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Aditya 12pm

Homework 7

1) This question involves deconstructing and reconstructing the given images using discrete Fourier transformation and its inverse. This was easily achieved by using the built in matlab functions fft2() and ifft2().

```
%Load in the matlab images so that they are accessible to the workspace
in01 = load('IMG_7401.mat');
in05 = load('IMG_7405.mat');
orig01 = in01.I;
orig05 = in05.I;

%Show the original images
figure
imshow(orig01);
figure
imshow(orig05);

%Take the 2d DFT of the original images
dft01 = fft2(orig01);
dft05 = fft2(orig05);

%Take the real component of the inverse DFT of the DFT of the original
%images.
recon01 = uint8(real(ifft2(dft01)));
recon05 = uint8(real(ifft2(dft05)));

%Show the reconstructed images from the inverse DFT.
figure
imshow(recon01);
figure
imshow(recon05);
```

Original 7401

Original 7405

Reconstructed 7401

Reconstructed 7405

2) To create a reconstructed image using limited coefficients, I had to find the cutoff value for which coefficients to keep. After this, I took the coefficients that were greater than this value and used them to reconstruct the image using the inverse dft like in number one.

```
in01 = load('IMG_7401.mat');
in05 = load('IMG_7405.mat');
orig01 = in01.I;
orig05 = in05.I;

%Make a call to my ProcessPlusPrint function to deconstruct and
reconstruct
%my images and save the outputs for the different coefficient
percentages.
[a, b, c, d, e] = ProcessPlusPrint(orig01);
[f, g, h, i, j] = ProcessPlusPrint(orig05);

%Make a call to my local RMSE function and store the values.
RMSEa = RMSE(orig01, a);
RMSEb = RMSE(orig01, b);
RMSEc = RMSE(orig01, c);
RMSEd = RMSE(orig01, d);
RMSEe = RMSE(orig01, e);
RMSEf = RMSE(orig05, f);
RMSEg = RMSE(orig05, g);
RMSEh = RMSE(orig05, h);
RMSEi = RMSE(orig05, i);
RMSEj = RMSE(orig05, j);

%Print out the RMSE values
disp(RMSEa);
disp(RMSEb);
disp(RMSEc);
disp(RMSEd);
disp(RMSEe);
disp(RMSEf);
disp(RMSEg);
disp(RMSEh);
disp(RMSEi);
disp(RMSEj);

%Show each of the images, with all 5 coefficients of the first image
first,
%then the 5 coefficients of the second image.
figure
imshow(a);
figure
imshow(b);
figure
imshow(c);
figure
imshow(d);
figure
imshow(e);
figure
imshow(f);
```

```
figure
imshow(g);
figure
imshow(h);
figure
imshow(i);
figure
imshow(j);

%This function calculates the RMSE values the same way as the given
%equation.
function X = RMSE(original, reconstruct)
    [M, N] = size(original);
    sum = 0;

    for m=1:M
        for n=1:N
            sum = sum + (double(original(m,n)) -
double(reconstruct(m,n)))^2;
        end
    end
    X = sqrt(sum/(M*N));
end

function [A, B, C, D, E] = ProcessPlusPrint(orig)
    %Initialization section of the function that calculates dft and
    %initializes matrices.
    dft = fft2(orig);
    dftABS = abs(dft);
    [M,N] = size(dftABS);
    percentValues = zeros(5);

    %This block calls the local function that finds the coefficient
cutoff
    %values.
    percentValues(1) = minmax(dftABS, .5);
    percentValues(2) = minmax(dftABS, .2);
    percentValues(3) = minmax(dftABS, .1);
    percentValues(4) = minmax(dftABS, .05);
    percentValues(5) = minmax(dftABS, .01);

    %Outer for loop makes the process run for the different percentage
    %values we need to find
    for z=1:5
       percentValue = percentValues(z);
       newDFT = dftABS;
       %The inner for loops check the dft to see if the current element
is
       %above the cutoff for the given percentage
       for m=1:M
           for n=1:N
               if(dftABS(m,n)<percentValue)
                   newDFT(m,n) = 0;
               else
                   newDFT(m,n) = dft(m,n);
               end
           end
```

```
            end
            %Reconstruct the image using the limited dft coefficients.
            recon = uint8(real(ifft2(newDFT)));
            if(z==1)
                A = recon;
            elseif(z==2)
                B = recon;
            elseif(z==3)
                C = recon;
            elseif(z==4)
                D = recon;
            else
                E = recon;
            end
        end
    end

    %This function finds the cutoff element to determine which coefficients
    we
    %should keep.
    function J=minmax(orig, percent)
    arr = reshape(orig, 1, []);
    sortArr = sort(arr);
    [~, length] = size(sortArr);
    mm = length*(1-percent);
    J=sortArr(uint32(round(mm)));
    end
```

RMSE Values

DFT	50%	20%	10%	5%	1%
IMG_7401	1.9656	5.0204	7.3082	9.4335	13.5149
IMG_7405	2.3792	5.6921	8.2171	10.7855	16.4175

Reconstructed 7401 50%

Reconstructed 7401 20%

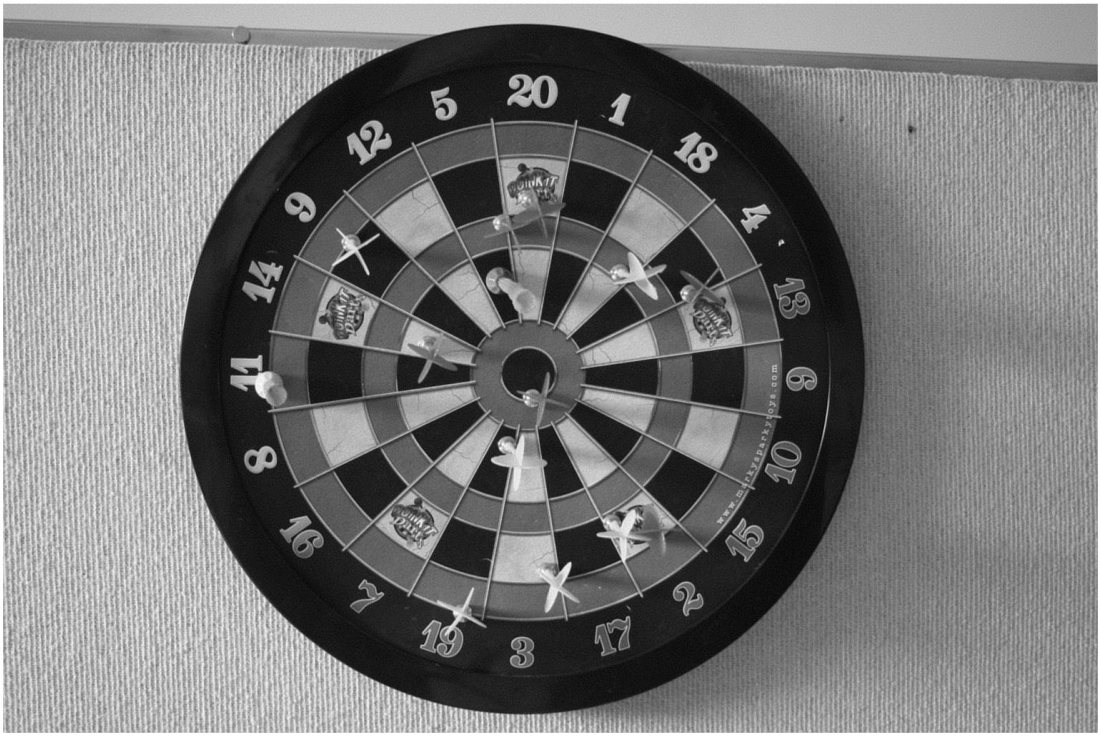
Reconstructed 7401 10%

Reconstructed 7401 5%

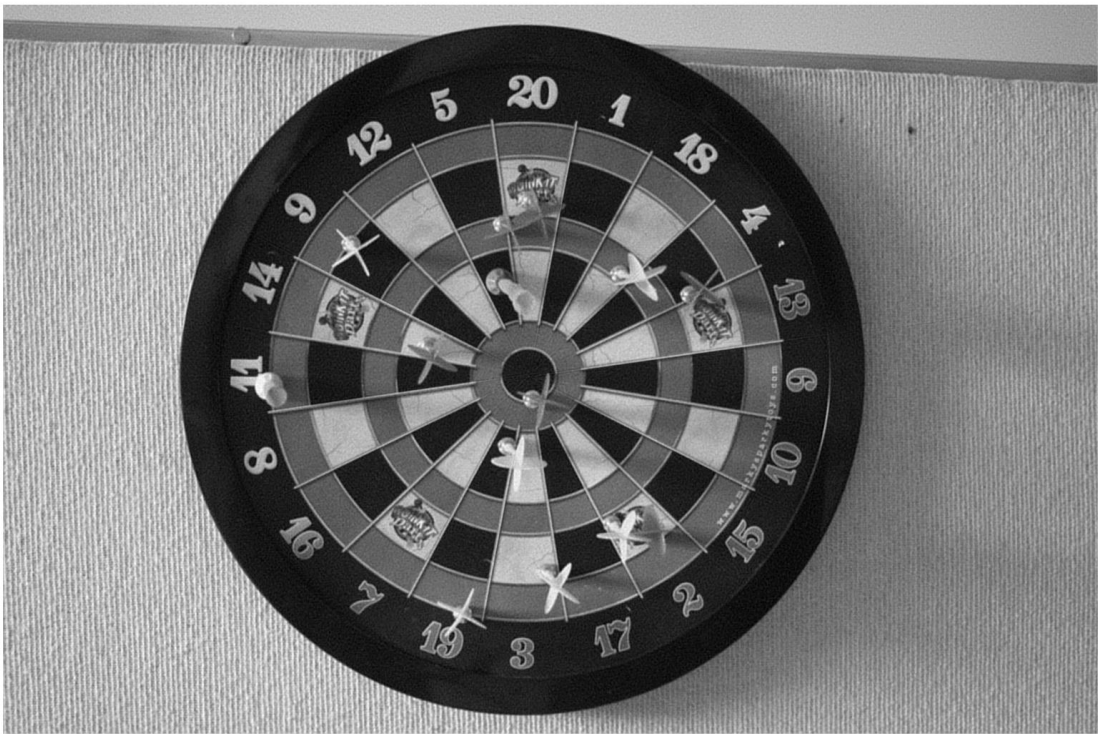
Reconstructed 7401 1%

Reconstructed 7405 50%

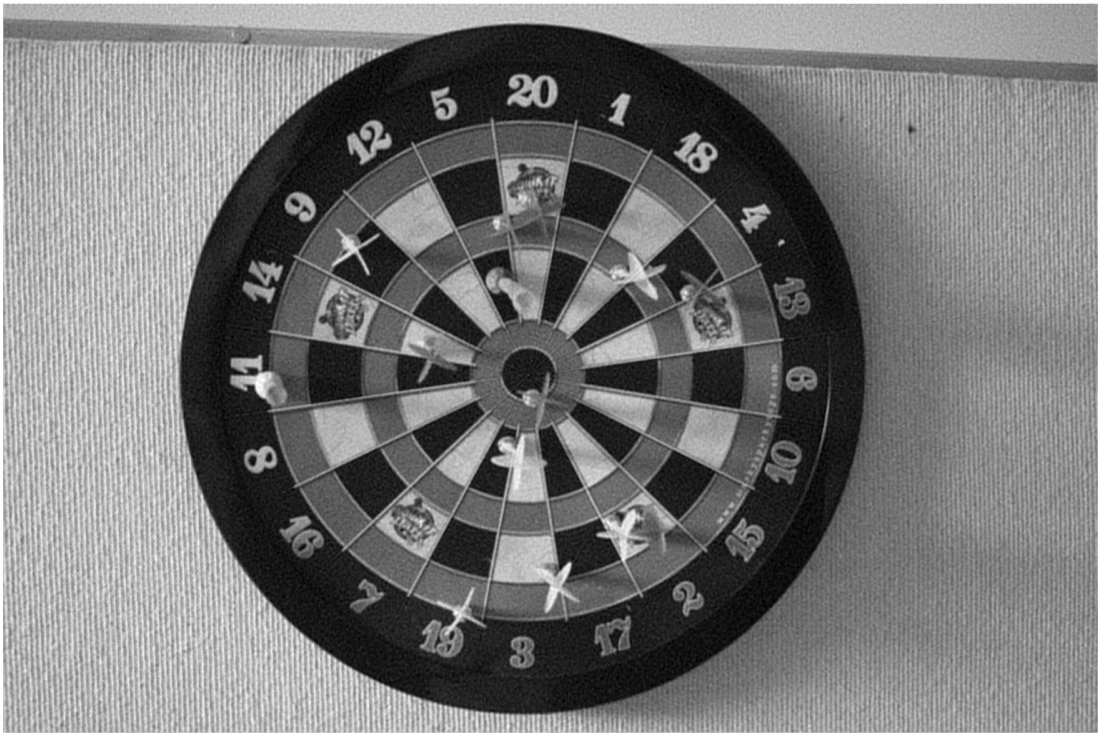
Reconstructed 7405 20%



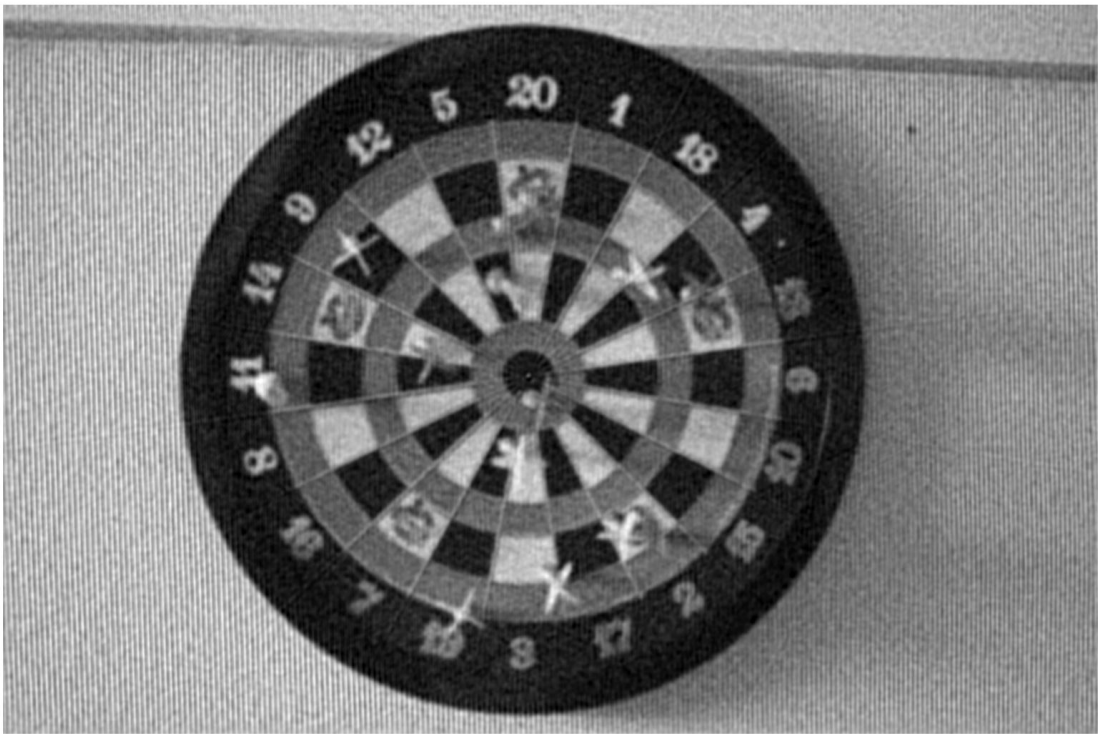
Reconstructed 7405 10%



Reconstructed 7405 5%



Reconstructed 7405 1%



3) To create a reconstructed image using limited coefficients, I had to find the cutoff value for which coefficients to keep. After this, I took the coefficients that were greater than this value and used them to reconstruct the image using the inverse dct like in number one.

```
in01 = load('IMG_7401.mat');
in05 = load('IMG_7405.mat');
orig01 = in01.I;
orig05 = in05.I;

%Make a call to my ProcessPlusPrint function to deconstruct and
reconstruct
%my images and save the outputs for the different coefficient
percentages.
[a, b, c, d, e] = ProcessPlusPrint(orig01);
[f, g, h, i, j] = ProcessPlusPrint(orig05);

%Make a call to my local RMSE function and store the values.
RMSEa = RMSE(orig01, a);
RMSEb = RMSE(orig01, b);
RMSEc = RMSE(orig01, c);
RMSEd = RMSE(orig01, d);
RMSEe = RMSE(orig01, e);
RMSEf = RMSE(orig05, f);
RMSEg = RMSE(orig05, g);
RMSEh = RMSE(orig05, h);
RMSEi = RMSE(orig05, i);
RMSEj = RMSE(orig05, j);

%Print out the RMSE values
disp(RMSEa);
disp(RMSEb);
disp(RMSEc);
disp(RMSEd);
disp(RMSEe);
disp(RMSEf);
disp(RMSEg);
disp(RMSEh);
disp(RMSEi);
disp(RMSEj);

%Show each of the images, with all 5 coefficients of the first image
first,
%then the 5 coefficients of the second image.
figure
imshow(a);
figure
imshow(b);
figure
imshow(c);
figure
imshow(d);
figure
imshow(e);
```

```
figure
imshow(f);
figure
imshow(g);
figure
imshow(h);
figure
imshow(i);
figure
imshow(j);

%This function calculates the RMSE values the same way as the given
%equation.
function X = RMSE(original, reconstruct)
    [M, N] = size(original);
    sum = 0;

    for m=1:M
        for n=1:N
            sum = sum + (double(original(m,n)) -
double(reconstruct(m,n)))^2;
        end
    end
    X = sqrt(sum/(M*N));
end

function [A, B, C, D, E] = ProcessPlusPrint(orig)
    %Initialization section of the function that calculates dct and
    %initializes matrices.
    myDCT = dct(double(orig));
    dctABS = abs(myDCT);
    [M,N] = size(dctABS);
    percentValues = zeros(5);

    %This block calls the local function that finds the coefficient
cutoff
    %values.
    percentValues(1) = minmax(dctABS, .5);
    percentValues(2) = minmax(dctABS, .2);
    percentValues(3) = minmax(dctABS, .1);
    percentValues(4) = minmax(dctABS, .05);
    percentValues(5) = minmax(dctABS, .01);

    %Outer for loop makes the process run for the different percentage
    %values we need to find
    for z=1:5
       percentValue = percentValues(z);
       newDCT = dctABS;
       %The inner for loops check the dft to see if the current element
is
       %above the cutoff for the given percentage
       for m=1:M
           for n=1:N
               if(dctABS(m,n)<percentValue)
                   newDCT(m,n) = 0;
               else
                   newDCT(m,n) = myDCT(m,n);
```

```
                end
            end
        end
        %Reconstruct the image using the limited dct coefficients.
        recon = uint8(real(idct(newDCT)));
        if(z==1)
            A = recon;
        elseif(z==2)
            B = recon;
        elseif(z==3)
            C = recon;
        elseif(z==4)
            D = recon;
        else
            E = recon;
        end
    end
end

function J=minmax(orig, percent)
arr = reshape(orig, 1, []);
sortArr = sort(arr);
[~, length] = size(sortArr);
mm = length*(1-percent);
J=sortArr(uint32(round(mm)));
end
```

RMSE Values

DCT	50%	20%	10%	5%	1%
IMG_7401	1.9214	5.7880	9.0346	12.2163	19.0654
IMG_7405	2.1873	6.3045	9.8902	13.7483	23.9203

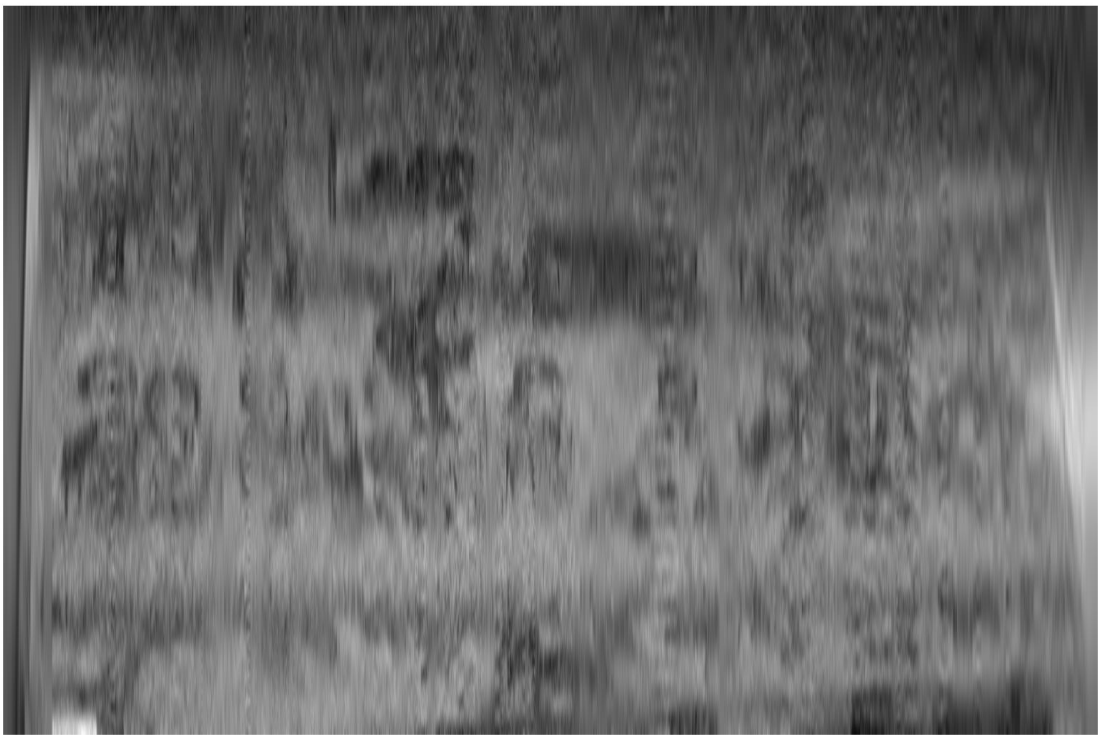
Reconstructed 7401 50%

Reconstructed 7401 20%

Reconstructed 7401 10%

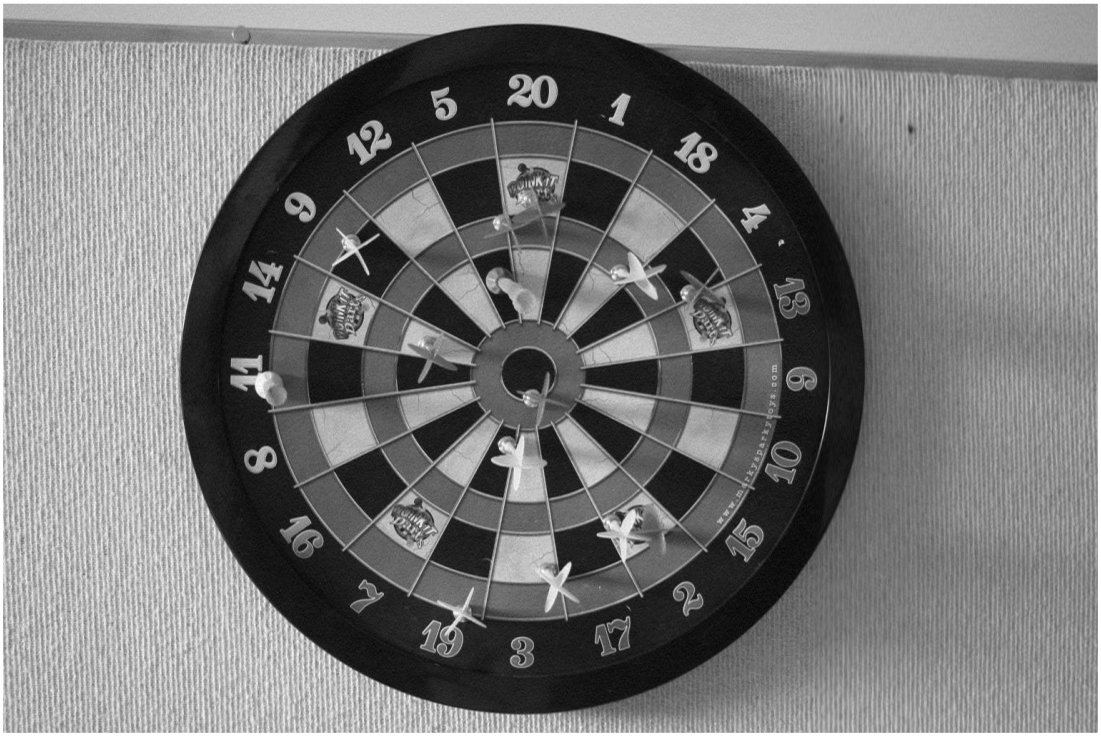
Reconstructed 7401 5%

Reconstructed 7401 1%

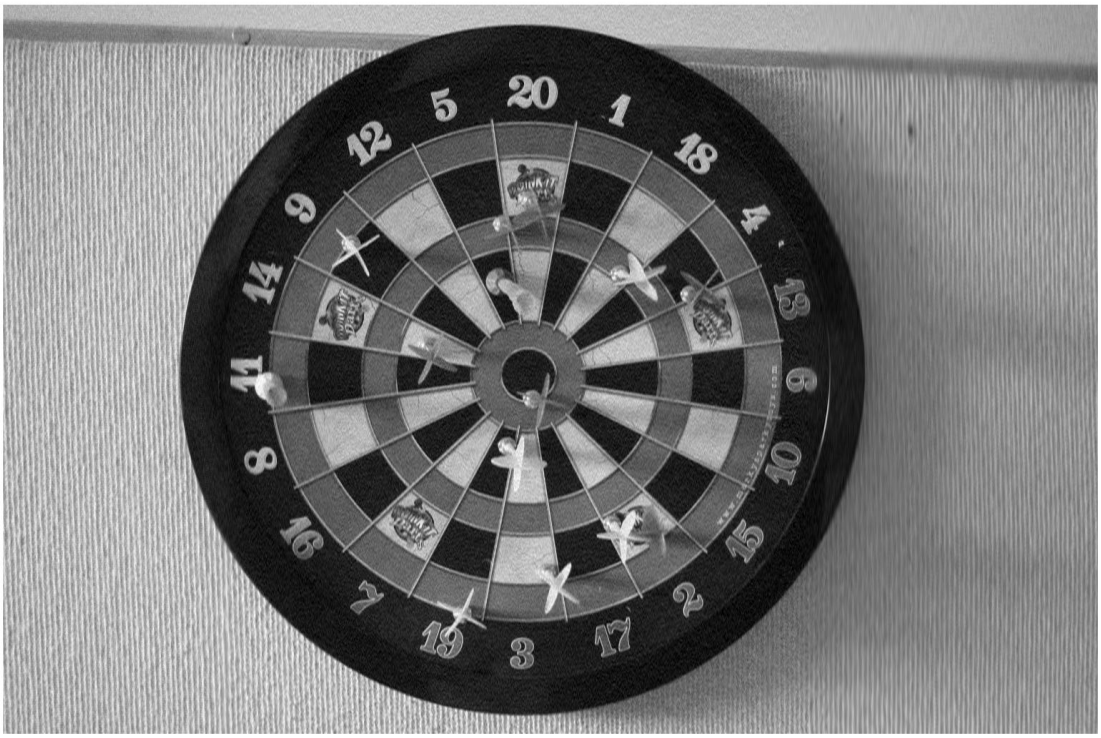


Reconstructed 7405 50%

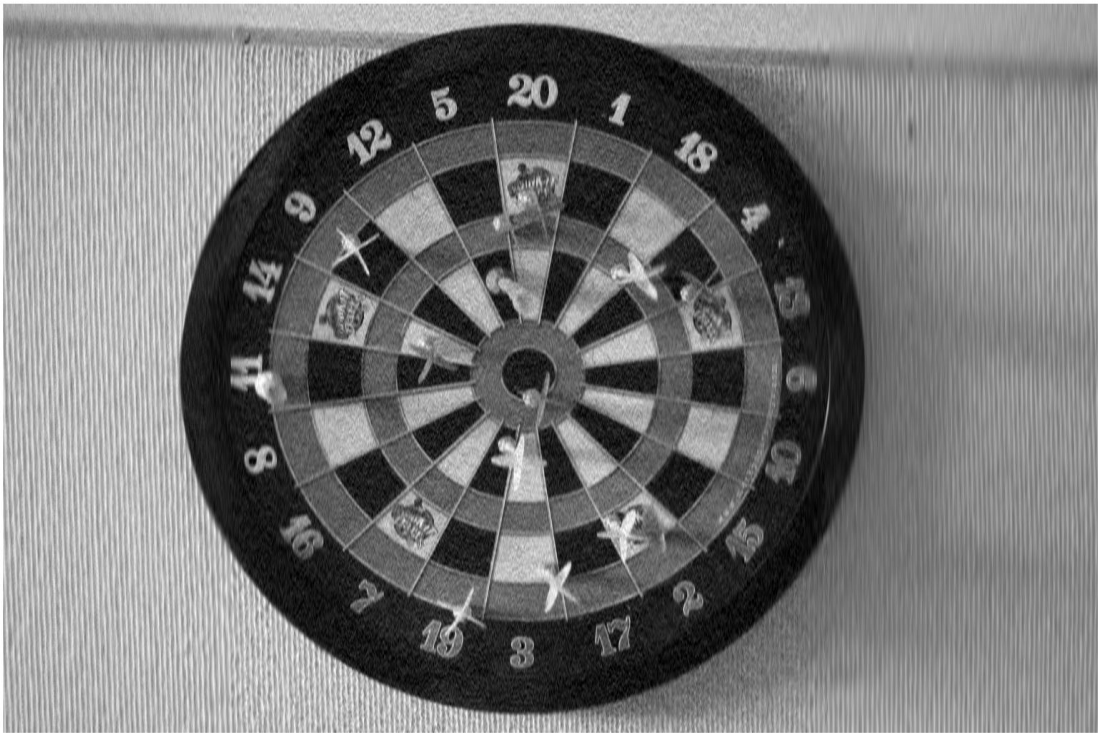
Reconstructed 7405 20%



Reconstructed 7405 10%



Reconstructed 7405 5%



Reconstructed 7405 1%