MLS theory basics

MLS in a nutshell...

MLS is an abbreviation for **M**aximum **L**ength **S**equence. It is basically a pseudo-random sequence of pulses.
Nowadays MLS measurements are quite standard in many different application fields. One of them is acoustics.

Using MLS techniques, it is possible to perform **quasi-anechoic** measurements of a **loudspeaker** without having to place it inside an anechoic chamber (a room free from echoes and reverberations). The impulse response can be easily windowed in the time domain, in order to analyze the signal and reject the reflections from the walls of the room. Moreover the **room impulse response** itself (and all the related parameters such as reverberation time) can be measured.

The MLS method can also be used to analyze and obtain information about the **impedance** or the **absorption coefficient** of a surface.

The N-order MLS sequence is periodic with period (2^N)-1. Different MLS sequences of the same order can exist. They can be easily obtained by using a shift-register with different feedback taps.

The MLS signal can be used to measure the response of any type of **LTI** (**L**inear **T**ime **I**nvariant) system. The impulse response of the system can be easily obtained by computing the cross-correlation between input and output signals.

For LTI systems, the **frequency response** can thus be computed by performing a **FFT** of the windowed impulse response.

The MLS technique has many advantages when compared with other methods of measuring the response of a system.

Among them the following:

- The MLS has a quasi-flat power spectrum. The spectrum envelope follows a square(sin(x)/x) law and falls by about 1.6 dB at 1/3 of the sampling rate.
- MLS technique rejects the DC component of the sampled signal.
- MLS measurements have a very high Signal/Noise ratio. The cross-correlation used to compute the impulse response reduces all background noise (uncorrelated with MLS), so that measurements can be performed also in noisy environments. The use of averaging techniques can furhter increase the S/N ratio.
- The measured distortion of the system is spread throughout the computed impulse response. Every MLS sequence has his own characteristic distorsion pattern: more measurements on the same system with different MLS sequences (of the same order) allow an easy recognition of the distortions.

Some precautions must be taken when using the MLS method:

- The MLS signal length must be longer than the impulse response of the system under test or have the same length. If these conditions are not satisfied, some parts of the computed impulse response will overlap (time-aliasing).

- The system under test must be time-invariant, at least during the measure interval.

More information and references about MLS measurement theory can be found in the bibliography section.
