博士班基本學科考試：數位影像處理
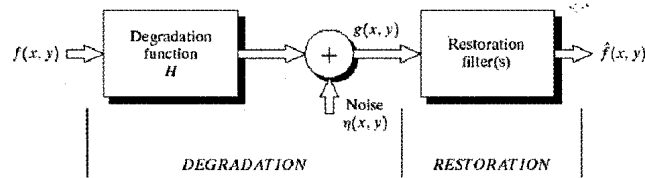
1. **(40%)**

   (i) (10%) What is bilinear interpolation?

   (ii) (10%) What is alpha-trimmed filter?

   (iii) (10%) What is zero-phase-shift filters?

   (iv) (10%) What is Butterworth Lowpass Filter (BLPF)?

2. **(20%)** Consider the following model of the image degradation and restoration process.

   It can be shown that the optimal reconstructed image is the inverse Fourier transform of $\hat{F}(u,v)$, known as the Wiener filter, where

   $$\hat{F}(u, v) = \left[\frac{H^*(u, v)S_f(u, v)}{S_f(u, v)|H(u, v)|^2 + S_\eta(u, v)} \right] G(u, v)$$

   (i) (10%) This reconstructed image is optimal in which sense? More precisely, what is the criterion that is minimized in order to find this optimal solution?

   (ii) (10%) When does the above filtering process reduce to inverse filtering? Why?

3. **(10%)** Please design a morphological filter for Fig. 3.1 to Fig. 3.2. Explain your procedure.

Fig. 3.1   Fig. 3.2

4. **(15%)** What is full-scale histogram stretch? What is histogram equalization? What is their difference when used for image enhancement?

5. **(15%)** Steve applied five different filters to the image shown in (a), and obtained the output images shown in (b)-(f).

   (i) Can you tell what filters were used to obtain each of the output images? Please describe in details each of the filters you think that were used, and explain the reason of your inference

   (ii) How can the corners of the white bars in (b) become "curved", while the edge is still sharp?

   (iii) Can you modify the filter, which was used to generate the result in (b), so that it can be used to preserve both the corners and the edges while still being able to reduce the noise? How?

(a)   (b)   (c)

(d)   (e)   (f)