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Simultaneous Transfer Function Measurement of a Multiple Input Multiple Output System

Introductory Presentation

Trishita Banerjee

29. March 2018

- About Me
- Introduction
- Exponential Sine Sweep
- Multiple Exponential Sweep Method
- My project

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About Me

My origin

- Name: Trishita Banerjee
- Nationality: Indian
- Native City: Kolkata, India



About Me

My education



- Completed B.Tech from West Bengal University of Technology in Electronics and Communications Engineering

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Introduction

Motivation

- Why MESM?

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- Why MESM?
 - Multiple Exponential Sine Sweep method (MESM) uses overlapping and interleaving sweeps in an optimized way to detect the impulse responses of the measured system for different spatial positions
 - Multiple Exponential Sine Sweep method, till date is the fastest way to accelerate HRTF measurement

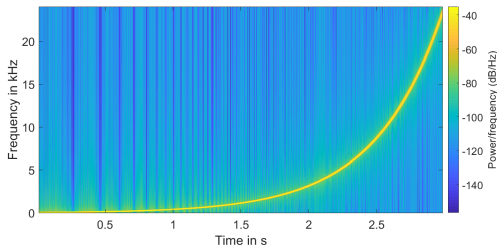
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Exponential Sine Sweep

Excitation signal

- $x(t)$ is a bandlimited sinusoidal sweep signal for which the frequency is varied exponentially with time, starting at Ω_1 to Ω_2

$$x = \sin \left[\frac{\Omega_1 \cdot (L - 1)}{\ln(\frac{\Omega_2}{\Omega_1})} \cdot (e^{\frac{n}{L-1} \cdot \ln(\frac{\Omega_2}{\Omega_1})} - 1) \right] \quad (1)$$



Exponential Sine Sweep

Advantages

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 2. Separation of linear and nonlinear parts of weakly nonlinear systems
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 4. Low sensitivity to transient noise, having an impact within a narrow frequency band only.

Exponential Sine Sweep

Deconvolution of exponential sine sweep

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Exponential Sine Sweep

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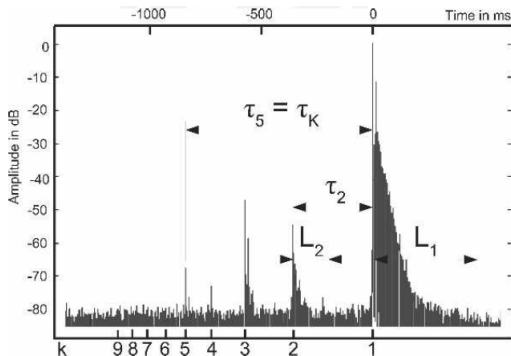
$$- C = \frac{\pi L \cdot \left(\frac{\Omega_1}{\Omega_2} - 1\right)}{2(\Omega_2 - \Omega_1) \cdot \ln\left(\frac{\Omega_1}{\Omega_2}\right)}$$

Exponential Sine Sweep

Series of resulting harmonic impulse responses



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$$\tau_k = \left[\frac{T}{\ln\left(\frac{\omega_2}{\omega_1}\right)} \cdot \ln(k) \right] \quad (2)$$

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- Introduction
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Multiple Exponential Sweep Method

Overview

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Multiple Exponential Sweep Method

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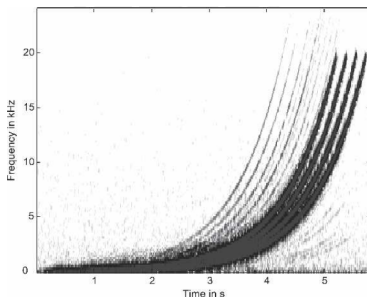
- The exponential sweep is played by a loudspeaker and the impulse response recorded. The set up is repeated for each remaining system
- The three mechanisms:
 - Interleaving
 - Overlapping
 - Combination of Interleaving and Overlapping

Multiple Exponential Sweep Method

Interleaving

- The excitation of the second system is delayed so that its IR is placed between the IR and the second-order HIR of the first system

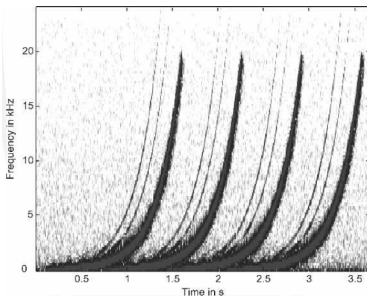
$$\Delta t_{int} = (i - 1) \cdot L_1 \quad (3)$$



Multiple Exponential Sweep Method Overlapping

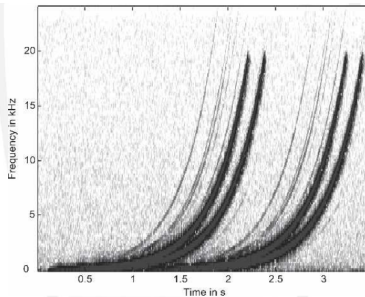
- The mechanism involves playing a single sweep and play the next sweep even if its not finished

$$\Delta t_{ov} = \tau_k + L_1 \quad (4)$$



Multiple Exponential Sweep Method MESM

- First interleaving for systems in specific groups and then these groups are overlapped with intergroup delay



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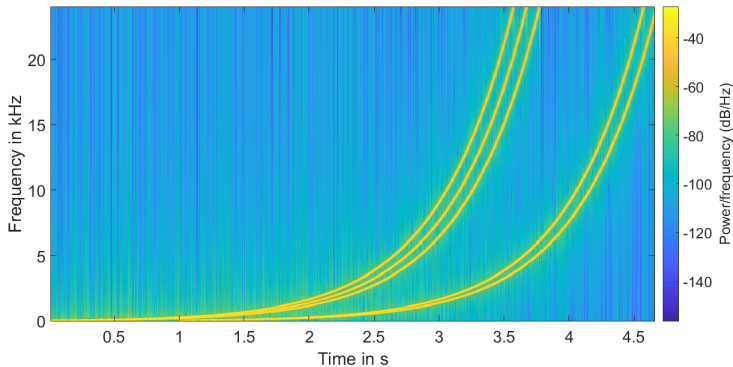
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- Program the MESM excitation signal with the corresponding parameters

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- Program the MESM excitation signal with the corresponding parameters
- Simultaneous measurement of the transfer functions between 5 speakers and 2 microphones

My project

My work so far



- Adjust MESM to the measurement setup

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- Use MATLAB Data Acquisition Toolbox for playback of the delayed sine sweeps through different loudspeakers

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- Simultaneous measurement of Multiple Input Multiple Output (MIMO) system

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- Use MATLAB Data Acquisition Toolbox for playback of the delayed sine sweeps through different loudspeakers
- Simultaneous measurement of Multiple Input Multiple Output (MIMO) system
- Compare performance of MESM to single Exponential Sine Sweep measurement

- [1] P.Majdak, P.Balazs, and B. Laback, "Multiple Exponential Sweep Method for Fast Measurement of Head-Related Transfer Functions," Journal of the Audio Engineering Society, vol.55, no.7/8, pp.623-637, Jul/Aug 2007



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