(1) (20 points) Suppose that two images shown in Fig. 1 have the same size.

Fig. 1(a)

Fig. 1(b)

(a) (15 points) Please describe how to obtain Fig. 1(b) from Fig. 1(a).
(b) (5 points) Is it possible to warp Fig. 1 (b) back to Fig. 1(a) perfectly? Why or why not?

(2) (35 points)
(a) (10 points) Let $H(u,v)$ be an ideal low-pass filter with cutoff frequency D. Please write down its mathematical expression and describe how it is performed on a given image of size M×N.
(b) (10 points) Please explain why the ideal low-pass filter causes ringing artifact in the spatial domain by applying inverse Fourier transform to the ideal low-pass filter described in (a).
(c) (15 points) Suppose $H_1(u,v)$ is an ideal low-pass filter with cutoff frequency D_1 and $H_2(u,v)$ is another with cutoff frequency D_2, where $D_1 > D_2$. Which filter results in more blurring effect and which one causes more ringing artifacts? Why?

(3) (20 points)
(a) (5 points) What is the difference between gradient and Laplacian operators for edge detection?
(b) (5 points) What is the difference between global and local histogram equalization?
(c) (10 points) What is K-means clustering? What criterions state a good clustering method?

(4) (25 points)
Given an image with impulse noise as shown in Fig. 2. Please complete the following tasks with detailed descriptions.

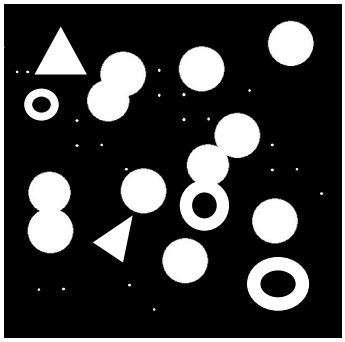

Fig. 2

(a) (5 points) Please design a filter to remove the impulse noise.
(b) (10 points) Please design a method to extract the boundaries of objects.
(c) (10 points) Please design a method to count the number of objects.