Abstract

Thanks to its unique sound, the *Hammond organ* has reached an outstanding popularity in several musical genres up to now. However, due to the difficulties of its transport and maintenance, a significant need has arisen for its substitution by digital devices. Owing to the specialities of the instrument – instead of the sample-replaying solutions used in ordinary synthesizers – a *model based approach* seems to be more suitable that considers the working principle of the organ.

In this thesis, the modelling method of the electromechanical Hammond organ is discussed from studying the structure of the instrument, through the tasks of signal analysis and synthesis based on measurements, until the development of the real-time Hammond simulator application. My work has been founded both on sound samples recorded from a Hammond A-100 model, and on the available literature on-line.

Firstly, the function and operation of the organ components – such as *tonewheel generator*, *harmonic mixing unit*, *percussion circuit* and *preamplifier* – are introduced. After that, the software models of the above units are discussed, which have been developed in MATLAB. First, a *signal model* based on the analysis of the generator signals is shown. It is followed by the *weight-and-sum algorithm* and *stochastic key click model* representing the harmonic mixing unit, and the *envelope generator* of the percussion system. Thereafter, the software based modelling of the linear and nonlinear transfer characteristics of the preamplifier is presented: the description of the *extended Wiener-Hammerstein model* is followed by the experiments aiming the identification of model parameters. Meanwhile, a technique is introduced which has been used to measure the linear frequency response applying *logarithmic sweep* signal. Finally, the *parallel IIR filter system* is described that implements the transfer function of the preamplifier unit, which is followed by the *expression control* pedal.

After that, the real-time application based on the previous MATLAB models is outlined, which has been constructed in *JUCE application framework*. A description is given on the framework itself and the structure of the software. Then the evaluation of test results are presented, demonstrating the suitability of the application. Finally, the performed tasks are summarized, and suggestions are given about the possible directions of future development.