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Question 1

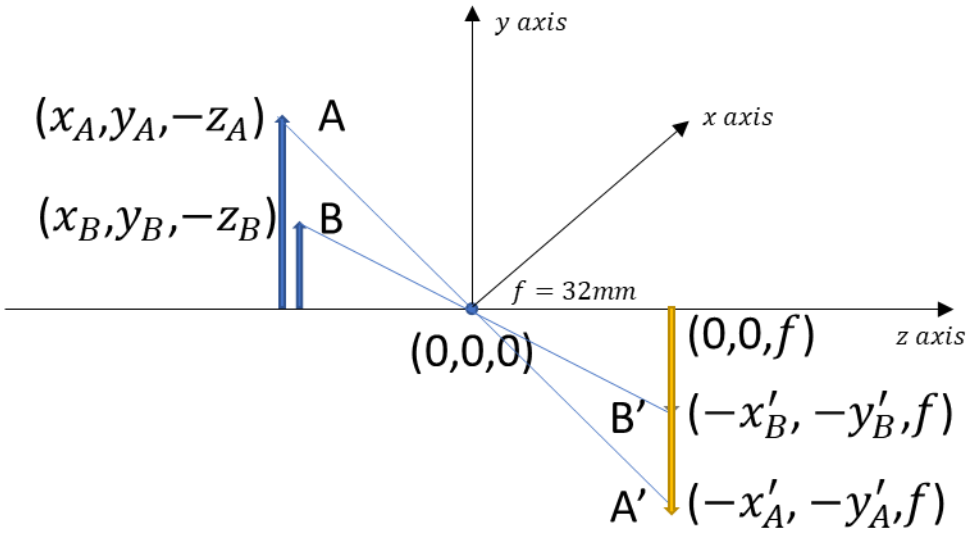

Fig 1 The Pinhole Projection Model

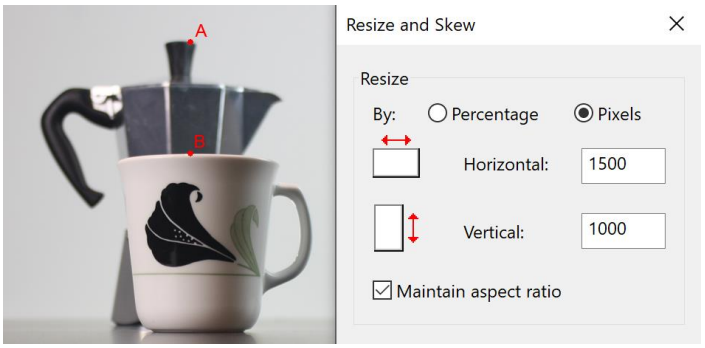

Fig 2 The Pixel Size of the Photo

As shown in Fig 2, the horizonal pixel size is 1500px and sensor size is 22.2mm. Hence,

$$mm\ px\ ratio = \frac{22.2mm}{1500px} = 1.48 \times 10^{-2} mm/px$$

Similarly, the vertical pixel size is 1000px and sensor size is 14.8mm. Hence,

$$mm\ px\ ratio = \frac{14.8mm}{1000px} = 1.48 \times 10^{-2} mm/px$$

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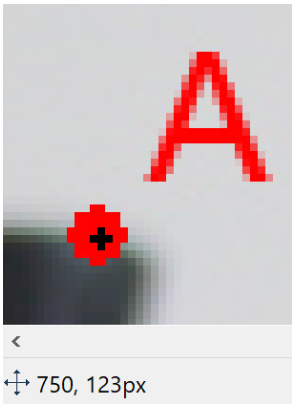

Fig 3 Location of Point A in Pixel

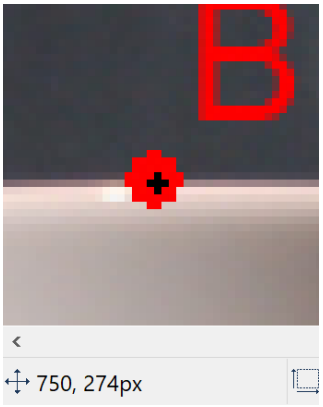

Fig 4 Location of Point B in Pixel

$$f = 32mm$$

From Fig.2, The centre of the image is 750, 500px. Hence,

$$x'_A = 750px - 750px = 0$$

$$x'_B = 750px - 750px = 0$$

$$y'_A = 500px - 123px = 377px = 377 \times 1.48 \times 10^{-2}mm \approx 5.58mm$$

$$y'_B = 500px - 274px = 226px = 226 \times 1.48 \times 10^{-2}mm \approx 3.34mm$$

From the lecture slides & figure 1,

$$\frac{x_A}{x'_A} = \frac{y_A}{y'_A} = \frac{z_A}{f}$$

Hence,

$$x_A = x'_A \frac{y_A}{y'_A} = 0, z_A = f\frac{y_A}{y'_A} = 32\frac{215}{5.58} = 1232.97mm$$

Similarly,

$$x_B = 0, z_B = f\frac{y_B}{y'_B} = 32\frac{90}{3.34} = 862.28mm$$

In conclusion,

$$Point\ A = (0, 215, -1233)$$

$$Point\ B = (0, 90, -862)$$

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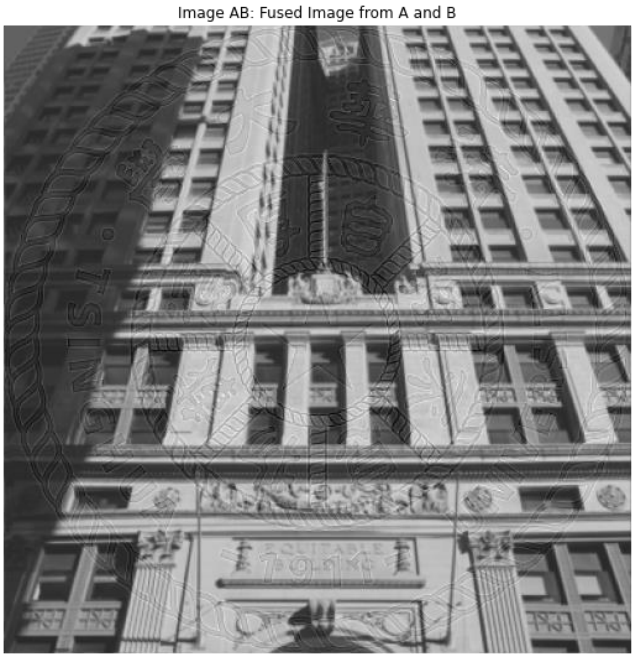
Question 2



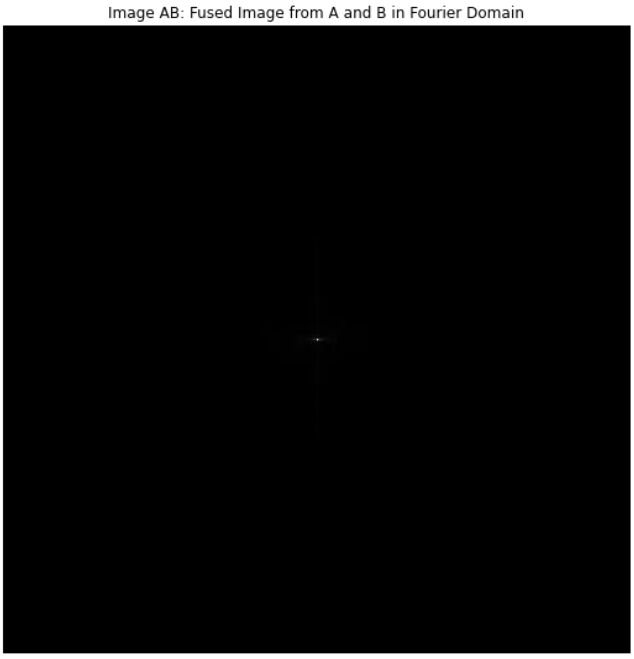


Fig2.1 The Final Result of Fused Image A & B

$$Final\ Threshold\ of\ the\ Low\ Pass\ Filter = 105$$

$$Final\ Threshold\ of\ the\ High\ Pass\ Filter = 115$$

Fig2.2 The Result of Too Low Threshold of LPF = 50

As shown in Fig 2.2, if the threshold of LPF is too low, the resulting image will become very ambiguous. This is because the LPF filters out too much information from image B, especially on the edges of the patterns, where the high frequency components exist.

Fig2.3 The Result of Too High Threshold of HPF = 200

As shown in Fig 2.3, if the threshold of HPF is set too high, the image A could not be seen from the fused image AB. In this case, the HPF filtered out too much low frequency components and the high frequency parts left over could not reach human's eyes after the fusion.

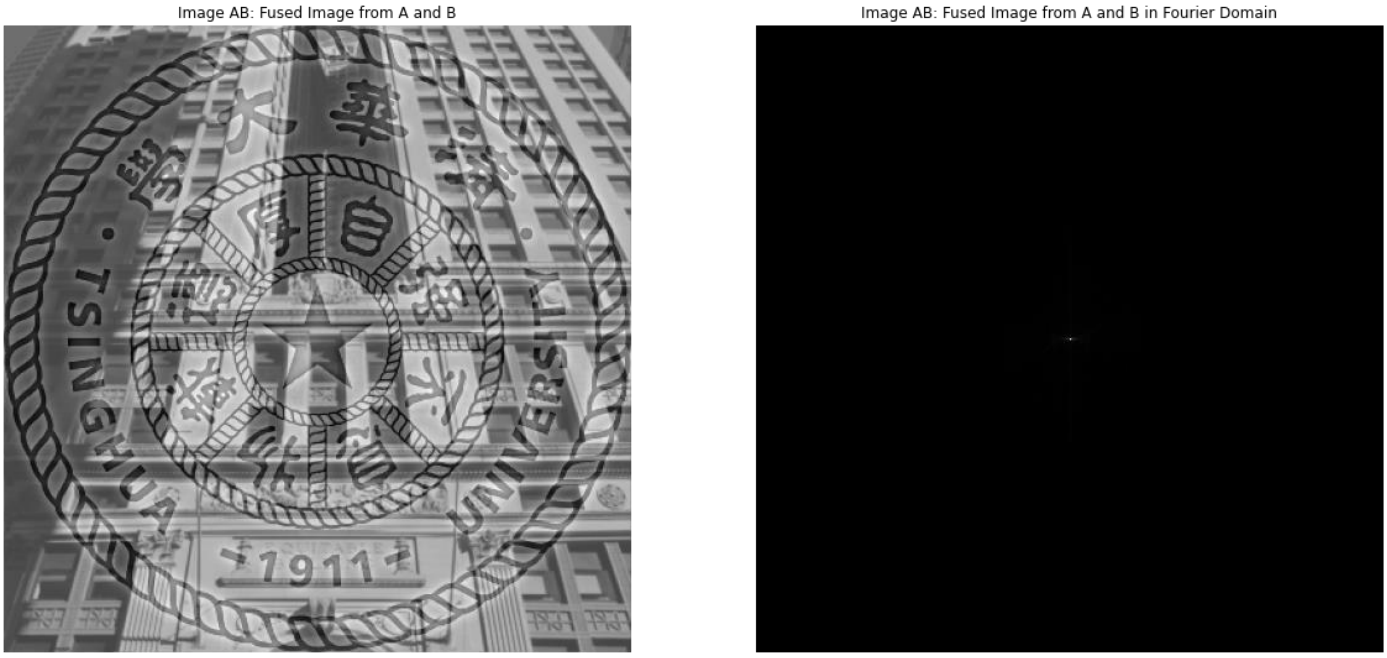


Fig2.4 The Fused Result with HPF & LPF Threshold Overlapping HPF = 20 LPF=100

As shown in Fig 2.3, if the threshold of LPF is larger than HPF, the image A won't disappear from the fused image if looking from a distance. This is because looking from a distance acts like applying a low pass filter to the image. As shown in Fig 2.5, if the $Threshold_{LPF(B)} > Threshold_{HPF(A)}$, it is impossible to tune thresholds so that all the component of image A disappears while image B keep the same if looking from the distance (applying the LPF). If

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$Threshold_{LPF(B)} < Threshold_{HPF(A)}$, as shown in Fig 2.6, the thresholds can be found easily as long as they stays on the each side of the LPF(look from distance) threshold.

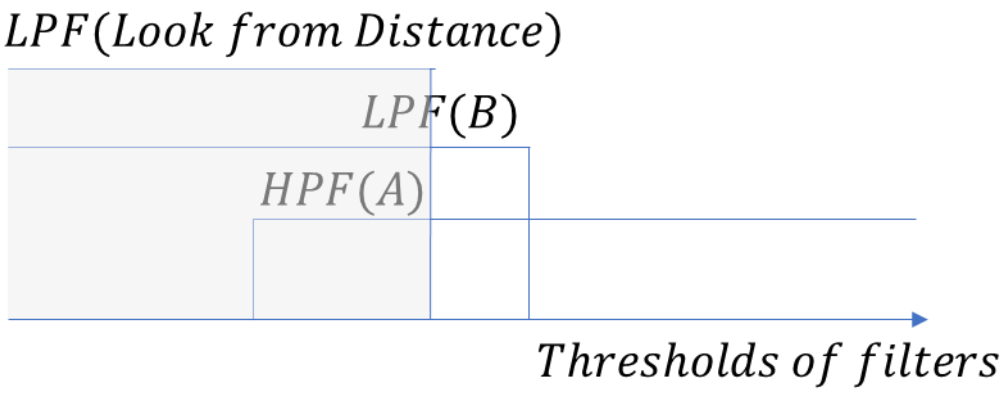

Fig 2.5 Component of Image A Remains after the LPF if $Threshold_{LPF(B)} > Threshold_{HPF(A)}$

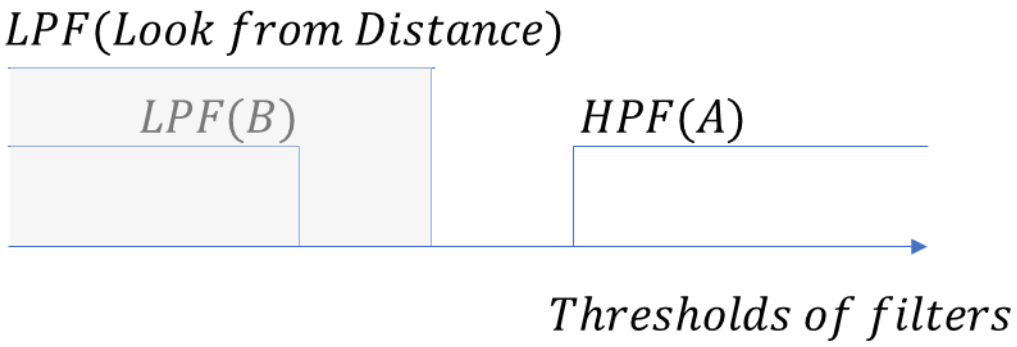

Fig 2.6 Component of Image A can be Removed after the LPF if $Threshold_{LPF(B)} < Threshold_{HPF(A)}$