Principles and Applications of Digital Image Processing

Hw2

Part 1:

2.5

(a) pixel size = 5 cm / 2048 ≈ 0.0244 mm/pixel ≈ 10.245 line pairs /mm

(b) ppi = 1024 ⇒ dpi has to be larger than 1024 to print it clearly.

2.12

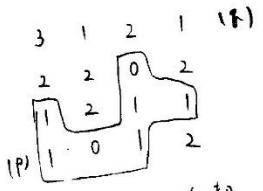
$i(x,y) = K e^{-[(x-x_0)^2+(y-y_0)^2]} = f(x,y)$ based on lecture 02-55

I think K = 5

2.18

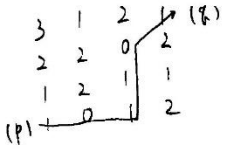
(a) V = {0, 1}

4-adjacency



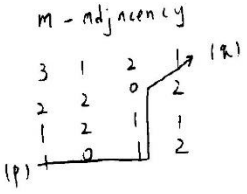
(q) 相上下左右都不屬於 V，故一定到不了

8-adjacency



length = 5

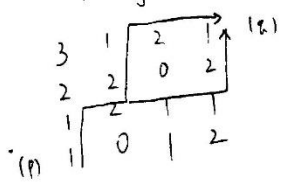
m-adjacency



length = 5

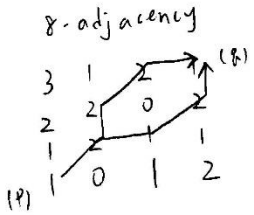
(b) V = {1, 2}

4-adjacency



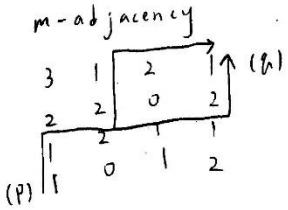
length = 6

8-adjacency



length = 4

m-adjacency



length = 6

2.36

(a) scaling and translation = $\begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} c_x & 0 & 0 \\ 0 & c_y & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{pmatrix} c_x & 0 & t_x \\ 0 & c_y & t_y \\ 0 & 0 & 1 \end{pmatrix}$ #

(b) scaling, translation and rotation = $\begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} c_x & 0 & t_x \\ 0 & c_y & t_y \\ 0 & 0 & 1 \end{pmatrix}$

$= \begin{pmatrix} c_x\cos\theta & -c_y\sin\theta & t_x\cos\theta - t_y\sin\theta \\ c_x\sin\theta & c_y\cos\theta & t_x\sin\theta + t_y\cos\theta \\ 0 & 0 & 1 \end{pmatrix}$ #

(c) vertical shear, scaling, ... = $\begin{pmatrix} 1 & s_h & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} c_x\cos\theta & -c_y\sin\theta & t_x\cos\theta - t_y\sin\theta \\ c_x\sin\theta & c_y\cos\theta & t_x\sin\theta + t_y\cos\theta \\ 0 & 0 & 1 \end{pmatrix}$

$= \begin{pmatrix} c_x(\cos\theta - s_h\sin\theta) & c_y(\sin\theta - s_h\cos\theta) & t_x(\cos\theta + s_h\sin\theta) + t_y(\sin\theta \\ c_x\sin\theta & c_y\cos\theta & t_x\sin\theta + t_y\cos\theta \\ 0 & 0 & 1 \end{pmatrix}$ $s_h\cos\theta)$

(d) Sure, tanslation and scaling = $\begin{pmatrix} c_x & 0 & 0 \\ 0 & c_y & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} c_x & 0 & c_x t_x \\ 0 & c_y & c_y t_x \\ 0 & 0 & 1 \end{pmatrix}$

3.1:

$p_1(r) = -2r + 2 = (-2 \;\; 2) \begin{pmatrix} r \\ 1 \end{pmatrix} \mapsto [v]_B$

$p_2(z) = 2z = (2 \;\; 0) \begin{pmatrix} z \\ 1 \end{pmatrix} \mapsto [v]_{B'}$

$2z = -2r + 2$

$z = -r + 1$

3.21

(a) $f * w = \begin{pmatrix} 9 & 12 & 12 & 12 & 9 \\ 12 & 16 & 16 & 16 & 12 \\ 12 & 16 & 16 & 16 & 12 \\ 12 & 16 & 16 & 16 & 12 \\ 9 & 12 & 12 & 12 & 9 \end{pmatrix}$

(b) No, cuz f & w are symmetric.

以上兩圖為手寫後經掃描再二元化，有點模糊請見諒。

Part 2: Image File Reading, Display and Basic Processing

Gui overview

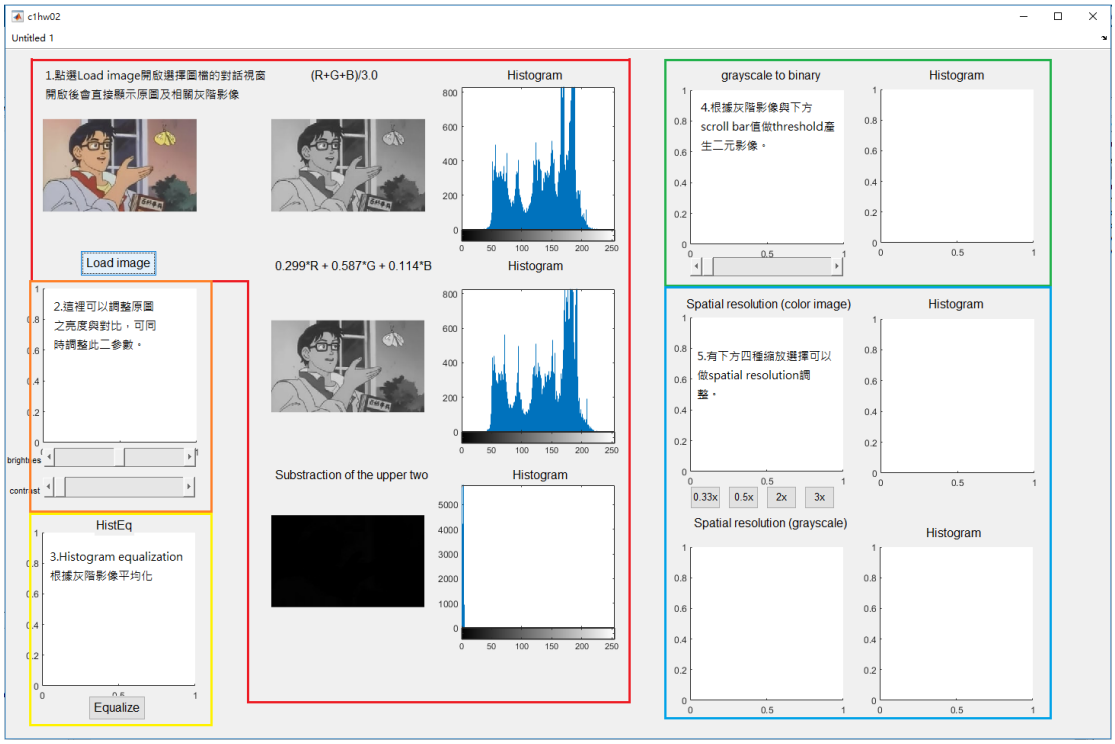


Figure 1 設計基本介紹

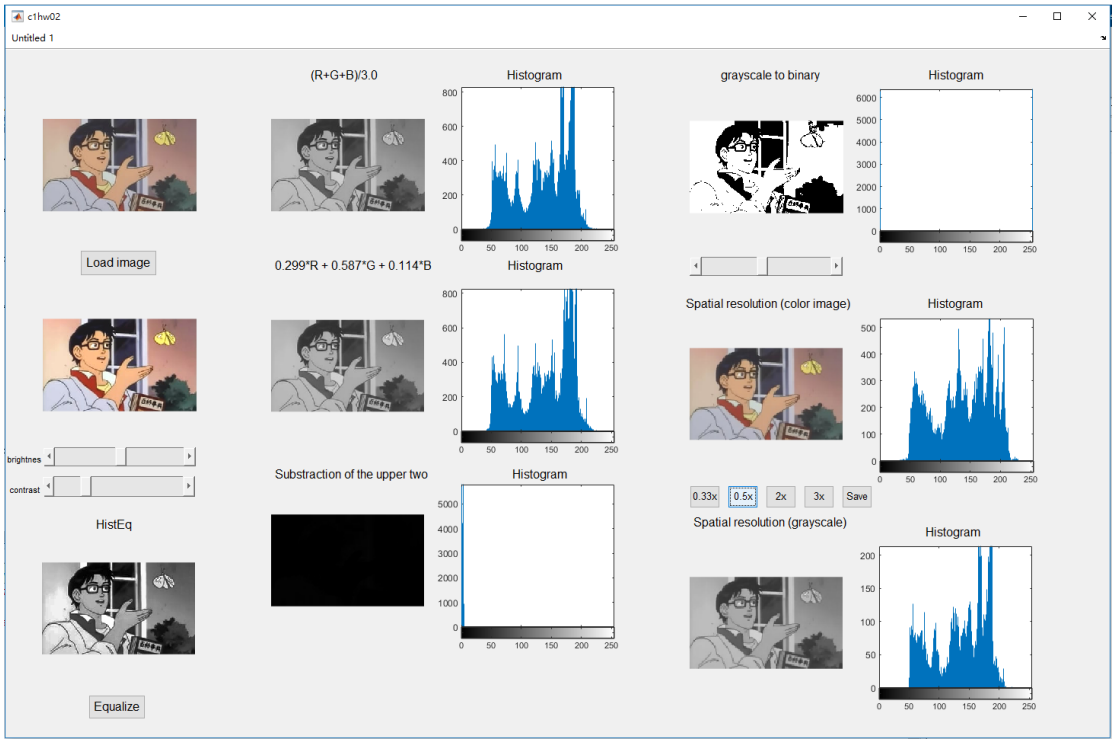


Figure 2 上圖結果

Functions compared with PhotoImpactX3:

(a) Brightness and contrast adjustment

https://youtu.be/l5GbsF0CIgM

以上連結為 demo 影片，針對亮度與對比度調整的部分。

(b) Histogram equalization

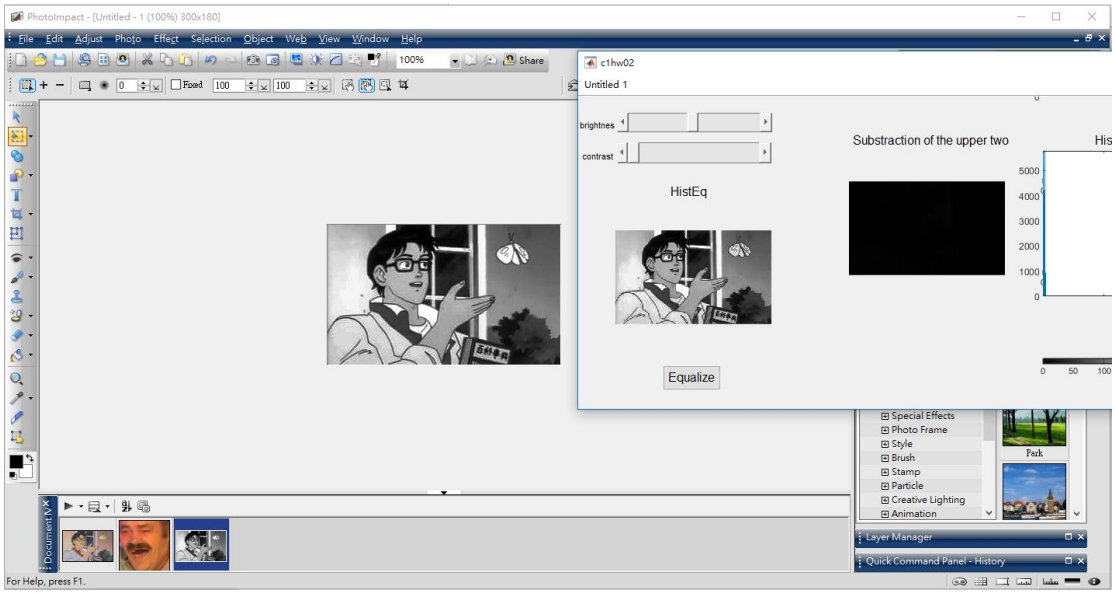


Figure 3 比較修圖軟體與自行設計軟體之結果

由於我設計的程式沒有另外做一個存下 Histogram equalization 結果的功能，所以和修圖軟體結果放在一起再截圖做比較；結果看起來幾乎一樣，應有成功實作這項功能。

(c) Binary image conversion

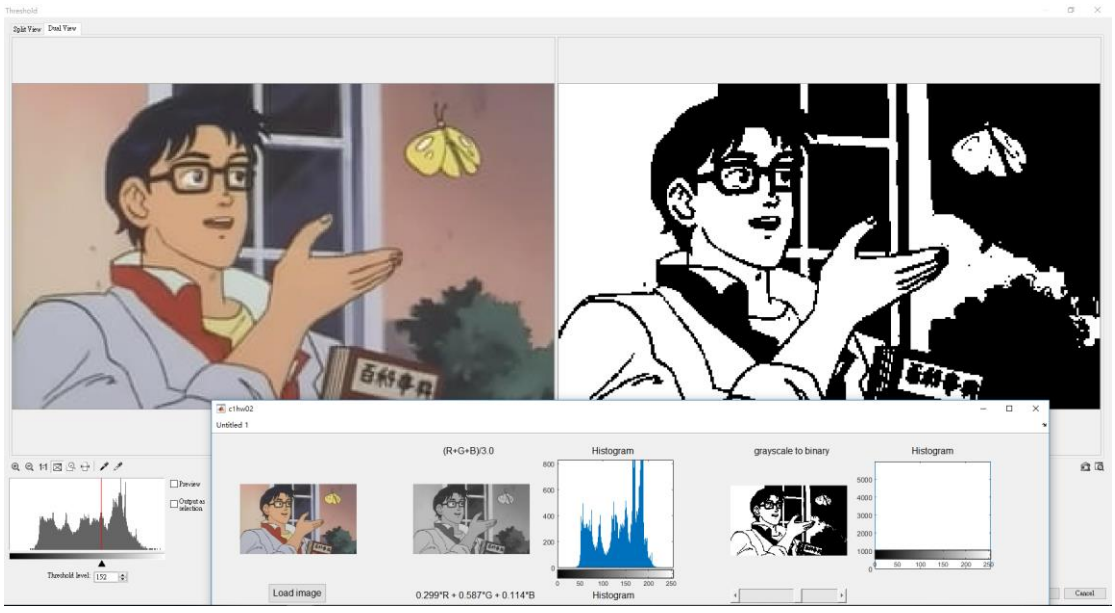


Figure 4 比較修圖軟體與自行設計軟體之結果

和前項(b)原因一樣，所以以這樣的方式呈現；先將原圖做灰階，再根據閾值區分 0 與 255，看起來結果是正確的。

(d) Resize the image

上圖左為設計之程式縮放 0.5 倍得到的結果，上圖右為 PhotoImpactX3 縮放 0.5 倍的結果，內插法分別為 linear 與 bilinear。可以看出細節上有所不同，bilinear 比較具抗噪能力。

上圖左為設計之程式縮放 2 倍得到的結果，上圖右為 PhotoImpactX3 縮放 2 倍的結果，內插法分別為 linear 與 bilinear。在 ppi 較高的情況下，兩者幾無二致。

(e) Other results

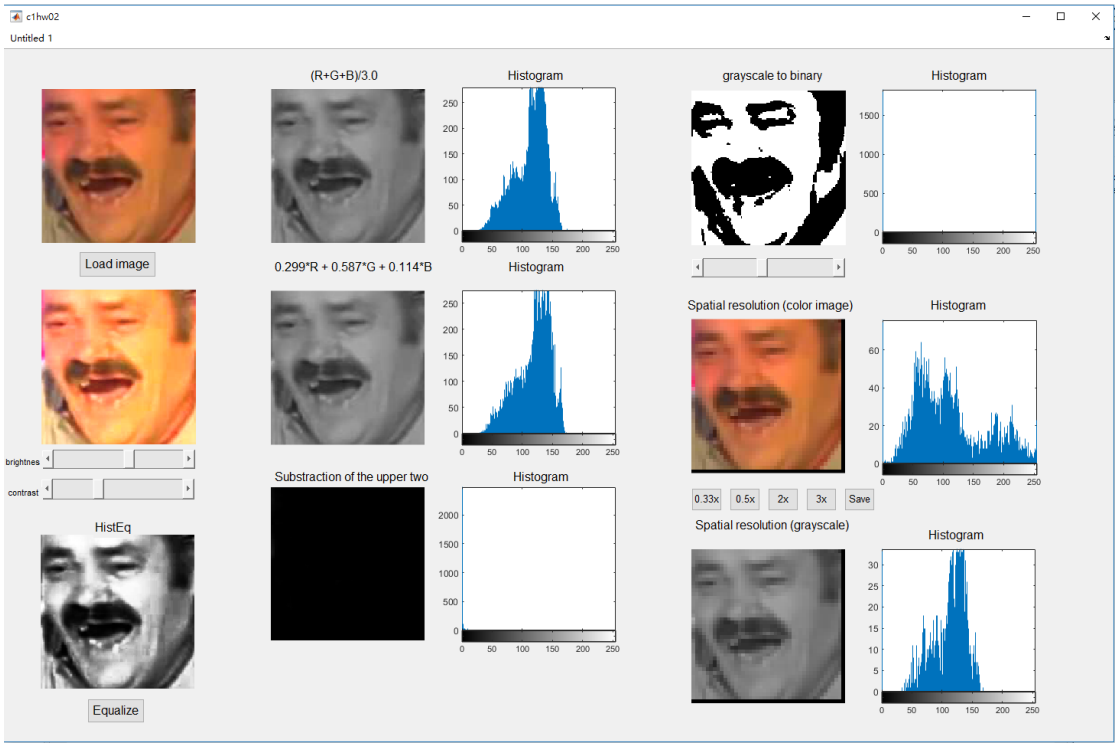


Figure 5 其他圖片結果之一

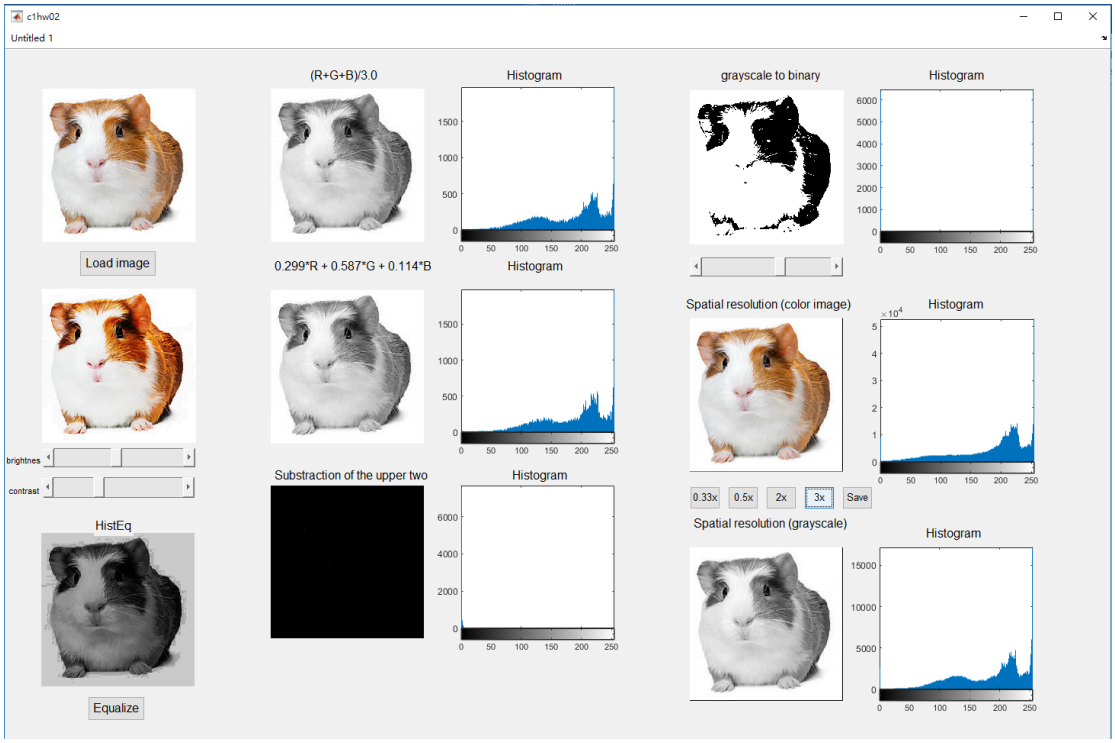


Figure 6 其他圖片結果之二

Code 部分說明請參閱.m 檔內註解。