Programming Assignment

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→ **Team:**

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→ **Problem:**

Given ~~[illegible]~~ noised and blurred signal $y[n]$. Our task is to denoise and deblur it to get the original signal $x[n]$.

1) First denoise then deblur.
2) First deblur then denoise.

e) Theoretical Explanation.

$$y[n] = x[n] * h[n] + d[n]$$

$$h[n] = \frac{1}{16}[1\ 4\ 6\ 4\ 1] \quad \left(\begin{matrix}\text{Bluring}\\ \text{matrix}\end{matrix}\right)$$

$d[n] \longrightarrow$ Noise signal.

1) First denoise than deblur

$$z[n] = x[n] * h[n] = y[n] - d[n]$$

↳ Denoised Signal.

For denoising apply averaging method

i.e. $y[n] * d'[n]$

where

$$d'[n] = \frac{1}{3}[1\ 1\ 1] \quad \text{or} \quad \frac{1}{5}[1\ 1\ 1\ 1\ 1]$$

or in general

$$\frac{1}{k}[1\ 1\ 1 \ldots (k \text{ times})]$$

k is odd

Here middle value corresponds to $n = 0$.

$\therefore \quad z[n] = y[n] * d'[n]$

By fourier transform,

$Z(e^{j\omega}) = Y(e^{j\omega}) \times D(e^{j\omega})$

$z[n]$ is denoised $\longrightarrow$ Step 1

$z[n] = x[n] * h[n]$

$\therefore \quad Z(e^{j\omega}) = X(e^{j\omega}) \times H(e^{j\omega})$

$\therefore \quad X(e^{j\omega}) = \dfrac{Z(e^{j\omega})}{H(e^{j\omega})} \longrightarrow$ Step 2

Now,

$$x[n] = \frac{1}{2\pi} \int_{-\pi}^{\pi} X(e^{j\omega})\, e^{j\omega n}\, d\omega$$

For computing integral we use summation

$$d\omega = \frac{2\pi}{1000}$$

lower limit : $-\pi \rightarrow -500\left(\frac{2\pi}{1000}\right)$

upper limit : $\pi \rightarrow 500\left(\frac{2\pi}{1000}\right)$

$$\therefore \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\omega})\, e^{j\omega n}\, d\omega$$

$$= \frac{1}{2\pi}\sum_{k=-499}^{499} X(e^{j\omega_k})\, e^{j\omega_k n}\left(\frac{2\pi}{1000}\right)$$

$$= \frac{1}{1000}\sum_{k=-499}^{499} X(e^{j\omega_k})\, e^{j\omega_k n}$$

$$\left(\omega_k = k \times \frac{2\pi}{1000} = \frac{k\pi}{500}\right)$$

$$\therefore x[n] = \frac{1}{1000}\sum_{k=-499}^{499} X(e^{j\omega_k})\, e^{j\omega_k n}$$

— Step 3

$\therefore$ $Y(e^{j\omega}) \longrightarrow Z(e^{j\omega}) = \frac{Y(e^{j\omega})}{H(e^{j\omega})}$

$Z(e^{j\omega}) \longrightarrow X(e^{j\omega}) = Z(e^{j\omega}) \times D(e^{j\omega})$

$X(e^{j\omega}) \longrightarrow x_1[n]$

2) First deblur than denoise

$$Z(e^{j\omega}) = \frac{Y(e^{j\omega})}{H(e^{j\omega})}$$

$z[n]$ is deblured —— Step 1

$$Z(e^{j\omega}) \times D(e^{j\omega}) = X(e^{j\omega})$$

—— Step 2

$$x[n] = \frac{1}{1000} \sum_{k=-499}^{499} X(e^{j\omega_k}) e^{j\omega_k n}$$

$$\left(\omega_k = \frac{k\pi}{500}\right)$$

—— Step 3

Also theoretically

$$X_1(e^{j\omega}) = \frac{[Y(e^{j\omega}) * D(e^{j\omega})]}{H(e^{j\omega})}$$

$$X_2(e^{j\omega}) = \left[\frac{Y(e^{j\omega})}{H(e^{j\omega})}\right] \times D(e^{j\omega})$$

$$\therefore \quad X_1(e^{j\omega}) = X_2(e^{j\omega})$$

$$\therefore \quad x_1[n] = x_2[n]$$

Contribution

Group Members :-

- Dhruv Shah (B20EE017)
- Sudhir Singh (B20ME082)

- Interactions/discussions on google meet

- Theoretically problem was discussed by both.
- Concept and code of denoising by averaging method worked by *Dhruv*.
- Concept and code of deblurring and improving fourier transform to get better result worked by *Sudhir*.
- Code for fourier transform and reverse fourier done by *Sudhir*.
- Using Riemann integral for integration ideated by *Dhruv*.
- Use of graphs for better outputs ideated by *Sudhir*.
- Coding part was looked by both.