Département de génie électrique et de génie informatique
Faculté des sciences et de génie

Vision numérique
GIF-4100 / GIF-7001

Date November 10, 2015
Local PLT-2548
Heure 13h30 - 16h20

Partial Exam 2 A2015

All documents allowed except the Internet

Question 1. (20 points) Radiometry

Consider the geometry in Figure 1 showing a point source of intensity 10 000 lux which illuminates a Lambertian surface element dA_1 having an area of 0.1 m^2 and a BRDF p = 0.0155. The surface element dA_1 diffuses the light towards a surface element dA_2 having an area of 0.1 m^2. What is the illuminance received by dA_2? Please provide the details of the steps involved in your calculation.

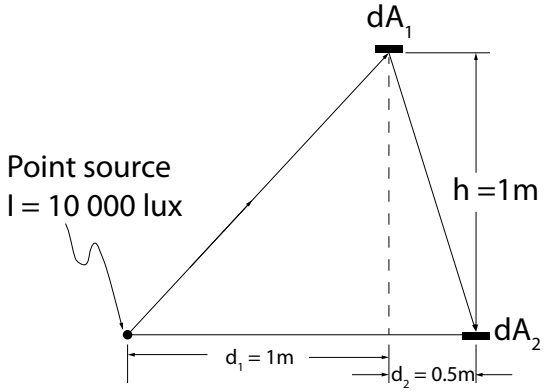

Figure 1. Geometry of Question 1

Question 2. (15 points) Median filtering

Consider the line in the image shown in Figure 2 (a). The numbers represent the discrete illuminance on a dynamic range of 8 bits in each pixel of the line. We would like to reduce the effects of impulse noise on this line by applying a median filter whose kernel is shown in Figure 2 (b). On the kernel, symbol x represents the center pixel of the filter. Provide the result of filtering and explain your answer.

015	015	015	020	125	015	022	017	215	215	010

(a)

	X	

(b)

Figure 2. (a) Line of the image (b) Kernel of the median filter

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Question 3. (15 points total) Detection of illuminance discontinuities

A. (5 points) Consider the illuminance signal showing a "jump" discontinuity inFigure 3 (a). What is the signal that will result from the application of discontinuities detection operator -1 0 1 on this signal? Is this operator adequate to detect the discontinuity? Explain your answer.

B. (5 points) Now consider the illuminance "plateau" signal in Figure 3 (b). What is the signal resulting from the application of discontinuities detection operator -1 0 1 on the signal? Is this operator adequate to detect the discontinuity? Explain your answer.

C. (5 points) Now consider the illuminance signal showing a discontinuity of the type "roof" in Figure 3 (c). What is the signal resulting from the application of discontinuities detection operator -1 0 1 on the signal? Is this operator adequate to detect the discontinuity? Explain your answer.

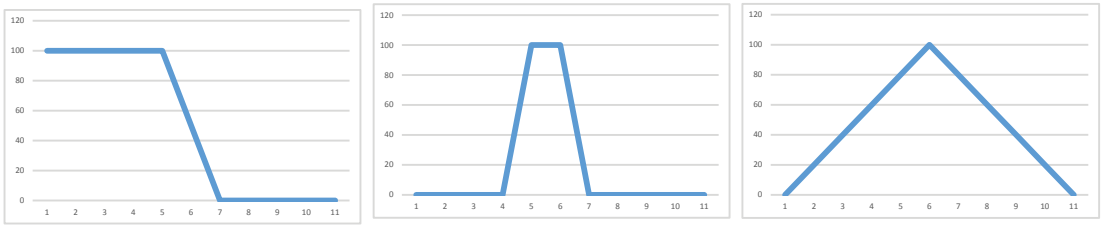

Figure 3. (a) Signal "jump", (b) Signal "plateau" (c) Signal "roof" of Question 3

Question 4. (15 points) Nonlinear Filtering

Consider the binary signal in Figure 4. What dilation mathematical morphology structuring element is sufficient to fill the hole formed by "0" values? Explain your answer.

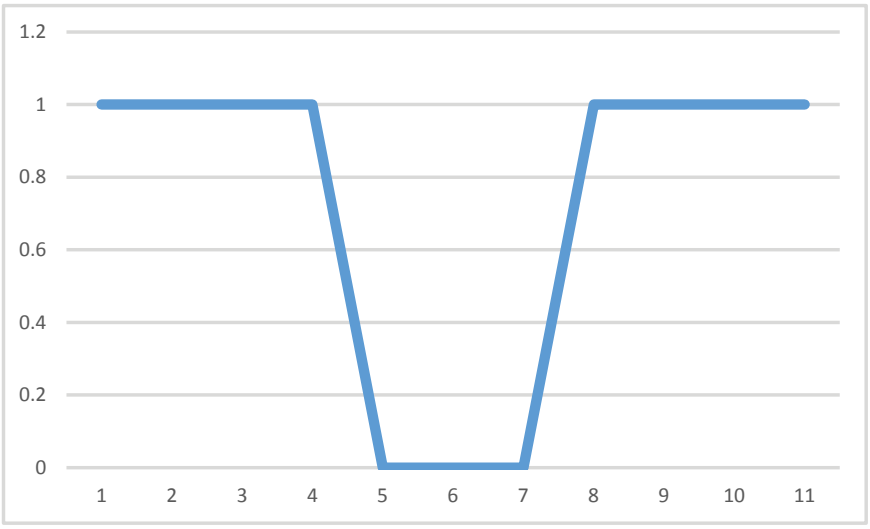

Figure 4. Binary signal of Question 4

Question 5. (15 points) SIFT descriptor

Briefly describe the steps for calculating the SIFT descriptor.

Question 6. (20 points) Stereoscopic Reconstruction

Consider the stereoscopic geometry in a canonical position (i.e. with parallel optical axes) in Figure 5. The disparity is defined as $d = x_d - x_g$, where x_d and x_g are respectively the image coordinates of an object point located at a distance z from two cameras (assume that the y coordinates are zero (i.e. in the plane of the page)).

From the above definition and the geometry of the problem, derive the expression of z as a function of the disparity d, of the focal length F of the pinhole cameras, and the separation Δ between the two pinhole cameras.

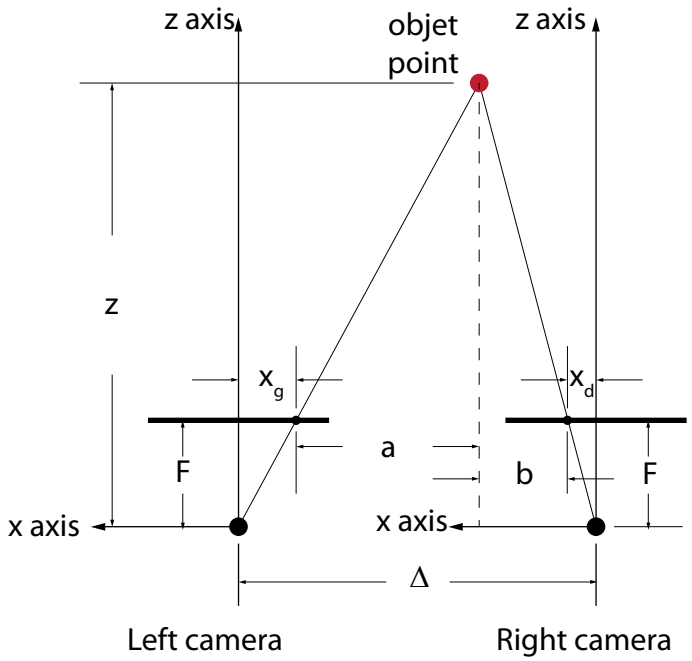

Figure 5. Geometry of Question 6