Video Signals

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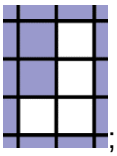
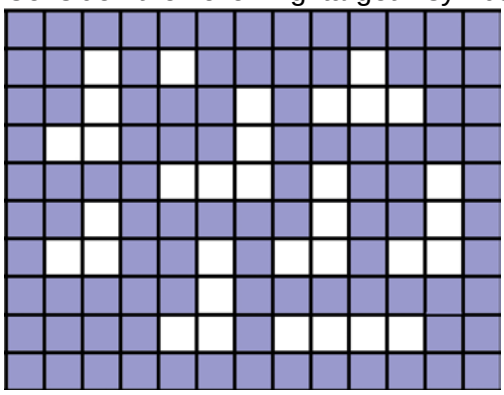
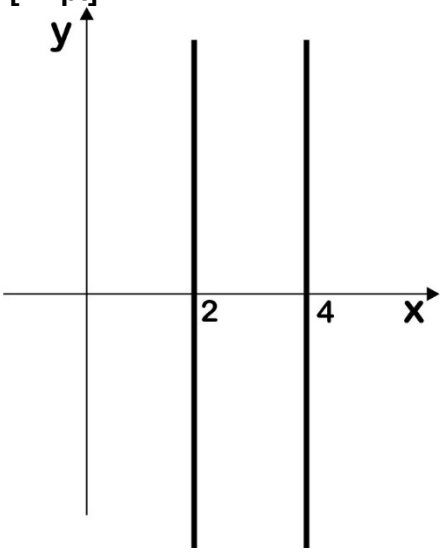
Ex.1.[11 Pt]

Consider the following target symbol:  ; Define how it can be found and counted in the following image skipping any similar but not exactly equal symbol.



Provide a detailed description of the procedure, of the geometry of the involved objects and of possible problems/drawbacks.

Es.2. [11 pt]



An image is represented by two vertical lines with abscissas equal to 2 ad 4. What is its Discrete Space Fourier Transform?

.**Es.3 [11 pt] MATLAB**

Re-implement exercise 1 in matlab defining assuming that the image is already a Black and White image represented by a matrix ‘Image’ and the target (the flipped ‘L’) is represented by a matrix ‘Target’. In particular find the position of the targets in the image and count them.

Es.3. [13 pt] You are walking in the park when suddenly a wild Pokémon appears! Well, actually the Pokémon needs your help in order to be able to appear in augmented reality. Given a Pokémon stored in the image *pikachu.png*, and the scene *DEIB_park.jpg* captured by your smartphone camera (both are RGB images with 8bit per channel), write the MATLAB code that places the Pokémon inside the captured scene. Proceed as follows:

a) Read and visualize the two images;

b) Prepare the Pokémon image for the mixing:
   b1) resize it so that its height is 1/4 of the height of the scene image;
   b2) knowing that on the image the background is pure green, find the coordinates of Pokémon pixels, i.e. rows and columns of the image that are not the background (hint: `[row, col] = find(…)`);

c) Elaborate the scene image in order to find a suitable location for our Pokémon (it can't just randomly fly around, right?). To do so, let's suppose that there is a table in the scene and that somehow we know that its color is close to $[R_0, G_0, B_0] = [188, 186, 197]$. To find the table, divide the image into pieces and find the piece that contains the highest number of pixels that are close to the given color:
   c1) we want to divide the image using a 9x6 uniform grid – find the size of the pieces (height and width in pixels) and initialize a matrix that will be used to store the distance measure of each piece with respect to the reference color $[R_0, G_0, B_0]$;
   c2) for each piece do the following: knowing the size of the pieces, compute the positions of the current piece pixels and use them to extract the corresponding R, G and B planes. For each color plane analyze its histogram to find the bin with highest number of pixels. Use the corresponding color values R_m, G_m, B_m to compute the color distance of the current piece from the reference color $[R_0, G_0, B_0]$, as

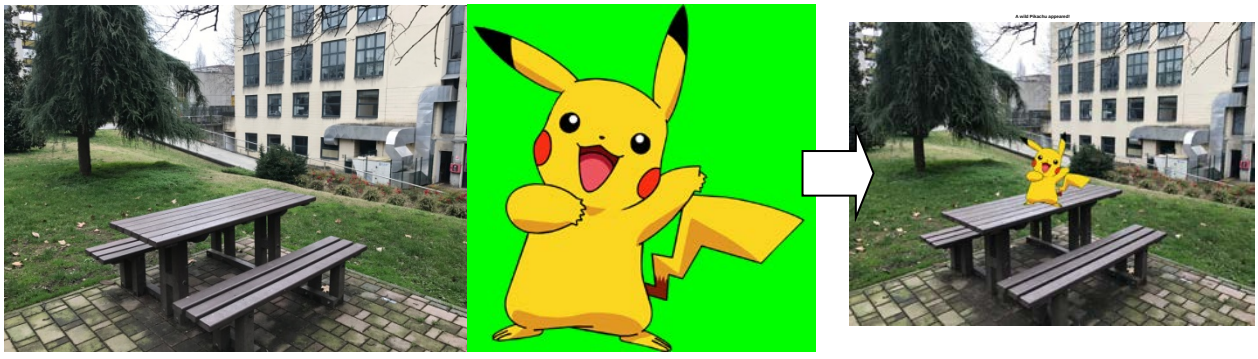
$$dist = \sqrt{(R_m - R_0)^2 + (G_m - G_0)^2 + (B_m - B_0)^2}$$

   Store the computed distance in the previously initialized matrix;
   c3) given the matrix that contains the distance measure computed for each image piece, find the piece with lowest distance value. We want to use the center of this piece as a Pokémon location – compute its coordinates;

d) Place the Pokémon inside the scene: for each pixel that is not a background, computed in step b2), find a corresponding pixel in the scene image, staring from the coordinates computed in step c3), and replace it with the Pokémon pixel. Visualize the result. Finally, a wild Pokémon appeared!

Matlab
List of possible functions

```
figure
im2double
im2bw
rgb2gray
fspecial
imread
imresize
imrotate
imfilter
imnoise
imhist
fft2
ifft2
imshow
imagesc
getimage
size
zeros
find
abs
angle
conj
double
max
min
imerode
imdilate
imopen
imclose
```



Solutions

Ex.1

Ex.2

Ex.3

```
% a)
I1 = imread('pikachu.png'); figure; imshow(I1);
I2 = imread('DEIB_park.jpeg'); figure; imshow(I2);

% b1)
I1 = imresize(I1, 0.25*size(I2,1)/size(I1,1));
% b2)
[pika_r, pika_c] = find(I1(:,:,1) ~= 0 | I1(:,:,2) ~= 255 | I1(:,:,3) ~= 0);

% c1)
Nr = 9; nRows = size(I2,1)/Nr;
Nc = 6; nColumns = size(I2,2)/Nc;
colorDist = zeros(Nr,Nc);
% c2)
for i = 1:Nr
    for j = 1:Nc
        pieceRows = nRows*(i-1)+1:nRows*i;
        pieceColumns = nColumns*(j-1)+1:nColumns*j;
        hR = imhist(I2(pieceRows, pieceColumns,1));
        hG = imhist(I2(pieceRows, pieceColumns,2));
        hB = imhist(I2(pieceRows, pieceColumns,3));
        [~,R] = max(hR); [~,G] = max(hG); [~,B] = max(hB);
        colorDist(i,j) = norm(double([R,G,B]+1) - [188,186,197]);
    end
end
% c3)
[i,j] = find(colorDist == min(colorDist(:)));
start_r = nRows*(i-1) + nRows/2 - size(I1,1);
start_c = nColumns*(j-1) + nColumns/2;

% d)
for n = 1:length(pika_c)
    I2(start_r + pika_r(n), start_c + pika_c(n),:) = I1(pika_r(n),pika_c(n),:);
end
figure; imshow(I2); title('A wild Pikachu appeared!');
```