

# Video Signals

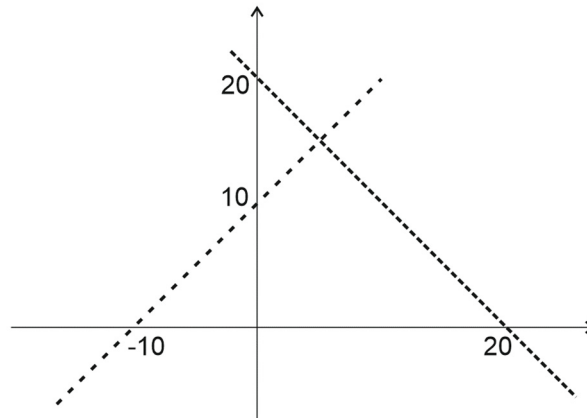
Date: 12 January 2023

**Ex.1. [9 pts]** Given the following image where two dashed lines are present crossing the axes in the indicated coordinates,

[4 pts] describe the steps that allow the Hough transform to estimate their equations and calculate their associated parameters.

[5 pts] describe a possible approach that, using the information of the Hough transform, allows us to estimate the intersection point of the two straight lines.

[Hint] For simplicity you can think to work in the continuous domain.



**Ex.2. [12 pts]** Given the following black and white image (where black pixels have a value of 1 and white pixels have a value of 0), we need to apply the morphological skeletonization in order to describe its structure.

The structuring element is a 5x5 cross on the right.

0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	1	1	1	1	1	1	1	0
0	0	0	1	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	1	1	0
0	0	0	1	1	1	1	1	1	1	0
0	0	0	1	1	1	1	1	1	1	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

[4 pts] Describe the procedure and the steps in order to get the skeleton.

[8 pts] Calculate the skeleton and describe the procedure, starting from it, to rebuild the original image.

**Ex. 3 is overleaf**

**Es.3. [12 pts to be solved writing MATLAB code on the paper]**

You have to implement a preprocessing step (contrast enhancement and edge extraction) in a plate reading application.



Write a MATLAB script able to perform the following steps:

- a) Read the 8-bit grayscale image (stored in the file *'img.png'*), convert it to a double representation and visualize it.
- b) Apply histogram equalization using 256 bins for enhancing the contrast.
- c) Define a 5x5 Laplacian of Gaussian kernel and apply it using convolution on the image obtained in b), producing *I\_log*.
- d) Obtain a binary matrix (called *mask\_lap*) performing zero crossing on *I\_log*. In particular, for each pixel location assign a true value if the value *I\_log* in the inspected location has a different sign in respect to the value on the left or the value above.
- e) Starting from the image obtained in b), produce an estimation of the gradient magnitude using Sobel filters.
- f) Set *thr\_h* and *thr\_l* as 10% and 5% respectively of the maximum gradient magnitude value.
- g) Get a binary mask (called *mask\_high*) with true values in locations in which *mask\_lap* is true and the gradient magnitude is greater than *thr\_h*.
- h) Using a 5x5 square structuring element apply a dilation on *mask\_high*.
- i) Get the final binary mask by setting to true the locations in which *mask\_lap* is true, the gradient magnitude is greater than *thr\_l* and the mask obtained in h) is also true. Visualize the result.

**List of possible Matlab functions**

```
figure
im2double
imread
rgb2gray
imcrop
conv2
imhist
imopen
rgb2ind
histeq
hist
imshow
fspecial
imerase
strel
imnoise
imdilate
```



The reconstruction will be union of the results of dilating the skeleton elements with the structuring element as many times as indicated in the skeleton and adding, as the final steps, the 'leaves', i.e., the elements indicated by '0'.

### Es.3

```
clc
close all
clear all

%a)
I = im2double(imread('img.png'));
figure
imshow(I)

%b)
I = histeq(I,256);

%c)
log = fspecial('log',5);
I_log = conv2(I,log,'same');

%d)
mask_lap = zeros(size(I_log));
for i=2:size(I_log,1)
    for j=2:size(I_log,2)
        if(I_log(i,j)*I_log(i-1,j)<0 || I_log(i,j)*I_log(i,j-1)<0)
            mask_lap(i,j)=1;
        end
    end
end

%e)
dy = fspecial('sobel');
dx = dy';
I_x = conv2(I,dx,'same');
I_y = conv2(I,dy,'same');
I_mgn = sqrt(I_x.^2+I_y.^2);

%f)
thr_h = 0.1*max(I_mgn(:));
thr_l = 0.5*thr_h;

%g)
mask_high = I_mgn>thr_h & mask_lap;

%h)
se = strel('square',5);
mask_high_dil = imdilate(mask_high,se);

%i)
mask = I_mgn>thr_l & mask_high_dil & mask_lap;
figure
imshow(mask)
```