1.1

EEE391 – Matlab Assignment 2
Turgut Alp Edis
21702587

Q2)

$$y[m,n] = \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty} x[k,l]\delta[m-k,n-l]$$

As in done for 1D DT LTI system, we can denote that $\delta[m,n] = h[m,n]$
So, the equation becomes

$$y[m,n] = \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty} x[k,l]h[m-k,n-l]$$
$$y[m,n] = x[m,n] ** h[m,n]$$

Q3)

$M_y = M_x + M_h - 1$ and $N_y = N_x + N_h - 1$
Matlab Code for DSLSI2D(h,x) function:

```
function [y] = DSLSI2D(h,x)
[Mh, Nh] = size(h);
[Mx, Nx] = size(x);
My = Mx + Mh - 1;
Ny = Nx + Nh - 1;
y = zeros(My, Ny);
for k=0:Mh-1
for l=0:Nh-1
y(k+1:k+Mx,l+1:l+Nx)=y(k+1:k+Mx,l+1:l+Nx)+h(k+1,l+1)*x;
end
end
end
```

Q4)

The 2D FIR low pass filter function to prepare h:

```
function [h] = h_func(s, B)
Mh = s;
Nh = s;
h = zeros(Mh, Nh);
for m=1:Mh
for n=1:Nh
    h(m, n) = sinc(B * (m - (Mh-1)/2))*sinc(B * (n - (Nh-1)/2));
end
end
end
```

The filtered output with different filters when B=0.5, B=0.2 and B=0.05 is

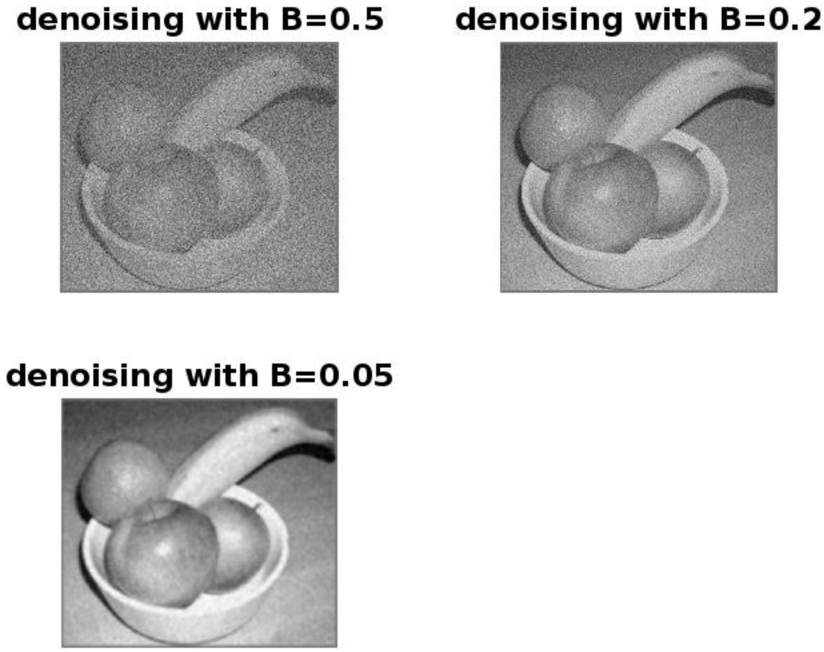

Figure 1. The filtered output

The filter, when B is 0.05, is the most appropriate one since it removes all the noise from the image. However, the image quality decreased, probably due to the missing pixels. So, this filter could not save all images but could save most of them.

Q5)

Given properties for the part 5**:**

x = The image array of “Part5.bmp”

$h_1 = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$ and $h_2 = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$

$y_1[m,n]$ = DSLSI2D(h_1,x) and $y_2[m,n]$ = DSLSI2D(h_2,x)

$s_1[m,n] = y_1^2[m,n]$

$s_2[m,n] = y_2^2[m,n]$

$s_3[m,n] = \sqrt{y_1{}^2[m,n] + y_2{}^2[m,n]}$

Figure 2. The output image of $s_1[m,n] = y_1^2[m,n]$

From Figure 2, it can be said that the edges of the image are emphasized.

Figure 3. The output image of $s_2[m,n] = y_2^2[m,n]$

From Figure 3, it can also be said that the edges of the image are emphasized. However, it more emphasizes the edges than Figure 2. The reason for the difference is the filter function's values. The h1 has no value in the middle column, while h2 has no value in the middle row. Figure 1 emphasizes vertical lines and edges, and figure 2 emphasizes the vertices of the picture.

Figure 4. The output image of $s_3[m,n] = \sqrt{{y_1}^2[m,n] + {y_2}^2[m,n]}$

From Figure 4, almost all points of the image are emphasized. It is better image than Figure 2 and Figure 3 since it is the total points of these two figures. Therefore the missing piece of these pictures is completed after the addition.

Q6)

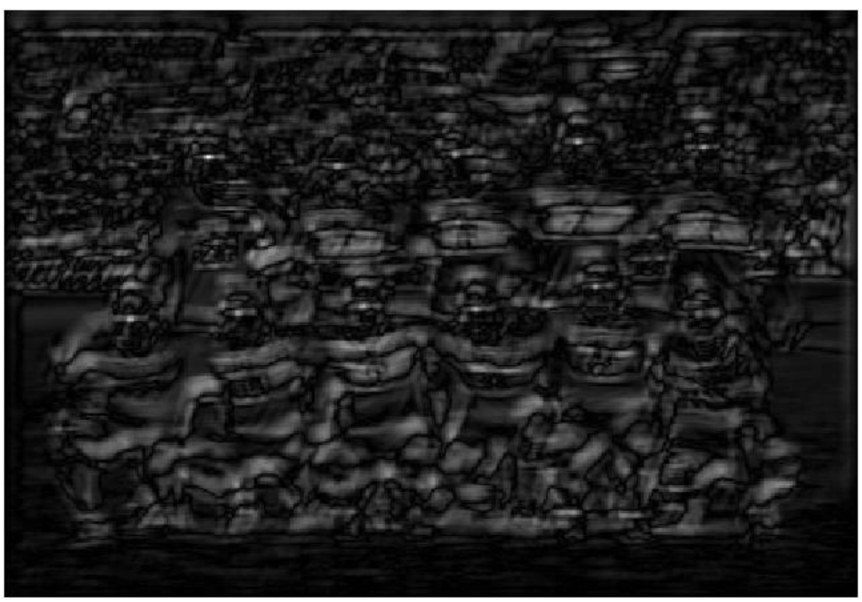

Figure 5. Absolute value of output image |y[m,n]|

From Figure 5, the bright points occur in the faces of the players. There is not no other bright point that is not in the face. However, one player does not have bright point in his face.

Figure 6. Power of 3 of Figure 5 $|y[m,n]|^3$

From Figure 6, the brightest point is the face that is used as impulse response for the filter. However, there are still bright points that can be pointed as faces of the players.

Figure 7. Power of 5 of Figure 5 $|y[m,n]|^5$

From figure 7, only one point can be seen clearly, which belongs to the face of the impulse response.

Therefore, from figures 5, 6, and 7, taking the power of 3 is sufficient to detect the face. This method successfully finds the face after the power of 3. It is finding the face power of 1, but other points can be identified as the wanted face. However, after the power of 3, the bright point is determined on the desired face. Thus, the filter successfully detected the face after the power of 3.

Index of comments

1.1 Part 2: Proof would be more elaborate: -5
Part 3: How My, Ny were derived was not explained: -5

Total grade: 90