Abstract

Synthethisers are almost indespensible in today's music. They can often imitate hundreds of different instrumets mostly by playing recorded samples. In most cases this method produces a satisfying sound. However, in the case of wind and bowed string instruments the musician can influence the sound even after the attack of the note. This cannot be accurately modeled using recorded samples. Physics-based sound synthesis can overcome this problem, since it generates sound using the physical model of the instrument.

In this thesis I present the physics-based sound synthesis of the clarinet. I present a continous time model for the clarinet bore, the bell, the toneholes, and the mouthpice. Using the continous time models, I also present the discrete-time description of the instrument.

The analytical solution for the wave propagation in the bore is known, so the waveguide method can be used for modeling. The clarinet bore is cylindar so the waveguide model consists of two delay lines representing the right and left going components. The bell can be modeled as a pair of complementer filters. For the tonehole implementation I use a simple model, and place them in the waveguide using fractional delay filters.

I pay particular attention to the mouthpiece, which is the excitaion of the instrument. I present the most common model in the literature, which is a static model. I also present a dynamic model and compare it with the static model. The waveforms are more or les similar, but the dynamic model produces a more pleasant, more clarinet-like sound. However, the computing time of the dynamic model is much higher due to its implicit iterative algorythm.

In order to avoid the high computing time, I propose a model, which produces more similar sound to the dynamic model, but executes the static model with dynamically changing parameters. These parameters can be calculated from off-line simulated waveforms, and can be stored in look-up-tables.

The aforementioned combined model cannot be used in one case: when the reed does not touch the mouthpiece. This happens when the mouthpressure is low. In this case, however, the singularity of the dynamic model's differential-equation is negligible, so a simple, explicit method can be used to solve it. Thus a hybrid model is created, which uses the dynamic model when the mouth pressure is low, and uses a dynamic model based static model when the mouth pressure is higher.

Using theese ideas I create an efficent model, which represents the dynamic behaviour of the instrument quite well, with the hope that it will be suitable for an effective real-time synthesis.