ENGI 7854/9804 Image processing and applications (Spring 2020)

Assignment 1; Total Marks : 50, each question worth 10 Marks

Submit your assignment to the appropriate dropbox folder.

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1. A CCD camera chip of dimensions 7mm×7mm, and having 1024×1024 elements, is focused on a square, flat area, located 0.5 m away. How many line pairs per mm (rounded to the nearest integer) will this camera be able to resolve? The camera is equipped with a 35 mm lens. Assume an ideal pinhole camera model.

2. An image was scaled, rotated and translated, and the affine transformation matrix was found to be as follows :

$$A = \begin{bmatrix} 0.25 & 0.433 & 0 \\ -0.2598 & 0.15 & 0 \\ 50 & 75 & 1 \end{bmatrix}$$

   Calculate the translation, angle of rotation and scale in both the x and y axis

3. An image with intensities in the range [0,1] has the PDF $p_r(r)$ shown in the following diagram. It is desired to transform the intensity levels of this image so that they will have the specified $p_z(z)$ shown. Assume continuous quantities and find the transformation (in terms of r and z) that will accomplish this.

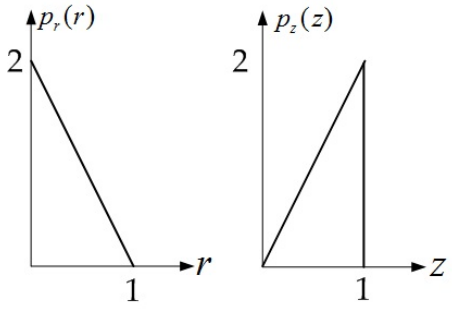
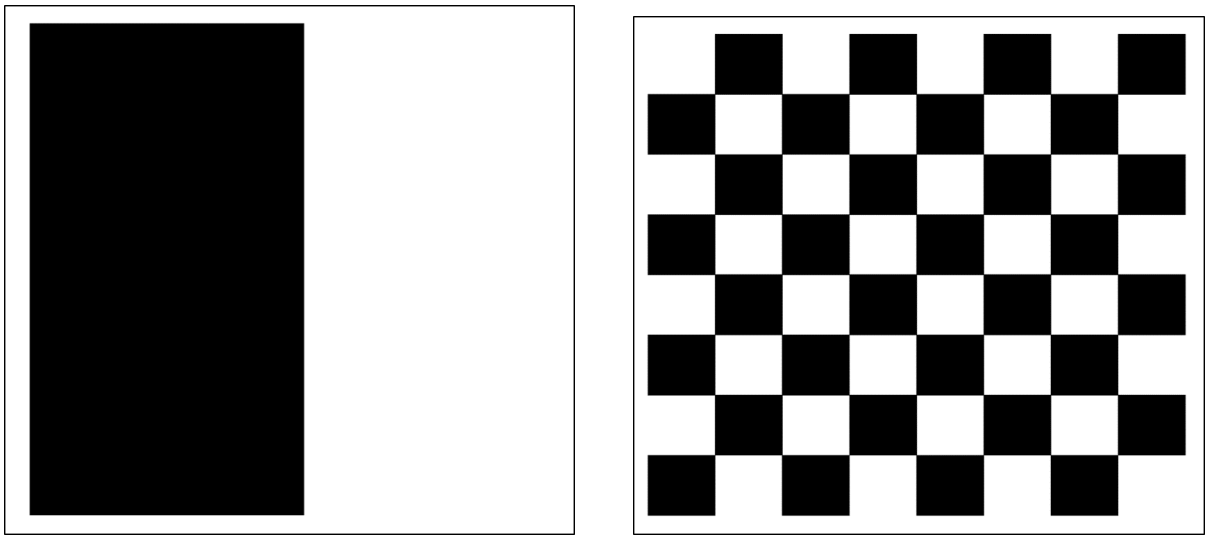


Figure 2

4. The images shown below are quite different, but their histograms are the same. Note that the black border and white padding around the images is only to aid in their display. The left image boundary is tight to the black and white rectangles (of equal size), and the right image boundary is tight to the outer black and white squares. Suppose that each image is blured with a 3×3 averaging mask.

   (a) Would the histograms of the blured images still be equal? Explain

   (b) If your answer is no, sketch the two histograms.



5. Design a fuzzy, rule-based system for reducing the effects of impulse noise on a noisy image with intensity values in the interval [0, L-1]. As in lecture (using fuzzy sets for spatial filtering), use only the differences d_2, d_4, d_6, and d_8, in a 3×3 neighborhood in order to simplify the problem. Let z_5 denote the intensity at the center of the neighborhood, anywhere in the image. The corresponding output intensity values should be $z_5' = z_5 + v$, where v is the output of the fuzzy system. That is, the output of the fuzzy system is a correction

factor used to reduce the effect of noise spike that may be present at the center of 3×3 neighborhood. Assume that noise spikes occur sufficiently apart so that you need not to be concerned with multiple noise spikes being present in the same neighborhood. The spikes can be dark or light. Use triangular membership function throughout. Consider the lecture on "Spatial Filters - Part 2", slides 43, 46 and 47 (page 20, 24 and 25).

(a) Give three fuzzy statements for this problem using positive (PO), negative (NE) and zero (ZR), with the differences d_i and fuzzy system output v.

(b) Specify the three fuzzy statements as the mininimum number of IF-THEN and ELSE rules.

(c) Specify the membership functions graphically.

(d) Show a graphical representation of the rule set.