INFO449 E
Image, Video & Audio
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Final 2016 - 2017
Date: 23 June 2017
Duration: 2 hours
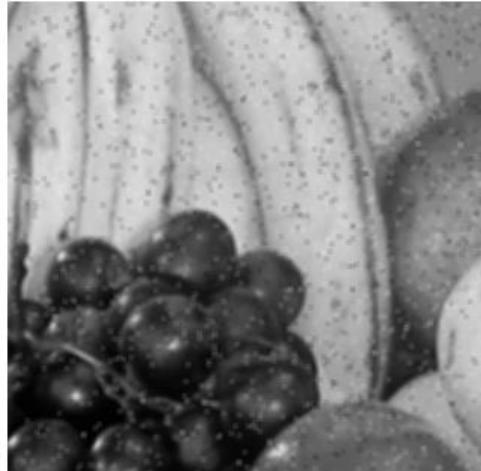
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Exercise I: Multiple choices [12 pts]

Fill the following table with the correct answer.

1	2	3	4	5	6	7	8	9	10

1. The image in the figure on the left is affected by impulse noise (salt). If the image in the right figure is the result of convolving the image on the left with a convolution mask H having the form in the third figure, what are the most likely values for the parameters a and b?

$$H = a \cdot \begin{bmatrix} 1 & 1 & 1 \\ 1 & b & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

a. a = 1; b = -8
b. a = 1/8; b = -8
c. a = 1; b = 1
d. a = 1/9; b = 1

2. Consider the original image below (an original image affected by salt and pepper noise). Most likely, the Fourier amplitude spectrum of this image will look like:


Fig a)
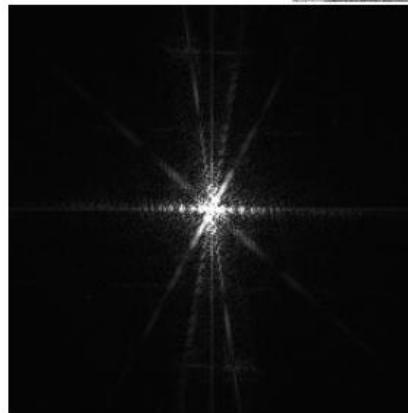
Fig. b)
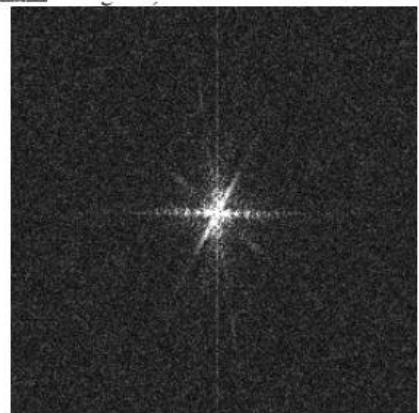
Fig. c)

Fig. d)
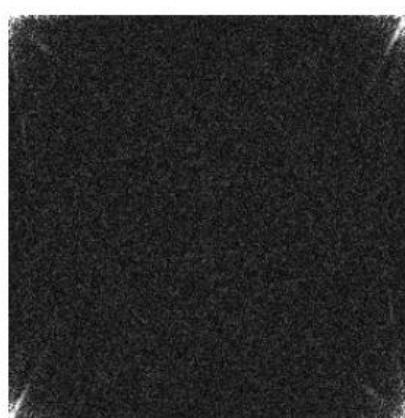
Fig. .e)

a. Fig b)   b. Fig c)

c. Fig d)   d. Fig e)

3. In order to obtain the image in Fig. b) from the original image in Fig. a), the following point processing operation should be applied:


Fig. a

Fig. b.

a. Contrast compression;   b. negative

c. Histogram equalization   d. None of the above

4. On the original grey scale image from Fig. a), which of the following point processing operation(s) could have been applied to obtain the image in Fig. b)?

Fig. a

Fig. b

a.	Contrast compression	b.	Negative
c.	Some grey scale slicing operation	d.	Extraction of the most significant bit

5. Fig. a) represents the grey level histogram of a digital image. After processing this image, we get another grey level digital image with the grey level histogram shown in Fig. b). What is the most plausible processing applied on the original image from the ones below?

a.	Negative	b.	Binary thresholding
c.	Histogram equalization	d.	None of the above
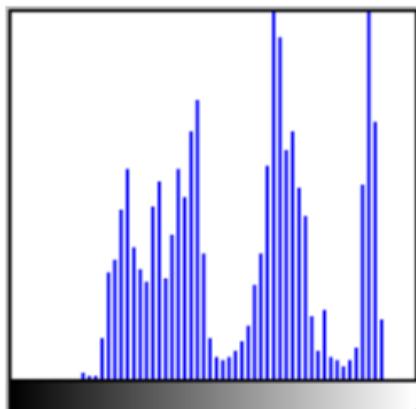
Fig. a)
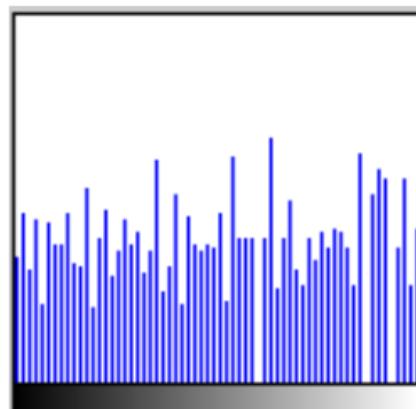
Fig. b)

6. A quantizer has the role of:

a.	Converting a continuous variable into a discrete one	b.	Reading signal samples discretely, at evenly spaced spatial positions
c.	Improving the signal-to-noise ratio of an image	d.	None of the above

7. In natural photographs, the highest energy is concentrated in:

a.	Lowest frequencies	b.	Highest frequencies
c.	Medium frequencies	d.	None of the above

8. JPG compression analyzes images in blocks of _____ pixels in size and selectively reduces the detail within each block.

a. 8 x 8	b.	16 x 16
c. 32 x 32	d.	8 x 16

9. A source of 4 symbols a1, a2, a3, a4 having probabilities P(a1)=0.6, P(a2)=0.2, P(a3)=P(a4)=0.1 are encoded by four different encoding schemes and the corresponding codes are shown below. Which of the following gives us the best coding efficiency?

a. a1 = 00, a2 =01, a3 =10, a4 =11	b. a1 = 0, a2 =10, a3 =110, a4 =111
c. a1 = 00, a2 =100, a3 =1100, a4 =1101	d. a1 = 111, a2 =110, a3 =10, a4 =0

10. Match the following:

a. Hue	1. Amount of color
b. Saturation	2. Intensity
c. Brightness	3. Name of the color

Exercise II: True or False [10 pts]

For each of the following questions, fill the table with true or false.

1	2	3	4	5	6	7	8	9	10

1. Histogram of equalized image has better contrast than the original one.
2. Contrast stretching aims to reduce the contrast of an image.
3. When size of median filter increases, the image becomes more blurred.
4. Apply a max filter on an image twice has the same effect as if the filter is applied one time.
5. Two different images have necessarily two different histograms.
6. DCT is better for compression than DFT.
7. Median filter is more effective than average filter for salt and pepper noise.
8. Using machine intelligence algorithms, it is theoretically possible to search inside video files for a particular person.
9. Huffman and Arithmetic encoding both require symbol frequencies.
10. TV signals are sent in RGB.
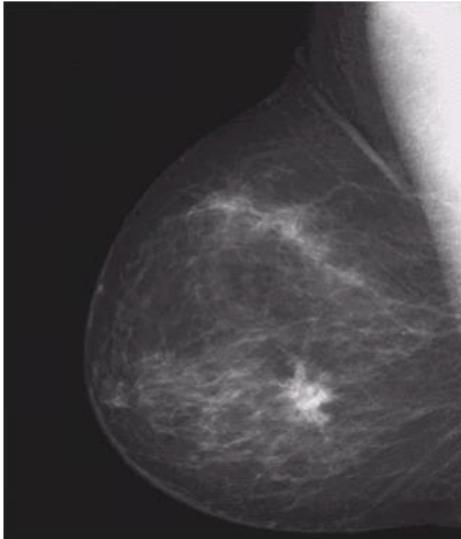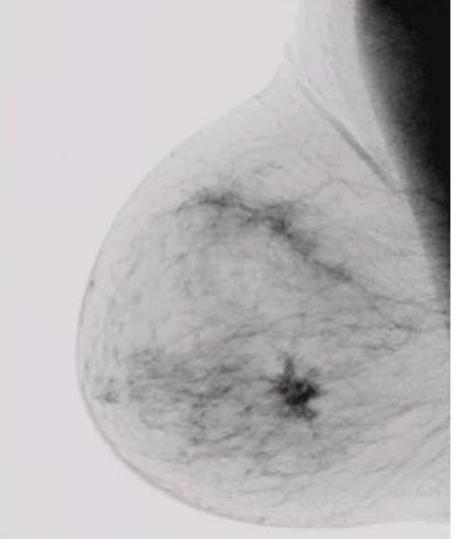
Exercise III: Image Transformations [7 pts]
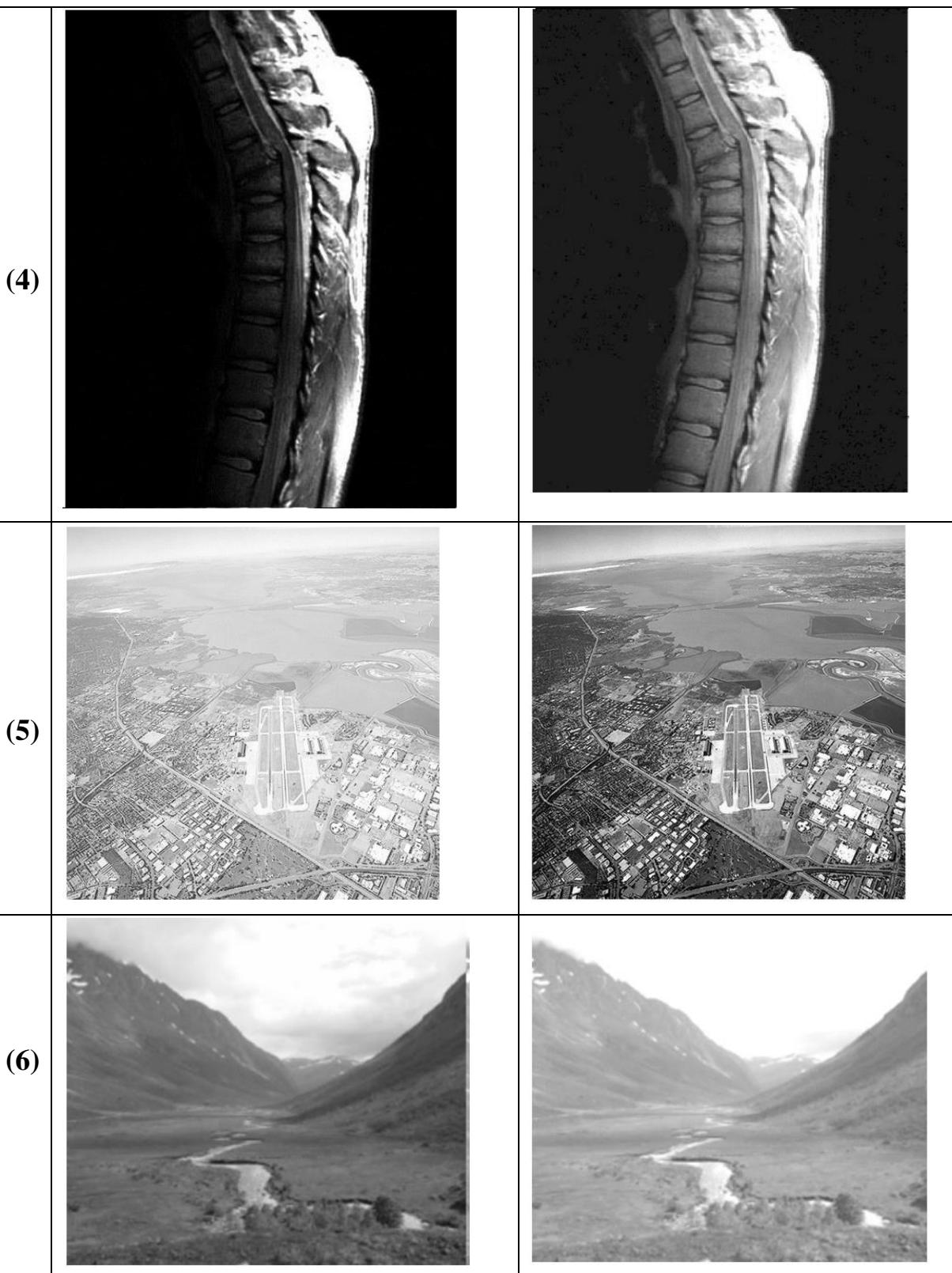
1	2	3	4	5	6	7

Given the table shown below in which the first column contains original images and the second column contains the transformed images. Fill in the table above for each image below, which

transformations among the ones below has been applied on the original image to obtain the transformed one. The transformations used are:

(a) image brightening, (b) image darkening, (c) gamma correction with lambda = 4, (d) gamma correction with lambda = 0.4, (e) equalization, (f) negative, (g) thresholding.

	Original image	Transformed image
(1)		
(2)		
(3)		

(4)		
(5)		
(6)		

(7)	

Exercise IV: Histograms [3 + 4 pts]

A. Given the following three images, associate each of them to one of the histograms below and indicate which one has low contrast, normal contrast or high contrast. Fill your answers in the table below.
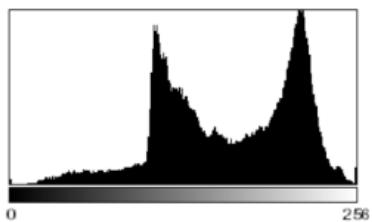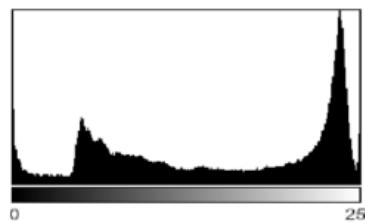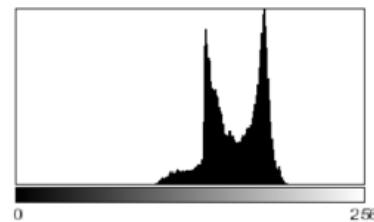

(a) (b) (c)
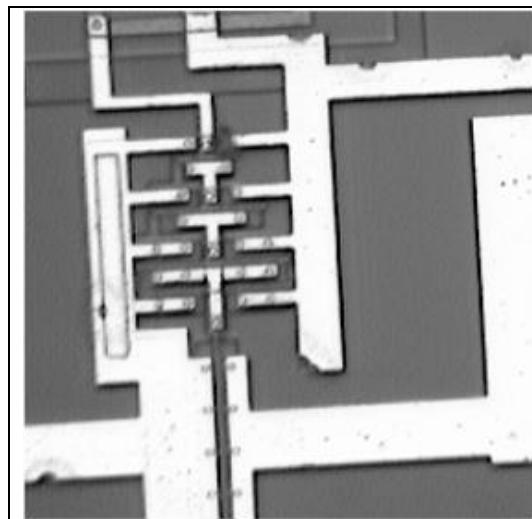
(a) (b) (c)
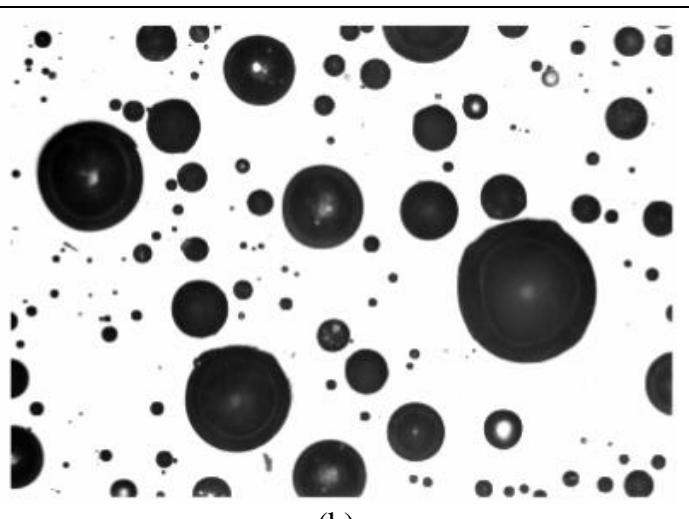
| Image	Histogram	Contrast
(a)		
(b)		
(c)		

Answer table

B. Match each image with the corresponding correct histogram. Fill your answer in the table below.

(a)

(b)

(c)

(d)


(1)

(2)

(3)

(4)
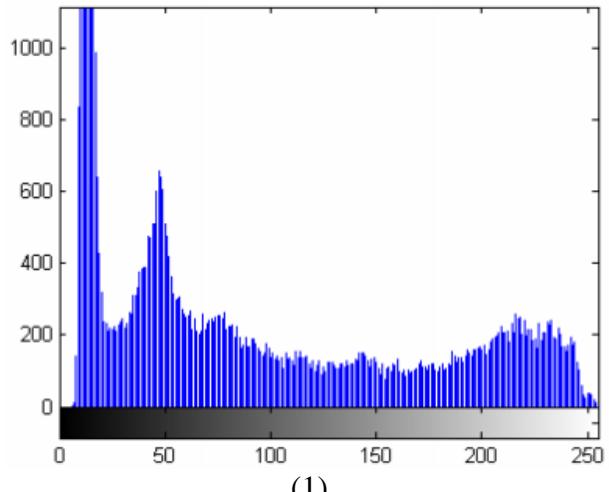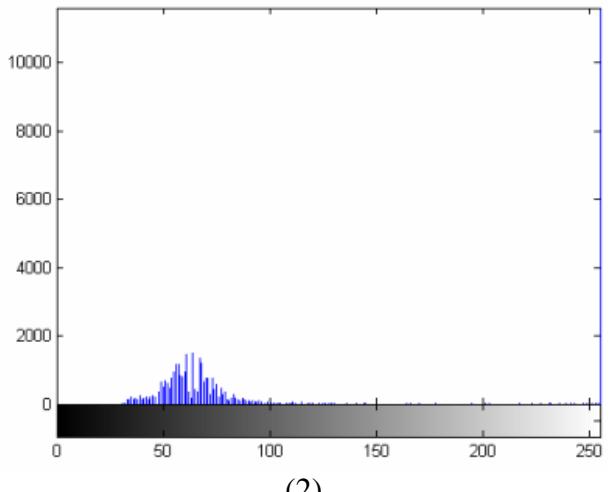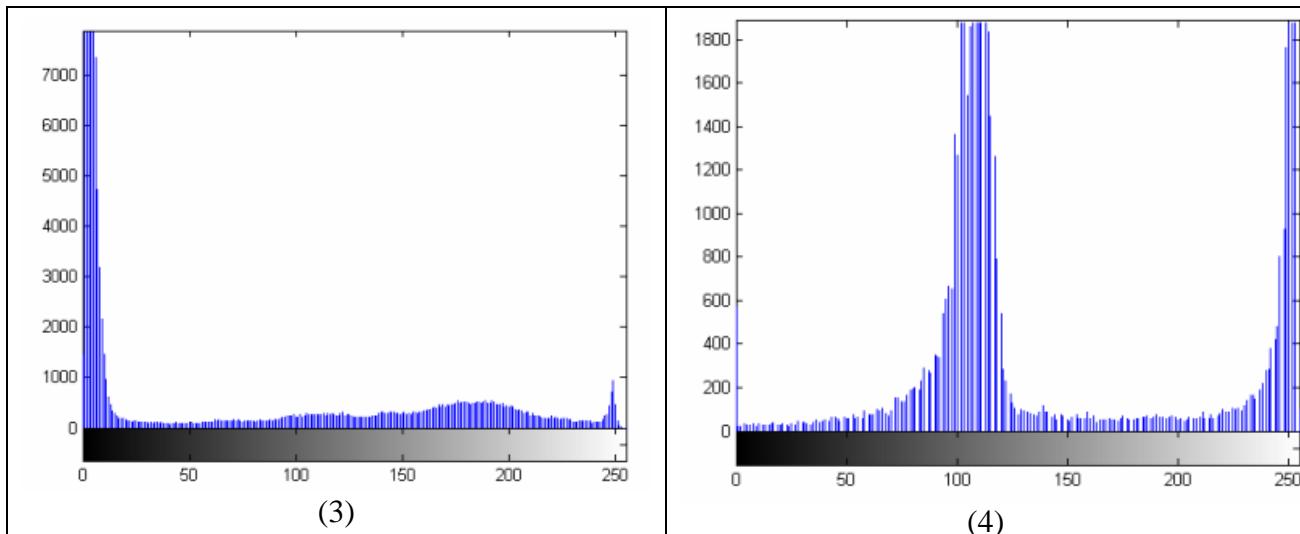
Image	Histogram
(a)	
(b)	
(c)	
(d)	

Answer table

Exercise V: Histogram matching [12 pts]

Given the following histogram in the first table for an image I with 8 gray levels. In the second table, we have the histogram of a second image J.

Gray Level – Image I	0	1	2	3	4	5	6	7
Number of pixels	790	1023	850	656	329	245	122	81

Gray Level – Image J	0	1	2	3	4	5	6	7
pdf	0	0	0	0.15	0.2	0.3	0.2	0.15

a. Compute the pdf for the image I.

b. Compute a distance between the two images I and J based on their pdfs.

c. Apply on image I the matching operation. Take the image J as the target image.

d. Deduce the distance between the image resulted from the part c and the image J.

Exercise VI: Video size [10 pts]

Suppose that you are contacted to project a medium quality videoconference system over multi-campus DSL network supporting an average of 600 Kbps at constant bit rate. In order to achieve and maintain the required bit rate, you can organize the frames into groups (GOPs) of 40 frames each. The format of each frame is 352*288, where the average number of bit per pixel is 10 bits.

1. What is the bit rate of the video stream (before compression)?

2. How many bits are contained in each GOP (before compression)?

3. Each GOP starts with an I frame followed by P and B frames, where three B frames are inserted between P and I frames. What is the number of P and B frames contained in each GOP?

4. Consider that I frames and B frames are compressed with compression ratios 75% and 99.5 % respectively. What should be the compression ratio of P frames in order to maintain the constant bit rate of 600 Kbps.

Exercise VII: Motion Vectors [12 pts]

Consider the encoding of a 640x480 video at 30 fps using I and P frames. To encode the P and B frames, we consider 8x8 macroblocks and a search area of $k = 8$. How many MADs is done to find the best motion vector for each macro-bloc in a P frame if the search method used is:

    a. Sequential search.

    b. Logarithmic search.

    c. Hierarchical with 4 levels.

Suppose now that the search method is the logarithmic one.

    d. How many macroblocks are there in each image.

Consider now 10 minutes of video knowing that one I frame is inserted after every 8 consecutive P frames and there are 4 B frames between each couple of P frames as follows:
I B B B B P B B B B P B B B B P B B B B P B B B B P B B B B I ………

e. How many MADs are done for the 10 minutes of the video.