A Virtual Signal Generator Based on Audio Card and MatLab

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Outline

- Modal Analysis
- Experimental Modal Analysis
- Virtual Signal Generator
• Modal Analysis is the study of the dynamic characteristics (resonance frequency, damping, mode shapes) of structures.

Frequency domain:

\[ F(j \omega) \rightarrow H(j \omega) \rightarrow x(j \omega) \]

- \( F(j \omega) \): input signal (force)
- \( H(j \omega) \): frequency response function
- \( x(j \omega) \): output signal (displacement)
Experimental Modal Analysis (EMA)

- Signal generator
- Amplifier
- Electromagnetic shaker
- Force sensor
- Accelerometer

Not arbitrary signal

\[ H(j\omega) \]
%% Open the analog device and channels
AO = analogoutput('winsound', 0);
Chan = addchannel(AO, 1);

%% Set the sample rate and how long we will send data
duration = 1;
SampleRate = 44100;
set(AO,'SampleRate',SampleRate)
Set(AO,'TriggerType','Manual')
NumSamples = SampleRate*duration;

%% Create a signal that we would like to send
...

%% Put the data in the buffer, start the device, and trigger
putdata(AO,data)
start(AO)
trigger(AO)

%% clean up, close down
waittilstop(AO,5)
delete(AO)
clear(AO)
Virtual Signal Generator

• MatLab produces an arbitrary waveform in digital signal
  - write signal in vector y

\[ y = [0 \ldots 0 \ldots 1 \ldots 0 \ldots 0 \ldots 1 \ldots 0 \ldots 0] \]

• Sound card transform digital signal to analog signal and play.

- Diagram:
  - MatLab vector
  - DAC
  - Operational amplifier
Operational amplifier

inverting amplifier

1. No Current Flows into the Input Terminals
2. The Differential Input Voltage is Zero as $V1 = V2 = 0$ (Virtual Earth)

\[
i = \frac{V_{in} - V_{out}}{R_{in} + R_{f}}
\]

Therefore,
\[
i = \frac{V_{in} - V2}{R_{in}} = \frac{V2}{R_{f}}
\]

and as,
\[
i = \frac{V_{in} - 0}{R_{in}} = \frac{0 - V_{out}}{R_{f}}
\]

the Closed Loop Gain is given as,
\[
\frac{V_{out}}{V_{in}} = \frac{R_{f}}{R_{in}}
\]
EMA With Virtual Signal Generator

virtual signal generator

PC with sound card

operational amplifier

force sensor

electromagnetic shaker

amplifier

accelerometer

arbitrary waveform

amplify

$H(j\omega)$
Summary

- Non-stationary modal analysis requires arbitrary signal to excite.

- Arbitrary waveforms can be generated using sound card and MatLab.

- Next Time
  - How to work with non-stationary signal
  - Hilbert Huang Transform to analysis non-stationary signal
Thank you for your Atention