Video Signals

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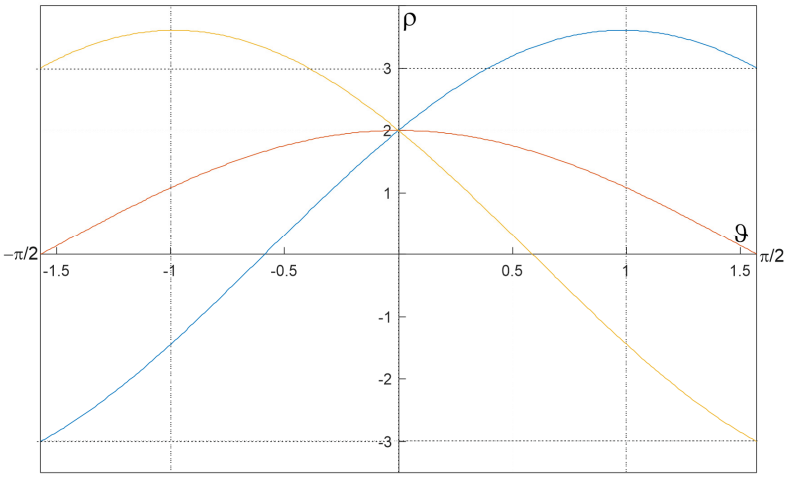
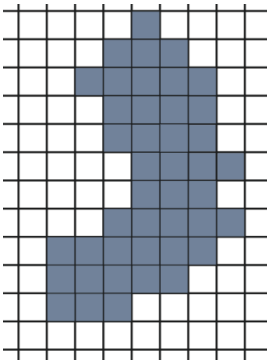
Ex.1.[8 pts] In the plot below it is represented the Hough transform of a set of points. What are their position in the 2D Cartesian plane? (Justify the answer).



Ex.2.[8 pts] The following values represent the intensities of an image portion. For the central part (inside the thicker border) evaluate the Local Binary Pattern.

70	177	112	47
11	81	97	125
24	243	195	114
210	8	203	165

Ex.3.[6 pts]



Consider the B/W object on the left, describe the morphological procedure to extract its edge.

Describe the whole procedure using this structuring element.

Furthermore, define a stopping condition for the algorithm.

Ex. 4 is overleaf

Es.3. [11 pts to be solved writing on the paper a suitable MATLAB code]

You have to implement a medical application able to extract the vessels from a retina image, like the one shown below.

Write a MATLAB script able to perform the following steps:

a) Read the *'eye.jpg'* image, convert it to a double representation and visualize it.
b) Convert the image to grayscale and apply a 7x7 gaussian filter with sigma equal to 0.5, obtaining image *B*.
c) Using a 5x5 square structuring element apply a dilation to *B*, obtaining *C*.
d) Obtain *D* by calculating the pixelwise ratio between *B* and *C* (hint: add a small quantity to avoid dividing by 0).
e) Using Sobel kernels calculate the gradient magnitude of *B*. Apply a morphological dilation with the same structuring element used in c) to obtain *E*.
f) Define *thr_1* and *thr_2* as the average values of *D* and *E* respectively. Obtain *F* by setting to true all the pixels in which *D* is less than *thr_1* and *E* is greater than *thr_2*.
g) Assign a label to all the connected components of F.
h) Initialize a mask called H to zeroes and, going through all the connected components, find the ones having a pixel area (count the pixels) greater than 50. For these ones set the corresponding pixels of H to one.
i) Apply the mask H to the input color image by setting all the pixels having false value in H to black and visualize the result.

List of possible Matlab functions

```
figure
im2double
imread
rgb2gray
imcrop
imfilter
imhist
imopen
rgb2ind
histeq
hist
imshow
fspecial
imerase
strel
imdilate
bwlabel
```

Solutions

Es.1

Considering the equation $\rho = x\cos(\vartheta) + y\sin(\vartheta)$ for each curve, we can assert that all of them pass through the point $\rho = 2, \quad \vartheta = 0, \quad \rightarrow \; 2 = x \cdot 1 + y \cdot 0 \rightarrow x = 2$

Then we can set three further equations:

$$3 = x\cos\left(\frac{\pi}{2}\right) + y\sin\left(\frac{\pi}{2}\right) \rightarrow y = 3$$

$$0 = x\cos\left(\frac{\pi}{2}\right) + y\sin\left(\frac{\pi}{2}\right) \rightarrow y = 0$$

$$-3 = x\cos\left(\frac{\pi}{2}\right) + y\sin\left(\frac{\pi}{2}\right) \rightarrow y = -3$$

The points will be $P_1(2,-3), P_2(2,0), P_3(2,3)$

Es.2

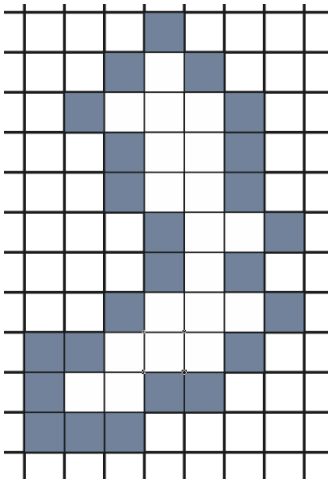
According to the Local Binary Pattern approach, starting from the North (Pixel above the considered one) and moving in a clockwise direction, we get the following walues:

$$\begin{bmatrix} 11111000 & 10111101 \\ 00000000 & 00001010 \end{bmatrix} \rightarrow \begin{bmatrix} 248 & 189 \\ 0 & 5 \end{bmatrix}$$

Es.3

Details on morphological edge extraction can be found in lectures.

The result will be:



Es.4

```
clc
close all
clear all

%a)
img = im2double(imread('eye.jpg'));
figure
imshow(img)

%b) convert to gray
gray = rgb2gray(img);
g = fspecial('gaussian',7,0.5);
B = imfilter(gray,g,'conv','sym','same');

%c)
s = strel('square',5);
C = imdilate(B,s);

%d)
D = B./(C+0.001);

%e)
k = fspecial('sobel');
i_x = imfilter(B,k,'conv','sym','same');
i_y = imfilter(B,k','conv','sym','same');
grad = sqrt(i_x.^2 + i_y.^2);
E = imdilate(grad,s);

%f)
thr_1 = mean(D(:));
thr_2 = mean(E(:));
F = D<thr_1 & E>thr_2;

%g)
label = bwlabel(F);

%h)
H = zeros(size(label));
thr = 50;
for i = 1:max(label(:))
   mask_loc = (label == i);
   area = sum(mask_loc(:));
   if(area>thr)
       H = H+mask_loc;
   end
end

%i)
output = H.*img;
figure
imshow(output)
```