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# IVP Assignment 1

```
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```

# Creating a new environment.

```
clc;
clear all;
close all;
```

# Functions Created for the Assignment: rgb_to_grayscale

```
% Function that Converts an RBG image to a grayscale by averaging
 across channels

function [img] = rgb_to_grayscale(image)
    img = (image(:,:,1) + image(:,:,2) + image(:,:,3)) ./ 3 ;
```

# Functions Created for the Assignment: rgb_to_cmyk

```
% Function that converts RBG to CMYK

function [img] = rgb_to_cmyk(image)
    img = image;
    img(:,:,1) = (1 - img(:,:,1) ./ 255) .* 255;
    img(:,:,2) = (1 - img(:,:,2) ./ 255) .* 255;
    img(:,:,3) = (1 - img(:,:,3) ./ 255) .* 255;
```

# Functions Created for the Assignment: rgb_to_hsi

```
% Function that converts an rgb image to hsi.

function [hue, sat, inten] = rgb_to_hsi(red, green, blue, img)
    hue = acos((1/2 * ((red - green)+(red - blue)))./((red - green).^2
 + sqrt((red-blue).*(green - blue))+0.000001));
    hue(blue>green)= 360 - hue(blue>green);
    sat = 1 - 3./(sum(img, 3)) .* min(img,[],3);
    inten = sum(img, 3)./3;
```

# Functions Created for the Assignment: image_negative

```
% Function that computes the negative of an image.

function [negative] = image_negative(image)
    negative = image;
    [~, dim] = size(size(image));

    % If conditional is used to check whether the image is 2D or 3D.
    if dim == 2
        [row, col] = size(image);
        for i = 1:row
            for j = 1:col
                negative(i, j) = 255 - negative(i, j);
            end
        end
    else
        [row, col, channels] = size(image);
```

```
        for i = 1:row
            for j = 1:col
                for k = 1: channels
                    negative(i, j, k) = 255 - negative(i, j, k);
                end
            end
        end
    end
```

# Functions Created for the Assignment: dft_2d

```
% Function that computes the 2D-DFT for an image.

function [dft2d] = dft_2d(image)
    image = double(image);
    [M, N] = size(image);

    % m, n should go from -pi to pi for better interpretation.
    m = -(M-1)/2:1:(M-1)/2;
    n = -(N-1)/2:1:(N-1)/2;

    % Creates the X exponentials required to compute the DFT.
    exponential_x = m' * m;
    exponential_x = exp(-2 * pi * 1i / M .* exponential_x);

    % Creates the Y exponentials required to compute the DFT.
    exponential_y = n' * n;
    exponential_y = exp(-2 * pi * 1i / N .* exponential_y);

    % Final FFT Computation.
    dft2d = exponential_x * image * exponential_y;
```

# Functions Created for the Assignment: log_transform

```
% Function that computes the log transform for an image.

function [log_trans] = log_transform(image, c)
    log_trans = double(image);
    [~, dim] = size(size(image));

    % If conditional is used to check whether the image is 2D or 3D.
    if dim == 2
        [row, col] = size(image);
        for i = 1:row
            for j = 1:col
                log_trans(i, j) = c * log( 1+ (log_trans(i, j)));
```

```
            end
        end
    else
        [row, col, channels] = size(image);
        for i = 1:row
            for j = 1:col
                for k = 1: channels
                    log_trans(i, j, k) = c * log(1 + (log_trans(i, j,
k)));
                end
            end
        end
    end
```

# Functions Created for the Assignment: gamma_transform

```
% Function that computes the gamma transform for an image.

function [gamma_trans] = gamma_transform(image, c, gamma)
    gamma_trans = double(image);
    [~, dim] = size(size(image));

    % If conditional is used to check whether the image is 2D or 3D.
    if dim == 2
        [row, col] = size(image);
        for i = 1:row
            for j = 1:col
                gamma_trans(i, j) = c * (gamma_trans(i, j))^(gamma);
            end
        end
    else
        [row, col, channels] = size(image);
        for i = 1:row
            for j = 1:col
                for k = 1: channels
                    gamma_trans(i, j, k) = c * (gamma_trans(i, j,
k))^(gamma);
                end
            end
        end
    end
```

# Functions Created for the Assignment: pixel_hist_2d

```
% Function that computes the frequency of pixels of a particular
% intensity in an image.

function [pixel_hist_] = pixel_hist_2d(image)
    pixel_hist_ = zeros(1, 256);
    [row, col] = size(image);
    for i = 1:row
        for j = 1:col
            % Statement that adds one value to each array position
 where
            % the pixel intensities lie.
            pixel_hist_(image(i, j)+1) = pixel_hist_(image(i, j)+1) +
 1;
        end
    end
```

# Functions Created for the Assignment: histogram_equalization

```
% Function that performs histogram equalization.

function [histeqimage] = histogram_equalization(image)
    [row, col] = size(image);
    keys = [];
    histeqimage = image;

    % hist_map contains is a hash map that contains the freq
 histogram.
    hist_map = containers.Map();
    % hist_map contains is a hash map that contains the cdf.
    cdf_map = containers.Map();
    % hist_map contains is a hash map that contains the transformed
 results.
    hist_eq_map = containers.Map();

    % Computing the frequency.
    for i=1:row
        for j=1:col
            key = char(image(i, j));
            if isKey(hist_map, key)
                hist_map(key) = hist_map(key) + 1;
            else
                hist_map(key) = 1;
                keys = [keys; key];
            end
        end
    end

    keys = sort(keys);
    sum = 0;
```

```
    cdf_min = hist_map(keys(char(1)));

    [key_length, ~] = size(keys);

    % Computing the CDF.
    for i=1:key_length
        sum = sum + hist_map(keys(i));
        cdf_map(keys(i)) = sum;
    end

    % Computing the transformation function.
    for i=1:key_length
        hist_eq_map(keys(i)) = round((cdf_map(keys(i))-cdf_min)*255/
(row*col-cdf_min));
    end

    % Transforming the Image.
    for i=1:row
        for j=1:col
            key = char(image(i, j));
            histeqimage(i,j) = hist_eq_map(key);
        end
    end
```

# Image Imports

```
cameraman = imread('C:\Chanakya\Projects\ivp-assignments
\Assignment-1\images\cameraman.tif');
lena_color = imread('C:\Chanakya\Projects\ivp-assignments
\Assignment-1\images\lena_color_256.tif');
```

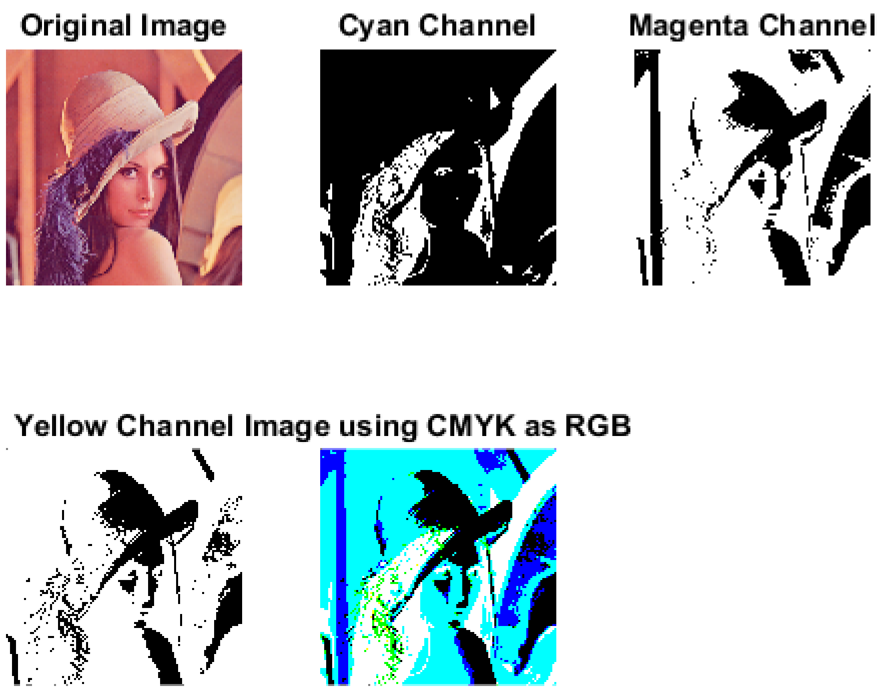
# Question 1: Seperate an RGB image into its constituent colours and then convert the image to other formats.

```
% Decomposing the image to its constituent colors.
red = lena_color(:,:,1);
green = lena_color(:,:,2);
blue = lena_color(:,:,3);

% Plotting the image and its constituent RGB Colors.
figure('Name', 'Decomposing an RGB Image to its Constituent Colours');
subplot(2,2,1);
imshow(lena_color);
title('Original Image');

subplot(2,2,2);
imshow(red);
title('Red Channel');
```

```
subplot(2,2,3);
imshow(blue);
title('Blue Channel');

subplot(2,2,4);
imshow(green);
title('Green Channel');

% Converting the RGB image to Grayscale
gray_scale_img = rgb_to_grayscale(lena_color);

% Comparing the RGB image and the corresponding Greyscale image.
figure('Name', 'Converting an RGB image to Grayscale');
subplot(1,2,1);
imshow(lena_color);
title('Original Image');

subplot(1,2,2);
imshow(gray_scale_img);
title('Gray Scale Image');

% Converting the RGB image to CMYK
cmyk_image = rgb_to_cmyk(lena_color);

% Comparing the RGB image and the consituent CMYK image

% Comparing the hue, saturation and intensity to the original image.
figure('Name', 'Decomposing an RGB Image to CMYK');
subplot(2,3,1);
imshow(lena_color);
title('Original Image');

subplot(2,3,2);
imshow(uint8(cmyk_image(:,:,1)));
title('Cyan Channel');

subplot(2,3,3);
imshow(uint8(cmyk_image(:,:,2)));
title('Magenta Channel');

subplot(2,3,4);
imshow(uint8(cmyk_image(:,:,3)));
title('Yellow Channel');

subplot(2,3,5);
imshow(uint8(cmyk_image));
title('Image using CMYK as RGB');

% Calling the rgb_to_hsi function.
[hue, sat, int] = rgb_to_hsi(double(red), double(green), double(blue),
 double(lena_color));

% Comparing the hue, saturation and intensity to the original image.
```

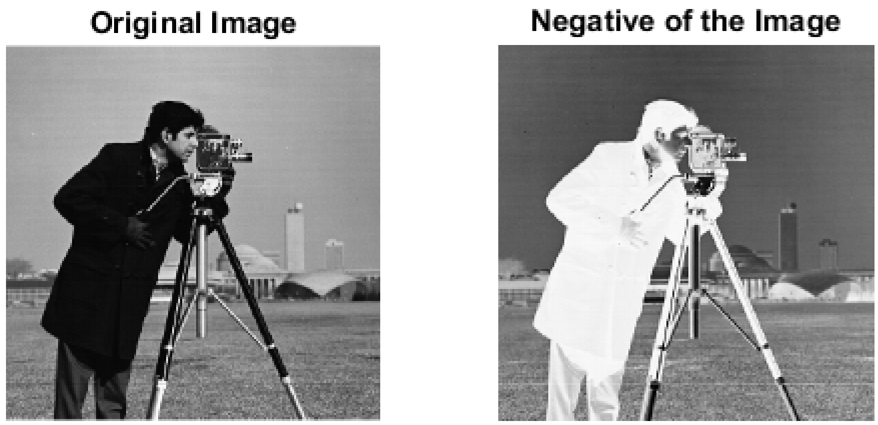
```
figure('Name', 'Decomposing an RGB Image to HSI');
subplot(2,3,1);
imshow(lena_color);
title('Original Image');

subplot(2,3,2);
imshow(uint8(hue));
title('Hue Channel');

subplot(2,3,3);
imshow(uint8(100 * sat));
title('Saturation Channel');

subplot(2,3,4);
imshow(uint8(int));
title('Intensity Channel');

% Computing the RBG image assuming HSI channels.
his_image(:,:,1) = hue; his_image(:,:,2) = sat; his_image(:,:,3) =
 int;
subplot(2,3,5);
imshow(uint8(his_image));
title('Image using HSI as RGB');
```


Original Image
Gray Scale Image


Original Image
Cyan Channel
Magenta Channel
Yellow Channel
Image using CMYK as RGB

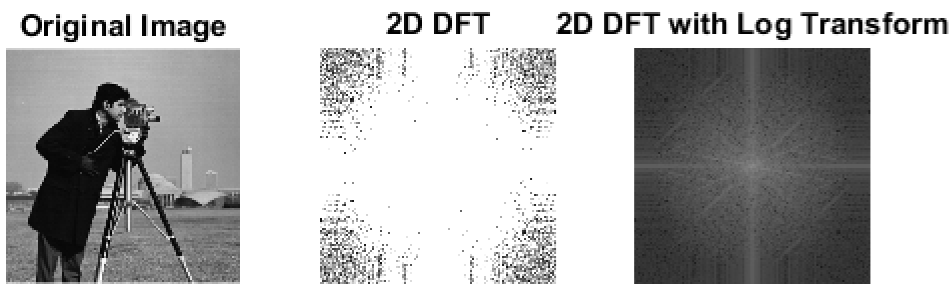

# Question 2: Obtaining the negative of the image.

```
image = cameraman;
% Calling the image_negative function.
negative = image_negative(image);

% Comparing the image and the image negative.
figure('Name', 'Transforming an image to its negative.');
subplot(1,2,1);
imshow(image);
title('Original Image');

subplot(1,2,2);
imshow(negative);
title('Negative of the Image');
```



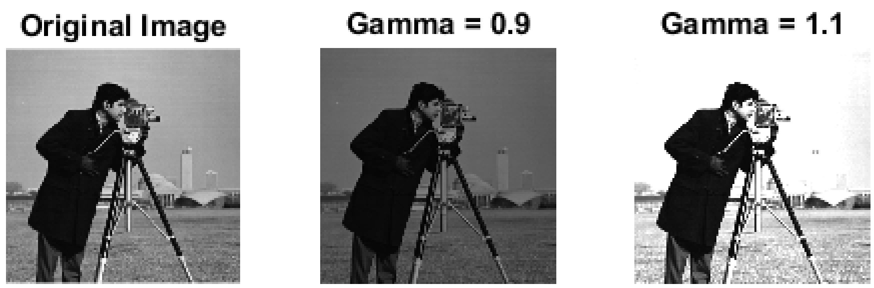

## Question 3: Computing the 2D-DFT of the image and then its log transform

```
% Calling the dft_2d function.
dft2d = dft_2d(cameraman);

% Comparing the image, the 2D-DFT and the log transform of the 2D DFT.
figure('Name', 'Computing the 2D-DFT of the image.');
subplot(1,3,1);
imshow(cameraman);
title('Original Image');

subplot(1,3,2);
imshow(uint8(abs(dft2d)));
title('2D DFT');

subplot(1,3,3)
imshow(uint8(log_transform(abs(dft2d), 10)));
title('2D DFT with Log Transform');

% The DFT can be easily visualized after the log transform.
```




# Question 4: Computing the gamma transform of images.

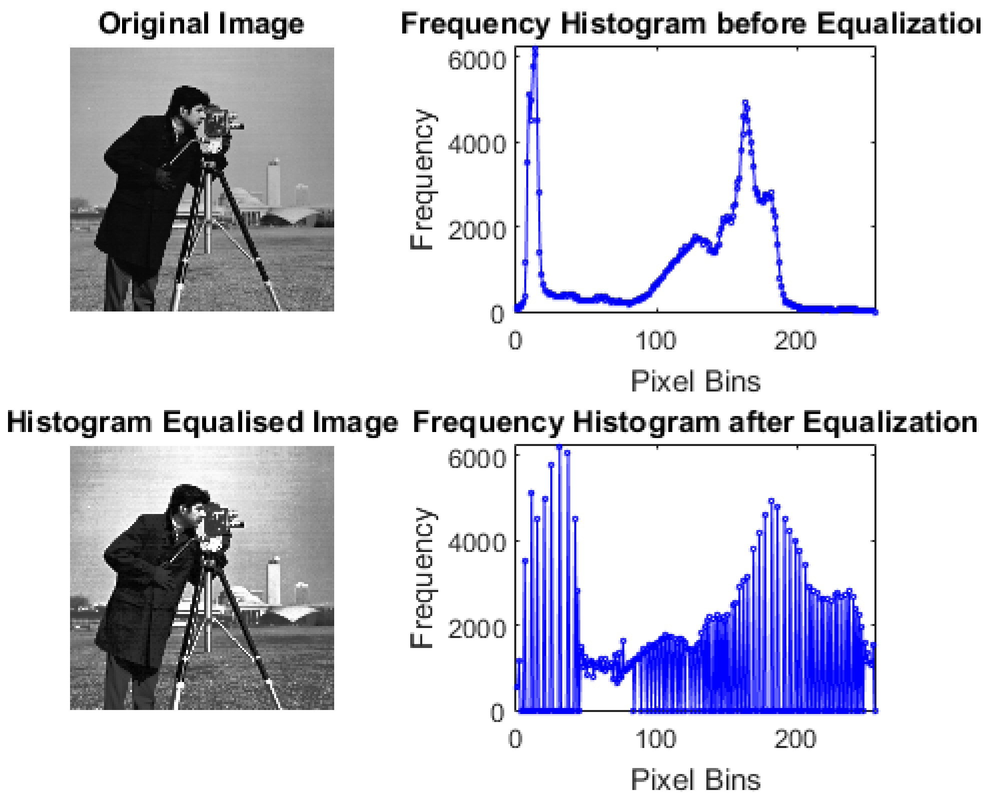
```
% Calling the gamma_transform function.
image_1 = gamma_transform(cameraman, 1, 0.9);
image_2 = gamma_transform(cameraman, 1, 1.1);

% Comparing the iamge, the 2D-DFT and the log transform of the 2D DFT.
figure('Name', 'Computing the 2D-DFT of the image.');
subplot(1,3,1);
imshow(cameraman);
title('Original Image');

subplot(1,3,2);
imshow(uint8(image_1));
title('Gamma = 0.9');

subplot(1,3,3)
imshow(uint8(image_2));
title('Gamma = 1.1');
```




# Question 5: Using Histogram Equalization on the image.

```
% Calling the hist_2d function to get the histogram before
 equalization.
hist_before = pixel_hist_2d(cameraman);

% Calling the histogram_equalization function to get the histogram
% equalised image.
histeq_image = histogram_equalization(cameraman);

% Calling the hist_2d function to get the histogram after
 equalization.
hist_after = pixel_hist_2d(histeq_image);

% Comparing the iamge, the 2D-DFT and the log transform of the 2D DFT.
figure('Name', 'Computing the 2D-DFT of the image.');
subplot(2,2,1);
imshow(cameraman);
title('Original Image');

subplot(2,2,2);
plot(0:1:255, hist_before, '-bo', 'MarkerSize', 2);
title('Frequency Histogram before Equalization');
```

```
xlabel('Pixel Bins');
ylabel('Frequency');
axis tight;

subplot(2,2,3)
imshow(histeq_image);
title('Histogram Equalised Image');

subplot(2,2,4);
plot(0:1:255, hist_after, '-bo', 'MarkerSize', 2);
title('Frequency Histogram after Equalization');
xlabel('Pixel Bins');
ylabel('Frequency');
axis tight;
```




# Conclusion

From the first question we can observe that images can be converted into other formats which might make it easier to interpret them in certain occasion. For example: If we wanted to find the hue, or saturation we can easily convert into the format we desire. From the second question we can observe that the negative of an image can be easily observed by just taking the additive inverse and adding the maximum pixel value to it. This transformation helps, when we want to highlight the dark components more. From the third question we can observe that the magnitude of the 2D-DFT image is correlated to the edges of the image. Moreover, we can also notice that the magnitude of the 2D-DFT has to be enhanced using the log transform as the magnitude of the 2D-DFT is feeble and corresponds to low pixel intensities. From the fourth question we can observe that if the gamma value is greater than 1, the image gets brighter and if its less than 1 the image gets darker. From the fifth question, we can observe the changes that take place when histogram equalization is performed on an image. A darker image usually gets brighter and a brighter image usually gets darker. Moroever on comparing the pixel distribution histograms, we can observe that that the histogram after equalization has a distribution similar to a uniform distribution as compared to the histogram of the original pixel distribution.

# References


```
% 1. https://en.wikipedia.org/wiki/Histogram_equalization
% 2. https://www.imageeprocessing.com/2013/05/converting-rgb-image-to-hsi.html
```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