1. (a) digital signal 較容易在電腦上做訊号的處理及相關的應用 缺優點... -1

(b) 使 sample rate 滿足 $r=2f$ (Nyquist theorem) why? -2
或 提高 quantization 的精確度

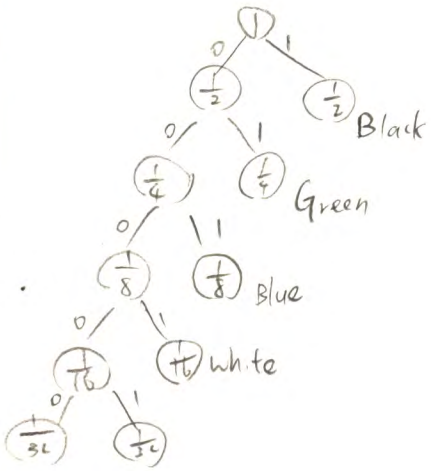
2. (a) Black $\frac{1}{2}$ White $\frac{1}{16}$ Red $\frac{1}{32}$ Green $\frac{1}{4}$ Blue $\frac{1}{8}$ Yellow $\frac{1}{32}$

(b) $H(s)=\eta=\frac{1}{2}\log_2 2+\frac{1}{16}\log_2 16+\frac{1}{32}\log 32+\frac{1}{4}\log 4+\frac{1}{8}\log 8+\frac{1}{32}\log 32$

$=\frac{1}{2}+\frac{1}{4}+\frac{5}{32}+\frac{1}{2}+\frac{3}{8}+\frac{5}{32}$

$=\frac{62}{32}=\frac{31}{16}$ # the optimal solution of average bits per color

(c)



Black = 1
Green: 01
Blue: 001
White: 0001
Yellow: 00001
Red: 00000

$\frac{1+2+3+4+5+5}{6}$

$=\frac{20}{6}=\frac{10}{3}$ bits per color

X -1

根據 Shannon-Fano. sort. 由左至右. 由大至小. 0在左方.

-2.

3. pixel1: R=88, G=126, B=229

pixel2: R=86, G=126 B=224

pixel3: R=88, G=~~143~~, B=223

4.

(a) A 8×8 matrix

-4

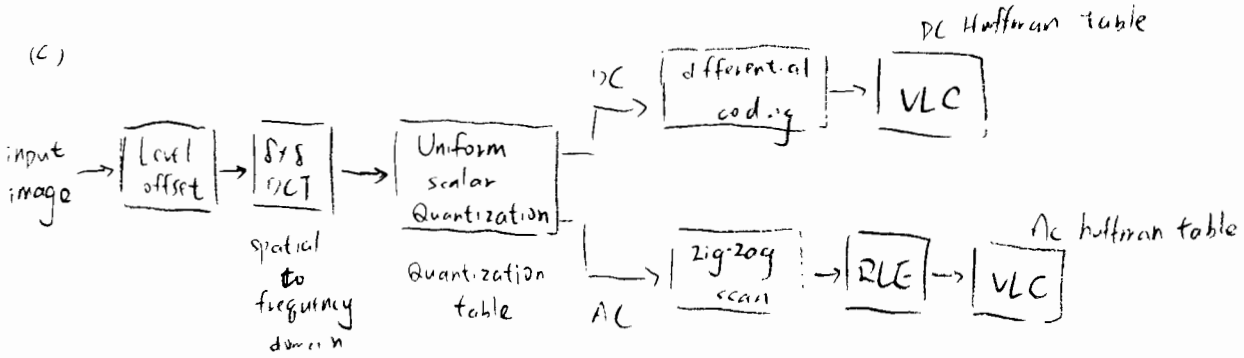
1 basis images

(b)

F(u v) 在 (u v) 點上 frequency 的 magnitude

magnitude 告訴我們有對應到 spatial domain 的 amplitude

(c)



the main source of error / distortion in JPEG compression is in Quantization

(d)

JPEG image ratio / quality use Quality factor (Q_f)

-4

$$S = (Q_f < 50) \ ? \ \frac{5000}{Q_f} \ : \ 200 - 2Q_f$$

Using standard JPEG Quantization table then assign each element

$$T_S[i] = \left[\frac{S * T_b[i] + 50}{100} \right]$$ and we can get a new table

5. a

$$a_n = \frac{1}{N}\sum_{k=0}^{N-1} f_k \cos(2\pi nk/N)$$

$$b_n = \frac{1}{N}\sum_{k=0}^{N-1} f_k \sin(2\pi nk/N)$$

then, magnitude of the n^{th} frequency component : $A_n = \sqrt{a_n^2 + b_n^2}$

phase : $\phi_n = -\tan^{-1}(b_n/a_n)$ $0 \le n \le N-1$

magnitude 表示實際 frequency domain 上的 amplitude.

b) $y(n) = h(n) \otimes f(n) = \sum_{k=0}^{N-1} h(k) f(n-k)$ TF - ?

-1

c) use DFT => Let $F = DFT(f)$, $H = DFT(h)$,

and $Y = F * H$,

=> $DFT^{-1}(Y)$ and we get $f \otimes h$

6.

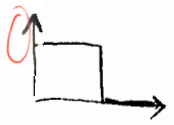
a)

FIR filter $y(n) = h(n) \otimes f(n)$

$= \sum_{k=0}^{N-1} h(k) f(n-k)$, TF. ? cost ?

-3

b) low-pass filter band-pass filter



y-axis ?

-1

c)

FIR 的原始訊号有限

IIR 的則為 inf, te, but it is hard to calculate,

-3.5 so transform the equation to recursive form

$$\sum_{k=0}^{N-1} a_k x(n-k) - \sum_{k=1}^{M} b_k y(n-k)$$

echo effect ?

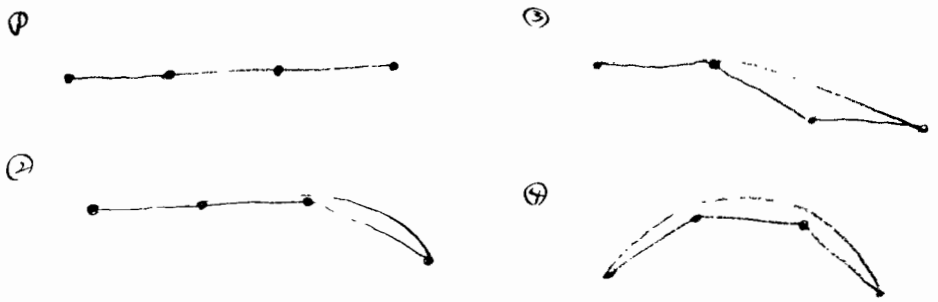
7

$t) = (T^*M)^*G$

$= (1-t)^3 P_0 + 3t(1-t^2) P_1 + 3t^2(1-t) P_2 + t^3 P_3$

1

(c)



every four points is a group

-7.5 ~~the first and last is fixed point~~. the other is direction point which is P_0, P_1, P_2, P_3 (b)

use the blending function and we can get Bezier curve and every condition we can get a convex hull.

8. ~~-15~~ -2

$$SAD(i,j) = \sum_{k=0}^{N-1} \sum_{l=0}^{N-1} |T(x+k, y-k) - R(x+k+i, y-l+j)|$$

N? T? (x, y)?

b) let pq be the postion of T block in the target frame

then the search range in the reference frame is $(p-8, q-8)$ to $(p+8, q+8)$

for $(i = p-8$ to $p+8)$

for $(j = q-8$ to $q+8)$

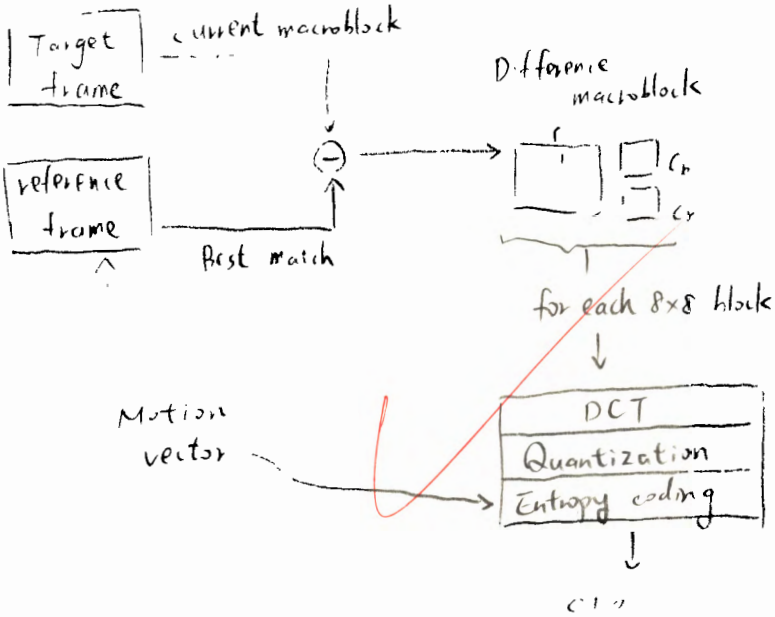
$$SAD(i,j) = \sum_{k=0}^{I} \sum_{l=0}^{J} |T(x+k, y+l) - R(x+k+\ldots, y+\ldots)|$$

if $(SAD < min)$ $min = SAD$

record the corresponding position of min

(assume m: row, n: column)

motion vector = $(p-m, q-n)$


Target frame
current macroblock
Difference macroblock
reference frame
Best match
C_R
C_Y
for each 8×8 block
Motion vector
DCT
Quantization
Entropy coding