

Input Devices and Mapping Techniques for the Intuitive Control of Composition and Editing for Digital Music

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ABSTRACT

This paper describes the work so far on my DPhil research, which falls under the banner of composition and editing interfaces for digital musicians. Three new input devices are presented that share the aim of providing a fluid, intuitive and detailed method of control for musicians. The first system, named Phalanger, uses computer vision algorithms to track hand movement, and uses Artificial Intelligence (AI) techniques to interpret the tracking data. The other two are graspable interfaces that use arrays of sensors and AI techniques to interpret fine grained hand manipulation. Phalanger is currently undergoing evaluation using a longitudinal technique based on Gaver's cultural probe. The next stage in the project is to focus on refining the hardware and mapping techniques and carry out further evaluations.

ACM Classification Keywords

H.5.2 Information Interfaces and Presentation: User Interfaces—*Input Devices and Strategies*

General Terms

Human Factors, Algorithms, Design

Author Keywords

music, human computer interaction, gesture, artificial intelligence, physical computing

INTRODUCTION

While there are many intuitive and expressive performance interfaces for digital musicians, the default devices for editing digital music are still the mouse and keyboard, devices which provide limited possibilities for interaction in comparison. My research attempts to examine this gap, looking at the nature of interaction between musicians and machines, and how editing interfaces can be improved to allow more natural, fluid and intuitive interaction between computer and musician. Taking the perspective that the editing interfaces are also a class of musical instrument, blurring the boundary between composition and performing (e.g. [3], [1]),

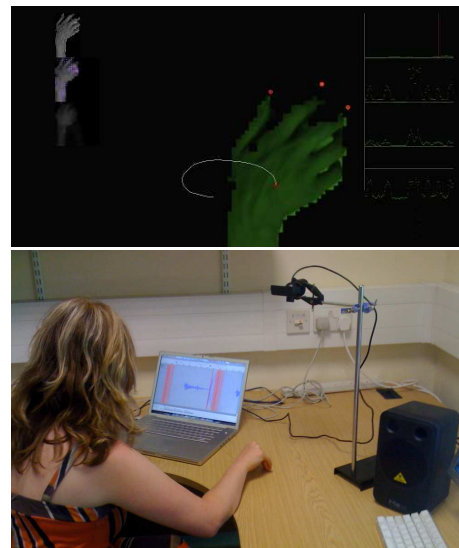


Figure 1. Phalanger's Gesture Recognition System

the properties of interaction in acoustic instruments can be seen as a source of inspiration for designing new editing interfaces. Such interfaces should enable complex and fine grained control by the musician, allowing freedom of expression and giving potential for virtuosity. My research has fallen into three main areas: the design of new input devices, investigation into mapping techniques and evaluation.

INTERFACES

Three new input devices will be described here that share a common theme of using complex, multi-dimensional input to enable subtle and fine grained control of music software. Phalanger [6] uses a combined computer vision and AI approach to facilitate control of musical applications using detailed hand motion. The system uses a low cost webcam with a neural network based skin detection algorithm for background segmentation. Two versions of the system exist. The first uses a Support Vector Machine (SVM) to differentiate between hand positions, using this information together with continuous spatial data to control a host music application (see figure 3). The second version (see figure 1) is designed for segmenting and recognising discrete gestures from a continuous stream of hand motion, with an emphasis on a detailed control.

The other two devices are hardware devices for sensing hand

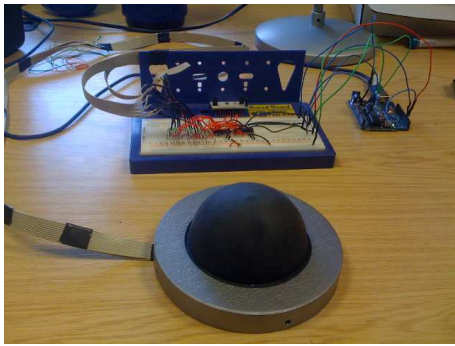


Figure 2. A Graspable Interface Using Foam And QTC Sensors

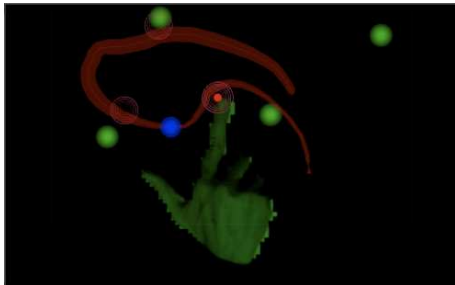


Figure 3. A Hand Tracking Interface for Soundscape Generation

manipulation. The first (see figure 2) uses an array of Quantum Tunnelling Composite (QTC) sheeting pressure sensors placed on a plastic hemisphere and covered by a layer of malleable foam. The user can press and manipulate the foam in a variety of ways to create control information. The last device is a cube of low density conductive foam, filled with an array of randomly placed contacts. Reading the contacts gives an array of values that is unique for each shape made with the foam. As with the previous device, the user can flex, compress and manipulate the device in order to generate control information. Due to the complexity of the data from the sensors, the mapping technique is key to creating meaningful control information from this device.

MAPPINGS

With relatively complex data streaming from these input devices, I've looked to AI techniques for ways to interpret this data, in particular using Echo State Networks (ESNs) [4]. ESNs are capable of modelling arbitrary non-linear dynamical systems, so they are well suited to the purpose of mapping and interpreting multiple continuous data streams over time. In the case of the gesture recognition version of Phalanger, an ESN is trained to segment meaningful gestures from the continuous input stream. The ESN is trained using human motion, lending a natural feel to the interaction. With the two hardware devices, ESNs are trained to infer continuous control data and to segment discrete gestures.

EVALUATION

HCI user experience evaluation techniques provide a valuable framework for the evaluation of interactive systems. However the evaluation of musical systems constitutes a special case for evaluation techniques, with their artistic as well

as functional aims, and also their highly interactive nature [5]. The process of learning a musical instrument involves spending time discovering and transcending its creative and functional constraints [1], so for this reason I chose to evaluate the Phalanger system using a longitudinal evaluation technique based on Gaver's cultural probe [2]. The participants are given the system to use in their own environment for a period of a month, and during this time record their experience of using a device with photos, videos, audio recordings, questionnaires and a diary. These multimedia items are brought together at the end of the study for an interview where the participants reflect on their experience. The evaluation for the hand pose recognition version of the Phalanger system is currently underway.

CONCLUSIONS AND FUTURE WORK

My research so far has examined the qualities of musical interfaces that may enhance intuitive and fluid interaction within the context of composing and editing digital music. Taking the nature of these qualities into account, I have also reviewed HCI techniques to find the most appropriate evaluation methods for musical controllers. Three different input devices are currently under development, all of which share a theme of employing AI techniques to interpret and map multi-dimensional data streams to provide detailed and subtle control of musical software. My future plans involve the continual development of these devices along with the software techniques and algorithms for interpreting the data they produce. For the Phalanger system, I'm aiming to merge the two versions into a single system which uses both continuous motion and discrete gestures for control. A key aim here is to look at how to design interaction that employs both these methods seamlessly. The longer term aim is to develop more music application software scenarios for these devices to control, and evaluate the effectiveness of the controllers and mapping techniques.

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