CONTROLLING THE VIRTUAL BODHRAN - THE VODHRAN

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ABSTRACT

In order to have a successful interface it is preferred to employ a metaphor that the end user of the artefact is familiar with. The application described in this paper aims to provide users with an expressive virtual musical instrument, based on the traditional Bodhran. This is not designed entirely to simulate the Bodhran, but to provide an instrument which can be played in a similar way, and which creates a recognisable Bodhran-like sound; a virtual Bodhran, the Vodhran. This instrument is to be an extension of the original, allowing for additional playing techniques and styles, which could not be accomplished with the real instrument. In two experiments the same sound model implementing the Bodhran was used. In the first experiment the sound model was controlled both with data obtained from measurements of gestures of drum player, and with a traditional playing approach by using two different controllers. The Radio Baton and the ddrum (a drum pad) were used as interfaces for this experiment. Both interfaces were controlled with a traditional bodhran double beater. In the second experiment a sensor-based controller was used to translate player's gestures into sound model controls. The sound generation mechanism for the Vodhran is based on the modal description of the drum and a robust numerical solution of a nonlinear stick-membrane interaction model. The model includes different forms of a player's interference.

1. INTRODUCTION

In order to have a successful interface it is widely known that it is preferred to employ a metaphor that the end user of the artefact is familiar with. In the following pages we illustrate an application that aims to provide users with an expressive virtual musical instrument, based on the traditional *Bodhran*, the *Vodhran*. This is not designed entirely to simulate the *Bodhran*, but to provide an instrument which can be played in a similar way, and which creates a recognisable Bodhran-like sound. This instrument is to be an extension of the original, allowing for additional playing techniques and styles, which could not be accomplished with the real instrument.

In the *Bodhran*, sound is emitted in response to a stick (beater) beating the skin, generally executed by the right hand. The sound is modulated/dampened by the use of pressure placed on the inside of the *Bodhran* by the left hand. The beater is held loosely in the hand and is moved/controlled primarily by wrist action (rotation). The contact with the *Bodhran* is made with alternative ends of the beater in rapid succession. The damping factor is discrete application of pressure, but more often than not a dynamic/colourful range in pitch can be achieved by continuous control over the damping achieved by its application in counter direction to the beater. There are a variety of different applications of the damping factor employed by the musicians e.g. fingers only, side of hand only (see Figure 1).

In the following sections four control modalities are discussed. In all of them the same sound model implementing the *Bodhran* was used.

Figure 1: Traditional *Bodhran*.

The sound generation mechanism for the *Vodhran* is based on the (approximate and simplified) modal description of the drum and a robust numerical solution of a nonlinear stick-membrane interaction model [1]. The model is described in detail by Matthias Rath in [2].

2. CONTROLLING THE VODHRAN

The sound model was controlled with four different modalities. These involve both software and hardware controllers (see Figure 2) , and are presented in the following.

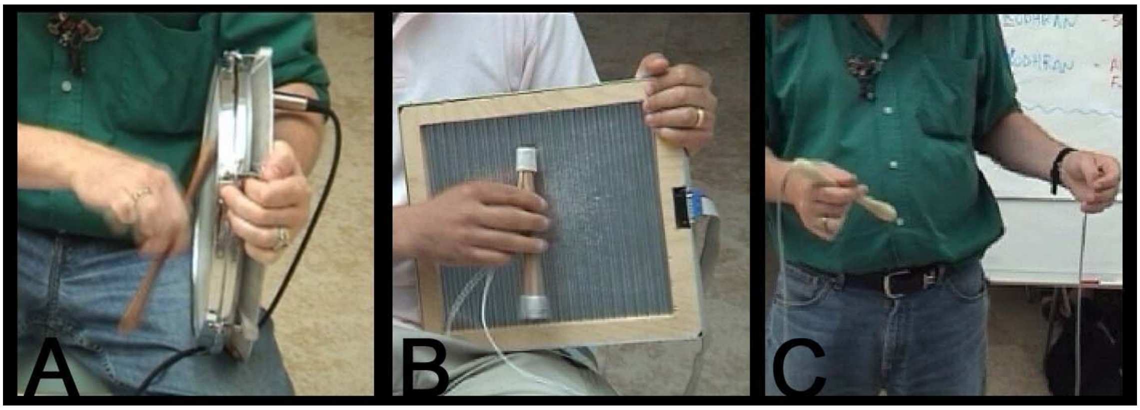

Figure 2: The three hardware controllers used to implements the Virtual *Bodhran*, the *Vodhran*. (A) The ddrum, (B) the Radio Baton, and (C) the Polhemus Fastrack.

2.1. Control by modelling real players

A pd patch implementing the model of professional percussionists was used for controlling the sound model of the *Bodhran*. This control model was obtained by the measurements described [3]. The measured striking velocities of two players were used as excitation velocity for the sound model. The pd patch, a "metronome rhythm generator", plays metronome beats with a striking velocity that is affected by dynamic level (*pp*, *mf*, or *ff*), chosen playing style (symphonic or drumset) and tempo. Any time an accent can be generated, and depending on the current tempo, dynamic level and playing style the striking velocity exciting the model will be changed accordingly. The shift between the two playing styles can also be generated in real-time.

To enable a swift change between the different playing styles and dynamic levels these control parameters were connected to an external custom made switch board. The switches were connected to the PC through a device to take analogue signals through the parallel port, the pico [4].

The control for tempo was mapped to the Korg KAOSS pad, a MIDI controller with a touch pad. The x-axis on the touch pad controls the tempo between 100 and 250 beats per minute. The y-axis controls the fundamental frequency of the physical model. By using the touch sensitivity, from the touch pad it is possible to start the metronome by touching the pad and stopping it on release. In this manner the onset and offset of beats becomes immediate and very flexible, resulting in less resemblance to a metronome. The rhythm generator was played in a live concert at Centro Candiani in Mestre-Venezia, Italy, on the 20th of June 2002 (see the Sounding Object website for more information about this event, including movies and sound examples: http://www.soundobject.org).

2.2. The Radio Baton as control device

In the same concert, the metronome rhythm generator was used together with a more direct control device for playing, Max Mathew's Radio Baton [5] (see Figure 2 B).

The set-up used in the concert is seen in Figure 3. The set-up used the Radio Baton with the two radio transmitters at each end of a *Bodhran* stick, and the antenna was played with the stick as a "normal" *Bodhran* by the player. The position of each end of the stick versus the antenna controlled the playing position of the sound model, i.e. the distance from the frame of the drum. During the concert the dampening and the fundamental frequency of the model was also controlled through devices such as the KAOSS pad and Doepfer pocket dial knobs. During the concert this was not done by the player herself, although this could be remedied by using foot switches that would leave the hands free for playing.

2.3. The ddrum as control device

In addition to the control devices described above, the ddrum [6] was used to play the sound model of the *Bodhran* (see Figure 2 A). The ddrum is a commercial available electronic drumpad and the MIDI velocity out from the control unit was used to excite the sound model. For the pad used there was also MIDI poly-aftertouch, which was used to control the dampening of the model. The ddrum is a nice interface to play the model because of it's tactile feedback to the player and the lack of cables to the sticks used for playing.

2.4. Control by tracking gestures in real time

A fourth modality of control was based on tracking users body gestures. The process of tracking users movements requires a means of capturing gestures in real time, and extracting the relevant features of the gesture. This requires some form of input device which can take a gesture as input and extract the relevant characteristics of this gesture.

Traditionally, the use of gesture as input involves the use of computer vision techniques, such as recording of gesture with a camera, and the tracking of the movement of a person over time. These systems have a number of limitations, for instance they can be too slow for real-time use, and do not cope well with tracking more than one user. Also, they might not be accurate enough for present requirements.

So, it was decided to use a Polhemus Fastrak [1] device in order to track the users movement (see Figure 2 C). This system tracks the position of up to four small receivers as the move through 3D space, relative to a fixed electromagnetic transmitter. Each sensor returns full six degree-of-freedom measurements of position (X, Y, and Z Cartesian coordinates) and orientation (azimuth, elevation,

[1] Polhemus Fastrak `http://www.polhemus.com/fastrak.htm`

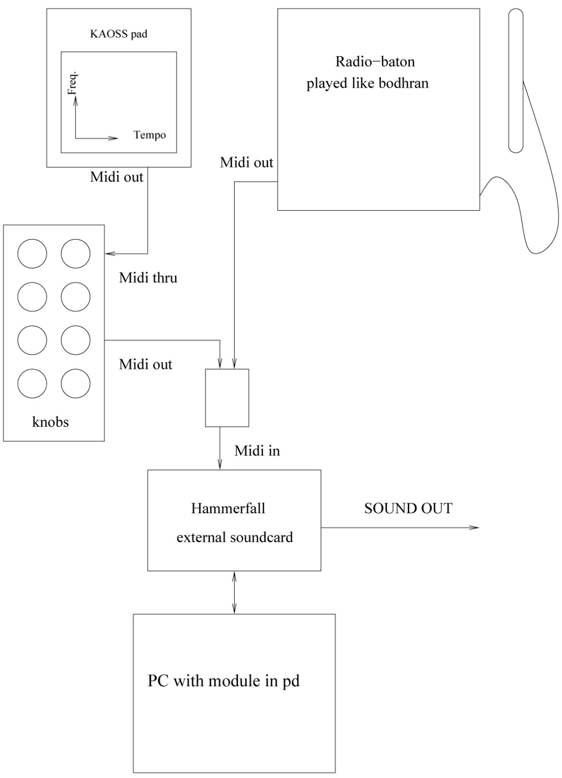

Figure 3: Set-up used for the concert at Centro Candiani in Mestre-Venezia, Italy, on the 20th of June 2002. A player used a *Bodhran* stick, modified with cables to transmit radio signals, and played the antenna like a *Bodhran*. While the position across the antenna controlled the striking position of the model, the fundamental frequency and dampening was manipulated of another person through the Korg KAOSS pad and a set of knobs. The same person also played the "metronome rhythm generator" and then used the x-axis of the KAOSS pad to control the metronome tempo.

and roll). The device connects to a computer through its RS-232 port, and operates at a speed of up to 115.2 K baud, with an accuracy of 0.03" (0.08 cm) RMS for the X, Y, or Z receiver position, and 0.15 RMS for receiver orientation, and a resolution of 0.0002 inches/inch of range (0.0005 cms/cm of range), and 0.025. For a more detailed description of the system see [2].

2.4.1. System design

In order to establish the requirements for the control system, in terms of usability, methods of interaction and sound quality, a day-long workshop was held. Three expert *Bodhran* players, each with their own distinct and different styles and techniques took part. The players also had varying amounts of experience in the use of technology in performance.

The players were asked to perform different traditional rhythms with the sensor attached to the beater, the results were recorded in order to further analyse the gestural patterns involved in *Bodhran* playing. Video data was also gathered for further analysis.

The results of the analysis of this data are being used to determine any common movements, gestures, or techniques that are used by the players, so that the control parameters of the model may be extended in order to allow more interaction for the players.

By examining the data in this way, and continuing to extend the model, we ensure that the overall goal of the project is met, in that a virtual instrument is created, which can be played like a *Bodhran*, but is not limited to the physical characteristics of a *Bodhran*.

The analysis of the workshop has led to a number of additional features in the design of the system. The nuances of how a *Bodhran* is played are very complex, involving both the left and right hands, with the right hand beating the skin, while the left hand can be used to dampen certain modes of the skin.

Damping. This left-handed damping was used by all of the players, and in some cases was used to produce very complex tone changes, even to provide a melody from the rhythmic beating of the skin. This damping effect is a major part of how the *Bodhran* is played, and as such will have to be incorporated fully into the system. Currently the sound model does contain a facility to damp the skin, but only at a single point at any given time. Also, the damping portion of the model would have to be coupled to the Fastrak hardware, and a Fastrak sensor attached to the left hand of a player, to allow them to damp the virtual Bodhran in a similar way to the real instrument.

Tactile feedback. During the course of the workshop, when the players were being asked to use the beater from the virtual *Bodhran* in order to create a simple beat by striking a virtual plane, it was noticed that some players require more tactile feedback from the system than others. While some of players were able to hold the beat, using just the beater and listening to the generated sound, one in particular found this difficult. The addition of a physical plane of reference, which matches the virtual one, was found to alleviate this problem. This opens to some further investigation, to determine whether or not a physical reference is required, and if so, the form of this reference.

Frame of reference. Another point that was raised by this workshop was that of a frame of reference for the instrument. Currently, the system uses a fixed reference point, which does not move with the player. In order for any virtual instrument to be internalised there needs to responsive in a non-arbitrary way and the modification was made for an extension to expressivity and also to allow deliberate musical control on the part of the musician in terms of control sensitivity and control selection. To meet this requirement, the system must allow the players to move naturally, as they would while playing the actual instrument. This would allow players to add to their movement range, without infringing on their standard movements. To enable this, the frame of reference for the system needs to move with the player, so that should they turn or lean as they play (which most players seem to do), the system will continue to function normally, in its new frame of reference.

3. CONCLUSIONS

The control systems that were described in this paper cover three different kinds of interaction with a sound model based on different levels of abstraction; (1) algorithmic control, based on measurements of real players gestures, (2) interaction by mean of percussive instruments, that allow players using traditional gestures with haptic feedback, (3) use of a gesture tracking system providing continuos controls to the sound model. In particular, the system based on the Fastrack is a novel gesture-based interface to a sound model, which is used as a virtual musical instrument. By basing the design of the system on the real instrument, and by involving players in the analysis and design of the system, it is hoped to create an instrument, which captures the intrinsic characteristics of the real instrument.

However, by not restricting the system to just the characteristics of the real instrument, and by not necessarily tying the instrument to any physical presence, an instrument which allows the players to expand their playing vocabulary can be created.

4. ACKNOWLEDGMENTS

Research presented in this paper was supported by the *Sounding Object* (SOb) EU project IST-2000-25287, `http://www.soundobject.org`.

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