Final (100%) June 28th

Please remember to write down your name and student number.
The procedures leading to your answers are required to grade.

1. (33%) Answer each of the following questions:
   (a) (5%) Draw and explain two examples of "optical illusion."
   (b) (5%) Describe and explain "highboost filtering."
   (c) (5%) Describe and explain "ringing effect".
   (d) (5%) What is the purpose of using backpropagation in CNN?
   (e) (5%) Describe and explain "brightness adaptation."
   (f) (8%) What is aliasing? What condition can cause aliasing?

2. (10%) Describe how to test the effect of blind spot using the figure below.

3. (25%) Consider the following intensity matrix of a 5x5 image A. The depth of a pixel is 3 bits.

Image A

5	5	4	6	5
6	4	5	5	6
7	3	3	4	5
6	2	4	3	6
5	4	3	2	3

Image B

2	1	6	4	6
6	4	1	5	1
4	3	3	4	6
7	7	3	3	5
2	0	1	0	6

   (a) (15%) For image A, what is the intensity matrix of the histogram-matched image such that the output image has a histogram of the shape similar to what image B has?
   (b) (10%) What is the intensity of the pixel in the middle position (shaded one of Image A) of the median-filtered image?

4. (5%) The discrete Fourier Transform of two-variable function $f(x,y)$ is defined as

$$F(u,v)=\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)e^{-j2\pi(ux/M+vy/N)} \quad u=0,1,2,\ldots M-1; v=0,\ldots,N-1.$$

Prove that $f(x,y)$ is real and even $\Leftrightarrow$ $F(u,v)$ is real and even .

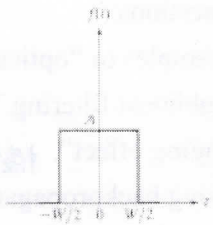
<Next Page>

5. (15%) The continuous Fourier Transform of one-variable function *f(x)* is defined as

$$F(u) = \int_{-\infty}^{\infty} f(x) e^{-j2\pi ux} dx .$$

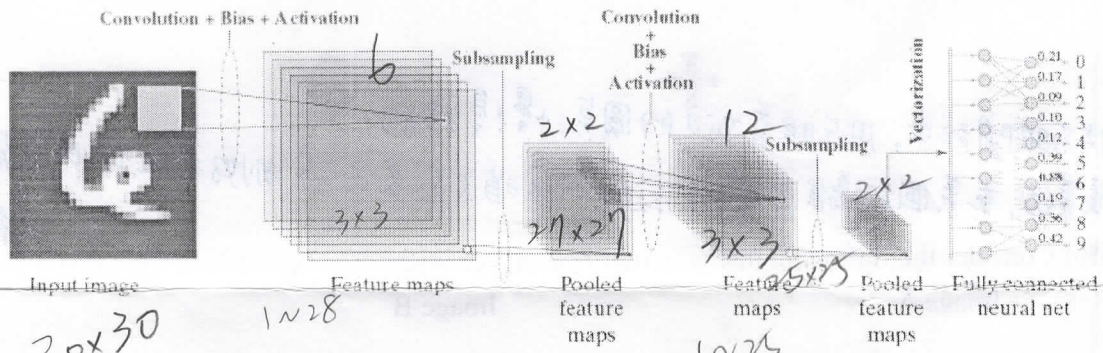
(a) (8%) Derive the Fourier transform of *f(t)* shown below.

(b) (7%) Draw its **spectrum** of Fourier transform.



6. (12%) For the CNN below, there are 6 feature maps for the first layer and 12 feature maps for the second layer. The receptive field is 3x3. And, 2x2 max pooling neighborhood is used. Suppose that the size of an input image (greyscale) is 30x30.

p.852



(a) (6%) What are the spatial resolutions of the feature maps in the first layer and in the second layer, respectively? What are the resolution of the pooled feature maps in the first layer and in the second layer, respectively?

(b) (6%) According to what we taught in the class, calculate the number of the parameters to generate the feature maps in the first layer. Similarly, calculate the number of the parameters to generate the feature maps in the second layer.

< Happy Summer Vacation!>

1. (a) 在印製或掃描東西時，因兩頻率相近的波疊合，產生的干擾現象

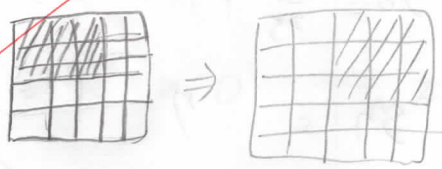
(b) 因為兩個頻率接近的訊號進行計算，產生了干擾

(c) 可以用 zero padding 填補訊號

(d) 信號在劇烈轉換的時候（像是因為濾波器的值從1變成0），導致圖片邊緣產生失真

(e) ideal lowpass filter , ideal high pass filter

(f) filter 移動的步數 sx = stride = 2



(g) 利用 backpropagation 可以知道這次的parameter的使用對 CNN 的結果的成效，利用 backpropagation 的計算更新下次的 parameter

+2.

to find the parameters that minimize an error function

Q 2 = (a)

i	n_i
0	1
1	0
2	3
3	5
4	5
5	6
6	5
7	0

$S = T(r) = \frac{7}{25}\sum_{i=0}^{7} n_i$

$S_0 = \frac{7}{25} \cdot 1 \approx 0$

$S_1 = \frac{7}{25}(1+0) \approx 0$

$S_2 = \frac{7}{25}(1+0+3) \approx 1$

$S_3 = \frac{7}{25}(1+0+3+5) = \frac{63}{25} \approx 3$

$S_4 = \frac{7}{25}(1+0+3+5+5) = \frac{98}{25} \approx 4$

$S_5 = \frac{7}{25}(1+0+3+5+5+6) = \frac{140}{25} \approx 6$

$S_6 = \frac{7}{25}(1+0+3+5+5+6+5) = 7$

$S_7 = 7$

7	6	4	7	6
7	4	3	6	7
4	3	7	4	6
6	1	4	3	6
1	0	3	1	3

#

(b)

$+6 \cdot \nabla^2 f(x,y) = 3+3+4+4-24$

$= -10$

$6-(-10) = 16 \Rightarrow 7$

Q 3 =

first e

for c1 [0

W

for c2

[1.

W

second

for c1

[

for c2

[1

W

Q3 =

first epoch =

for C1 $\begin{bmatrix}0&0&0\end{bmatrix}\begin{bmatrix}3\\4\\1\end{bmatrix} = 0 \not> 0$

$W_1 = \begin{bmatrix}0&0&0\end{bmatrix}^T + 0.5\begin{bmatrix}3&4&1\end{bmatrix}^T = \begin{bmatrix}1.5&2&0.5\end{bmatrix}^T$

for C2

$\begin{bmatrix}1.5&2&0.5\end{bmatrix}\begin{bmatrix}1\\1\\1\end{bmatrix} = 4 \not< 0$

$W_2 = \begin{bmatrix}1.5&2&0.5\end{bmatrix}^T - 0.5\begin{bmatrix}1&1&1\end{bmatrix}^T = \begin{bmatrix}1&1.5&0\end{bmatrix}^T$

second epoch

for C1

$\begin{bmatrix}1&1.5&0\end{bmatrix}\begin{bmatrix}3\\4\\1\end{bmatrix} = 3+6 = 9 > 0$, W不變

for C2

$\begin{bmatrix}1&1.5&0\end{bmatrix}\begin{bmatrix}1\\1\\1\end{bmatrix} = 2.5 \not< 0$

$W_3 = \begin{bmatrix}1&1.5&0\end{bmatrix}^T - 0.5\begin{bmatrix}1&1&1\end{bmatrix}^T = \begin{bmatrix}0.5&1&-0.5\end{bmatrix}^T$

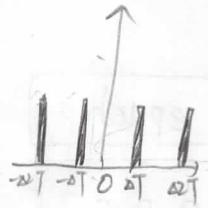
weight $= \begin{bmatrix}0.5&1&-0.5\end{bmatrix}^T$ #

Q4 =

(a) $F(u) = \sum_{n=-\infty}^{\infty} \delta(t - n\Delta T)\, e^{-j2\pi ut}$

$= \frac{1}{\Delta T}\, e^{-j2\pi ut}$

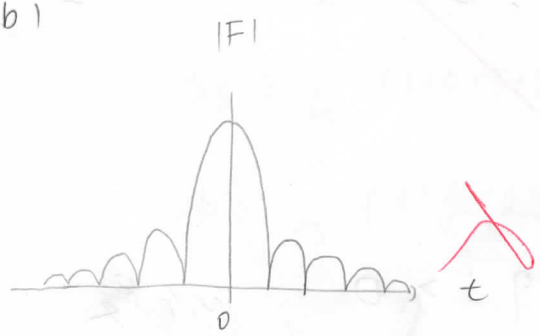
$s_{\Delta T}(t) \Rightarrow$



$\delta(t) = \begin{cases} 1, & t = 0 \\ 0, & t \neq 0 \end{cases}$

$\delta(t - t_0) = \delta(t_0)$

(b)



Q5 =

(a)

(b)

(c)

(f)

(g)

(h)

Q5 =

(a) $P = 2M$, $Q = 2N$

(b) zeros

(c) $(-1)^{x+y}$

(f) $G(u,v) = H(u,v)F(u,v)$

(g) $g_p(x,y) = \{ \text{real}[\mathcal{F}^{-1}[G(u,v)]] \} f(x,y)$

(-1)

(h) left top quadrant

14