Sound Collage Creation on a Curved Touch Display

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ABSTRACT
We present a novel audio workspace for creating sound collages based on a vertically curved display. In contrast to flat interactive surfaces, this form factor avoids ergonomic problems of tabletop displays or vertical touch screens and enables continuous touch interaction across vertical and horizontal display parts. Additionally, it allows combining established software and hardware components with novel multi-touch interaction concepts. We propose a design rationale for developing musical workspaces on such displays and present a prototypical application that is capable of creating sound collages by blending conventional workflows with seamless touch interaction across displays and devices. The core elements of our application are visual representations of audio files, which can be edited with touch gestures and triggered by a physical pad controller on the horizontal part of the display and arranged in a step sequencer on the vertical part of the display. Furthermore, we integrated text search into the pad controller which enables to request and load sound files from a web service without switching context.

Keywords
Sound collage, audio workspace, curved display, augmented controllers, sound sketching.

1. INTRODUCTION
Collages of prerecorded sound samples are an important element of many musical styles, most notably of Hip hop music. The creation of sample-based music typically involves (1) the organization of a sound collection, (2) the transfer of sounds into an audio workstation and (3) dedicated software instruments and hardware controllers to trigger and arrange samples. This workflow requires musicians to create permanent or temporary workspaces that comprise both software and hardware tools.

Many research projects explored the use of large interactive surfaces (i.e. tabletop displays, tilted displays or wall displays) in musical contexts. While the form factor and the direct touch input of such displays inspired researchers to think of new, more direct and social ways to interact with electronic musical instruments, the suitability of such displays to serve as workspaces is limited due to ergonomic reasons. Long working sessions with a horizontal display lead to neck fatigue and touch input on vertical touch screens causes what is known as the *gorilla-arm-syndrome* (arm fatigue).

A recently popular trend in commercial electronic instruments is bundling sound generating software with dedicated hardware controllers (e.g. Native Instruments Maschine [10]). An important feature of such bundles is the tight integration of controller and software that enables users to control almost every aspect of the software with the controller device. While coupling controller devices with software comes with many benefits such as a non-disruptive and performance-oriented workflow as well as regular software updates, they are rather closed systems. Integrating them into other workflows – such as using them as plugins in digital audio workstation – requires the usage of conventional WIMP user interfaces for tasks such as file browsing, loading custom sounds or configuring *Midi* settings.

We argue that integrating such devices and workflows into a novel audio workspace combining a vertical with a horizontal interactive surface can (a) enrich current usage patterns of audio workstations and plugins and (b) extend the non-disruptive style of work with commercial hardware controllers by bridging the gap between different inherently closed systems using a curved multi-touch display.

Therefore, we propose a rationale for designing musical workspaces on curved displays. Furthermore, we present a prototypical application developed for our curved display prototype that enables users to compose sound collages consisting of audio files that can be freely dragged across different software and hardware components placed both on the horizontal and the vertical interactive surface.

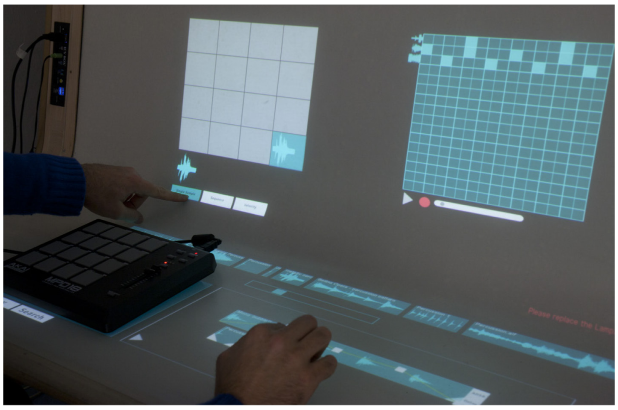

Figure 1 **The workspace concept. On the vertical display: the virtual pad controller (left) and the sequencer (right); on the horizontal display: the physical pad controller (left) and the sound sketch area (right). Between the displays is the horizontal file browser.**

2. BACKGROUND
In the following, we discuss related work regarding both curved touch displays and novel audio workspaces.

2.1 Vertically Curved Displays
Vertically curved interactive displays such as the Curve [18] or the BendDesk [17] (figure 2, left) seamlessly combine a horizontal and a vertical touch screen via a curved display segment. Technically, these displays are based on rear projection with two projectors and FTIR optical touch tracking. The curved connection closes the gap between previously separated areas of workspaces: (1) The vertical displays

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we focus our eyes on and (2) the horizontal table surface that holds controllers we interact with. The concept of vertically curved displays allows exchanging objects between these areas by simple touch gestures such as dragging [5] or flicking [15]. Furthermore, the curved connection enables a visualization technique that extends the physical horizontal surface into the depth virtually [6]. When combining two curved displays, this technique can be used to create immersive teleconferencing settings that allow users to converse and interact across a "continuous collaborative workspace" (figure 2, right).

2.2 Novel audio workspaces

The use of touch input for musical interaction has a long history. Buxton illustrated the benefits of responsive multi-touch technology with the example of emulating a piano keyboard [9] – a pervasive example in today's musical apps for tablet devices. In 2005, the French company *Jazzmutant* introduced the multi-touch controller *Lemur* [7]. In 2006, Davidson and Han presented a large multi-touch surface for live control of audio synthesis [3]. While these projects illustrate that fast multi-touch tracking can enable expressive musical performance, we are interested in blending the distinct advantages of conventional workspaces (e.g. ergonomics, the ability to deploy a heterogeneous ecology of hardware and software tools) with touch-based musical interactions.

Using physical objects on interactive surfaces has been researched in various projects, such as the *reacTable* [8] or *Audiopad* [12]. In contrast to these projects, we focus our attention on integrating and augmenting existing musical controllers into our audio workspace.

The use of interactive tabletops to explore novel interaction concepts for common audio-related tasks has been explored for instance by Carrascal and Jordà [2], who use a stage metaphor for audio mixing that replaces the audio channel layout from analogue mixing consoles with a spatial metaphor enabling users to mix audio sources by positioning them in 2D-space.

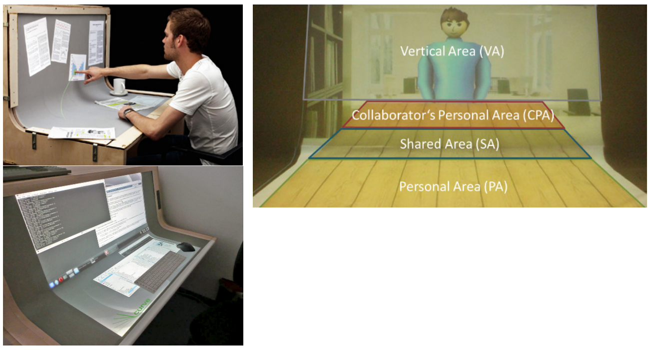

Figure 2 **BendDesk [17] (top left) and Curve [18] (bottom left), continuous collaborative workspace [6] on the right**

3. A PRELIMINARY DESIGN RATIONALE

Based on the design guidelines from Wimmer et al. [18], we derived the following preliminary design space for musical workspaces on vertically curved displays.

3.1.1 Large screen

Graphical user interfaces in music production software usually consist of a variety of dedicated views (e.g. sequencer, mixer, plugin GUIs). Consequently, musical workspaces often employ multi-monitor display setups to minimize switching between windows. The increased screen space of the curved display holds the potential to further simplify the work with many views. However, this display setup is still not well explored with regard to space and layout management as well as context switching.

3.1.2 Dual use

Understood as a physical table, the horizontal surface of the display is a space where physical things can be put. In musical workspaces, a physical table often is essential not only as primary input space for desktop applications, but also as a necessary area to store musical controllers or additional task-related devices such as audio interfaces or record players.
The touch screen function of the horizontal surface should blend into existing workspaces and can be used to bridge gaps between physical and virtual objects.

3.1.3 Combination of both display orientations

Digital audio workstations enable a variety of tasks, such as recording audio, browsing files, spatial arrangement of sound sequences or mixing audio channels. As previous studies indicate that user preference for a display orientation depends on the task [14], the design of an audio workspace based on a curved display should consider the orientation of user interface elements as a task-dependent factor and combine both horizontal and vertical surfaces.

3.1.4 Interaction model

The haptic continuity provided by the curved connection enables seamless dragging of digital objects across the whole display surface. In addition to direct touch, such a workspace might also provide input from pointing devices as well as from dedicated music controllers. A further potential input technique for such a display setup is indirect touch input [16]. Apart from the ergonomic suggestion that touch interaction should be concentrated on the horizontal surface, relatively little is known about the variety of possible combinations of interaction techniques in such display setups.

4. THE CONCEPT WORKSPACE

In this section we present a prototypical application that we developed to start exploring the previously described design space. Our concept focuses on the workspace for the creation of sound collages and comprises a sound browser that contains audio files loaded from *Freesound* [4], a physical pad controller with a corresponding virtual counterpart, a simple step sequencer with sixteen channels and an area on the horizontal part of the display used to edit sound samples.

4.1 Horizontal sound file browser

A horizontal file browser is positioned between the vertical and the horizontal parts of the display. It contains rectangles that represent previously loaded sound files by displaying the corresponding waveform visualizations and the name of the files (figure 1). Each sound file can directly be played by touching it. Users can scroll through the samples by using a scrollbar below the samples and either drag a sample directly up on a conventional sequencer component or onto the virtual pad component, or down to edit it on the horizontal part of the display, depending on if they want to edit or arrange the sound file before playing it back with the pad controller or the sequencer or not. In our prototype, example sounds from a local folder are displayed initially, but new sound files can be loaded by search (see section 4.4).

4.2 Sound sketches

Audio files dragged onto the horizontal part of the display next to the physical pad controller can be edited and layered with touch gestures. Once the user drags samples from the sound file

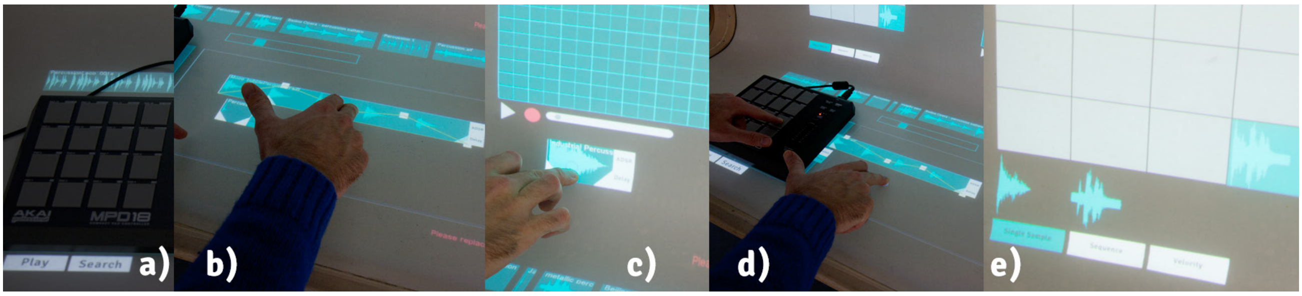

Figure 3 **a) physical pad controller with virtual buttons, b) creating sound sketches, c) dragging sketches to the sequencer, d) assigning sound sketches to the pad controller by dragging them into it, e) layers in the virtual pad controller**

browser onto this area, a *sketch* is created. Sketches can contain multiple sound files which can be arranged freely within the surrounding area by dragging interactions (figure 3 b, figure 4).

Currently, sound files can be edited in three ways: (1) The envelope of the audio sample can be controlled, (2) the start and end position of each sample can be adjusted and (3) a simple delay effect can be switched on and off. This way, samples can directly be layered, edited and arranged in a fashion that does not require using dedicated sequencing software for creating sound collages. Subsequently, sketches can be dragged into the physical controller (figure 3 d) or onto the step sequencer for playback.

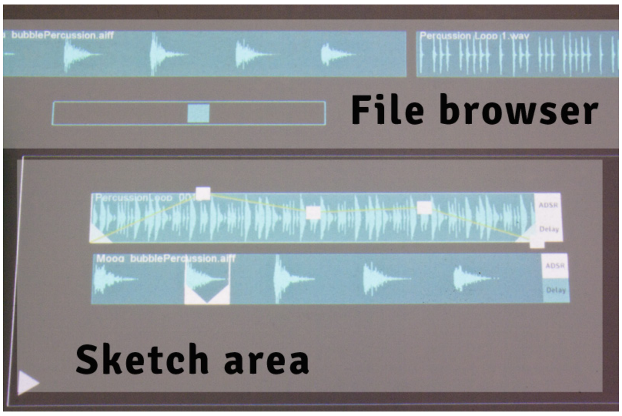

Figure 4 **Detail: Sketch area with two sounds showing envelope and start/stop locators. Sound files can simply be dragged down from the horizontal file browser.**

4.3 The pad controller

The pad controller is used both for triggering the playback of sound sketches and for text input during sound search operations. The physical controller is placed on the horizontal surface and is complemented with a virtual counterpart on the vertical part of the display.

4.3.1 The physical controller

The physical controller in our prototype is the commercially available AKAI MPD-18. It can be used in two modes: (1) during playback mode the pads trigger sound sketches that have been assigned to them before. (2) In search mode, the pads are used to enter search queries in a multi-tap text entry fashion known from mobile phones with physical keys (figure 5). Modes can be switched by two virtual buttons displayed on the horizontal surface below the physical controller (figure 3 a).

4.3.2 The virtual pad component

In playback mode, the virtual pad component can be used to manage and visualize the assignment of sound sketches to pads. Sketches can either be dragged into the physical controller or onto the virtual component. As soon as a sound sketch is assigned to a pad, the corresponding virtual pad displays a minified image containing the waveforms of the sketch. In contrast to the conventional one-to-one mapping of pads to sounds, sketches can be assigned to multiple layers of one pad by assigning sketches to non-empty pads. Clicking on a virtual pad opens a detail view showing the different layers (figure 3 e). Here, layers can be rearranged and trigger rules can be defined ((a) one sound, (b) all sounds sequentially and (c) all sounds based on velocity).

4.4 Sound Search

While many controller devices support browsing of a predefined set of sound files via rotary knobs or buttons, issuing a textual search query within a collection of sound files (e.g. in a local file explorer or online sound databases) usually requires a shift to a text input device. In order to explore a tighter integration of search into the audio workflow, we implemented a sound file search that allows users to query the sound collection of *Freesound* [4] with keywords using the musical controller device (figure 5). The sounds contained in the query result are loaded into the horizontal sound browser and then can be directly used with the pad controller, the sequencer or to create sketches.

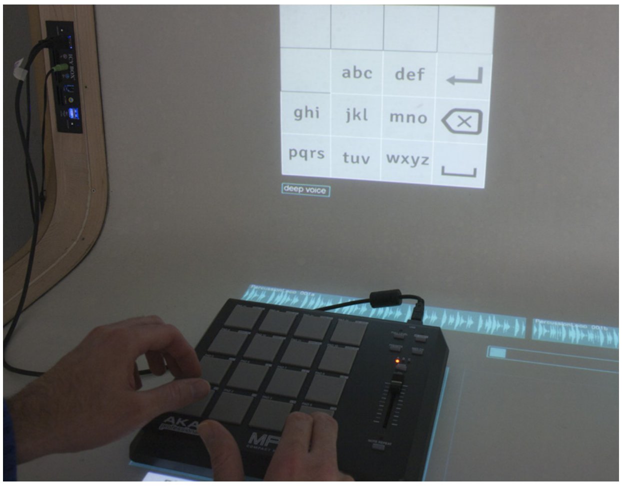

Figure 5 **Performing text search with the pad controller**

4.5 Step Sequencer

In order to create little arrangements we implemented a simple step sequencer that can play back up to 16 sound sketches that can be arranged in a one bar grid divided into 1/16 steps. When a sound sketch is dragged onto the sequencer (figure 3 c), a little waveform icon to the left of the grid indicates the assignment to the channel and patterns can be created via touch. Additionally, the sequencer can be used to record the pad controller input and to set the playback time.

5. IMPLEMENTATION

In general, we use *Multitouch for Java* (MT4J) [11] as basic programming framework for the development of multi-touch applications on our curved display. For the application described in this article we additionally used *Beads* [1] for sound processing tasks such as loading and playing audio samples, controlling envelopes, effects or clocks as well as audio analysis for displaying the waveform representation of the sound files. The midi communication is implemented with *MidiBus*[13], a processing library for the midi protocol. The search for sound files is implemented using the *Freesound* API [4].

The textual search with the pad controller uses note-on midi events as input for a multi-tap text entry algorithm that allows entering multiple characters with one pad based on the number of pushes within a short time frame.

Currently, the placement of the pad controller on the horizontal surface is static, which allows us to use a rectangular area drawn beneath the controller for interacting with the controller in a simple way. However, using optical markers on the bottom side of the controller would easily allow determining its current position on the surface dynamically.

6. CONCLUSION AND FUTURE WORK

We characterized different properties of curved displays that open up a rich design space for novel musical workspaces. We then presented a novel workspace for creating sound collages on a curved display. Our motivation was to explore our display's suitability to serve as audio workspace that a) enables a non-disruptive workflow for creating sound collages including the search, editing and arrangement of audio files and b) combines conventional elements such as vertical and horizontal areas, hardware controllers and existing musical user interfaces such as a step sequencer with a continuous touch interaction across displays and devices.

Currently, we use the horizontal part of the display as sketching area for the sound collages. This area could be extended in the future with more controls, such as the possibility to mix the audio samples. A well-known metaphor for mixing audio on interactive surfaces is the stage metaphor [2], which could be integrated into the workspace and allow the user to mix sound sketches without the need to control channel based mixers.

A direct next step will be a formative evaluation of the current prototype with potential users. We therefore plan to organize a workshop during which participants are asked to create their own sound collages.

In the future, we plan to further explore the proposed design space. A suitable interaction model ideally enables seamless, dedicated and effortless control on both surfaces and across different modalities.

A further interesting property of vertically curved displays is their potential to enable new forms of musical interactions in both co-located and remote collaboration scenarios. In co-located scenarios, the continuous workspace could provide an improved awareness of actions without introducing orientation problems known from tabletop scenarios. Additionally, the shared workspace visualization presented in section 2 (figure 2) might be useful to share sound files, sketches or patterns across distances without losing awareness.

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