CS 6643 Computer Vision, Spring 2018, **G. Gerig**

Assignment 1

Out: 2/13/2018

Due: 2/27/2018 (deadline: midnight)

(upload of electronic documents of 1) theoretical part, 2) report of practical part, and 3) zipped file of code, images, resulting images, plots etc.

Late submissions: Late submissions result in 10% deduction for each day. The assignment will no longer be accepted 3 days after the deadline.

Office hours:

		Monday	Wed	Thu	Fri
Guido Gerig	office 10.094	2 - 4pm			
Yida Zhou	yz4499@nyu.edu			1-3pm	
Zebin Xu	zebinxu@nyu.edu		2 - 4pm		
Andrew Dempsey	ad4338@nyu.edu				10 - noon
Monil D. Shah	mds747@nyu.edu	4 - 6pm			

Location: Cubicle spaces in front of my office named 10.098 A,B,D,E,H.

A) Theoretical questions:

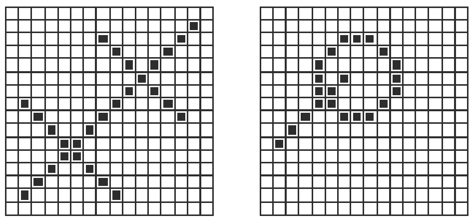
A1) Image formation:

A professional full-frame digital camera uses an image size of 36mm x 36mm and standard focal length of 50mm. Let us say that the square sensor provide 16 megapixels. Now you buy smartphone with a 16 megapixel sensor (assuming a square image too), but given a focal length of 4mm so that the phone fits into your pocket.

- Using the pinhole camera projection equation, calculate the size of the light-sensitive image sensor of your smart-phone. Calculate the ratio of this size relative to the professional camera sensor size.
- Calculate the size of a sensor pixel element for the professional and your smart-phone cameras. Provide a short discussion of eventual advantages/disadvantages of your resulting measures, and reasons why some professionals or amateurs favor more expensive large cameras.
- Calculate the storage requirement assuming storage of raw images with color RGB channels, for both cameras.

A2) Connectivity foreground/background

One solution to digitization paradoxes is to mix connectivities. Using 8-neighborhood for foreground and 4-neighborhood for background, examine the paradoxes shown in the book (Fig. 2.7). Discuss the number of components of fore- versus background given this choice. Also discuss the #of components when either using 4-n (and also 8-n) for both fore- and background, and when reversing the notion and using 8-n for background and 4-n for foreground. You can discuss in words and also include sketches of your thoughts to this section.

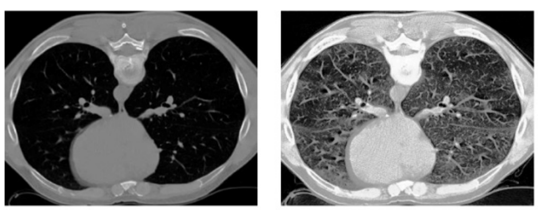


(a) (b)

Figure 2.7: Paradoxes of crossing lines. © *Cengage Learning 2015.*

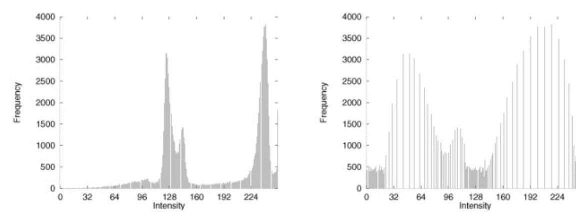
A3) Histogram equalization

Remember the main goal of histogram equalization to result in a uniform intensity distribution (histogram). Below you see the images from the book referring to image equalization. Explain why the histogram of a discrete image is not flat after histogram equalization. (Hint: You may first work on the practical part to get a closer insight).



(a) (b)

Figure 5.3: Histogram equalization. (a) Original image. (b) Equalized image. © *Cengage Learning 2015.*



(a) (b)

Figure 5.4: Histogram equalization: Original and equalized histograms corresponding to Figure 5.3a,b. © *Cengage Learning 2015.*

Instructions on theoretical part:

- You can use pencil/paper but also word processing to write, sketch and graph your solutions. Clearly indicate which questions you anwer.
- Please provide readable writing so that our TA's can clearly understand your results.
- After finishing your report, please use document scanning (e.g. CamScanner or your choice on smartphones or scanner) to scan your solutions.
- Concatenate scanned images into a single document/report which includes your name and ID at the top, convert into an Acrobat pdf format, and upload as your report to NYU classes.
- Work on your own: Please remember NYU's honor code: Any copyright violation such as copying code, using code from existing sources, copying text, or plagiarism will violates the honor code.

B) Practical programming assignments:

B1) Compute a Histogram and CDF

Write code that reads a 2D image as input and returns a 1D array of the relative frequencies of occurrence of greylevels in your image. Provide a choice for quantizing a binning of the greylevels into *n* quantized bins between 0 and the maximum value (please remember that for an 8bit image, this is the range 0 … 255 for the range 0 … L-1).

- Calculate the histogram of an image of your choice, please note that a color image first needs to be converted into black-and-white.
- Normalize the histogram by the image size to present a probability density function (pdf), plot the pdf.
- Calculate the cumulative distribution function CDF from your pdf and plot the function.
- Creatively experiment with a second image that may show different structures.
- Write a short report that shows the original images, and the corresponding pdf and CDF plots. Provide a short discussion if the shape of the histograms that may reflect some of the visible properties of the image, and discuss differences between results from the two images.

B2) Histogram Equalization

Use the histogram code as developed above, and provide an additional function for histogram equalization.

- Follow instructions as in the book and course notes to calculate the histogram, pdf, CDF and then a binning of the frequency axis into *n* bins that determines the mapping of intensities to form a uniform distribution.
- Apply your histogram equalization code to the images used before. Calculate and plot the new histogram after equalization.
- Add an additional section to the report by showing images, pdf's and CDF's before/after equalization. Briefly discuss what you see in the histogram equalized images and the corresponding plots of pdf's and CDF's.

B3) Histogram Matching

Following the course notes, develop code that maps intensity values of a preferably bad image into intensity distribution of a good looking image.

- Select an image with somewhat poor contrast or visibility of structures. Select a second image which looks good.
- Calculate histograms, pdf's, CDF's of both images. Follow course instructions to map the intensity distributions of the first image into those of the second image (histogram matching).
- Add a section to the report that shows original images and plots of pdf's and CDF's. Then show the results of the adjusted first image, and its pdf and CDF's.
- Provide a short discussion of what you see and if the procedure resulted in the anticipated result.

Instructions practical part:

- You can use Matlab or python to solve these questions.
- Use your own images taken with your camera/smart-phone whenever possible to personalize the assignment, but feel free to also image data from the web if you prefer.
- Your submission to NYUclasses should include:
    - A report (e.g. pdf format) of your report including your name and ID at the top, images, plots, and some short description and critical discussion of your results – just enough that a reader can follow what you did and what you think about your results.
    - A zip file of your code, images, plots etc, just the whole material which you used zipped into an archive.
- Work on your own: Please remember NYU's honor code: Any copyright violation such as copying code, using code from existing sources, copying text, or plagiarism will violates the honor code.