THE DRUM PANTS

Søren Holme Hansen
University of Copenhagen
Department of Musicology
Klerkegade 2
DK-1308 København K, Denmark
holme3@hotmail.com

Alexander Refsum Jensenius
University of Oslo
Department of Musicology
P.O. 1017 Blindern
N-0315 Oslo, Norway
a.r.jensenius@imv.uio.no

Abstract. This paper describes the concept and realization of The Drum Pants, a pair of pants with sensors and control switches, allowing the performer to play and record a virtual drum set or percussion rack by hitting the thighs and waist with the hands. The main idea is to make a virtual percussion instrument with a high level of bodily control and which permits new visual performance possibilities.

1 Introduction

Drummers and percussionists have a habit of tapping themselves pretending to play their instrument. This can be seen as a way to practice without their instrument at hand, but also as a natural way of getting beats or rhythmic figures into the body. The latter reflects a close interrelation between musical sound, mental imagery and bodily experience as suggested in [1]. In this project we have been interested in using such a connection in the design of a new instrument.

Most of the commercially available electronic drum and percussion interfaces are designed to simulate the acoustical instruments they are replacing, like the electronic drum set or different kinds of percussion sensing plates. Why not exploit the natural way of feeling the rhythm in the body and develop a new kind of interface which allows a closer contact between rhythm and body?

Even though drum performances can be visually interesting, drummers are usually locked to their stationary instruments and do not have the same amount of physical freedom to participate and interact in visual performance on stage as for example singers, guitarists or saxophone players. It would be quite natural to see the drummer moving around to the beat he is playing. From this the drum performance would be an integrated combination of rhythm and dance and could thereby add a visually interesting dimension to the performance.

Today, when programming beats, grooves and rhythmic soundscapes on the computer with sample software, there seems to be a need for more human friendly controllers besides keyboard/mouse and MIDI-keyboards. Of course, it is possible to use the afore-mentioned commercial drum interfaces, but there will still be a lack of flow in the programming as you normally have to switch from the controller to computer or sampler and back again. A solution where a drum interface and a sample-controller is combined in an ecologically sound design, would therefore be preferable and an interesting way of improving the flow and creative energy in the process of programming.

In developing The Drum Pants we sought to integrate and solve these issues by means of a new wearable drum interface design.

2 The Design Idea

The idea of wearable electronic instruments has been exploited by a number of artists and musicians throughout the years, for example Joseph Paradiso [2], Ståle Stenslie [3] and Rolf Wallin [4]. These designs have focused on creating new sounds with new interfaces. We have been interested in exploring the control of traditional sounds with a new interface, and in the following sections we will focus on three main issues concerning the design: physical freedom while playing, sensor types and placements, and the dependence of the computer while playing.

2.1 Physical Freedom

In order to give the most possible physical freedom for the performer, we chose to develop a pair of pants, since it leaves the upper body and arms free of electronics and wires. Cotton where chosen as the material for the pants in order to get a comfortable and light pair of pants. The sensors placed on the legs are flexible, which means that all kinds of physical activity are possible wearing The Drum Pants, like stretching, bending, walking, jumping, dancing etc.

2.2 Sensor Types and Placements

The Drum Pants is implemented with six force sensors on the thighs, and seven digital switches plus one potentiometer around the waist. In addition to the pants there is a pair of shoes with a force sensor under one of the soles, connected to the pants with a wire (see Figure 1). The reason for using analog force sensors, and not just digital touch sensors, was to be able to get a natural connection between the level of tapping and the dynamics of the music. Furthermore, the possibilities of dynamic variation makes the beats produced more alive and authentic, as accentuation, ghost-notes and crescendo/decrescendo figures are possible.

Figure 1: The Drum Pants.

The placements of the force sensors were decided after studying how people "play" drums on their pants, and a wish to adopt some features of an acoustical drum set; i.e. placing the sensors so it is possible to use both hands and foot at the same time as for example hi-hat, snare drum and bass drum. Furthermore, it has been a priority to place the sensors in a way which makes it easy to tap them in an upright standing position, as it would add to the performer a great deal of physical freedom and mobility while playing. The natural area of tapping on the pants in upright standing position is shown in Figure 2.
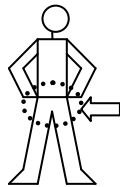

Figure 2: Natural area of tapping on pants in an upright standing position.

Within this natural area of playing there are three force sensors placed on each leg/thigh, which makes it possible to switch quickly between the three sensors with one hand, while at the same time being spaced much enough to avoid unintended sensor activation because of imprecise tapping. As it is seen in figure 1, the solution is an unsymmetrical placement of the sensors on each side, since it was felt more natural for the right handed test person to have a sensor slightly more on the outside of the right thigh than on the left. The result is an instrument which feels natural to play, and requires very little practice to get used to, since it is based on the simple idea of hitting your thighs and waist.

The digital sensors and the potentiometer around the waist serve as control buttons for different sampler-functions, as for example volume, effects, change of instrument presets, recording etc. The design of the digital sensors makes it possible to activate them by tapping, which is practical for fast and accurate control, for example when starting and stopping

record to create a loop. In general, the placement design around the waist makes it easy to control the sampler-functions while playing. In addition eight diode lights are placed right under the waist as a visual help in controlling the sampler-functions.

2.3 Dependence of Computer

All the sensors are connected with wires to a USB sensor interface placed in the hip pocket. The design of the Drum Pants with its various sampler-functions makes the performer independent of the computer while performing on stage or during programming beats or rhythms in the studio. On stage this means that the performer can focus on being in contact with the audience or fellow musicians rather than having to concentrate on the computer. In the studio, the integrated drum interface and sampler design helps keeping focused in a more fluent programming process. In addition, the overall mobile and flexible design brings a new dimension of physical activity into the discourse of drum interfaces, allowing the performer to walk, jump, dance etc. while playing.

3 Implementation

The implementation process involved the hardware design and developing software to use the pants.

3.1 Sensor Interface

The USB interface used is a Phidgets USB interface kit[1] with eight analog inputs (the seven force sensors and the potentiometer), eight digital inputs (the switches around the waist) and eight digital outputs (the diode lights). Using the analog inputs the interface kit provides a standard 0-5V range. The interface is connected directly to the computer with a USB cable, and since it draws the necessary power from the USB cable, it is not necessary with a separate power supply. Of course, although it is possible to extend the range with powered USB hubs, the length of the USB cable is a clear limitation in a performance situation with this prototype.

3.2 Sensors

The type of force sensor used for pants is the Flexiforce sensor[2], which acts as a force sensing resistor in an electrical circuit. The Flexiforce sensor is a very thin and flexible strip, and is easily incorporated into a circuit (Figure 3).

Figure 3: The Flexiforce sensor. The sensing area to the right is 9.53 mm in diameter.

The two outer pins of the connector are active and the center is inactive. The sensing area is only 9.53 mm in diameter, so it has been necessary to construct a flat cone of thick cardboard which is glued on to the sensing area in order to increase the hitting area (black circles on the pants in Figure 1). The force range of the sensors placed on the pants is 0-4.4 N, whereas the range for the sensor placed under the shoe is 0-110 N to allow for a greater force. Due to the thin (0.208 mm) and flexible design of the Flexiforce sensor a very close contact between sensor and body is possible.

The potentiometer and digital switches placed around the waist on The Drum Pants are standard sensors, even though the design

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[1] http://www.phidgets.com/

[2] http://www.tekscan.com/flexiforce.html

of the switches is carefully chosen as it allows activating by tapping and not switching.

3.3 Pants

The potentiometer and digital switches are positioned on the outside of the pants by means of sewing, while the force sensors and all wires are fastened with strong tape on the inside of the pants. In a future version it would be desirable to use a more durable solution than tape, but for this prototype model it made the implementation process more flexible.

3.4 Programming

The software is developed in Max/MSP using an external object from Phidgets to read values from the sensor interface. Figure 4 shows an overview of the data process from sensor to sound.
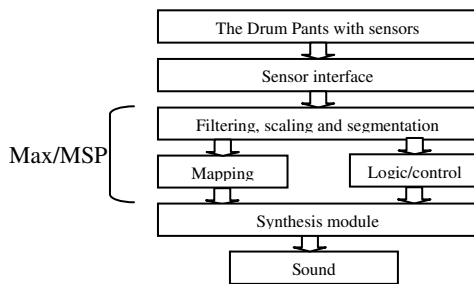
Figure 4: Schematic overview of the data process from sensor to sound.

The incoming data are run through a simple FIR-filter to smooth the data, and a threshold function is set to prevent unwanted attacks.

The sound module used for the prototype has been a simple sampler made in Max/MSP (Figure 5). The focus has been on creating a system which can easily be controlled from only a few centrally placed buttons. This was achieved with a "multiswitch" patch, which makes it possible to select up to 8 different channels with only one digital switch. The diode lights on the pants give visual feedback when controlling the multiswitch, as the number of lights turned on reveals which channel is chosen.

3.5 Mapping

Although we have only tested the pants with a sampler module, all the patches have been designed so that the pants can easily be used to control any type of sound module, for example a physical model or synthesis. Since all values are scaled to a 0.-1. range, they can easily be used to output data as Open Sound Control (OSC) messages [5], or be scaled and output as MIDI messages.
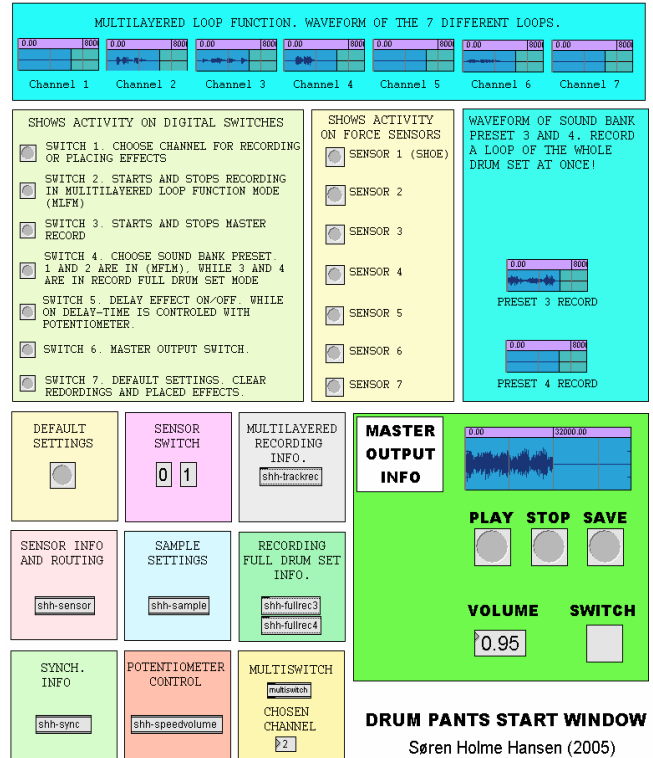
Figure 5: Main patch of The Drum Pants software.

In the patch (Figure 5), the filtered, scaled and segmented sensor data are divided into two signals; one for playing back a sample, and one for controlling the volume of the played sample. This is the basis of the real-time playing mode, where different sound bank presets can be selected with a sound-preset multiswitch. In addition to the real-time playing mode, there are three different recording modes: multilayered loop-recording (MLR), full drum set loop recording (FDLR) and master recording (MR).

With the MLR, a rhythmic figure can be built up by recording one sensor at a time in separate tracks. The sensor to record is chosen with the multiswitch, which also functions as activation of the MLR mode. The first recording made will be looped automatically and serves as the master-synchronization reference for all later recordings. The FDLR allows the performer to record several sensors simultaneously to one loop, as for example bass drum, snare drum and hi-hat. This recording mode is automatically activated when choosing sound bank preset three or four. With MR the main audio output is recorded, which means both loops and real-time playing. A separate switch is used for this purpose. It is possible to easily save the MR in The Drum Pants start window.

When choosing a channel with the multiswitch, it is possible to add two different types of effects to the sample: delay and manipulation of the sample-speed. The delay-time and sample-speed are then controllable with the potentiometer as with the main output volume. A switch for default settings, i.e. clear all recordings and added effects, makes it is easy to start all over again. All functions of the software are controllable from the pants.

The latency of sound when tapping the sensors in real-time playing mode is practically unnoticeable, which is essential when playing rhythms. We experience some latency when adding a lot of tracks and effects, but this could be improved by using a dedicated sampler program rather than our own sampler.

4 Conclusion

In this paper we have presented The Drum Pants, a wearable interface built around the idea that drummers like to "play" drums on their own body. The interface offers a new drum playing experience and is inspiring when creating beats and grooves. The fact that the performer also feels every tap on his or her own body provides the playing with an enhanced intimacy between rhythm and body compared to other electronic interfaces. In addition, the sampler-functions which can be controlled from switches placed at the waist line, makes it possible to easily create interesting multilayered rhythmic figures.

Besides the use in performance, we also think this instrument can be interesting in the field of music education. Playing the Drum Pants offers an intimate connection between rhythm and body, and could be used to study rhythm and its relation to human motor functions. In the future we would be interested in studying how people develop sense of rhythm by tapping themselves? Does the combination of sound, rhythm and intimate body experience ease the learning of human motor control? In continuation of this, it is interesting to imagine a model of the Drum Pants designed for children as a pedagogical toy to use both at home and in educational institutions.

Future development includes developing a sensor clip-on system, such that it is easier to adjust the sensor positions to match different performers. This could also be the solution for creating pants that can be washed, which is not possible with the prototype.

We will in addition be looking into improving the control of the sampler functions, with some kind of matrix-controller, controlled for example from a glove.

Finally, we will also be looking at possibilities for creating a fully embedded system, based on a mini-computer. Imagine being able to bring a full instrument with you inside your clothes. Just plug in a pair of headphones and you will have the ultimate mobile instrument, allowing you to practice and play anywhere, anytime.

5 References

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