Pin & Play & Perform

A rearrangeable interface for musical composition and performance

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ABSTRACT

We present the Pin&Play&Perform system: an interface in the form of a tablet on which a number of physical controls can be added, removed and arranged on the fly. These controls can easily be mapped to existing music sofware using the MIDI protocol. The interface provides a mechanism for direct manipulation of application parameters and events through a set of familiar controls, while also encouraging a high degree of customisation through the ability to arrange, rearrange and annotate the spatial layout of the interface components on the surface of the tablet.

The paper describes how we have realized this concept using the Pin&Play technology. As an application example, we describe our experiences in using our interface in conjunction with Propellerheads' Reason, a popular piece of music synthesis software.

Keywords

tangible interface, rearrangeable interface, midi controllers

1. INTRODUCTION

Music software can offer most the functionality of a whole studio in a single computer for a fraction of the cost. But much of the advantage is lost when the physical interface disappears and is replaced by a graphical replica. The mouse and keyboard are generic input devices, and although effective for word processing and graphic design oriented tasks, they are not ideally suited for musical editing and composition. We propose a type of interface that leverages the benefits of current software, the standardized MIDI protocol and novel technology to realize a system that aims to improve usability and experience of digital music manipulation.

We have designed and built an interface that allows the free placement, arrangement and 'on the fly' rearrangement of a set of physical controls on the surface of a tablet which is connected to a desktop computer. These physical controls can be mapped onto a set of graphical user interface elements on an existing music application with MIDI input capabilities. Physical manipulations and screen-based ones can be intermixed without any constraint and without confusing the application because our interface appears as a standard MIDI controller device to the application, which does not need to be modified in any way. The physical interface elements can be actively rearranged while the application is running.

Conceptually our system is based on a framework for tangible interaction which consists of a set of building blocks in the shape of interactive objects that can be easily and naturally manipulated. It also provides a simple way in which these building blocks can be associated with graphical controls on the interface of an application.

This paper provides a brief overview of previous work in this area, and discusses how our system builds upon and addresses some of the shortcomings of existing systems. We then describe our realized system, Pin&Play&Perform, and the technology used to implement it. Finally, to demonstrate the concept in practice, we describe how the interface was used in conjunction with an existing piece of commercial music software.

2. BACKGROUND AND MOTIVATION

2.1 Tangible user interfaces

The possibilities tangible user interfaces (TUIs) were first demonstrated in the work of Fitzmaurice, Ishii, Ullmer and Buxton in [2] and [3]. The theory suggests that new interaction modalities are to be found by exploiting the rich affordances provided by our physical environment, including our architectural surroundings and the physical objects within it.

Many compelling examples of TUIs can be found in the domain of music control, creation and performance as in the Audiopad [6], ReacTable [4], Block Jam [5] and the Squeezables [10]. This is not surprising, since the alternative interaction modalities can often be more useful, intuitive or enjoyable to a musician than the traditional keyboard and mouse, which are better suited to word processing and graphic design tasks.

2.2 The case for flexibility

The experimental musician and innovator John Bowers has used the term *performance ecology* to describe the arena for activity created by a musician in his immidiate surroundings. In his work regarding the ethnographically-informed

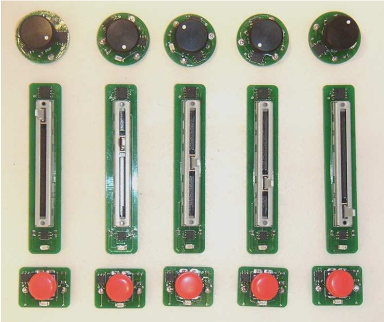

Figure 1: Example layout with five channel busses

design of improvising machines [1], he discusses the importance of the spacial arrangment of control devices and instruments - not only in allowing the musician to be more effective in his performance, but also in communicating his intentions to co-performers and audience. The ability to effectively organize the layout of these ecologies is a recurring theme throughout his work.

In the theoretical paper 'Towards a Musician's Cockpit' Vertegaal et al. [8] make the case for the importance of customization in musical systems. Instruments should be physically flexible to adapt to the changing needs of a performer, but this functionality should also be 'freezable' to allow the system to be properly internalized and learnt.

The theory has been realized in the form of the SensOrg system [9], which consists of an arrangement of physical modular devices and music software that provide a high-degree of customization and adaptation to allow a sufficient level of usability in an electronic musical system. These intentions are particularly evident in one of the components of the system - the Flexipad - that allows a number of buttons and faders to be positioned and oriented on a metal pad to comfortably fit the position and size of the performer's hand.

We believe that this work makes a strong case for taking adaptability as a central concern in the design of a musical interface, and one that is not clearly reflected in much of the current work. With this in mind, we have used our own platform for tangible interaction, called Pin&Play, to implement a type of highly flexible tangible interface for interacting with existing music software.

3. REARRANGING THE MUSICAL INTERFACE

With Pin&Play&Perform we set out to develop an interface which allows the easy addition, removal, arrangement and on the fly rearrangment of physical controls on a tablet. The physical forms of these controls are familiar to users of musical equipment, and how they are operated should be obvious.

The idea is that these controls can be freely arranged on a surface of the tablet according to their intended purpose and the personal ergonomic preferences of the user. A scratch mix may require only volume sliders, arranged in a horizonal array to emulate a mixing desk (e.g., as seen in Fig. 1). Fine-tuning one or two tracks could call for a different configuration, emulating a single channel bus, with additional rotary knobs controlling effects parameters placed above the channel volume slider (Fig. 2). A user may choose to cross fade between two tracks with a horizontally-placed slider, a configuration that is mechanically impractical in commercial, non-DJ mixing desks, but easily supported by our system.

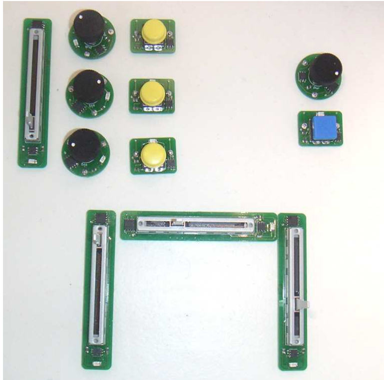

Figure 2: Example layout with two "channels" and a cross-fader

Flexibility is the most distinguishing characteristic of our interface. New controls can be added, removed and freely laid out on a surface according to the functional and ergonomic needs of the user. Once in place they are firmly attached, allowing the interface arrangement to remain static when required, which is an important requirement of an interface if its functionality is to be properly internalized and learnt. The set of available controls are familiar input devices with an easily recognizable operative affordance (pressing, turning and sliding). The user does not need to learn how to operate the controls, only remember (or specify) what a particular control does.

4. PIN& PLAY TECHNOLOGY

The current Pin&Play technology used to realize our system has been developed from a concept originally published in [7], and is the result of ongoing work into developing this technology as a usable platform and accompanying development toolkit. The system is characterized by an augmented surface, which provides data connectivity and physical support to tangible interactive artifacts that can be added to or removed from the surface. When an artifact is added, it becomes connected and acquires a digital representation. When it is removed, it retains its state and form. An artifact may provide other interaction capabilities that allow it to be manipulated while it is on the surface (input), or express some information (output).

A Pin&Play surface consists of two conductive fabric sheets separated by a layer of isolating rubberized foam. One of the conductive layers is connected to the signal line of a network interface, which carries both power and data signal. The second conductive layer is connected to the the return to ground. This allows the surface to act as a sort of two-dimensional network and power line.

Pin&Play interactive objects (nodes) can be attached to the surface by means of a specially designed coaxial pin connectors (Figure 3). These connector can pierce the several layers that make up the surface, providing physical attachment as well as a power and network connection to the node. Each node can provide its own interface by means of me-

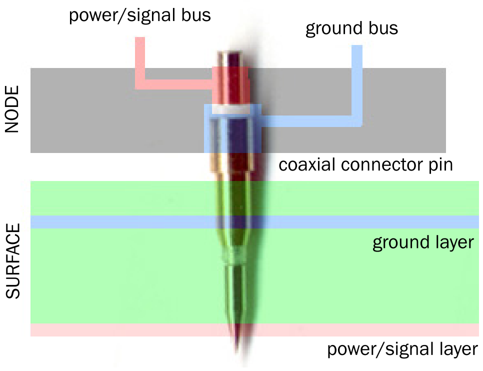

Figure 3: Pin&Play surface and node design.

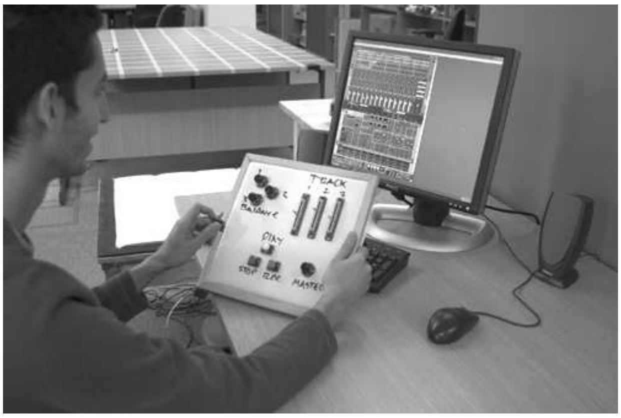

Figure 4: Pin&Play&Perform in operation.

chanical controls or sensors, while other nodes that contain actuators such as lights or simple displays can be used to express basic output.

The software programming interface of the system allows the detection and unique identification of each of these nodes as they are attached and removed from the surface. Whenever a node is added to the surface, an equivalent virtual object is created. Whenever one of the nodes is manipulated, an event is issued by the virtual object with information about its new state. This provides a straightforward, event-based programming interface for application developer, with events such as "Slider node with ID 1234 has been added", "Button node with ID 5678 has been removed" or "Dial node with ID 1010 has been rotated to 50%" being issued. These events can then be linked to actions or further processing by the application. The nodes also have the ability to signal on request, which results on a small bright light built onto the physical node being turned on or off.

5. PIN&PLAY&PERFORM

The Pin&Play&Perform is intended to be used as a complementary form of control to an application, alongside its traditional mouse-controlled GUI environment. In our prototypes we have used a wooden tablet augmented with a Pin&Play surface of about 30cm x 30cm. This size allows the tablet to be easily moved around, handled or placed on a desk surface (Figure 4). The tablet on which the controls are arranged can be of considerably larger or smaller size, depending on the requirements. It may even be vertically-placed (e.g. wall mounted) as the controls stay securely attached thanks to the pin connectors. The surface is connected to the PC via a USB link.

The interface kit also contains a 'control bag' a with number of button, dial and slider controls. The controls can be freely arranged and oriented on the surface of the tablet. It is also possible to make annotations about the controls on the surface by using a normal whiteboard marker.

5.1 Functionality

Pin&Play&Perform is developed on top of the Pin&Play platform. It consists of an additional software layer that translates node events into MIDI control commands. The program masquerades as a generic MIDI controller, which can be recognized as a valid MIDI input device by the Windows platform. Whenever a new node is attached to the tablet, a virtual MIDI object is created. If the node contains a button, then the MIDI object is created as a Note. Pressing and releasing the button will result in NoteOn and NoteOff events being issued. In the case of the node containing a slider or dial control, the MIDI object takes the form of a MIDI controller with a variable value of 0 to 127.

This assignment of controller numbers to controls should be transparent to the user, but if required, a small application window can be called up on the PC to display the current status of the surface: how many and which controllers are present, and what their MIDI mapping is.

Exactly how the linking of the MIDI controllers to the input of a music application is carried out is very much determined by the capabilities of the application itself. In this respect, we found the mechanism used by Reason to be particularly easy to use and well suited as a demonstrator of our concept.

5.2 Reason integration

Reason, by Propellerhead software, is a mature audio software suite that emulates a variety of different real-world audio devices. These devices may be connected with one another in a variety of different ways, and controlled with a "realistic graphical interface" that mimics the function of the physical devices. Hundreds of parameters may be controlled on-screen with the GUI.

The program has a very simple way of linking a MIDI controller with an on-screen control: selecting "Edit MIDI Remote Mapping" from the "Options" menu causes all controls to which a MIDI controller can be assigned to be highlighted with green arrow. Clicking on any of these controls causes the window in Figure 5 to appear. To create the link, a user can at this time manipulate any control on the surface (e.g. turning a dial by a few degrees) which will then be understood by Reason as the controller to be used for this particular control. Selecting "OK" completes the linking process and the control can be used straight away. The physical control can repositioned or reoriented and the link will be maintained. To break the link, the user must delete the MIDI mapping.

The physical controls were in large part chosen because of their similarity to the on-screen controls. However, it is not necessary that a physical slider be used to control an on-screen slider-like control. A user, according to their personal preference, may want to use a physical rotary dial

Figure 5: Assigning a MIDI controller to an on-screen control of the Reason GUI.

to carry out the same action. In this case, the mapping remains the same: the minimum and maximum of position of the dial (clockwise and counter-clockwise) are equivalent to those on the slider (left and right). If a button is linked to an on-screen dial or slider the mapping is not so obvious, but is still allowed and works. In this case pressing the button once will cause the control to go to its maximum state and pressing it again will take it to its minimum state. If the reverse happens – linking of a dial or slider to an on-screen button – the behavior is that whenever the control is rotated or translated, regardless of direction, the state of the on-screen button will be toggled.

6. DISCUSSION

We set out to design and build an interface to improve the usability and experience of a musician working with existing music software. In particular, we have given the user the ability to define their physical performance and composition environment, and use this as a complementary channel of control alongside the traditional graphical interface of the application. As it does not seek to replace current ways of working with music software, but rather exist alongside it to provide the tangible benefits, we imagine that Pin&Play&Perform could be easily incorporated into the existing working environment of an electronic musician. It will be interesting to see how the interface is used in practice – the flexiblity will almost certainly allow it to be appropriated and used in ways we have not thought of. We intend to carry out a series of exploratory studies, where a Pin&Play&Perform kit is supplied to a number of people who make regular use of the types of applications it supports. So far, the informal comments we have received are encouraging, and future experience and feedback gathering will inform us futher about the possibilities of our interface.

7. SUMMARY

We have developed a new type of tangible, rearrangeable interface to be used alongside the graphical environment of existing music software applications. An overview of previous work in the area of flexible physical interfaces was provided in order to highlight its distinguishing characteristics and potential. Through a combination of existing approaches at improving the usability of musical applications, as well as the application of tangible interface technology, we have realized a working prototype of the interface. Finally, the feasibility of such a system has been proven by using it in conjunction with a popular piece of music software.

8. ACKNOWLEDGMENTS

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