Acoustic Impulse Response Measurement Methods for Small Rooms

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Abstract. *This paper describes the results obtained in an under-grad project in the area of acoustical measuring. In this project, a research about the various acoustic impulse response measurement systems for small room was made. A research about room acoustical parameters, as well as about impulse response processing methods for its derivation, was also done. As a result of this project, a acoustic impulse response measurement system was developed.*

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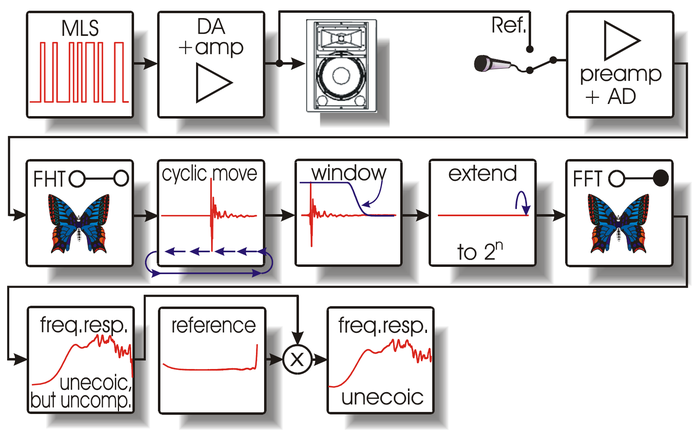
1. Measuring the Acoustic Impulse Response

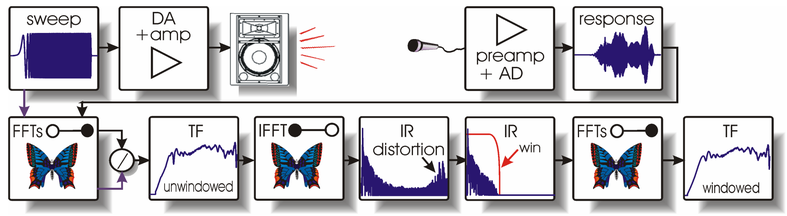
1.1 Maximum Length Sequences (MLS)



Characteristics
- ✓ Fast, high resolution/trustworthiness and easy excitation signal generation.
- × High vulnerability to time variance and non-linearity.

1.2 FFT analysis with Log Sweep excitation

Proposed name: "*Log-sweep FFT method*" or simply ***LSF***

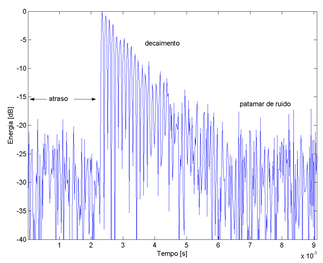


Characteristics
- ✓Fast, high resolution/trustworthiness.
- ✓Insensitive to time variance.
- ✓Immune against harmonic distortion.
- ✓Crest Factor smaller than of a colored noise.

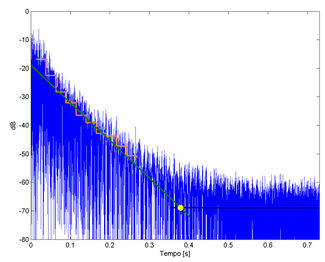
2. Measuring the Acoustic Parameters

Theory differs from praxis in three aspects:
1. Real IR presents sound arrival delay.
2. Decay can be composed of different parts with different decay rates.
3. The measured IR presents background noise, that limits the decay to a given level.

- *The underestimation of these effects can cause systematic errors in the derivation of acoustic parameters.*
  - Chu and Hirata methods attempt to minimize noise influence.
  - Lundeby method attempt to minimize the noise influence together with truncation effect at the Schroeder's integral.



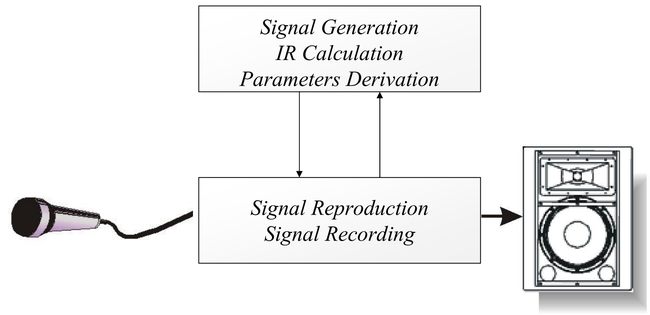
Real IR envelope



Lundeby's method

3. Measurement System

- The system architecture consists of two modules:
  - Signal generation, measurement of IR and processing of the acoustic parameters: Implemented with a computer.
  - Audio signal acquisition and reproduction: Implemented with a soundboard and a transductors set.



4. Conclusions

- Nowadays, with the actual processing speed, the **LSF** method becomes much more interesting than the **MLS** method for acoustic measurements. This was the method chosen to our product.
- The measured IR will always have a non-ideal behavior. Techniques should be employed to reduce the influence of these phenomena in the measurement of the acoustic parameters.

5. References

- **ISO 3382:1997. Acoustics – Measurement of the reverberation time of rooms with reference to other acoustical parameters.**
- **Lundeby A., Vigran T.E., Bietz H., Vorländer M. 1995. Uncertainties of Measurements in Room Acoustics. Acustica Vol. 81 (1995). pp. 344–355**
- **Müller, S., Massarani P., "Transfer Function Measurements with Sweeps". J.AES, Vol. 49, number 6, pp.443. 2001**
- **Vorländer M., Bietz H. 1994. Comparison of Methods for Measuring Reverberation Time. Acustica Vol. 80. pp. 205–215**