Linear Time-Invariant System Analysis

RESPONSE TO ARBITRARY SIGNAL AND FREQUENCY RESPONSE

Outline

- Purpose
- Tool
- Method
- GUI
- Analysis
- Demo
- Review

Purpose

- Linear Time-Invariant System
  - (A+B)(t)=A(t)+B(t) --Linear
  - A(t)->B(t) && A(t-1)->B(t-1) --Time-Invariant
- Response to Arbitrary Signal
- Frequency Response

Tool

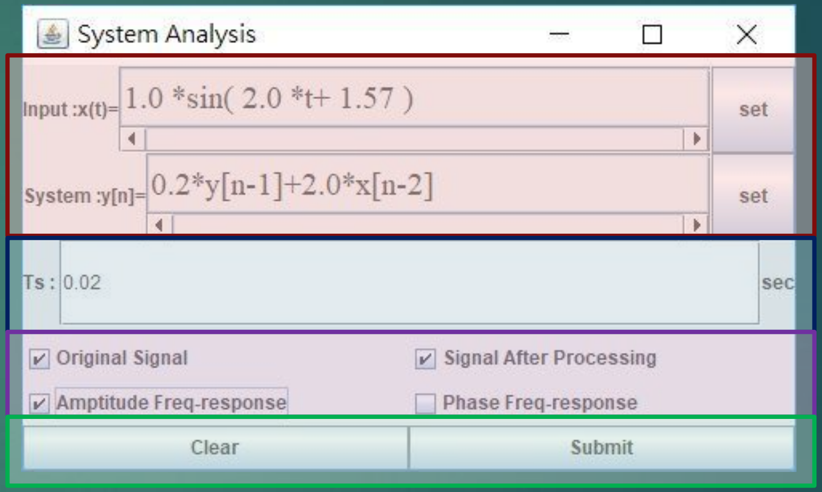
- IDE
  - Eclipse IDE for Java Developers
  - Neon Release (4.6.0)
- Programming Language
  - Java SE Development Kit 8u121

Method

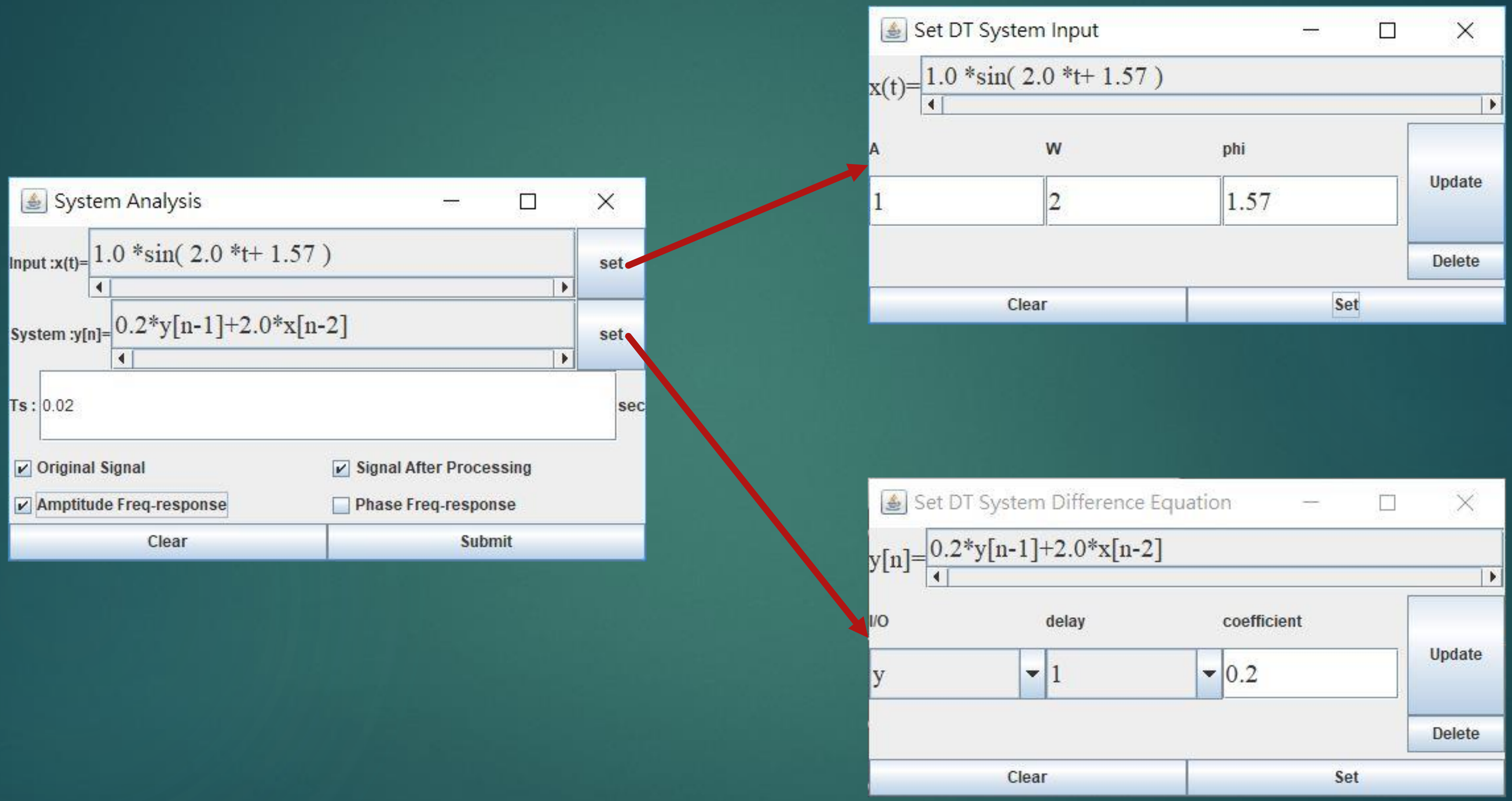
- Response to Arbitrary Signal
  - Convolution : $y[n]=(x*h)[n]$
- Frequency Response
  - Basic input : $x[n]=\sin(wn)$
  - Compare with Response $y[n]$
    - Amptitude = $\max(y[n]), n=0,1,2,\ldots,MAX$
    - Phase = $w*\Delta n$

GUI

- Input & System state area
- Ts setting textfield
- Output type setting area
- Comfirm area



GUI(cont’)



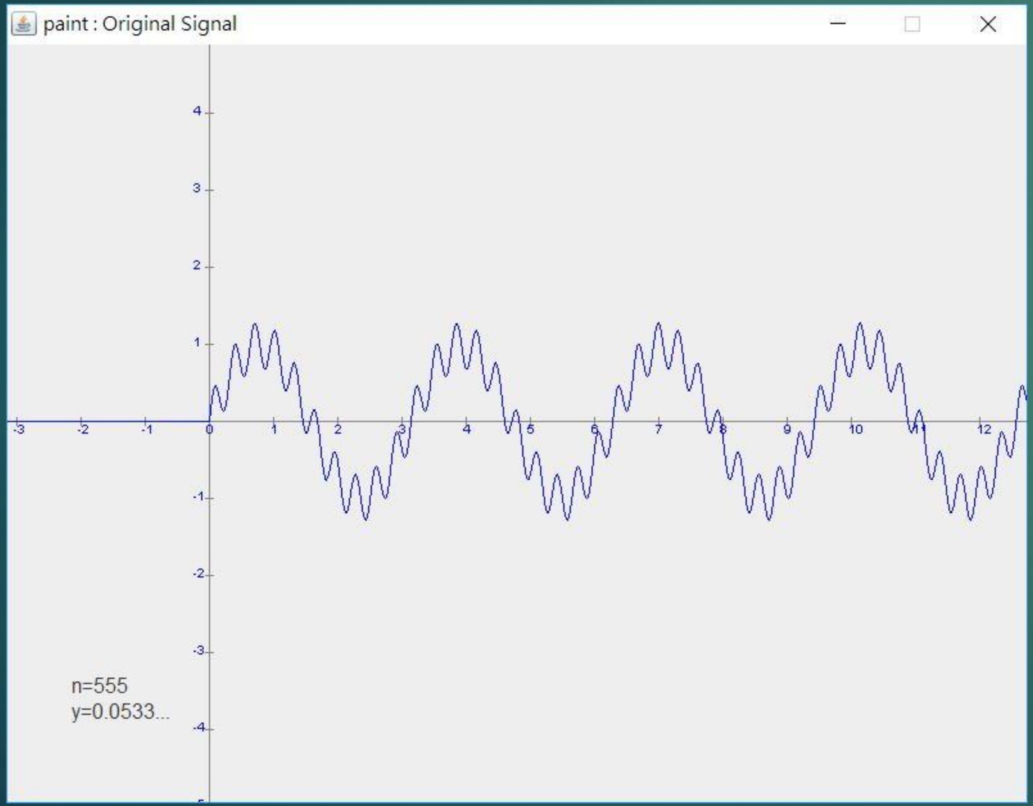
System Analysis
Input :x(t)=
1.0 *sin(2.0 *t+ 1.57)
set
System :y[n]=
0.2*y[n-1]+2.0*x[n-2]
set
Ts :
0.02
sec
Original Signal
Signal After Processing
Amptitude Freq-response
Phase Freq-response
Clear
Submit
Set DT System Input
x(t)=
1.0 *sin(2.0 *t+ 1.57)
A
W
phi
1
2
1.57
Update
Delete
Clear
Set
Set DT System Difference Equation
y[n]=
0.2*y[n-1]+2.0*x[n-2]
I/O
delay
coefficient
y
1
0.2
Update
Delete
Clear
Set

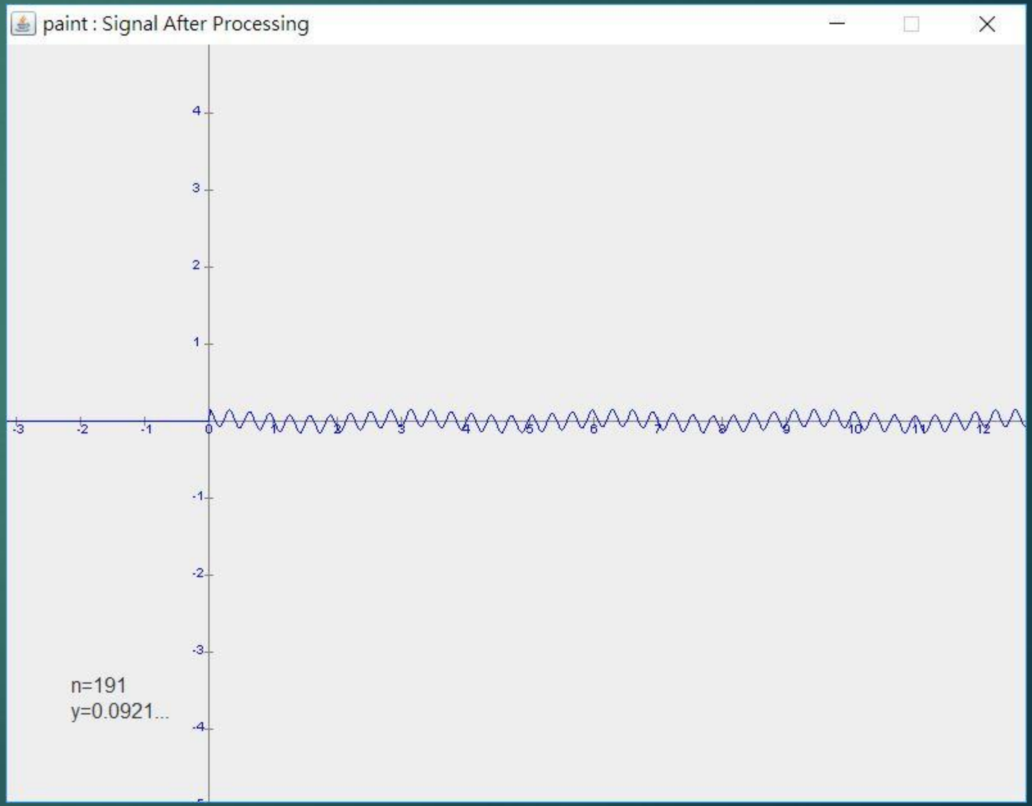
Analysis

- High-pass filter
- Low-pass filter
- Change Ts

Analysis(cont')

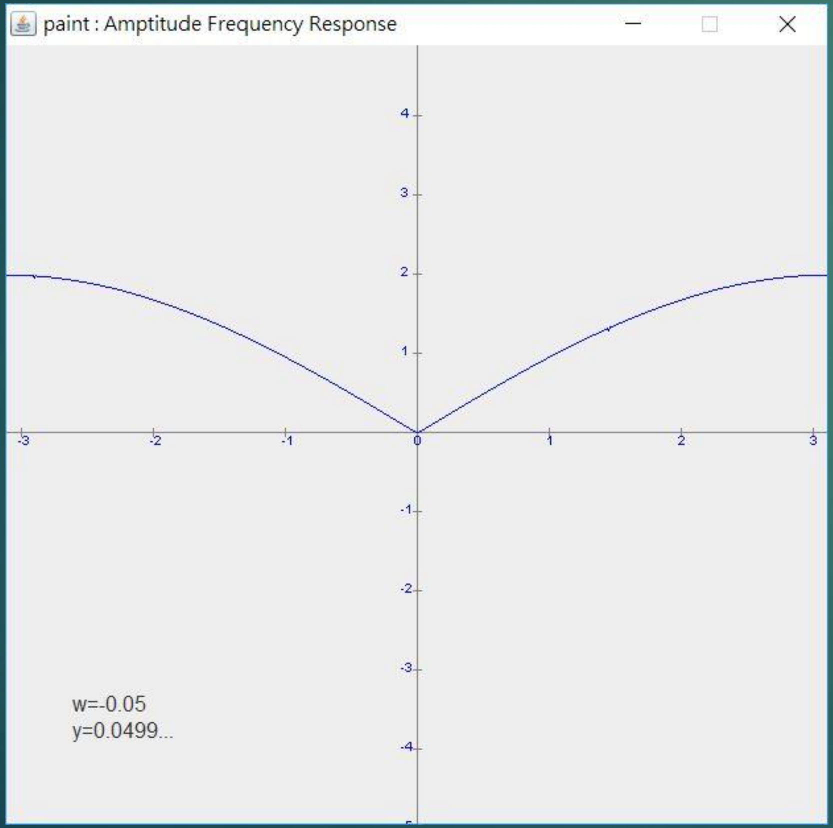
- High-pass filter

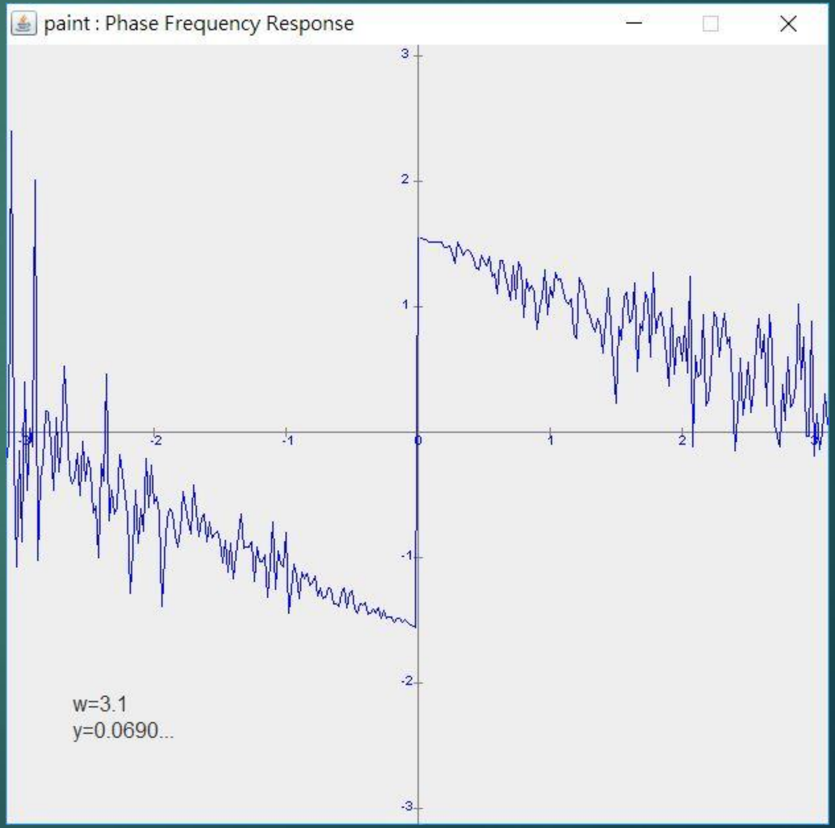




Analysis(cont')

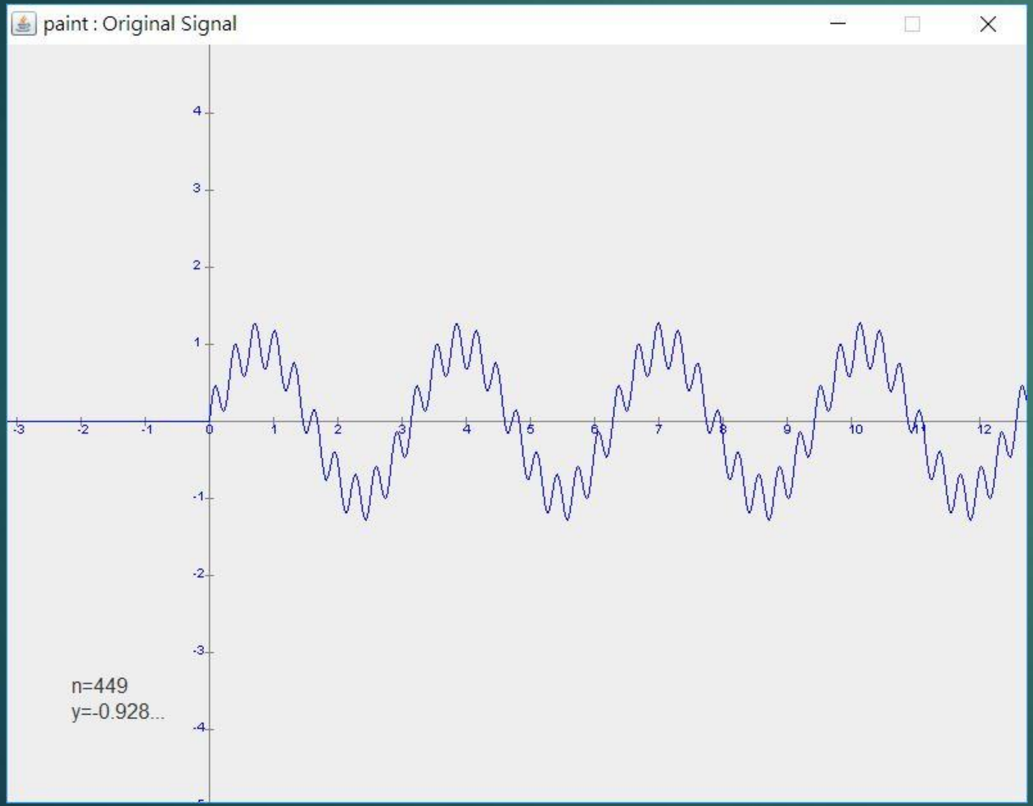
- High-pass filter

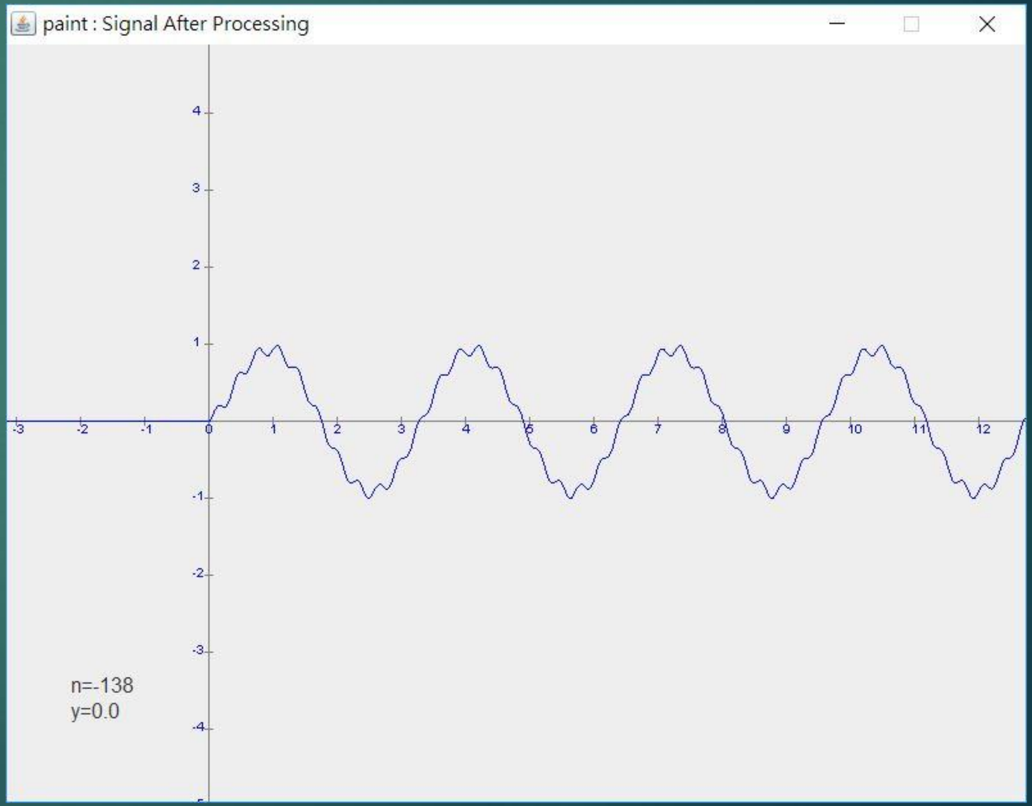




Analysis(cont')

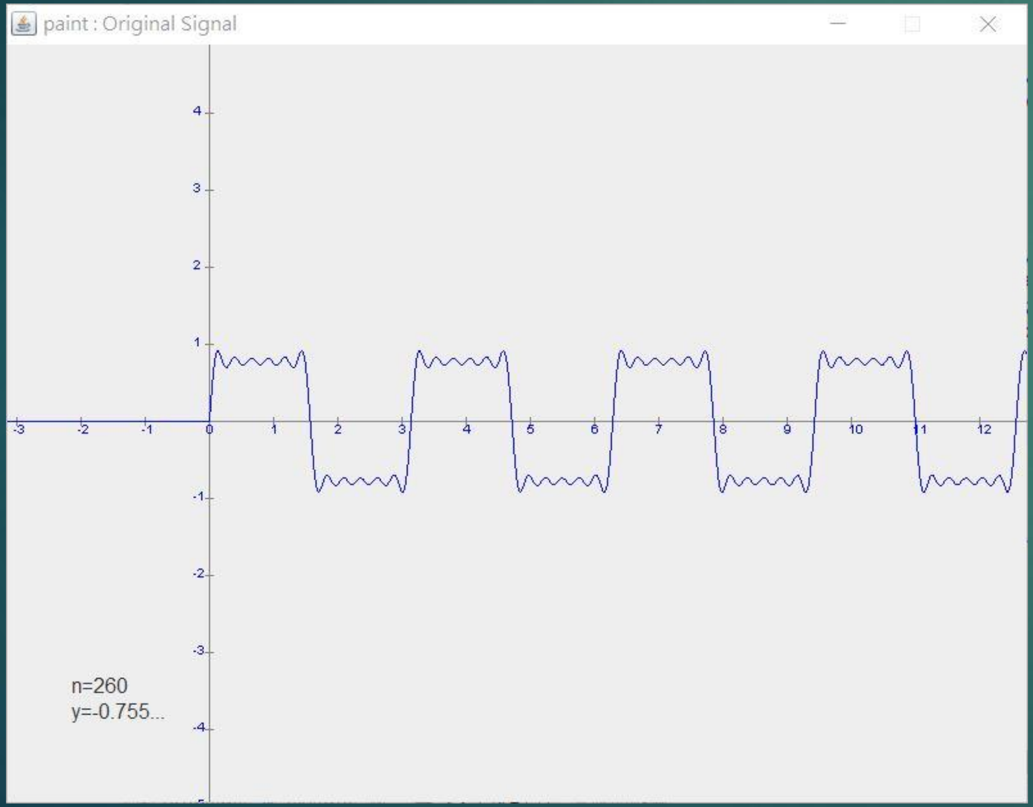
- Low-pass filter

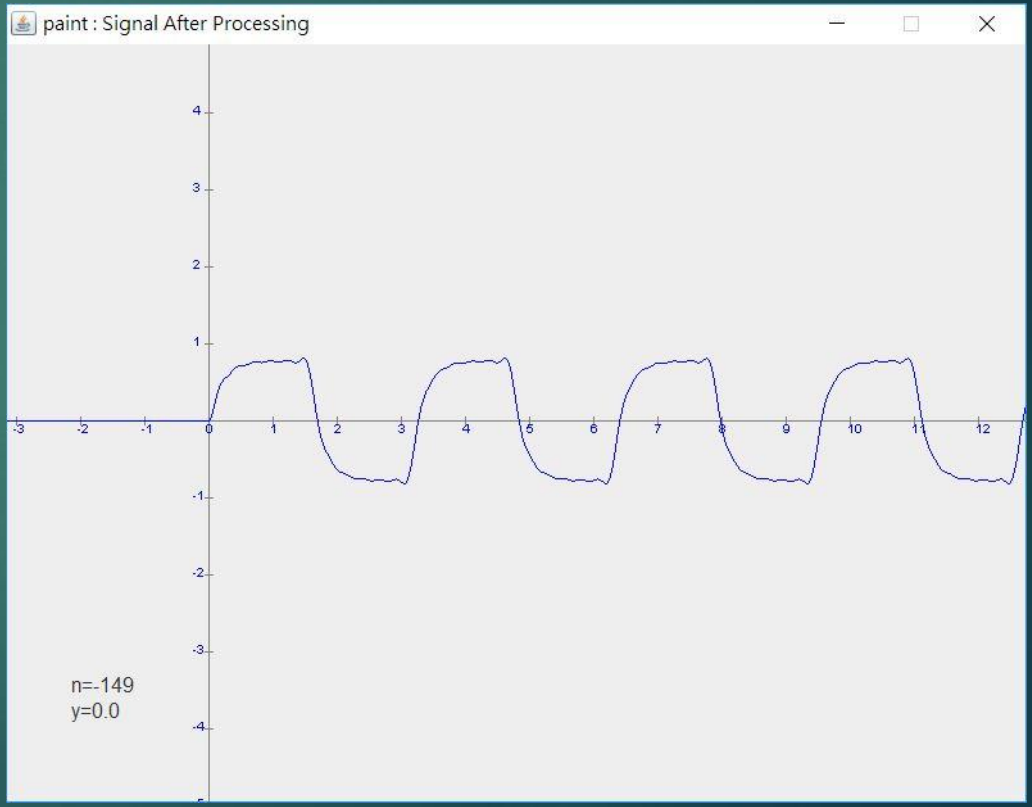




Analysis(cont')

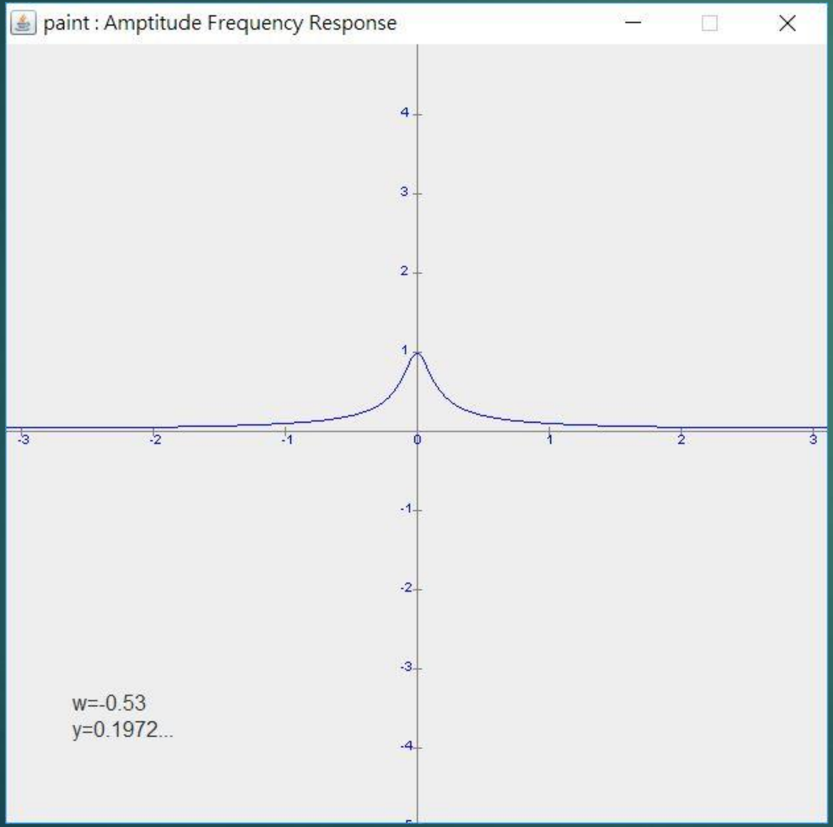
- Low-pass filter

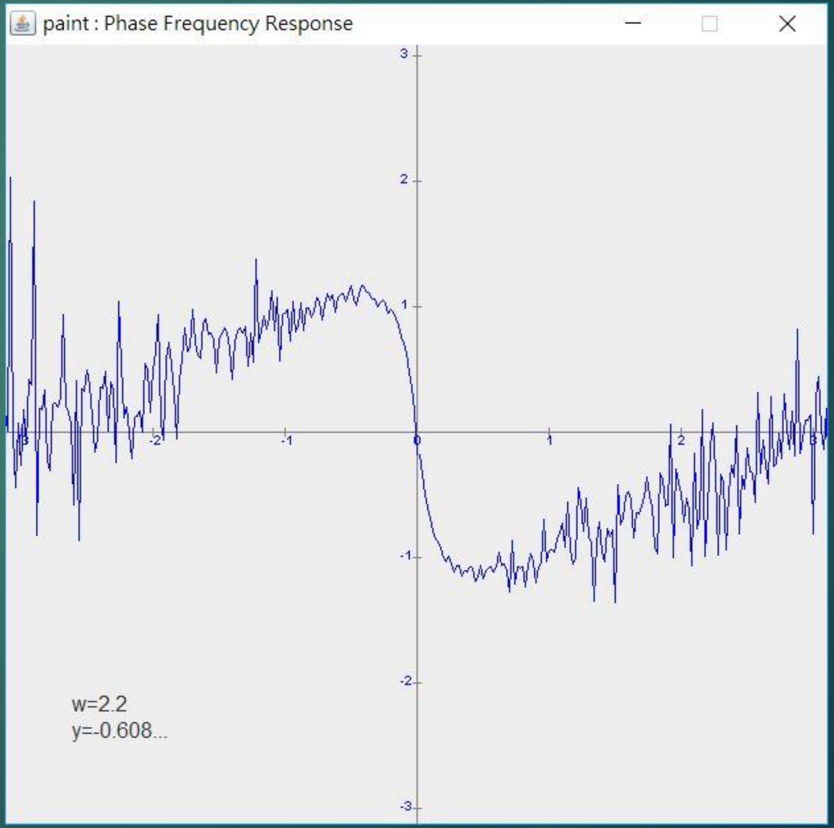




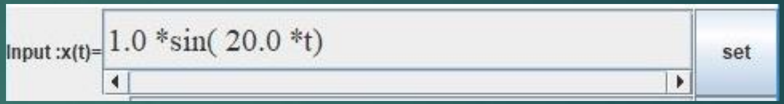
Analysis(cont')

- Low-pass filter

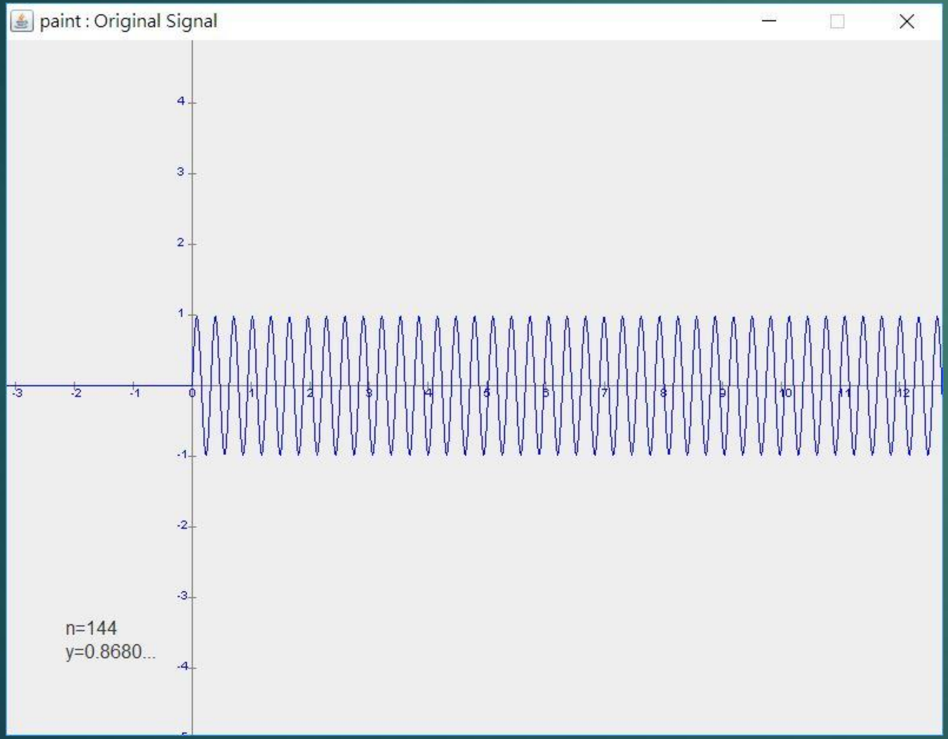


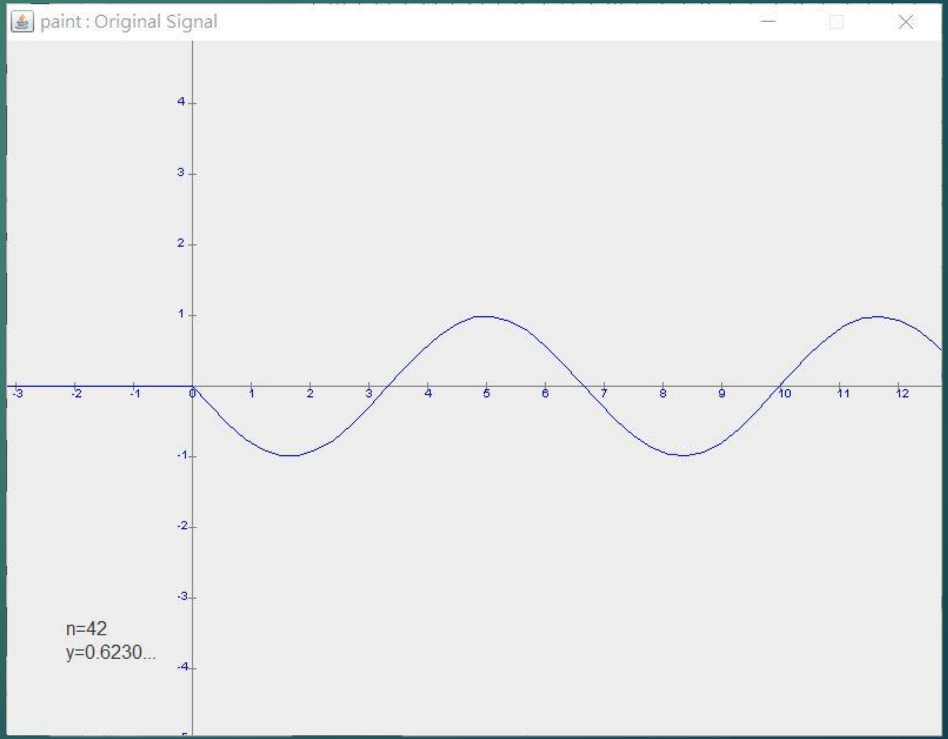


Analysis(cont')

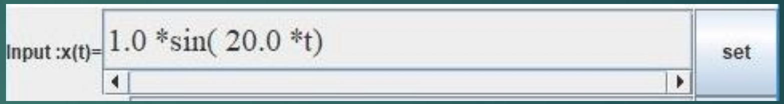


- Ts=0.02
- Ts=0.3





Analysis(cont')



- Depend on Nyquist-Shannon sampling theorem
  - Sampling time < $\frac{1}{2} \cdot T = \frac{\pi}{\omega}$
- Ts<$\frac{\pi}{20} = 0.157$sec

Demo

Review

- 此次專案製作期間，進一步使用了GUI中較為進階的部分，如：子母視窗切換及傳值等等。使我學習到更多GUI的設計技巧。
- 此外，計算相位差的部分，在實作時發現因為離散的因素而導致計算上會產生極大的誤差，這點目前可以想到的解決方式，大概僅能依靠$|H(z)|$及$\angle H(z)$，並利用圖形去求出相關數值。
- 總體來說，藉由此次的專案，不僅能看見波形在各種系統下的變化，還讓我更加了解信號處理的基本過程，使得我受益良多。