How changes in the mechanical design of the kantele affect its tonal, dynamical, and radiational behavior and applying this knowledge for sound synthesis purposes

Work plan

Henri Penttinen, 24.8.2006

The primary goal of this STSM is to investigate how changes in the mechanical design of the kantele affect its tonal, dynamical, and radiational behavior and how to apply this knowledge for sound synthesis purposes. In other words, the aim is to help the process to create physically motivated control parameters of a plucked string instrument for computer controlled sound synthesis. The collaboration between the Laboratory of Acoustics and Audio Signal Processing at Helsinki University of Technology (TKK) and the Luleå University of Technology (LUT) aims at 1) making sound field measurements on a traditional and new modified design of the musical instrument kantele, 2) developing the measurement equipment involved in this kind of a measurement, 3) analysing changes due to the modified construction, 4) evaluating the need for modeling the possible changes, and 5) publishing the results in a respected journal of the field.

Expressiveness in music and sound synthesis is an area with a wide range of specific topics. The chain from gestures of an artist to music and its perception has many stages. This research visit would focus on a part that is related firstly to the adaptation of musical gestures of a human player to acoustic sound and secondly how to adapt this knowledge to sound synthesis and how to control it with an expressive notation system (ENP 2.0) [Kuuskankare, 2002; Penttinen, 2006]. The instrument of interest in this study is the kantele which is an ancient plucked stringed instrument. It belongs to the family of zithers, and it is still used in traditional folk music in Finland, Northwest Russia, and the Baltic countries. This research concentrates on differences in a traditional and a modified design of the kantele [Penttinen, 2005] and how to consider these in sound synthesis and computer aided control. The main idea in the modified design of the kantele is to increase loudness of the instrument [Penttinen, 2005]. Musically the main purpose is also to increase the dynamical scale of the instrument.

In his Doctoral studies and research Henri Penttinen has worked on physic-based sound synthesis, calibration and control of synthesis parameters, and musical acoustics. A fine example is the physic-based sound synthesis model of the Chinese guqin, which was created through a Cost287-ConGAS collaboration between Ghent University and TKK [Penttinen, 2006]. Another example is the automatic plucking point estimation algorithm [Penttinen, 2004], which enables a player of the acoustic guitar to control an arbitrary parameter (e.g. the reverberation time) by changing the plucking point has he or she plays. Mr. Penttinen's dissertation is scheduled for fall 2006. In addition to scientific advantages, the visit to LUT, Luleå, would tremendously help Mr. Penttinen's transitional shift from a Phd. student to a post-doc and make new contacts within the COST-ConGAS community and member states.

The STMT visit would offer an opportunity for the TKK and LUT to be involved in scientific cooperation for the first time. In addition, as the expertise of both units seems to complete each other, the visit would hopefully be a start for a fruitful chain of collaborative projects. Also, this will be a part of applications where physics-based control parameters will be used in the Expressive Notation Package [Kuuskankare, 2002] and the PWGLSynth [Laurson, 2005] for controlling physic-based sound synthesis of musical instruments. During the visit Prof. Mikael Sjödahl will be the supervisor and Licen. Kourosh Tatar and MSc. Per Gren will participate in the collaboration.

The cooperation project can be divided into three stages, including the two visits during 13.-17.11.2006 and 8.-12.1.2007.

Stage 1: Planning, first visit, and preliminary analysis

At the preparatory stage planning of measurement setups, play-lists, and possible modifications of measurement equipment to suite the planned measurements will be conducted. Knowledge from previous research projects will be applied and communication will occur over email and phone.

The first visit will occur in November from the 13th to the 18th 2006. The objective of the first visit is two fold. Firstly, the effect of the excitation force and mechanism is investigated and a stable solution is sought. Secondly, the net result of the structural modifications on the plate resonances and the radiation patterns are look at. The measurements are to be conducted by scanning laser vibrometry techniques. The variations in the excitation force and types aim at creating a system that can repeat reliably a certain type of excitation. Continuous and impulsive excitation types are going to be tested.

Stage 2: Building three prototypes and second visit

The second stage will be initiated by evaluating the preliminary analysis results and applying those results to the construction of three prototypes of the modified design of the kantele. Instrument builder Jyrki Pölkki will construct three new kanteles especially for this visit, which will function as intermediate designs from the traditional to the modified design. By building the prototypes the measurements and analysis can focus on detailed step-by-step changes occurring in the instrument due to the changes in the construction.

The second visit (8.-12. Jan., 2007) will focus on deepening and strengthening the understanding of the measurement setup and conducting measurements on the new prototypes of the kantele.

Stage 3: Exploitation of results

The measurements during visit no. 1 aim at investigating the effect of the excitation force on the net result in both the traditional and the modified design. Moreover, the measurements during the second visit aim to gather information of specific changes in the modified design with the help of the intermediate prototypes.

Concerning the exploitation of the control parameters for the physically-based sound synthesis the final analysis stage is crucial. At this stage, by signal analysis means tones played with different kantele designs will be compared with the measurement results obtained from the visit to LUT. While knowing the excitation mechanism and level the changes and differences can be used as guide lines when controlling physical sound synthesis model.

As an output of the collaboration done at TKK and LUT at least one article will written.

As for future work, listening tests could give more insight to the results obtained by signal analysis means. In addition, other forms of collaborative measurements between TKK and LUT could easily be applied to also other instruments.

References

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