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รหัส 0649 $\rightarrow f = [0\ 6\ 4\ 9]$

Encoding (Fourier Transform)

$T(u=0) = [1\ 1\ 1\ 1]$ $\quad T(u=2) = [1\ -1\ 1\ -1]$

$T(u=1) = [1\ -i\ -1\ i]$ $\quad T(u=3) = [1\ i\ -1\ -i]$

Encoding Process

$F(u=0) = [1\ 1\ 1\ 1] \cdot [0\ 6\ 4\ 9] = (0+6+4+9) = 19$

$F(u=1) = [1\ -i\ -1\ i] \cdot [0\ 6\ 4\ 9] = (0-6i-4+9i) = -4+3i$

$F(u=2) = [1\ -1\ 1\ -1] \cdot [0\ 6\ 4\ 9] = (0-6+4-9) = -11$

$F(u=3) = [1\ i\ -1\ -i] \cdot [0\ 6\ 4\ 9] = (0+6i-4-9i) = -4-3i$

$\therefore F = [19\ \ (-4+3i)\ \ -11\ \ (-4-3i)]$

Decoding (Inverse Fourier Transform)

$T'(u=0) = (1/4)[1\ 1\ 1\ 1]$ $\quad T'(u=2) = (1/4)[1\ -1\ 1\ -1]$

$T'(u=1) = (1/4)[1\ i\ -1\ -i]$ $\quad T'(u=3) = (1/4)[1\ -i\ -1\ +i]$

Decoding Process

$X(u=0) = (1/4)[1\ 1\ 1\ 1] \cdot [19\ \ (-4+3i)\ \ -11\ \ (-4-3i)] = 0$

$X(u=1) = (1/4)[1\ i\ -1\ -i] \cdot$ ——— " ——— $= 6$

$X(u=2) = (1/4)[1\ -1\ 1\ -1] \cdot$ ——— " ——— $= 4$

$X(u=3) = (1/4)[1\ -i\ -1\ +i] \cdot$ ——— " ——— $= 9$

\# ผลลัพธ์การถอดรหัส $X = [0\ 6\ 4\ 9]$

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Exercise 2 : 2D Fourier Encoding

ข้อ ๒ $f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$

$$T[0,1] = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} \rightarrow F(u=0, v=1) = 4 - 4i$$

$$T[1,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} \rightarrow F(u=1, v=0) = 4 - 4i$$

$$T[1,1] = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} \rightarrow F(u=1, v=1) = 0$$

(1)

$N = 4$

$f = [1\ 5\ 0\ 0]$

(Encode process)

$F(u=0) = [1\ 1\ 1\ 1] \cdot [1\ 5\ 0\ 0] = 6$

$F(u=1) = [1\ {-i}\ {-1}\ i] \cdot [1\ 5\ 0\ 0] = 1-5i$

$F(u=2) = [1\ {-1}\ 1\ {-1}] \cdot [1\ 5\ 0\ 0] = -4$

$F(u=3) = [1\ i\ {-1}\ {-i}] \cdot [1\ 5\ 0\ 0] = 1+5i$

(Decode process) $F = [$ ~~6~~ $6\ (1-5i)\ (-4)\ (1+5i)]$

$X(u=0) = \frac{1}{4}[1\ 1\ 1\ 1]\ [6\ (1-5i)\ (-4)\ (1+5i)] = \frac{4}{4} = 1$

$X(u=1) = \frac{1}{4}[1\ i\ {-1}\ {-i}]\ [6\ (1-5i)\ (-4)\ (1+5i)] = 6 + (i+5) + 4 - (i-5) = \frac{20}{4} = 5$

$X(u=2) = \frac{1}{4}[1\ {-1}\ 1\ {-1}]\ [6\ (1-5i)\ (-4)\ (1+5i)] = 6 - 1 + 5i - 4 - 1 - 5i = \frac{0}{4} = 0$

$X(u=3) = \frac{1}{4}[1\ {-i}\ {-1}\ i]\ [6\ (1-5i)\ (-4)\ (1+5i)] =$ ~~6 - i - 5 + 4 + i - 5~~ $= \frac{0}{4} = 0$

$6 - i - 5 + 4 + i - 5 = \frac{0}{4} = 0$

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(2)

$$f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$$

$T(0,0) =$

~~$F(0,0) = 8$~~

~~$F(0,1)$~~

$F(u=0) = [\,4 \quad 4 \quad 0 \quad 0\,]$ $\quad t(00)$

$F(u=1) = [\,0 \quad 0 \quad 0 \quad 0\,]$ $\quad t(01)$

$F(u=2) = [\,4 \quad -4i \quad 0 \quad 0\,]$ $\quad t(10)$

$F(u=3) \quad [\,0 \quad 0 \quad 0 \quad 0\,]$ $\quad t(11)$

59010444 + 1 => 0446

#1D

∴ Fourier Encoding

∴ $T(u=0) = [1\ 1\ 1\ 1]$

$T(u=1) = [1\ -i\ -1\ i]$

$T(u=2) = [1\ -1\ 1\ -1]$

$T(u=3) = [1\ i\ -1\ -i]$

#Encoding Process

$F(u=0) = [1\ 1\ 1\ 1] \cdot [0\ 4\ 4\ 5] = 13$

$F(u=1) = [1\ -i\ -1\ i] \cdot [0\ 4\ 4\ 5] = -4+i$

$F(u=2) = [1\ -1\ 1\ -1] \cdot [0\ 4\ 4\ 5] = -5$

$F(u=3) = [1\ i\ -1\ -i] \cdot [0\ 4\ 4\ 5] = -4-i$

$\therefore F = [13\ \ (-4+i)\ \ -5\ \ (-4-i)]$

#Decoding Process

$T'(u=0) = 1/4\,[1\ 1\ 1\ 1]$

$T'(u=1) = 1/4\,[1\ i\ -1\ -i]$

$T'(u=2) = 1/4\,[1\ -1\ 1\ -1]$

$T'(u=3) = 1/4\,[1\ -i\ -1\ i]$

$X(u=0) = \frac{1}{4}[1\ 1\ 1\ 1] \cdot [13\ \ (-4+i)\ \ -5\ \ (-4-i)] = 0$

$X(u=1) = \frac{1}{4}[1\ i\ -1\ -i] \cdot [13\ \ (-4+i)\ \ -5\ \ (-4-i)] = 4$

$X(u=2) = \frac{1}{4}[1\ -1\ 1\ -1] \cdot [13\ \ (-4+i)\ \ -5\ \ (-4-i)] = 4$

$X(u=3) = \frac{1}{4}[1\ -i\ -1\ i] \cdot [13\ \ (-4+i)\ \ -5\ \ (-4-i)] = 5$

$X = [0\ 4\ 4\ 5]$ #

#2D

ข้อมูล $f = \begin{bmatrix} 1&1&0&0\\1&1&0&0\\1&1&0&0\\1&1&0&0 \end{bmatrix}$

$T[0,1] = \begin{bmatrix} 1&-i&-1&i\\1&-i&-1&i\\1&-i&-1&i\\1&-i&-1&i \end{bmatrix}$, $T[1,0] = \begin{bmatrix} 1&1&1&1\\i&i&i&i\\-1&-1&-1&-1\\-i&-i&-i&-i \end{bmatrix}$, $T[1,1] = \begin{bmatrix} 1&-i&-1&i\\-i&-1&i&-1\\-1&i&1&-i\\i&1&-i&-1 \end{bmatrix}$

$F(0,1) = \begin{bmatrix} 1&-i&-1&i\\1&-i&-1&i\\1&-i&-1&i\\1&-i&-1&i \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0\\1&1&0&0\\1&1&0&0\\1&1&0&0 \end{bmatrix} = 4-4i$

$F(1,0) = \begin{bmatrix} 1&1&1&1\\i&i&i&i\\-1&-1&-1&-1\\-i&-i&-i&-i \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0\\1&1&0&0\\1&1&0&0\\1&1&0&0 \end{bmatrix} = 0$

$F(1,1) = \begin{bmatrix} 1&-i&-1&i\\-i&-1&i&-1\\-1&i&1&-i\\i&1&-i&-1 \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0\\1&1&0&0\\1&1&0&0\\1&1&0&0 \end{bmatrix} = 0$

นายศรัณย์รัฐ พิมพ์ทอง 59010444

59010027 → 0027

1D

Fourir

$T(u=0) = [1\ 1\ 1\ 1]$

$T(u=1) = [1\ -i\ -1\ +i]$

$T(u=2) = [1\ -1\ 1\ -1]$

$T(u=3) = [1\ i\ -1\ -i]$

Encoding Process

$F(u=0) = [1\ 1\ 1\ 1]\cdot[0\ 0\ 2\ 7] = 0+0+2+7 = 9$

$F(u=1) = [1\ -i\ -1\ +i]\cdot(0\ 0\ 2\ 7) = 0-0i-2+7i = -2+7i$

$F(u=2) = [1\ -1\ 1\ -1]\cdot(0\ 0\ 2\ 7) = 0-0+2-7 = -5$

$F(u=3) = [1\ i\ -1\ -i]\cdot[0\ 0\ 2\ 7] = -2-7i$

Vector $= F = 9\ (-2+7i)\ -5\ (-2-7i)$

Encoded vector

$F = 9\ (-2+7i)\ -5\ (-2-7i)$

Decoding Process

$T'(u=0) = \frac{1}{4}[1\ 1\ 1\ 1]$

$T'(u=1) = \frac{1}{4}[1\ i\ -1\ -i]$

$T'(u=2) = \frac{1}{4}[1\ -1\ 1\ -1]$

$T'(u=3) = \frac{1}{4}[1\ -i\ -1\ +i]$

$x(u=0) = \frac{1}{4}\ 1\ 1\ 1\ 1 \cdot [9\ (-2+7i)\ -5\ (-2-7i)]$

$= \frac{1}{4}(0,0)$

$= 0$

$x(u=1) = \frac{1}{4}[1+i-1-i]\ [9\ (-2+7i)\ -5\ (-2-7i)]$

$= \frac{1}{4}(9-2+7+5+2i-7 = 0$

$x(u=2) = \frac{1}{4}[1-1\ 1-1]\ [9\ (-2+7i)\ -5\ (-2-7i)]$

$\frac{1}{4}\ 9(+2+7i)-5(+2+7i) = \frac{8}{4} = 2$

$x(u=3) = \frac{1}{4}[1-i-1+i]\ [9\ (-2+7i)\ -5\ (-2+7i)]$

$= \frac{1}{4}(9+2i+7+5-2i+7)$

$= \frac{28}{4} = 7$

Result $= 0027$

2D

$f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$

$T[0,1] = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix}$ $T[1,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ i & i & i & i \\ -1 & -1 & -1 & -1 \\ -i & -i & -i & -i \end{bmatrix}$ $T[1,1] = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix}$

$F(1,1) = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 0$

$F(0,1) \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 4-4i$

$F(1,0) \begin{bmatrix} 1 & 1 & 1 & 1 \\ i & i & i & i \\ -1 & -1 & -1 & -1 \\ -i & -i & -i & -i \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 0$

กฤษณ์ [illegible]

59010027

Exercise X2 2D Fourier Encoding

Forward Transform Masks

ข้อมูล $\rightarrow f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$

$$T[0,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}, \quad f(u=0, v=0) = 8$$

$$T[0,1] = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix}, \quad f(u=0, v=1) = 4-4i$$

$$T[1,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ i & i & i & i \\ -1 & -1 & -1 & -1 \\ -i & i & -i & -i \end{bmatrix}, \quad f(u=1, v=0) = 0-0i = 0$$

$$T[1,1] = \begin{bmatrix} 1 & i & -1 & -i \\ i & -1 & -i & 1 \\ -1 & -i & 1 & i \\ -i & 1 & i & -1 \end{bmatrix}, \quad f(u=1, v=1) = 0-0i = 0$$

[illegible] 59011098

[illegible] 59010615

Exercise #1

- 1D Fourier Encoding (Fourier Transform)

[1 0 9 8] → Fourier Coefficient

$T(u=0) = [1, 1, 1, 1]$, $F(u=0) = 1+0+9+8 = 18$

$T(u=1) = [1, -i, -1, i]$, $F(u=1) = 1-0i-9+8i = -8+8i$

$T(u=2) = [1, -1, 1, -1]$, $F(u=2) = 1-0+9-8 = 2$

$T(u=3) = [1, i, -1, -i]$, $F(u=3) = 1+0i-9-8i = -8-8i$

ผลลัพธ์การแปลงฟูเรียร์ $F = [18 \ (-8+8i) \ (10-8i) \ (-8-8i)]$

- 1D Fourier Decoding (Inverse Fourier Transform)

$F = [18 \ (-8+8i) \ 2 \ (-8-8i)]$

$T'(u=0) = (1/4)[1 \ 1 \ 1 \ 1]$, $X(u=0) = (1/4)[1 \ 1 \ 1 \ 1] \cdot [18 \ (-8+8i) \ 2 \ (-8-8i)] = 9$

$T'(u=1) = (1/4)[1 \ i \ -1 \ -i]$, $X(u=1) = (1/4)[1 \ i \ -1 \ -i] \cdot [18 \ (-8+8i) \ 2 \ (-8-8i)] = 0$

$T'(u=2) = (1/4)[1 \ -1 \ 1 \ -1]$, $X(u=2) = (1/4)[1 \ -1 \ 1 \ -1] \cdot [18 \ (-8+8i) \ 2 \ (-8-8i)] = 9$

$T'(u=3) = (1/4)[1 \ -i \ -1 \ +i]$, $X(u=3) = (1/4)[1 \ -i \ -1 \ +i] \cdot [18 \ (-8+8i) \ 2 \ (-8-8i)] = 8$

ผลลัพธ์การถอดรหัส $X = [1 \ 0 \ 9 \ 8]$

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นักศึกษา วิทยาศาสตร์ 59010615

ชื่อ วิชา รหัส

Ex 1.

$f = [1\ 4\ 4\ 9]$

$F(0) = 1\ 4\ 4\ 9 \cdot 1\ 1\ 1\ 1 = 18$

$F(1) = 1\ 4\ 4\ 9 \cdot 1\ -i\ -1\ i = -3+5i$

$F(2) = 1\ 4\ 4\ 9 \cdot 1\ -1\ 1\ -1 = -8$

$F(3) = 1\ 4\ 4\ 9 \cdot 1\ i\ -1\ -i = -3-5i$

$F = [18\ (-3+5i)\ -8(-3-5i)]$

$x(0) = \frac{1}{4}[1\ 1\ 1\ 1] \cdot [18\ (-3+5i)\ -8\ (-3-5i)] = \frac{18}{4} - \frac{3}{4} + \frac{5i}{4} - \frac{8}{4} - \frac{3}{4} - \frac{5}{4}i = 1$

$x(3) = \frac{1}{4}[1\ -i\ -1\ i] \cdot [18\ (-3+5i)\ -8\ (-3-5i)] = \frac{18}{4} + \frac{3i}{4} + \frac{5}{4} + \frac{8}{4} - \frac{3i}{4} + \frac{5}{4} = 9$

$x(2) = \frac{1}{4}[1\ -1\ 1\ -1] \cdot [18\ (-3+5i)\ -8\ (-3-5i)] = 4$

$x(1) = \frac{1}{4}[1\ -i\ -1\ i] \cdot [18\ (-3+5i)\ -8\ (-3-5i)] = 4$

Ex 2

$f = \begin{bmatrix} 1100 \\ 1100 \\ 1100 \\ 1100 \end{bmatrix}$

Mx N

$F(0,0) = 8$

$(0,1) = 0$

$(1,0) = 4-4i$

$(1,1) = 0$

$\begin{bmatrix} 4400 \\ 4400 \\ 4400 \\ 4400 \end{bmatrix}$

$\begin{matrix} 1111 \\ 1111 \\ 0000 \\ 0000 \end{matrix}$

[1 1 1 1]

$F(u=0) = [1\ 1\ 1\ 1] \cdot [1\ 1\ 1\ 1] = 10$

$F(u=1) = [1\ i\ -1\ -i] \cdot [1\ 1\ 1\ 1] = -6$

$F(u=2) = [1\ -1\ 1\ -1] \cdot [1\ 1\ 1\ 1] = 6$

$F(u=3) = [1\ -i\ -1\ i] \cdot [1\ 1\ 1\ 1] = -6$

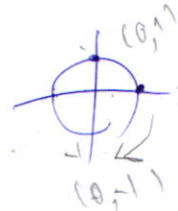
$F = [10\ \ -6\ \ 6\ \ -6]$

$X(u=0) = (1/4)[1\ 1\ 1\ 1] \cdot [10\ -6\ 6\ -6] = \frac{4}{4} = 1$

$X(u=1) = (1/4)[1\ i\ -1\ -i] \cdot [10\ -6\ 6\ -6] = \frac{4}{4} = 1$

$X(u=2) = (1/4)[1\ -1\ 1\ -1] \cdot [10\ -6\ 6\ -6] = \frac{24}{4} = 7$

$X(u=3) = (1/4)[1\ -i\ -1\ i] \cdot [10\ -6\ 6\ -6] = \frac{4}{4} = 1$



T.F

$F(u=0) = [4 + 4 + 0 + 0] = 8$

$F(u=1) = [0\ \ 0\ \ 0\ \ 0] = 0$

$F(u=2) = [4\ \ -4i\ \ 0\ \ 0] = 4 - 4i$

$F(u=3) = [0\ \ 0\ \ 0\ \ 0] = 0$

$F(u=0) = [2 + 2 + 2 + 2] = 8$

$F(u=1) = [2 + -2i\ \ -2 + 2i] = 0$

$F(u=2) = [2-i + 1-i + 1-i + 1-i] = 4 - 4i$

$F(u=3) = [1-i + -i-1 + -1+i + i+1] = 0$

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$f = [1\ 0\ 6\ 8]$

$F(u=0) =$ ~~[1 0 6 8]~~ $\cdot$

$= [1\ 1\ 1\ 1] \cdot [1\ 0\ 6\ 8] = (1+0+6+8) = 15$

$= [1\ -i\ -1\ i] \cdot [1\ 0\ 6\ 8] = (1+0+6+8i) = -5+8i$

$= [1\ -1\ 1\ -1] \cdot [1\ 0\ 6\ 8] = (1+0+6-8) = -1$

$= [1\ i\ -1\ -i] \cdot [1\ 0\ 6\ 8] = (1+0-6-8i) = -5-8i$

$F = [15\ (-5+8i)\ -1\ (-5-8i)]$ #

Inverse

$X(u=0) = (\frac{1}{4})[1\ 1\ 1\ 1] \cdot [15\ (-5+8i)\ -1\ (-5-8i)] = 1$

$(u=1) = (\frac{1}{4})[1\ i\ -1\ -i] \cdot [15\ (-5+8i)\ -1\ (-5-8i)] = 0$

$(u=2) = (\frac{1}{4})[1\ -1\ 1\ -1] \cdot [15\ (-5+8i)\ -1\ (-5-8i)] = 6$

$(u=3) = (\frac{1}{4})[1\ i\ -1\ -i] \cdot [15\ (-5+8i)\ -1\ (-5-8i)] = 8$

$$F = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$$

$$[0,1] = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = (1-i)+(1-i)+(1-i)+(1-i) = 4-4i$$

$$[1,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = (1+1)+(-i-i)+(-1-1)+(i+i) = 0$$

$$[1,1] = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = (1-i)+(-i-1)+(-1+i)+(i+1) = 0$$

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Student ID : 1268

Encoding

$F(u=0) = [1\ 1\ 1\ 1]\cdot[1\ 2\ 6\ 8] = 1+2+6+8 = 17$

$F(u=1) = [1\ -i\ -1\ i]\cdot[1\ 2\ 6\ 8] = 1-2i-6+8i = -5+6i$

$F(u=2) = [1\ -1\ 1\ -1]\cdot[1\ 2\ 6\ 8] = 1-2+6-8 = -3$

$F(u=3) = [1\ i\ -1\ -i]\cdot[1\ 2\ 6\ 8] = 1+2i-6-8i = -5-6i$

ผลลัพธ์การเข้ารหัส

Decoding

$X(u=0) = (1/4)[1\ 1\ 1\ 1]\cdot[17\ (-5+6i)\ -3\ (-5-6i)] = (1/4)[17-5+6i-3-5-6i] = (1/4)(4) = 1$

$X(u=1) = (1/4)[1\ i\ -1\ -i]\cdot[17\ (-5+6i)\ -3\ (-5-6i)] = (1/4)[17-5i+6i^2+3+5i+6i^2]$

$= (1/4)[17-5i-6+3+5i-6] = (1/4)(8) = 2$

$X(u=2) = (1/4)[1\ -1\ 1\ -1]\cdot[17\ (-5+6i)\ -3\ (-5-6i)] = (1/4)[17+5-6i-3+5+6i] = (1/4)(24) = 6$

$X(u=3) = (1/4)[1\ -i\ -1\ +i]\cdot[17\ (-5+6i)\ -3\ (-5-6i)] = (1/4)[17+5i-6i^2+3-5i+6i^2]$

$= (1/4)(17+5i+6+3-5i+6) = (1/4)(32) = 8$

2D

$$f\cdot T[0,1] = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} = (1+1+1+1-i-i-i-i+0\ldots+0) = 4-4i$$

$$f\cdot T[1,0] = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} = (1+1-i-i-1-1+i+i) = 0$$

$$f\cdot T(1,1) = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} = (1-i-i-1-1+i+i+1) = 0$$

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59010099

0 0 9 9

0	1	1	1	1	18
2	1	-1	1	-1	0
1	1	-i	-1	i	$(-9+9i)$
3	1	i	-1	-i	$(-9-9i)$

$0 +$

$18 + (-9+9i) + (-9-9i)$

$\frac{1}{4} \quad 18 - (9-9) = 0$

$(1 \; i \; -1 \; -i) \quad \frac{1}{4} \quad 18 + (-9i - 9) + 0 + (9i - 9) = 0$

$\frac{1}{4} \quad 18 + (9 - 9i) + 0 + (9 + 9i) = 9$

$\frac{1}{4} \quad 18 + (9i + 9) + 0 + (-9i + 9) = 9$

T[0,0] → 8

T[0,1] → $4 - 4\lambda$

T[1,0] → 0

T[1,1] → [0] → 0

$T(u=0) = [1\ 1\ 1\ 1] \cdot [0\ 1\ 8\ 5] = 14$

$T(u=1) = [1\ -i\ -1\ i] \cdot [0\ 1\ 8\ 5] = -8+4i$

$T(u=2) = [1\ -1\ 1\ -1] \cdot [0\ 1\ 8\ 5] = 2$

$T(u=3) = [1\ i\ -1\ -i] \cdot [0\ 1\ 8\ 5] = -8-4i$

$$f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$$

$T(0,0) = 8$

$$T(0,1) = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} \cdot f = 4-4i+0+0 = 4-4i$$

$$T(0,2) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} \cdot f = 0$$

$$T(1,1) = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} \cdot f = 0$$

$T(u=0) = (1/4)[1\ 1\ 1\ 1] \cdot [14\ \ -8+4i\ \ 2\ \ -8-4i] = 0$

$T(u=1) = (1/4)[1\ i\ -1\ -i] \cdot [14\ \ -8+4i\ \ 2\ \ -8-4i] = \frac{12+(-4)+(-4)}{4}$

$T(u=2) = (1/4)[1\ -1\ 1\ -1]\ [14\ \ -8+4i\ \ 2\ \ -8-4i] = 8$

$T(u=3) = (1/4)[1\ -i\ -1\ i]\ [14\ \ -8+4i\ \ 2\ \ -8-4i] = \frac{12+4+4}{4} = 5$

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สาวิร แสงภาระกุล 59011059

$f = [1\ 3\ 0\ 2]$

$F(u=0) = [1\ 1\ 1\ 1] \cdot [1\ 3\ 0\ 2] = (1+3+0+2) = 6$

$F(u=1) = [1\ -i\ -1\ i] \cdot [1\ 3\ 0\ 2] = (1-3i+0+2i) = 1-i$

$F(u=2) = [1\ -1\ 1\ -1] \cdot [1\ 3\ 0\ 2] = (1-3+0-2) = -4$

$F(u=3) = [1\ i\ -1\ -i] \cdot [1\ 3\ 0\ 2] = (1+3i+0-2i) = 1+i$

$F = [6\ \ (1-i)\ \ -4\ \ (1+i)]$

$x(u=0) = \frac{1}{4}[1\ 1\ 1\ 1] \cdot [6\ \ (1-i)\ \ -4\ \ (1+i)] = 1$

$x(u=1) = \frac{1}{4}[1\ i\ -1\ -i] \cdot [6\ \ (1-i)\ \ 4\ \ (1+i)] = 3$

$x(u=2) = \frac{1}{4}[1\ -1\ 1\ -1] \cdot [6\ \ (1-i)\ \ 4\ \ (1+i)] = 0$

$x(u=3) = \frac{1}{4}[1\ -i\ -1\ i] \cdot [6\ \ (1-i)\ \ 4\ \ (1+i)] = 2$

$$F(u=0, v=0) = \begin{bmatrix} 1&1&1&1 \\ 1&1&1&1 \\ 1&1&1&1 \\ 1&1&1&1 \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \end{bmatrix} = 8$$

$$F(0,1) = \begin{bmatrix} 1&-i&-1&+i \\ 1&-i&-1&+i \\ 1&-i&-1&+i \\ 1&-i&-1&+i \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \end{bmatrix} = 1+i-1-i = 0$$

$$F(1,0) = \begin{bmatrix} 1&1&1&1 \\ -i&-i&-i&-i \\ -1&-1&-1&-1 \\ +i&+i&+i&+i \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \end{bmatrix} = 4+4i = 4-4i$$

$$F(1,1) = \begin{bmatrix} 1&-i&-1&i \\ -i&-1&i&1 \\ -1&i&1&-i \\ i&1&-i&-1 \end{bmatrix} \cdot \begin{bmatrix} 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \\ 1&1&0&0 \end{bmatrix} = \begin{matrix} 1-i & -1+i \\ -i & -1 \end{matrix} = 0$$

$f = [1179]$

$F(U=0) = [1111] \cdot [1179] = (1+1+7+9) = 18$

$F(U=1) = [1 \; -i \; -1 \; i] \cdot [1179] = (1 - i - 7 + 9i) = 8i - 6$

$F(U=2) = [1 \; -1 \; 1 \; -1] \cdot [1179] = 1 - 1 + 7 - 9 = -2$

$F(U=3) = [1 \; i \; -1 \; -i] \cdot [1179] = 1 + i - 7 - 9i = -6 - 8i$

$$F = [18 \;\; (8i-6) \;\; -2 \;\; (-6-8i)]$$

$X(U=0) = (1/4)[1111] \cdot [18 \;\; (8i-6) \;\; -2 \;\; (-6-8i)] = 1$

$X(U=1) = (1/4)[1 \; -i \; -1 \; i] \cdot [18 \;\; (8i-6) \;\; -2 \;\; (-6-8i)] = 1$

$X(U=2) = (1/4)[1 \; -1 \; 1 \; -1] \cdot [18 \;\; (8i-6) \;\; -2 \;\; (-6-8i)] = 7$

$X(U=3) = (1/4)[1 \; i \; -1 \; -i] \cdot [18 \;\; (8i-6) \;\; -2 \;\; (-6-8i)] = 9$

$$F(U=0, V=0) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 8$$

$$F(0,1) = \begin{bmatrix} 1-i & -1 & +i & \\ 1-i & -1 & +i & \\ 1-i & -1 & +i & \\ 1-i & -1 & +i & \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 1 + i - 1 - i = 0$$

$$F(1,0) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ i & i & i & i \\ -1 & -1 & -1 & -1 \\ +i & +i & +i & +i \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 4 - 4i$$

$$F(1,1) = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = \begin{matrix} 1-i & -1+i \\ i & -1 \end{matrix} = 0$$

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[Forward Transform]

Input : [0,7,2,8]

$T(u) = e^{-j2\pi\left(\frac{ux}{M}\right)} = e^{-j\frac{\pi}{2}ux}$

$T(u=0) = [1\ 1\ 1\ 1]$; $F(u=0) = [1,1,1,1] \cdot [0,7,2,8] = (0+7+2+8) = 17$

$T(u=1) = [1\ -j\ -1\ j]$; $F(u=1) = [1,j,-1,j] \cdot [0,7,2,8] = (0-j7-2+j8) = -2+j$

$T(u=2) = [1\ -1\ 1\ -1]$; $F(u=2) = [1,-1,1,-1] \cdot [0,7,2,8] = (0-7+2-8) = -13$

$T(u=3) = [1\ j\ -1\ -j]$; $F(u=3) = [1,j,-1,-j] \cdot [0,7,2,8] = (0+j7-2-j8) = -2-j$

Results : $F = [17\ \ (-2+j)\ \ -13\ \ (-2-j)]$

[Inverse Transform]

Input : [17 (-2+j) -13 (-2-j)]

$T^{-1}(u) = \frac{1}{4}\left[e^{j2\pi\left(\frac{ux}{M}\right)}\right] = \frac{1}{4}e^{j\frac{\pi}{2}ux}$

$T(u=0) = \frac{1}{4}[1\ 1\ 1\ 1]$; $I(0) = (17+(-2+j)+(-13)+(-2-j))/4 = 0$

$T(u=1) = \frac{1}{4}[1\ j\ -1\ -j]$; $I(1) = (17+(-2+j)(j)+(-13)(-1)+(-2-j)(-j))/4 = 28/4 = 7$

$T(u=2) = \frac{1}{4}[1\ -1\ 1\ -1]$; $I(2) = (17+(-2+j)(-1)+(-13)(1)+(-2-j)(-1))/4 = 8/4 = 2$

$T(u=3) = \frac{1}{4}[1\ -j\ -1\ j]$; $I(3) = (17+(-2+j)(-j)+(-13)(-1)+(-2-j)(j))/4 = 32/4 = 8$

Results : $I = [0\ 7\ 2\ 8]$ Ans

$F(0,1) = \underline{f} \cdot T(0,1) = \begin{bmatrix} 1 & -j & -1 & j \\ 1 & -j & -1 & j \\ 1 & -j & -1 & j \\ 1 & -j & -1 & j \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = (1-j+1-j+1-j+1-j) = 4-j4$

$F(1,0) = \underline{f} \cdot T(0,1) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -j & -j & -j & -j \\ -1 & -1 & -1 & -1 \\ j & j & j & j \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = (1+1-j-j-1-1+j+j) = 0$

$F(1,1) = \underline{f} \cdot T(1,1) = \begin{bmatrix} 1 & -j & -1 & j \\ -j & -1 & j & 1 \\ -1 & j & 1 & -j \\ j & 1 & -j & -1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = (1-j-j-1-1+j+j+1) = 0$

แสดงว่าการแปลงฟูเรียร์ $F[0,0] = 8$

ต่อไป $\underline{F} = \left[\begin{array}{cc|cc} 8 & 4-j4 & ? & ? \\ 0 & 0 & ? & ? \\ \hline ? & ? & ? & ? \\ ? & ? & ? & ? \end{array}\right]$

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#1

<u>Encoding</u>

$T(u=0) = [1\ 1\ 1\ 1] \cdot [0\ 3\ 3\ 7] = 13$

$T(u=1) = [1\ {-i}\ {-1}\ i] \cdot [0\ 3\ 3\ 7] = -3+4i$

$T(u=2) = [1\ {-1}\ 1\ {-1}] \cdot [0\ 3\ 3\ 7] = -7$

$T(u=3) = [1\ i\ {-1}\ {-i}] \cdot [0\ 3\ 3\ 7] = -3-4i$

<u>Decoding</u>

$T'(u=0) = (1/4)[1\ 1\ 1\ 1] \cdot [13\ (-3+4i)\ -7\ (-3-4i)] = 0$

$T'(u=1) = (1/4)[1\ i\ {-1}\ {-i}] \cdot [13\ (-3+4i)\ -7\ (-3-4i)] = 3$

$T'(u=2) = (1/4)[1\ {-1}\ 1\ {-1}] \cdot [13\ (-3-4i)\ -7\ (-3-4i)] = 3$

$T'(u=3) = (1/4)(1\ {-i}\ {-1}\ i] \cdot [13\ (-3-4i)\ -7\ (-3-4i)] = 7$

#2

กับ $f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$

$T[0,1] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} = 8$

$T[1,0] = \begin{bmatrix} 1 & i & -1 & -i \\ 1 & i & -1 & -i \\ 1 & i & -1 & -i \\ 1 & i & -1 & -i \end{bmatrix} = 0$

$T[1,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} = 4-4i$

$T[1,1] = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} = 0$ #

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กลุ่ม yareyare

1D Fourier Encoding $f = [0\ 8\ 7\ 4]$

$T(u=0)$ $[1\ 1\ 1\ 1]$ $F(u=0) = [1\ 1\ 1\ 1]\cdot[0\ 8\ 7\ 4] = 19$

$T(u=1)$ $[1\ -i\ -1\ i]$ $F(u=1) = [1\ -i\ -1\ i]\cdot[0\ 8\ 7\ 4] = -7-4i$

$T(u=2)$ $[1\ -1\ 1\ -1]$ $F(u=2) = [1\ -1\ 1\ -1]\cdot[0\ 8\ 7\ 4] = -5$

$T(u=3)$ $[1\ i\ -1\ -i]$ $F(u=3) = [1\ i\ -1\ -i]\cdot[0\ 8\ 7\ 4] = -7+4i$

$F = [19\ (-7-4i)\ -5\ (-7+4i)]$

$\boxed{i^2 = -1}$

1D Fourier Decoding

$T'(u=0)$ $(1/4)[1\ 1\ 1\ 1]$ $X(u=0) = \frac{1}{4}[1\ 1\ 1\ 1]\cdot[19\ (-7-4i)\ -5\ (-7+4i)] = 0$

$T'(u=1)$ $(1/4)[1\ i\ -1\ -i]$ $X(u=1) = \frac{1}{4}[1\ i\ -1\ -i]\cdot[19\ \overset{-7i+4}{(-7-4i)}\ -5\ \overset{7i+4}{(-7+4i)}] = (19+4+5+4)/4 = 8$

$T'(u=2)$ $(1/4)[1\ -1\ 1\ -1]$ $X(u=2) = \frac{1}{4}[1\ -1\ 1\ -1]\cdot[19\ (-7-4i)\ -5\ (-7+4i)] = (19+7-5+7)/4 = 7$

$T'(u=3)$ $(1/4)[1\ -i\ -1\ i]$ $X(u=3) = \frac{1}{4}[1\ -i\ -1\ i]\cdot[19\ \overset{7i-4}{(-7-4i)}\ -5\ \overset{-7i-4}{(-7+4i)}] = (19-4+5-4)/4 = 4$

2D Fourier Encoding $f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$

$F(u=0, v=0)$ $\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}\cdot f = 8$

$F(u=0, v=1)$ $\begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix}\cdot f = 4+4i$

$F(u=1, v=0)$ $\begin{bmatrix} 1 & 1 & 1 & 1 \\ i & i & i & i \\ -1 & -1 & -1 & -1 \\ -i & -i & -i & -i \end{bmatrix}\cdot f = 0$

$F(u=1, v=1)$ $\begin{bmatrix} 1 & i & -1 & -i \\ i & -1 & -i & 1 \\ -1 & -i & 1 & i \\ -i & 1 & i & -1 \end{bmatrix}\cdot f = 0$

ข้อมูล -> $f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$

$$T[0,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} \circ \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 8$$

$$T[0,1] = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} \circ \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 4-4i$$

$$T[1,0] = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} \circ \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 0$$

$$T[1,1] = \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} \circ \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 0$$

Put tank in the wall

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(E1)

$T(u=0) = [1\ 1\ 1\ 1]$
$T(u=1) = [1\ -i\ -1\ i]$
$T(u=2) = [1\ -1\ 1\ -1]$
$T(u=3) = [1\ i\ -1\ -i]$

$f = [1\ 5\ 1\ 1]$

Encoding Process

$F(u=0) = [1\ 1\ 1\ 1] \cdot [1\ 5\ 1\ 1] = (1+5+1+1) = 8$
$F(u=1) = [1\ -i\ -1\ i] \cdot [1\ 5\ 1\ 1] = (1-5i-1+i) = -4i$
$F(u=2) = [1\ -1\ 1\ -1] \cdot [1\ 5\ 1\ 1] = (1-5+1-1) = -4$
$F(u=3) = [1\ i\ -1\ -i] \cdot [1\ 5\ 1\ 1] = (1+5i-1-i) = 4i$

ผลลัพธ์ $F = [8\ \ 4i\ \ -4\ \ (4i)]$

Decodeing

$T'(u=0) = (1/4)[1\ 1\ 1\ 1]$ $X(u=0) = (1/4)[1\ 1\ 1\ 1] \cdot [8\ -4i\ -4\ (4i)] = 1$

$T'(u=1) = (1/4)[1\ i\ -1\ -i]$ $X(u=1) = (1/4)[1\ i\ -1\ -i] \cdot [8\ -4i\ -4\ (4i)] = 5$

$T'(u=2) = (1/4)[1\ -1\ 1\ -1]$ $X(u=2) = (1/4)[1\ -1\ 1\ -1] \cdot [8\ -4i\ -4\ (4i)] = 1$

$T'(u=3) = (1/4)[1\ -i\ -1\ +i]$ $X(u=3) = (1/4)[1\ -i\ -1\ +i] \cdot [8\ -4i\ -4\ (4i)] = 1$

$X = [1\ 5\ 1\ 1]$

Put tank in the mall

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Exercise # 2

$$F(0,0) = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} = 8$$

$$f(0,1) = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} = 4-4i$$

$$f(1,1) = 0$$

$$f(1,0) = 0$$

จะได้ $F = \begin{bmatrix} 8 & 4-4i & ? & ? \\ 0 & 0 & ? & ? \\ ? & ? & ? & ? \\ ? & ? & ? & ? \end{bmatrix}$

[illegible]

59011345.

Exercis #1

1345 → Fourier coefficients

$T(v=0) = [1 \quad 1 \quad 1 \quad 1]$ $\quad T(v=2) = [1 \quad -1 \quad 1 \quad -1]$

$T(v=1) = [1 \quad -i \quad -1 \quad i]$ $\quad T(v=3) = [1 \quad i \quad -1 \quad -i]$

$F(v=0) = [1 \quad 1 \quad 1 \quad 1] \cdot [1 \quad 3 \quad 4 \quad 5] = (1+3+4+5) = 13$

$F(v=1) = [1 \quad -i \quad -1 \quad i] \cdot [1 \quad 3 \quad 4 \quad 5] = (1-3i-4+5i) = -3+2i$

$F(v=2) = [1 \quad -1 \quad 1 \quad -1] \cdot [1 \quad 3 \quad 4 \quad 5] = (1-3+4-5) = -3$

$F(v=3) = [1 \quad i \quad -1 \quad -i] \cdot [1 \quad 3 \quad 4 \quad 5] = (1+3i-4-5i = -3-2i$

$X(v=0) = [1/4] [1 \quad 1 \quad 1 \quad 1] [13 \quad (-3+2i) \quad -3 \quad (-3-2i)] = \frac{1}{4}(13-3+2i-3-3-2i) = 1$

$X(v=1) = [1/4] [1 \quad i \quad -1 \quad -i] [13 \quad (-3+2i) \quad -3 \quad (-3-2i)] = \frac{1}{4}(13-3i-2+3+3i-2) = 3$

$X(v=2) = [1/4] [1 \quad -1 \quad 1 \quad -1] [13 \quad (-3+2i) \quad -3 \quad (-3-2i)] = \frac{1}{4}(13+3-2i-3+3+2i) = 4$

$X(v=3) = [1/4] [1 \quad -i \quad -1 \quad +i] [13 \quad (-3+2i \quad -3 \quad (-3-2i] = \frac{1}{4}(13+3i+2+3-3i+2) = 5$

เศรษฐกิจ ดีงามพัฒนากา 59011345

นาย อิทธิธร สีมาพันธ์กิจ (59011194)
นาย ณัฐวัฒน์ บุญวัฒ (59010484)

Ex 1

=> Encoding

F = 1194

T(u=0) = [1 1 1 1]

T(u=1) = [1 -i -1 i]

T(u=2) = [1 -1 1 -1]

T(u=3) = [1 i -1 -i]

Encode process

F(u=0) = [1 1 1 1] • [1 1 9 4] = [1+1+9+4] = 15

F(u=1) = [1 -i -1 i] • [1 1 9 4] = [1 -i -9 +4i] = 3i-8

F(u=2) = [1 -1 1 -1] • [1 1 9 4] = [1 -1+9-4] = 5

F(u=3) = [1 i -1 -i] • [1 1 9 4] = [1+i-9-4i] = -3i-8

ผลลัพธ์ F = [15 (3i-8) 5 (-3i-8)]

=> Decoding

$T'(u=0) = (1/4)[1\ 1\ 1\ 1]$

$T'(u=1) = (1/4)[1\ i\ -1\ -i]$

$T'(u=2) = (1/4)[1\ -1\ 1\ -1]$

$T'(u=3) = (1/4)[1\ -i\ -1\ +i]$

Decoding process

$X(u=0) = (1/4)[1\ 1\ 1\ 1][15\ (3i-8)\ 5\ (-3i-8)]$

$= (1/4)[15+3i-8+5-3i-8]$

$= (1/4)[4]$

$= 1$

$X(u=1) = (1/4)[1\ i\ -1\ -i][15\ (3i-8)\ 5\ (-3i-8)]$

$= (1/4)[15-3-8i-5-3+8i]$

$= (1/4)[4]$

$= 1$

$X(u=2) = (1/4)[1\ -1\ 1\ -1][15\ (3i-8)\ 5\ (-3i-8)]$

$= (1/4)[15-3i+8+5+3i+8]$

$= (1/4)[36]$

$= 9$

$X(u=3) = (1/4)[1\ -i\ -1\ +i][15\ (3i-8)\ 5\ (-3i-8)]$

$= (1/4)[15+3+8i-5+3-8i]$

$= (1/4)[16]$

$= 4$

Exercise # 1

=> **Encoding**

$f = [1\ 3\ 2\ 5]$

$T(u=0) = [1\ 1\ 1\ 1]$

$T(u=1) = [1\ -i\ -1\ i]$

$T(u=2) = [1\ -1\ 1\ -1]$

$T(u=3) = [1\ i\ -1\ -i]$

Encoding process

$F(u=0) = [1\ 1\ 1\ 1]\cdot[1\ 3\ 2\ 5] = [1+3+2+5] = 11$

$F(u=1) = [1\ -i\ -1\ i]\cdot[1\ 3\ 2\ 5] = [1-3i-2+5i] = 2i-1$

$F(u=2) = [1\ -1\ 1\ -1]\cdot[1\ 3\ 2\ 5] = [1-3+2-5] = -5$

$F(u=3) = [1\ i\ -1\ -i]\cdot[1\ 3\ 2\ 5] = [1+3i-2-5i] = -2i-1$

ผลลัพท์ $F = [11\ \ (2i-1)\ \ -5\ \ (-2i-1)]$

~~decoding process~~

=> **Decoding**

$T'(u=0) = (1/4)[1\ 1\ 1\ 1]$

$T'(u=1) = (1/4)[1\ i\ -1\ -i]$

$T'(u=2) = (1/4)[1\ -1\ 1\ -1]$

$T'(u=3) = (1/4)[1\ -i\ -1\ +i]$

Decoding process

$x(u=0) = (1/4)[1\ 1\ 1\ 1]\cdot[11\ \ (2i-1)\ \ -5\ \ (-2i-1)] = (1/4)[11+2i-1-5-2i-1]$
$= (1/4)[4] = 1$

$x(u=1) = (1/4)[1\ i\ -1\ -i]\cdot[11\ \ (2i-1)\ \ -5\ \ (-2i-1)] = (1/4)[11-2-i+5-2+i]$
$= (1/4)[12] = 3$

$x(u=2) = (1/4)[1\ -1\ 1\ -1]\cdot[11\ \ (2i-1)\ \ -5\ \ (-2i-1)] = (1/4)[11-2i+1-5+2i+1]$
$= (1/4)[8] = 2$

$x(u=3) = (1/4)[1\ -i\ -1\ +i]\cdot[11\ \ (2i-1)\ \ -5\ \ (-2i-1)] = (1/4)[11+2+i+5+2-i]$
$= (1/4)[20] = 5$

ปวรุตม์ ลิมะวรรธนะ 59010829

ศุภชัย วีริยะเจริญกิจ 59011325

ภานุวิชญ์ อนันตกูลชัย 59011061
สรัล ลิมปลดิภาจ 59011371

100 PERCENT

Exercise # 1

- Encoding (Fourier Transform)

ข้อมูล → f = [1 0 6 1]

T(u=0) = [1 1 1 1]

T(u=1) = [1 -i -1 i]

T(u=2) = [1 -1 1 -1]

T(u=3) = [1 i -1 -i]

Forward Transform Masks

(Encoding Process)

F(u=0) = [1 1 1 1] · [1 0 6 1] = (1 0 6 1) = 8

F(u=1) = [1 -i -1 i] · [1 0 6 1] = (1+0-6+i) = -5+i

F(u=2) = [1 -1 1 -1] · [1 0 6 1] = (1+0+6-1) = 6

F(u=3) = [1 i -1 -i] · [1 0 6 1] = (1+0-6-i) = -5-i

ผลลัพธ์ F = [8 (-5+i) 6 (-5-i)]

- Decoding

T'(u=0) = (1/4) [1 1 1 1]

T'(u=1) = (1/4) [1 i -1 -i]

T'(u=2) = (1/4) [1 -1 1 -1]

T'(u=3) = (1/4) [1 -i -1 +i]

X(u=0) = (1/4) [1 1 1 1] · [8 (-5+i) 6 (-5-i)] = 1

X(u=1) = (1/4) [1 i -1 -i] · [8 (-5+i) 6 (-5-i)] = 0

X(u=2) = (1/4) [1 -1 1 -1] · [8 (-5+i) 6 (-5-i)] = 6

X(u=3) = (1/4) [1 -i -1 +i] · [8 (-5+i) 6 (-5-i)] = 1

ผลลัพธ์ = [1 0 6 1]

$$T[0,0]\cdot f = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 8 \quad [4 \;\; 4 \;\; 0 \;\; 0]$$

$$T[0,1]\cdot f = \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 4 - 4i$$

$$T[1,0]\cdot f = \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 0$$

$$T[1,1]\cdot f \quad \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = 0$$

ภาณุวัฒน์ อนันตกูลชัย 5901106 1

สิรัส ลิมปสถิรกิจ 5901137 1

5901 0555 ธนพิชญ์
5901 0651 ธีรัน } กลุ่ม meemix and master two

$f = [0\ 5\ 5\ 5]$

$F(U=0) = [1\ 1\ 1\ 1] \cdot [0\ 5\ 5\ 5] = (0+5+5+5) = 15$

$F(U=1) = [1\ -i\ -1\ i] \cdot [0\ 5\ 5\ 5] = (0+-5i-5+5i) = -5$

$F(U=2) = [1\ -1\ 1\ -1] \cdot [0\ 5\ 5\ 5] = (0-5+5-5) = -5$

$F(U=3) = [1\ i\ -1\ -i] \cdot [0\ 5\ 5\ 5] = (0\ 5i-5-5i) = -5$

พลังงานเท่ากับ $F = [15\ -5\ -5\ -5]$

$X(U=0) = (1/4)[1\ 1\ 1\ 1] \cdot [15\ -5\ -5\ -5] = 0$

$X(U=1) = (1/4)[1\ i\ -1\ -i] \cdot [15\ -5\ -5\ -5] = 5$

$X(U=2) = (1/4)[1\ -1\ 1\ -1] \cdot [15\ -5\ -5\ -5] = \frac{20}{4} = 5$

$X(U=3) = (1/4)[1\ -i\ -1\ i] \cdot [15\ -5\ -5\ -5] = \frac{20}{4} = 5$

พลังงานออกมาเท่ากับ $F = [0\ 5\ 5\ 5]$

$f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = \begin{matrix} 1\ 1\ 0\ 0 \\ 1\ 1\ 0\ 0 \\ 1\ 1\ 0\ 0 \\ 1\ 1\ 0\ 0 \end{matrix} = 8$

~~X~~

$F(U=0) = \begin{bmatrix} 1 & +i & -1 & +i \\ 1 & +i & -1 & +i \\ 1 & +i & -1 & +i \\ 1 & +i & -1 & +i \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = \begin{matrix} 1\ +i\ 0\ 0 \\ 1\ +i\ 0\ 0 \\ 1\ +i\ 0\ 0 \\ 1\ +i\ 0\ 0 \end{matrix} = 4+4i$

$F(U=1)$
$[T'[1,0]$ $\begin{bmatrix} 1 & 1 & 1 & 1 \\ i & i & i & i \\ -1 & -1 & -1 & -1 \\ -i & -i & -i & -i \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} = \begin{matrix} 1\ 1 \\ i\ i \\ -1\ -1 \\ -i\ -i \end{matrix} = 0$

ปณต ลักษณ์ 59010781
หทิมพ์ เฟิงเลา 59010734

ข้อมูล $f = [0\ 7\ 8\ 1]$

Encoding

$T(U=0) = [1\ 1\ 1\ 1] \cdot [0\ 7\ 8\ 1] = [0+7+8+1] = 16$

$T(U=1) = [1\ {-i}\ {-1}\ i] \cdot [0\ 7\ 8\ 1] = [0\ {-7i}\ {-8}\ i] = -8-6i$

$T(U=2) = [1\ {-1}\ 1\ {-1}] \cdot [0\ 7\ 8\ 1] = [0\ {-7}\ 8\ {-1}] = 0$

$T(U=3) = [1\ i\ {-1}\ {-i}] \cdot [0\ 7\ 8\ 1] = [0\ 7i\ {-8}\ {-i}] = -8+6i$

$F = [16\ \ (-8-6i)\ \ 0\ \ (-8+6i)]$

Decoding

16 -8 16 -8i+6 0 +8i+6 28

$x(U=0) = (1/4)[1\ 1\ 1\ 1] \cdot [16\ \ (-8-6i)\ \ 0\ \ (-8+6i)] = 0$

$x(U=1) = (1/4)[1\ i\ {-1}\ {-i}] \cdot [16\ \ (-8-6i)\ \ 0\ \ (-8+6i)] = 7$

$x(U=2) = (1/4)[1\ {-1}\ 1\ {-1}] \cdot [16\ \ (-8-6i)\ \ 0\ \ (-8+6i)] = 8$

$x(U=3) = (1/4)[1\ {-i}\ {-1}\ i] \cdot [16\ \ (-8-6i)\ \ 0\ \ (-8+6i)] = 1$

$X = [0\ 7\ 8\ 1]$

$$f = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$$

$$f(T(0,1)) = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} = 4-4i$$

$$f(T(1,0)) = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} = 0$$

$$f(T(1,1)) = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} = 0$$

[illegible] หวังเจริญ 59010401
[illegible] [illegible] 59010093

T(v=0) = [1 1 1 1] [0 4 0 1] = 5
u=1 = [1 -i -1 i] [0 4 0 1] = -3i
u=2 = [1 -1 1 -1] [0 4 0 1] = -5
u=3 = [1 i -1 -i] [0 4 0 1] = 3i

F = (5 -3i -5 3i)

T'(v=0) = (1/4)[1 1 1 1] · [5 -3i -5 3i] = 0
T'(v=1) = (1/4)[1 i -1 -i] · [5 -3i -5 3i] = 4
T'(v=2) = (1/4)[1 -1 1 -1] · [5 -3i -5 3i] = 0
T'(v=3 = (1/4)[1 -i -1 +i] · [5 -3i -5 3i] = 1

x = [0 4 0 1]

$$(0,1)\quad \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \\ 1 & -i & -1 & i \end{bmatrix} = 4-4i$$

$$(1,0)\quad \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 1 & 1 & 1 \\ -i & -i & -i & -i \\ -1 & -1 & -1 & -1 \\ i & i & i & i \end{bmatrix} = 0$$

$$(1,1)\quad \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & -i & -1 & i \\ -i & -1 & i & 1 \\ -1 & i & 1 & -i \\ i & 1 & -i & -1 \end{bmatrix} = 0$$