [7 x 7]

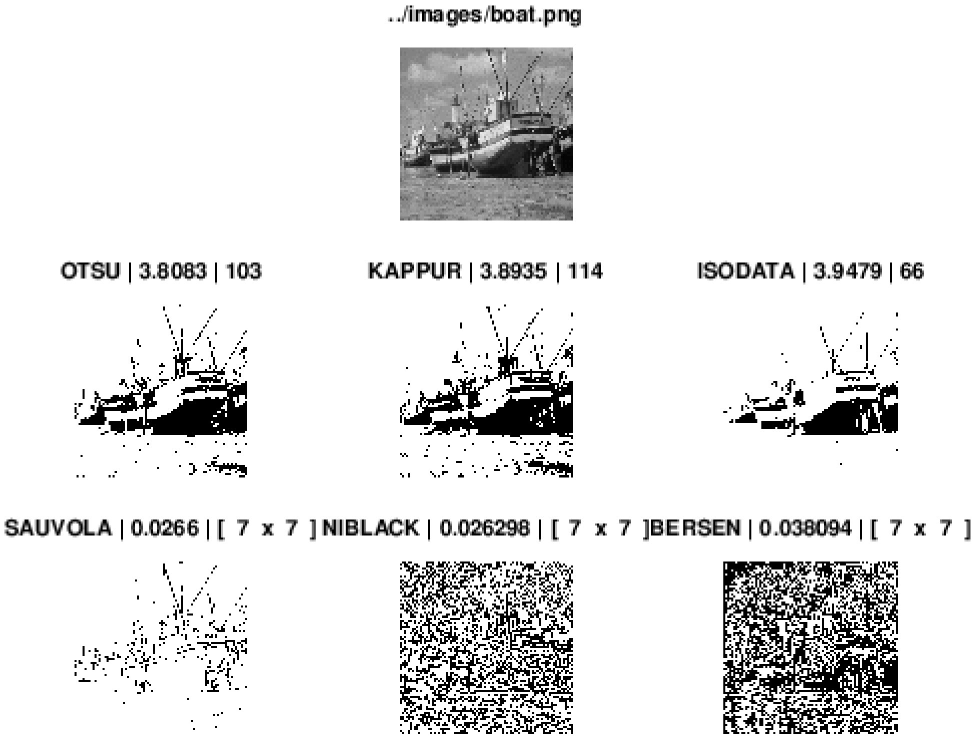

../images/coins.png
OTSU | 1.3259 | 127
KAPPUR | 1.4526 | 78
ISODATA | 1.5359 | 64
SAUVOLA | 0.009208 | [5 x 5]
NIBLACK | 0.0077009 | [5 x 5]
BERSEN | 0.0091481 | [5 x 5]

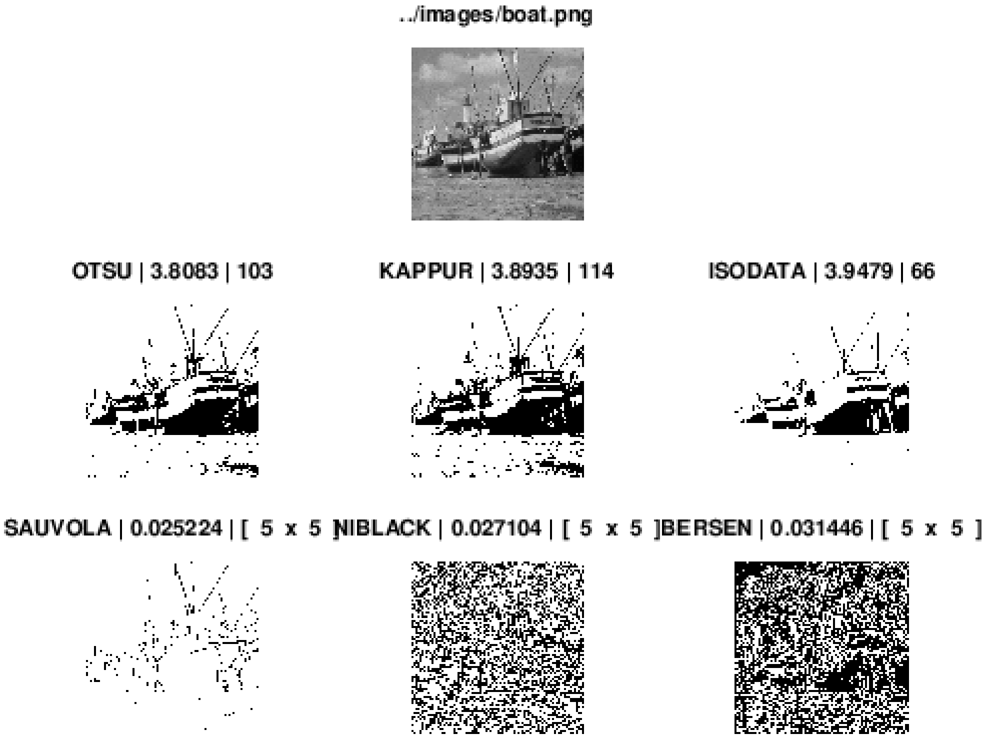

../images/coins.png
OTSU | 1.3259 | 127
KAPPUR | 1.4526 | 78
ISODATA | 1.5359 | 64
SAUVOLA | 0.0076511 | [3 x 3]
NIBLACK | 0.006907 | [3 x 3]
BERSEN | 0.0068691 | [3 x 3]

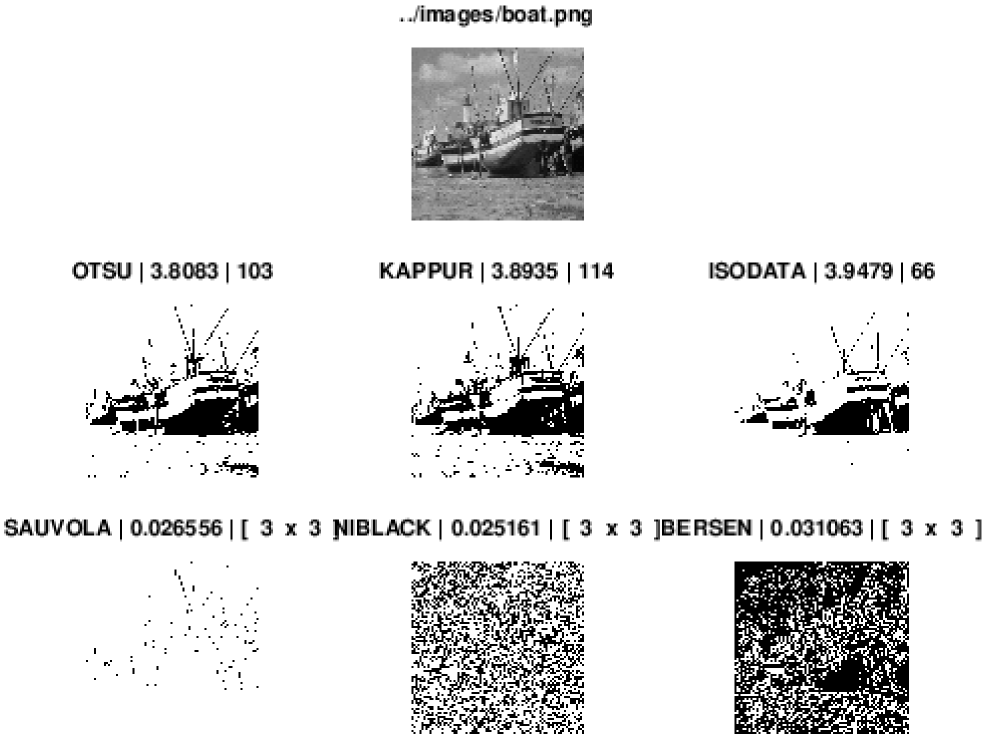

../images/cameraman.png
OTSU | 3.7203 | 109
KAPPUR | 3.8209 | 212
ISODATA | 3.8308 | 73
SAUVOLA | 0.024921 | [7 x 7]
NIBLACK | 0.023973 | [7 x 7]
BERSEN | 0.033302 | [7 x 7]


../images/cameraman.png
OTSU | 3.7203 | 109
KAPPUR | 3.8209 | 212
ISODATA | 3.8308 | 73
SAUVOLA | 0.022946 | [5 x 5]
NIBLACK | 0.023283 | [5 x 5]
BERSEN | 0.033072 | [5 x 5]


../images/cameraman.png
OTSU | 3.7203 | 109
KAPPUR | 3.8209 | 212
ISODATA | 3.8308 | 73
SAUVOLA | 0.022484 | [3 x 3]
NIBLACK | 0.022725 | [3 x 3]
BERSEN | 0.029315 | [3 x 3]


../images/boat.png
OTSU | 3.8083 | 103
KAPPUR | 3.8935 | 114
ISODATA | 3.9479 | 66
SAUVOLA | 0.0266 | [7 x 7]
NIBLACK | 0.026298 | [7 x 7]
BERSEN | 0.038094 | [7 x 7]


../images/boat.png
OTSU | 3.8083 | 103
KAPPUR | 3.8935 | 114
ISODATA | 3.9479 | 66
SAUVOLA | 0.025224 | [5 x 5]
NIBLACK | 0.027104 | [5 x 5]
BERSEN | 0.031446 | [5 x 5]



Tiempos de Ejecucion

```
[23]: results
```

```
results =

 Columns 1 through 6:

    3.8083231    3.8935239    3.9478810    0.0265560    0.0251610    0.0310631
    3.7202699    3.8208930    3.8307579    0.0224838    0.0227251    0.0293150
    1.3259499    1.4525571    1.5359390    0.0076511    0.0069070    0.0068691
    1.4100649    1.3360400    1.5340919    0.0076869    0.0066018    0.0073812
    3.8133199    3.8536358    3.7288752    0.0225470    0.0225980    0.0311570
    3.0017850    3.3677831    3.4003789    0.0179770    0.0175369    0.0215671
   11.3601019   11.1185050   11.2524040    0.0755689    0.0849769    0.1135900
    5.4430840    5.6717348    5.5796869    0.0340610    0.0367970    0.0488629
    1.4185028    1.3070779    1.5630691    0.0079379    0.0074360    0.0074971
    2.3663411    2.5160251    2.5732949    0.0158541    0.0141349    0.0217910

 Columns 7 through 12:
```

```
0.0252240    0.0271039    0.0314460    0.0266001    0.0262980    0.0380940
0.0229461    0.0232830    0.0330720    0.0249212    0.0239730    0.0333018
0.0092080    0.0077009    0.0091481    0.0088880    0.0074580    0.0094931
0.0090251    0.0072000    0.0081031    0.0081248    0.0070350    0.0091550
0.0267549    0.0211689    0.0273840    0.0253499    0.0240180    0.0267169
0.0188751    0.0177560    0.0218801    0.0191081    0.0180490    0.0229001
0.0767620    0.0744481    0.1042409    0.0741560    0.0768828    0.1220388
0.0356710    0.0368850    0.0457501    0.0357621    0.0353732    0.0469110
0.0080431    0.0076411    0.0076120    0.0090110    0.0069170    0.0092969
0.0143781    0.0128970    0.0170050    0.0151179    0.0132120    0.0178440
```

[24]:
```
csvwrite('./results/times.csv', results)
```

[ ]:
```

```