

資訊網路與多媒體研究所

博士班基本學科考試：數位影像處理

Oct. 2, 2008

1. (30%)
 - (a) Give one example of linear and median noise cleaning techniques.
 - (b) Compare opening and closing operations in morphological processing.
 - (c) Please compare the spatial-domain and frequency-domain image enhancement techniques.
 - (d) For k-means algorithm, what criteria state a good classification?
 - (e) Consider the application of the skeletonizing operation to a binary image. Is it possible to reconstruct the original image from the skeletonized image? Please explain why or why not.
 - (f) Suppose we apply the spatial warping technique to obtain a disk image D from a square image A, can we perform inverse warping to get a square image B from D? Is there any difference between the original image A and image B? If so, please explain the source of difference.

2. (25%)

Consider a gray-level image $F(i, j)$ that has the following histogram distribution:

$$H(x) = \begin{cases} x & \text{if } x \in \{0, 1, \dots, 64\} \\ 3x - 128 & \text{if } x \in \{64, 65, \dots, 255\} \\ 0 & \text{otherwise} \end{cases}$$

- (a) Is $F(i, j)$ a square image? Why?
- (b) Find the average gray level of $F(i, j)$.
- (c) Find the cumulative histogram distribution of $F(i, j)$.
- (d) Find the histogram distribution $\tilde{H}(x)$ after applying histogram equalization to $F(i, j)$.
- (e) One student, John, uses the inverse function to enhance the image, i.e. $G(i, j) = 1 / F(i, j)$. He claims the histogram distribution of $G(i, j)$ is

$$\hat{H}(x) = 1 / H(x)$$

Is it correct? Please explain your answer.

3. (25%)

(a) Let $A(211,396)=18$, $A(211,397)=45$, $A(222,396)=52$, and $A(222, 397)=36$.

What is $A(211.3,396.7)$ obtained by bilinear interpolation?

(b) An original image of size 256×256 is manipulated by the following operations:

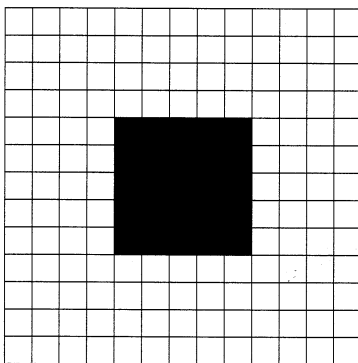
(i) rotate by 30 degrees counterclockwise about pixel $(\text{row}, \text{column})=(240,10)$

(ii) magnify by 37% larger than the original

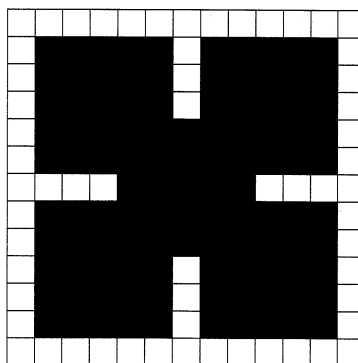
(iii) shift the obtained image such that the output image are bounded by the top and left boundary of the original image

Please give the transformation matrix for each step respectively, and the combined matrix of three operations.

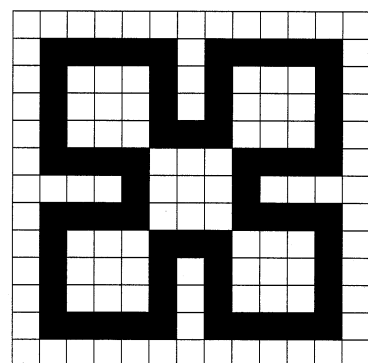
4. (20%) Please design morphological filters for binary images, where a white pixel represents 0 and a black pixel represents 1, respectively. You may use union (\cup), intersection (\cap), complement (\sim), exclusive-OR (XOR), and translation ($T_{r,c}\{F(j,k)\}$) as basic bit-wise operations. You may also use the structuring element. You should assume zero-padding if boundary extension is needed.



A



B



C

(a) Design a morphological processing algorithm to convert binary image A to binary image B.

(b) Design a morphological processing algorithm to convert binary image A to binary image C