**高等數位影像處理**

**作業#5**

姓名： 巫伯銘

學號： 111318096

指導老師： 張陽郎 教授

|  |  |
| --- | --- |
| **1.(1)** | |
| Figure | |
| 01\_rhombus\_magnitude\_spectrum\_DFT\_C.png | 02\_sine\_magnitude\_spectrum\_DFT\_C.png |
| 03\_lena\_magnitude\_spectrum\_DFT\_C.png | |
| Discussion | |
| 本題使用做兩次1D的DFT得到2D DFT的方式，結果如上所示。  因為空間域中越窄的訊號轉換至頻域，就會越寬；空間域中越寬的訊號轉換至頻域則反之。因此rhombus呈現X的形狀；sine只有水平方向有變化，所以點都集中在中間水平線上。 | |

|  |
| --- |
| **1(2)** |
| Discussion |
| 以下表格為C以及OpenCV的DFT執行時間：   |  |  |  | | --- | --- | --- | | DFT | C execution time(sec.) | OpenCV execution time(sec.) | | rhombus\_256.raw | 1.98982 | 0.0096883 | | sine\_128.raw | 0.230481 | 0.00009 | | lena\_256.raw | 2.0447 | 0.0002267 |   做出來的DFT結果基本上相同，但是在時間運算上差異非常大，原因是OpenCV內建是使用FFT運算。 |

|  |  |
| --- | --- |
| **1(3)** | |
| Figure | |
| 04\_rhombus\_IDFT\_C.png    (MSE =0.020) | 05\_sine\_IDFT\_C.png    (MSE =0.919) |
| 06\_lena\_IDFT\_C.png    (MSE =30.361) | |
| Discussion | |
| 拿IDFT與原圖做比較，其實用肉眼觀察不出來差異，但是使用MSE計算還是能發現些許誤差，推測可能是在將傅立葉級數轉換為0~255時有些小數點精度的問題導致的，因為使用unsigned char輸出必將捨去小數點。 | |

|  |
| --- |
| **1(4)** |
| Discussion |
| 以下表格為C以及OpenCV的IDFT執行時間：   |  |  |  | | --- | --- | --- | | IDFT | C execution time(sec.) | OpenCV execution time(sec.) | | rhombus\_256.raw | 1.7298 | 0.0038154 | | sine\_128.raw | 0.198424 | 0.0004802 | | lena\_256.raw | 1.72127 | 0.0004608 |   做出來的DFT結果基本上相同，但是在時間運算上差異非常大，原因是OpenCV內建是使用FFT運算。 |

|  |
| --- |
| **1(5)** |
| Figure |
| 07\_rhombus\_magnitude\_spectrum\_DCT.png    08\_sine\_magnitude\_spectrum\_DCT.png    09\_lena\_magnitude\_spectrum\_DCT.png |
| Discussion |
| 在執行程式時可以明顯發現DCT的運算時間比DFT快了很多，因為少了複數的運算處理，過程簡化很多。 |

|  |  |
| --- | --- |
| **2(1)** | |
| Figure | |
| 10\_raccoon\_BLPF\_5\_1\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 5, n = 1)  12\_raccoon\_BLPF\_5\_2\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 5, n = 2)  14\_raccoon\_BLPF\_5\_3\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 5, n = 3)  16\_raccoon\_BLPF\_20\_1\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 20, n = 1)  18\_raccoon\_BLPF\_20\_2\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 20, n = 2)  20\_raccoon\_BLPF\_20\_3\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 20, n = 3)  22\_raccoon\_BLPF\_50\_1\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 50, n = 1)  24\_raccoon\_BLPF\_50\_2\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 50, n = 2)  26\_raccoon\_BLPF\_50\_3\_magnitude\_spectrum.png    (Butterworth LPF, D0 = 50, n = 3)  28\_raccoon\_BHPF\_5\_1\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 5, n = 1)  30\_raccoon\_BHPF\_5\_2\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 5, n = 2)  32\_raccoon\_BHPF\_5\_3\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 5, n = 3)  34\_raccoon\_BHPF\_20\_1\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 20, n = 1)  36\_raccoon\_BHPF\_20\_2\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 20, n = 2)  38\_raccoon\_BHPF\_20\_3\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 20, n = 3)  40\_raccoon\_BHPF\_50\_1\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 50, n = 1)  42\_raccoon\_BHPF\_50\_2\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 50, n = 2)  44\_raccoon\_BHPF\_50\_3\_magnitude\_spectrum.png    (Butterworth HPF, D0 = 50, n = 3) | 11\_raccoon\_BLPF\_5\_1\_idft.png    (Butterworth LPF, D0 = 5, n = 1)  13\_raccoon\_BLPF\_5\_2\_idft.png    (Butterworth LPF, D0 = 5, n = 2)  15\_raccoon\_BLPF\_5\_3\_idft.png    (Butterworth LPF, D0 = 5, n = 3)  17\_raccoon\_BLPF\_20\_1\_idft.png    (Butterworth LPF, D0 = 20, n = 1)  19\_raccoon\_BLPF\_20\_2\_idft.png    (Butterworth LPF, D0 = 20, n = 2)  21\_raccoon\_BLPF\_20\_3\_idft.png    (Butterworth LPF, D0 = 20, n = 3)  23\_raccoon\_BLPF\_50\_1\_idft.png    (Butterworth LPF, D0 = 50, n = 1)  25\_raccoon\_BLPF\_50\_2\_idft.png    (Butterworth LPF, D0 = 50, n = 2)  27\_raccoon\_BLPF\_50\_3\_idft.png    (Butterworth LPF, D0 = 50, n = 3)  29\_raccoon\_BHPF\_5\_1\_idft.png    (Butterworth HPF, D0 = 5, n = 1)  31\_raccoon\_BHPF\_5\_2\_idft.png    (Butterworth HPF, D0 = 5, n = 2)  33\_raccoon\_BHPF\_5\_3\_idft.png    (Butterworth HPF, D0 = 5, n = 3)  35\_raccoon\_BHPF\_20\_1\_idft.png    (Butterworth HPF, D0 = 20, n = 1)  37\_raccoon\_BHPF\_20\_2\_idft.png    (Butterworth HPF, D0 = 20, n = 2)  39\_raccoon\_BHPF\_20\_3\_idft.png    (Butterworth HPF, D0 = 20, n = 3)  41\_raccoon\_BHPF\_50\_1\_idft.png    (Butterworth HPF, D0 = 50, n = 1)  43\_raccoon\_BHPF\_50\_2\_idft.png    (Butterworth HPF, D0 = 50, n = 2)  45\_raccoon\_BHPF\_50\_3\_idft.png    (Butterworth HPF, D0 = 50, n = 3) |
| Discussion | |
| 調整參數過程發現D0越小，LPF會越模糊，HPF則是保留的細節越多；n越大時，LPF會越模糊，HPF則是保留的細節會越少。 | |

|  |
| --- |
| **2.(2)** |
| Figure |
| 46\_owl\_HFE\_idft.png    (D0 = 50, n = 2, a = 0.5, b = 1) |
| Discussion |
| 本題使用Gaussian HPF，調整參數過程想辦法儘量讓翅膀以及木頭的線條紋理更明顯，如圖所示。 |

|  |
| --- |
| **3.(1)** |
| Figure |
| 47\_raccoon\_mark\_i\_raccoon\_mark\_i\_magnitude\_spectrum.png    48\_raccoon\_mark\_i\_raccoon\_mark\_i\_out\_idft.png |
| Discussion |
| 本題使用method i，加上浮水印的時域，其中w = 100，剛開始w設比較小發現頻譜圖都看不到浮水印，因此最後才將w調到100。 |

|  |
| --- |
| **3.(2)** |
| Figure |
| 49\_raccoon\_mark\_ii\_raccoon\_mark\_ii\_magnitude\_spectrum.png    50\_raccoon\_mark\_ii\_raccoon\_mark\_ii\_out\_idft.png |
| Discussion |
| 本題使用method ii，加上浮水印的頻域，其中w = 1，在調整w時發現w越大原圖影像會越暗，浮水印則會越明顯。 |

|  |
| --- |
| **4.** |
| Figure |
| 51\_house\_homomorphic.png    (rH = 1.3, rL = 0.85, c = 0.35, D0 = 0.4)  52\_house\_histogram\_equalization.png |
| Discussion |
| 本題調整參數過程讓rH > 1, rL < 1並調整c想辦法讓對比度出來，觀察使用histogram equalization方法的輸出影像對比度佳，但是暗細節上的顏色有很多片雜訊。 |