

Statistical modeling of noisy sounds: spectral density, analysis, musical transformations, and synthesis

Abstract: Computers offer new possibilities concerning sound processing. Existing research essentially concerns the modeling of the periodic parts of sounds. However, noisy sounds are more and more used in musical compositions.

Existing models consider sounds, or their noisy parts, as filtered white noise. Psychoacoustic studies about the perception of the spectral density of frequencies show that this assumption represents a restriction. We present a new spectral and statistical model, called CNSS, based on the thermal noise model. A noisy sound is defined by a fixed number of sinusoids. The CNSS model proposes new controls related to the distributions of the frequency and phase of the sinusoids, and thus provides new musical transformations.

A general analysis method for noisy sounds is proposed. We describe a first method which characterizes partials of the noisy components in the spectrum by statistically studying their intensity fluctuations. A second method defines parts of the temporal representation that contain transients by studying the distribution of the samples of the signal. Lastly, we detail a new technique which approximates the spectral density. The parameters of the CNSS model can then be estimated.

Then, the synthesis algorithms related to the CNSS model are then detailed. Moreover, problems due to the window overlap during the synthesis of random sounds are explained and some solutions are proposed.

The CNSS model has been implemented and provides real-time synthesis of noisy sounds. This implementation is planned to be integrated in the computer-assisted early-learning tool *Dolabip*, which is developed at the SCRIME. It is also a platform for exploring sounds and a sound synthesis for psychoacoustic experiences.

Discipline Computer Science

Keywords: statistical modeling, stochastic part, spectral density, analysis and synthesis of sound, noises, real-time additive synthesis.

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