Image and Video Processing Lab

Name: - Yash Rajput

Registration Number : 211060042 **Date: -** 09.02.2024

Experiment 2
2D DFT

Aim: - You are tasked with developing a program to compute 2D Discrete Fourier Transform (DFT) and comment on the results.

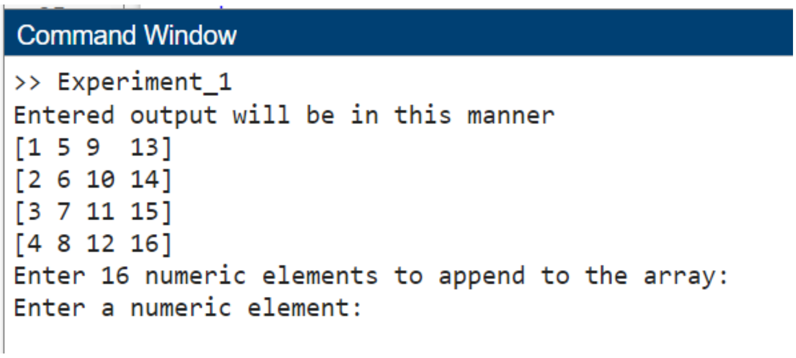
Software Used: - MATLAB

Code:

```
% IVP Lab – Experiment No: 2 – 2D DFT
% Yash Rajput – TY EC - 211060042

myArray = [];
disp('Entered output will be in this manner')
disp('[1 5 9  13]')
disp('[2 6 10 14]')
disp('[3 7 11 15]')
disp('[4 8 12 16]')
disp('Enter 16 numeric elements to append to the array:');

while length(myArray) < 16
    % Prompt the user for input
    userInput = input('Enter a numeric element: ', 's');

    % Convert the input to a number (if possible)
    numInput = str2double(userInput);

    % Check if the input is a valid number
    if ~isnan(numInput)
        % Append the number to the array
        myArray(end+1) = numInput;
        disp(['Element ', num2str(length(myArray)), ' added to the array.']);
    else
        disp('Invalid input. Please enter a valid numeric number.');
    end
end

matrix = reshape(myArray, 4, 4);
disp('Original Matrix:');
disp(matrix);
disp('Press 1 for Discrete Fourier Transform (DFT)')
disp('Press 2 for Discrete Cosine Transform (DCT)')
disp('Press 3 for Wavelet Transform')
choice = input('Enter your choice: ');

if choice == 1
% DFT
    type = 'DFT of Matrix';
    transformed_matrix = fft2(matrix);
elseif choice == 2
% DCT
    type = 'DCT of Matrix';
    transformed_matrix = dct2(matrix);
elseif choice == 3
% Wavelet Transform
    type = 'Wavelet Transform of Matrix';
    [c,s] = wavedec2(matrix, 2, 'db1');
     c = transformed_matrix;
else
    disp('Invalid Choice')
end
% Display the original matrix and its DFT
disp('Original Matrix:');
disp(matrix);
disp(type);
disp(transformed_matrix);

subplot(2,1,1)
imshow(matrix, []);
colormap(gray);
title('Original Matrix');

subplot(2,1,2)
imshow(abs(transformed_matrix), []);
colormap(gray);
title(type);
```

User Interface :

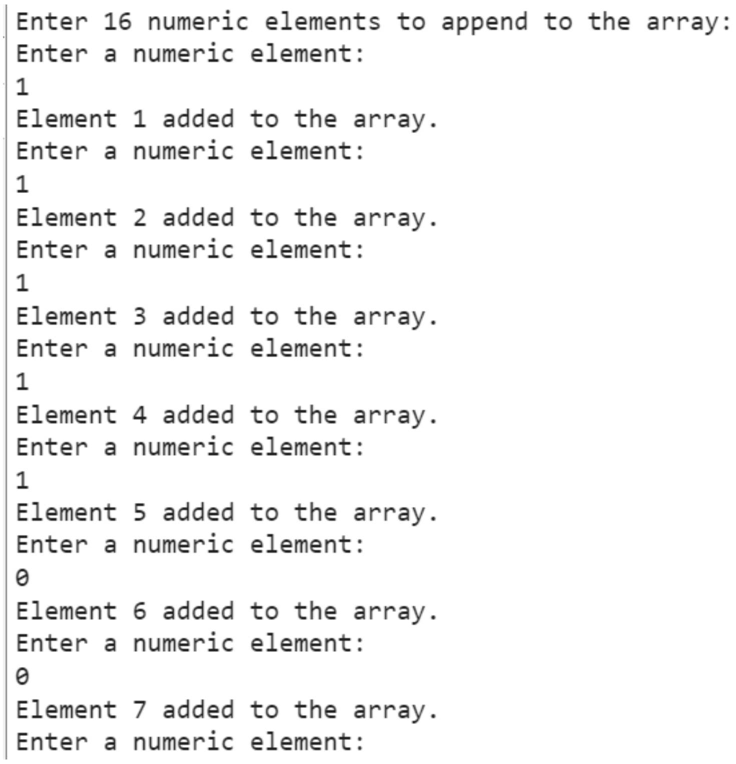
Step 1: The code begins with asking the user for the input matrix



```
>> Experiment_1
Entered output will be in this manner
[1 5 9  13]
[2 6 10 14]
[3 7 11 15]
[4 8 12 16]
Enter 16 numeric elements to append to the array:
Enter a numeric element:
```

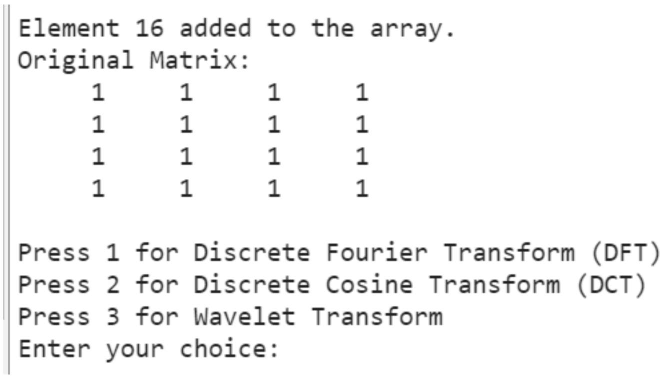
Step 2: Assuming there is not error in the input all the elements need to be entered one by one according to the sample matrix

Note: All the errors related to input are explained in the Error Handling Section



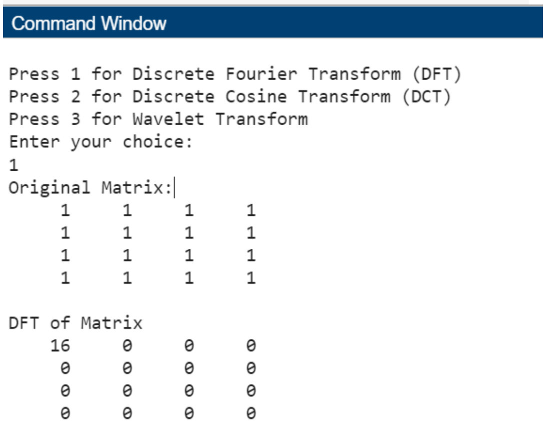
```
Enter 16 numeric elements to append to the array:
Enter a numeric element:
1
Element 1 added to the array.
Enter a numeric element:
1
Element 2 added to the array.
Enter a numeric element:
1
Element 3 added to the array.
Enter a numeric element:
1
Element 4 added to the array.
Enter a numeric element:
1
Element 5 added to the array.
Enter a numeric element:
0
Element 6 added to the array.
Enter a numeric element:
0
Element 7 added to the array.
Enter a numeric element:
```

Step 3: You will be shown your entered matrix and will be asked to choose the transformation you want to see

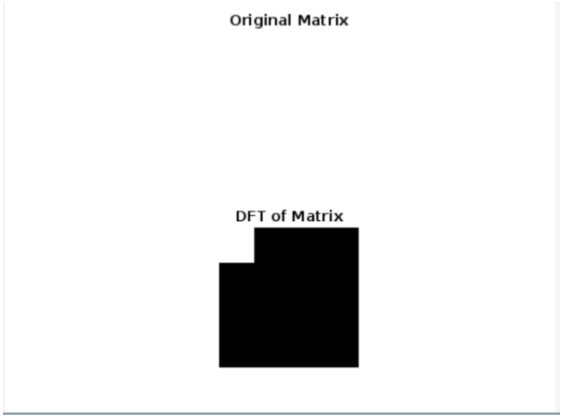


```
Element 16 added to the array.
Original Matrix:
     1     1     1     1
     1     1     1     1
     1     1     1     1
     1     1     1     1

Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
```

Step 3: After Entering your choice you can see the original matrix and the transformation in the Command Window and see its visualization in figure

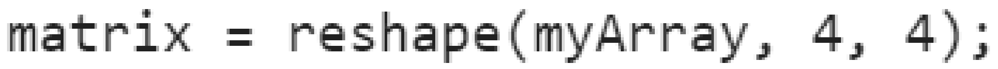


```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
1
Original Matrix:
     1     1     1     1
     1     1     1     1
     1     1     1     1
     1     1     1     1

DFT of Matrix
    16     0     0     0
     0     0     0     0
     0     0     0     0
     0     0     0     0
```



Error Handling:

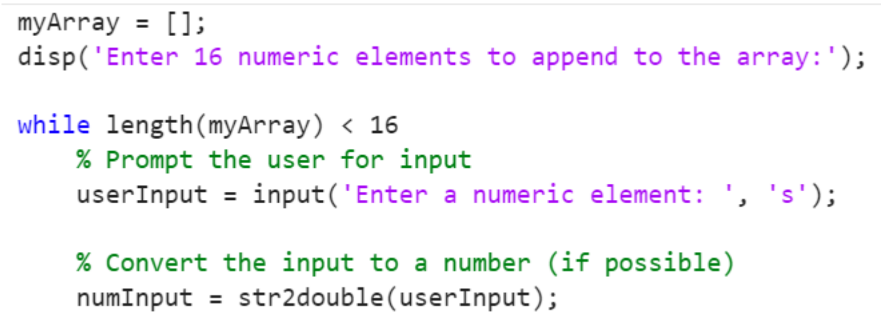
Case 1: The Entered Matrix is asymmetric



```
matrix = reshape(myArray, 4, 4);
```

The case of matrix being asymmetric cannot occur as we are collecting 16 elements in an array and then reshaping it into a 4x4 matrix

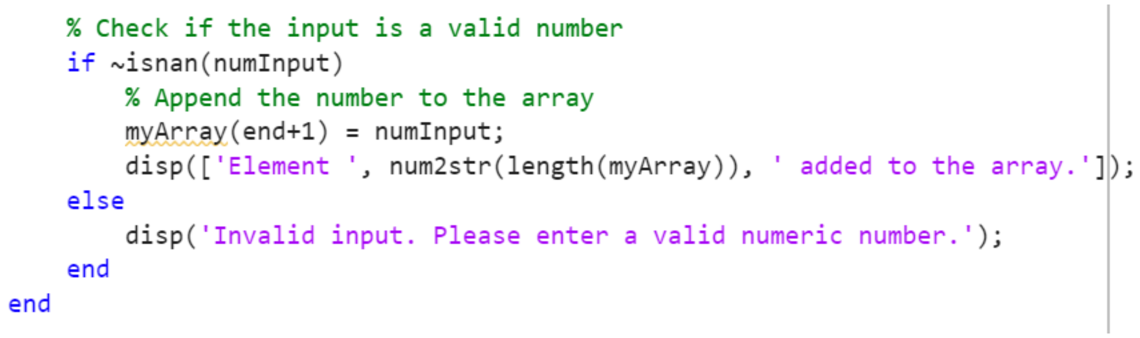
Case 2: The Entered Matrix is not of 4x4 order



```
myArray = [];
disp('Enter 16 numeric elements to append to the array:');

while length(myArray) < 16
    % Prompt the user for input
    userInput = input('Enter a numeric element: ', 's');

    % Convert the input to a number (if possible)
    numInput = str2double(userInput);
```

To deal with the input not having 16 elements, the code will simply not come out of the while loop until the user has entered 16 valid numbers

Case 3: The Entered Matrix contains non numeric number

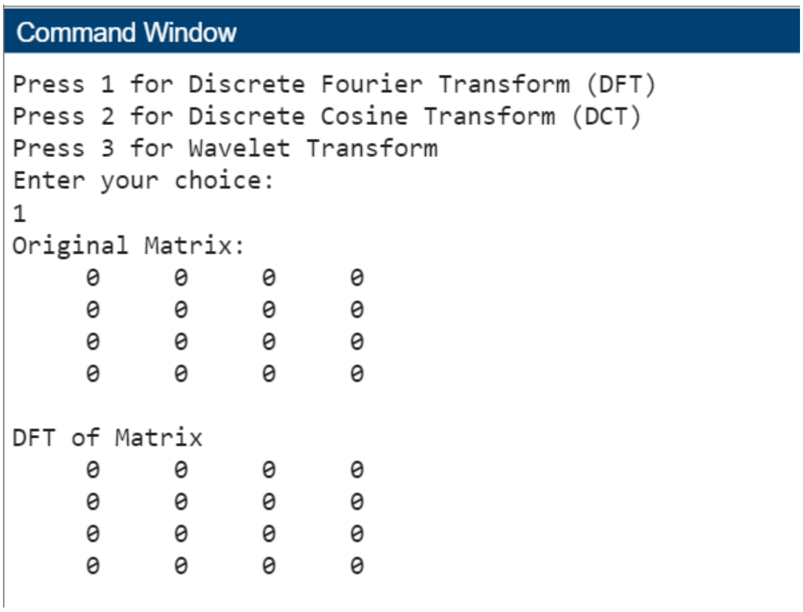


```
    % Check if the input is a valid number
    if ~isnan(numInput)
        % Append the number to the array
        myArray(end+1) = numInput;
        disp(['Element ', num2str(length(myArray)), ' added to the array.']);
    else
        disp('Invalid input. Please enter a valid numeric number.');
    end
end
```

Here the code will check each input before appending to the array, if the input is a valid number then it will append it otherwise it will skip it and the while loop will run until 16 numbers are completed

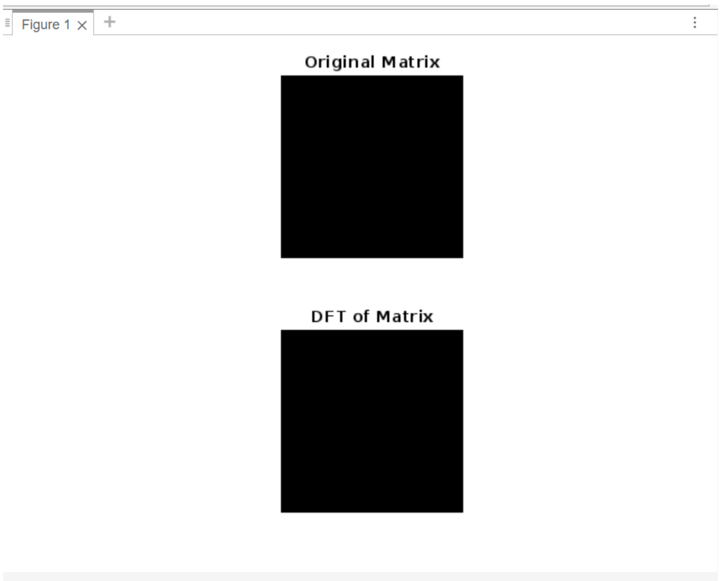
Output Analysis

Test Case 1: Black Image



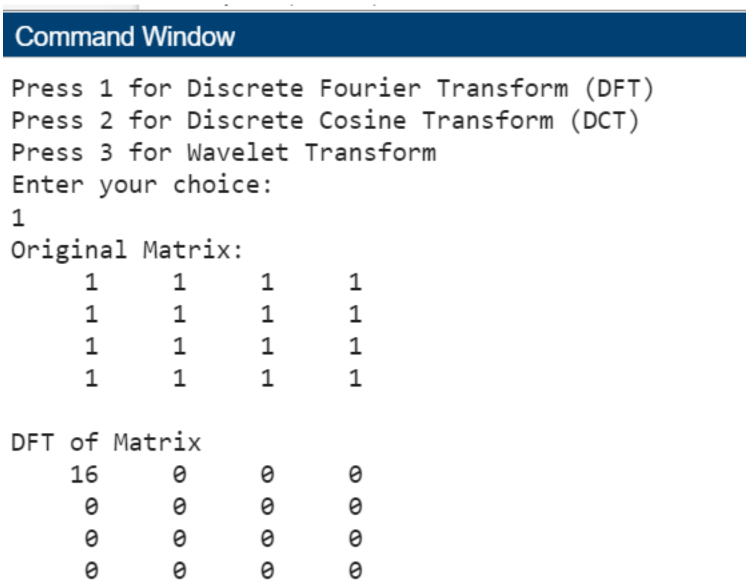
```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
1
Original Matrix:
     0     0     0     0
     0     0     0     0
     0     0     0     0
     0     0     0     0

DFT of Matrix
     0     0     0     0
     0     0     0     0
     0     0     0     0
     0     0     0     0
```

Visual Representation:



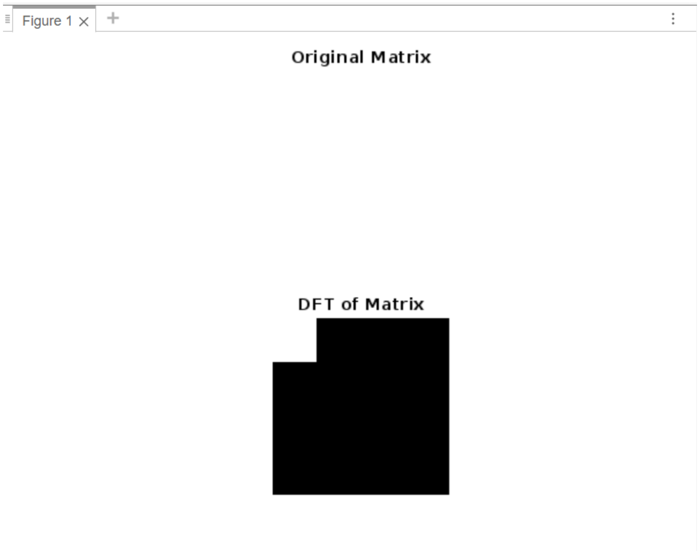
Conclusion: We can see that the original image and DFT of the image are same as the image does not contain any bright points and due to which the brightness of the image comes out to be 0

Test Case 2: White Image



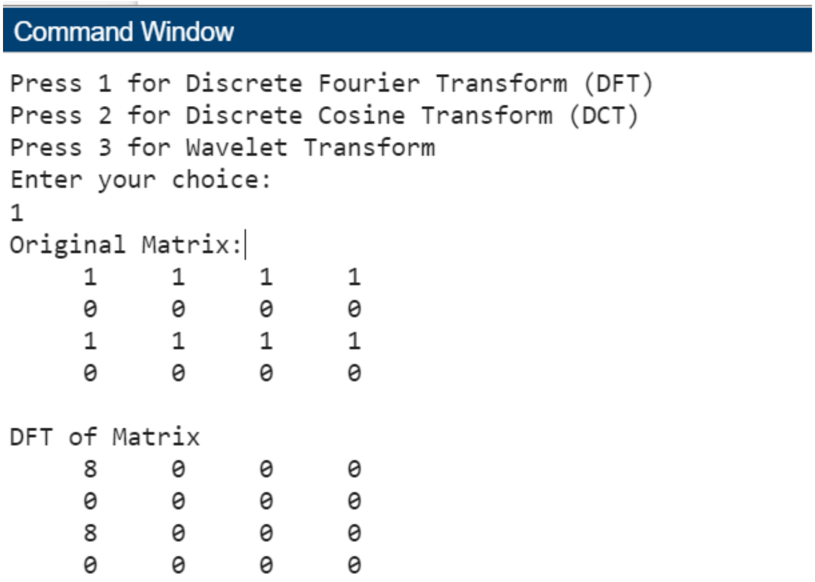
```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
1
Original Matrix:
     1     1     1     1
     1     1     1     1
     1     1     1     1
     1     1     1     1

DFT of Matrix
    16     0     0     0
     0     0     0     0
     0     0     0     0
     0     0     0     0
```

Visual Representation:



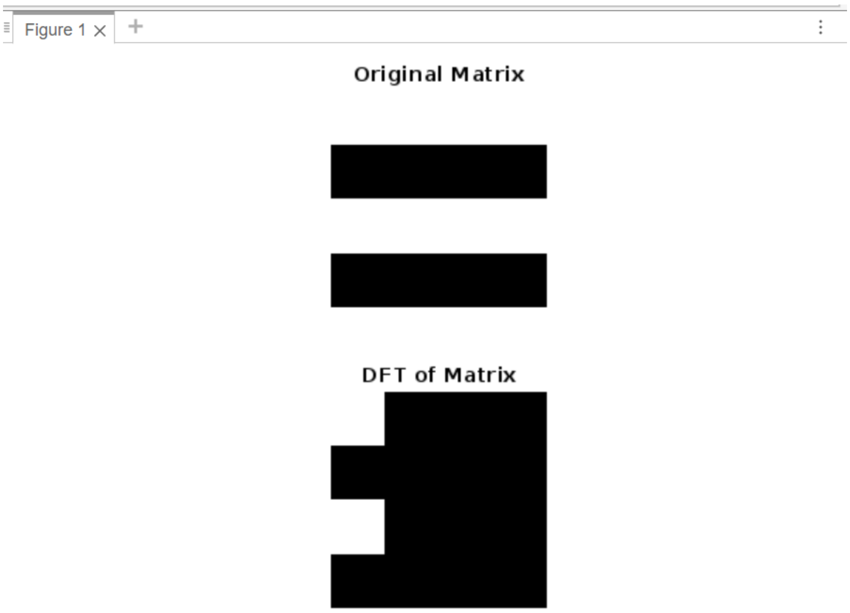
Conclusion: The original matrix cannot be seen as it is all white and has blend with the background. Over here the DFT shows the maximum brightness which is 16 as it’s the sum of all the elements and is at the point which denotes lowest frequency

Test Case 3: Horizontal Strips



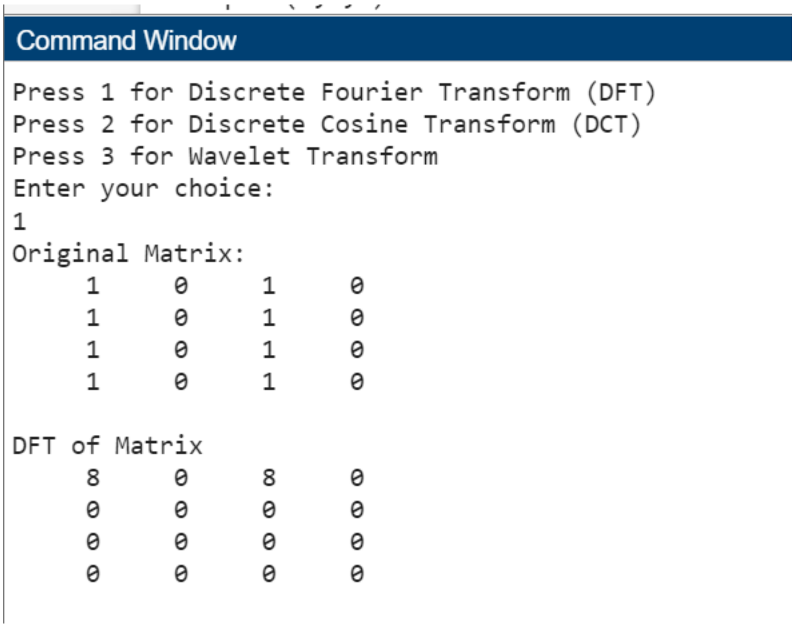
```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
1
Original Matrix:
     1     1     1     1
     0     0     0     0
     1     1     1     1
     0     0     0     0

DFT of Matrix
     8     0     0     0
     0     0     0     0
     8     0     0     0
     0     0     0     0
```

Visual Representation:



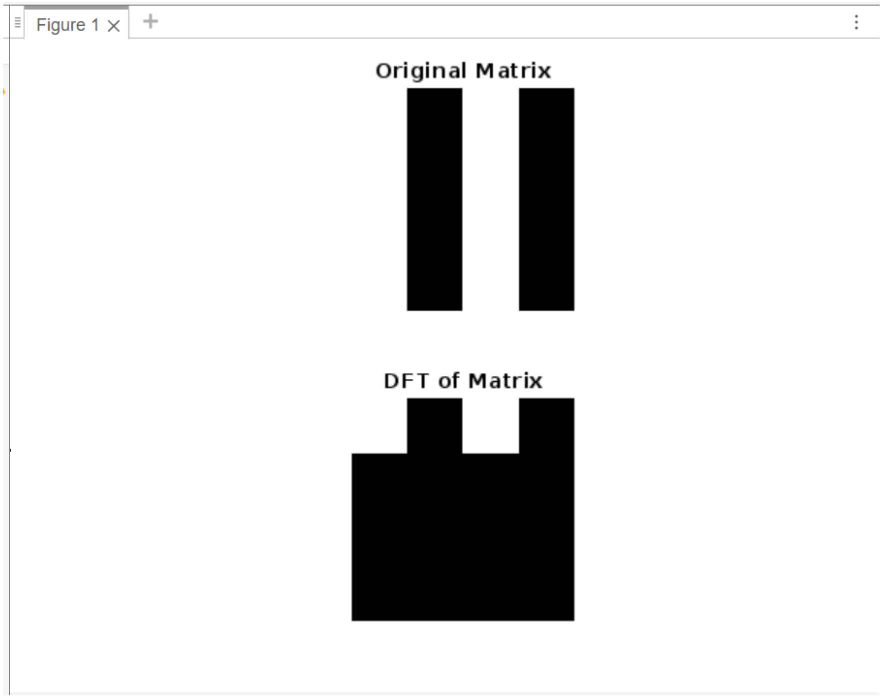
Conclusion: Over here we can see the brightness as 8 which is the sum of the elements in the original image, and as the original image has alternate rows the DFT shows the change in rows

Test Case 4: Vertical Strips



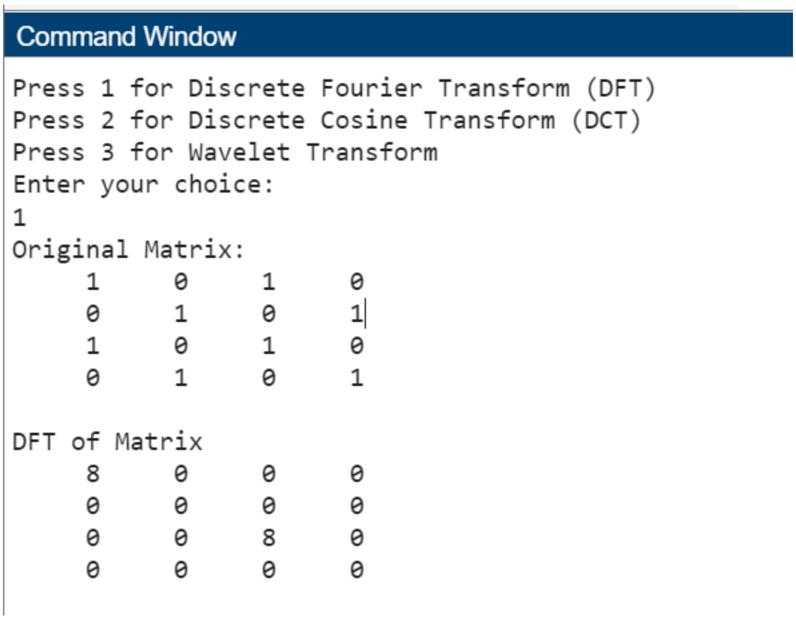
```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
1
Original Matrix:
     1     0     1     0
     1     0     1     0
     1     0     1     0
     1     0     1     0

DFT of Matrix
     8     0     8     0
     0     0     0     0
     0     0     0     0
     0     0     0     0
```

Visual Representation:



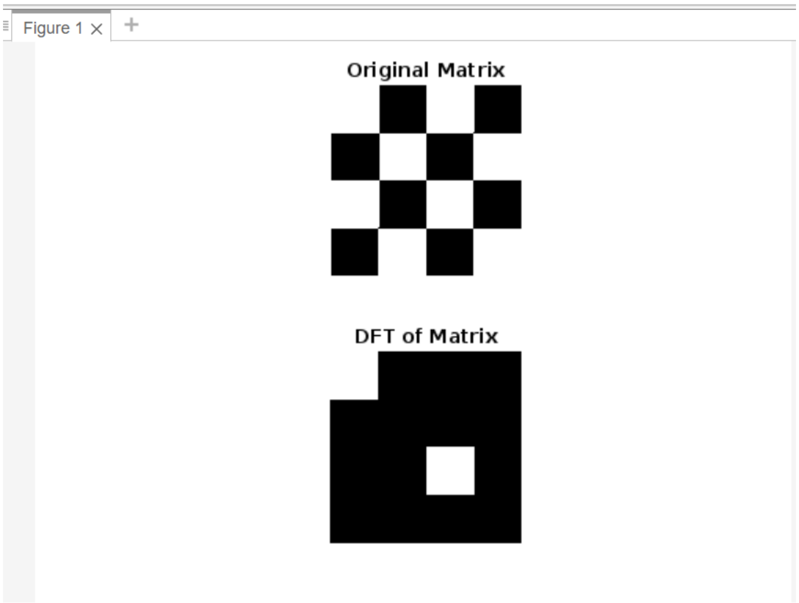
Conclusion: Over here we can see the brightness as 8 which is the sum of the elements in the original image, and as the original image has alternate columns the DFT shows the change in columns

Test Case 5: Chess Pattern



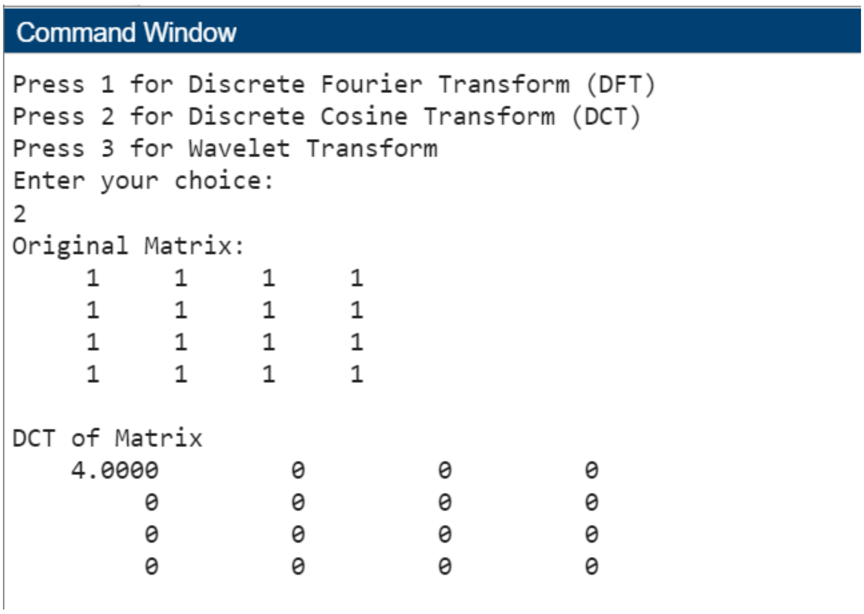
```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
1
Original Matrix:
     1     0     1     0
     0     1     0     1
     1     0     1     0
     0     1     0     1

DFT of Matrix
     8     0     0     0
     0     0     0     0
     0     0     8     0
     0     0     0     0
```

Visual Representation:



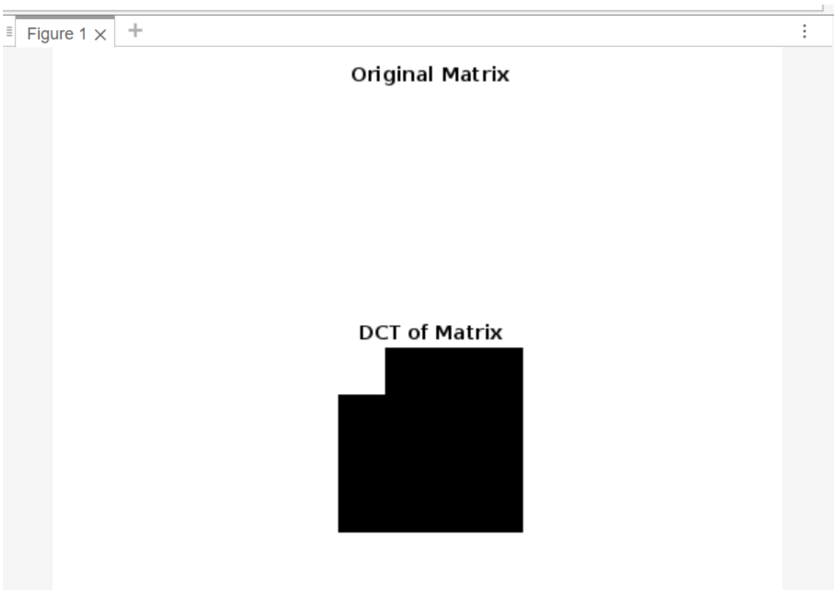
Conclusion: Over here we can see the bright points in DFT of the image is of value 8 we can see it being at the top left corner and another point in approximately in middle indicating that there’s frequent changes in the original image

Test Case 6: Discrete Cosine Transformation



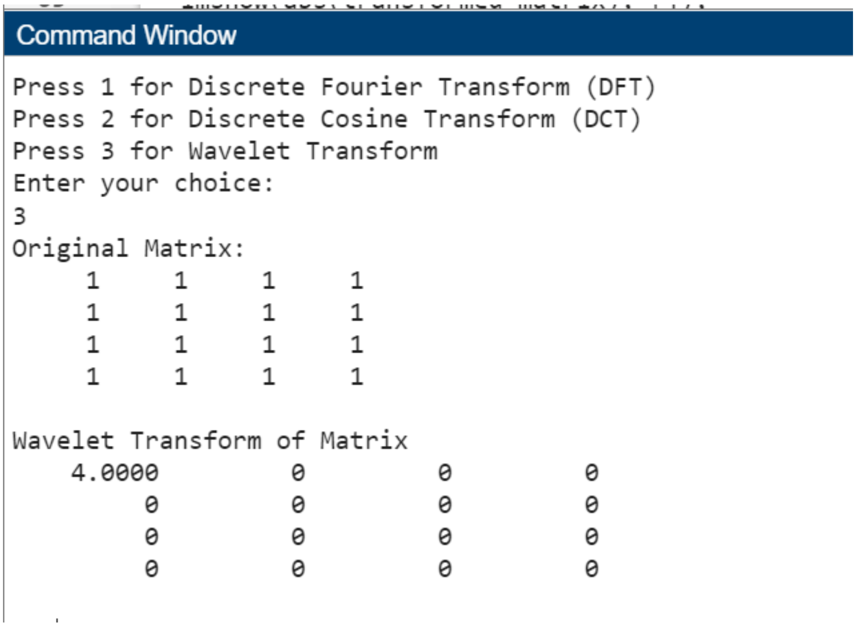
```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
2
Original Matrix:
     1     1     1     1
     1     1     1     1
     1     1     1     1
     1     1     1     1

DCT of Matrix
    4.0000         0         0         0
         0         0         0         0
         0         0         0         0
         0         0         0         0
```

Visual Representation:



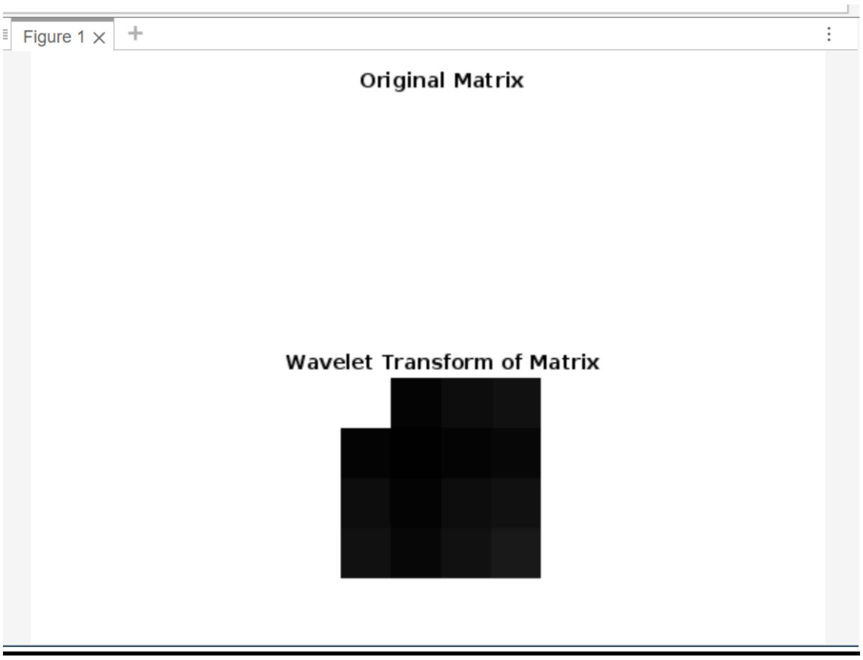
Conclusion: Over here we can see the bright points in DCT of the image is of value 4 as we analyze only the cosine part of the image

Test Case 7: Wavelet Transformation



```
Press 1 for Discrete Fourier Transform (DFT)
Press 2 for Discrete Cosine Transform (DCT)
Press 3 for Wavelet Transform
Enter your choice:
3
Original Matrix:
     1     1     1     1
     1     1     1     1
     1     1     1     1
     1     1     1     1

Wavelet Transform of Matrix
    4.0000         0         0         0
         0         0         0         0
         0         0         0         0
         0         0         0         0
```

Visual Representation:



Conclusion : wavelet decomposition of the matrix X at level N using the wavelet wname . The output decomposition structure consists of the wavelet decomposition vector C and the bookkeeping matrix S , which contains the number of coefficients by level and orientation.