Battle of the DJs: an HCI perspective of Traditional, Virtual, Hybrid and Multitouch DJing

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ABSTRACT

The DJ culture uses a gesture lexicon strongly rooted in the traditional setup of turntables and a mixer. As novel tools are introduced in the DJ community, this lexicon is adapted to the features they provide. In particular, multitouch technologies can offer a new syntax while still supporting the old lexicon, which is desired by DJs.

We present a classification of DJ tools, from an interaction point of view, that divides the previous work into Traditional, Virtual and Hybrid setups. Moreover, we present a multitouch tabletop application, developed with a group of DJ consultants to ensure an adequate implementation of the traditional gesture lexicon.

To conclude, we conduct an expert evaluation, with ten DJ users in which we compare the three DJ setups with our prototype. The study revealed that our proposal suits expectations of Club/Radio-DJs, but fails against the mental model of Scratch-DJs, due to the lack of haptic feedback to represent the record's physical rotation. Furthermore, tests show that our multitouch DJ setup, reduces task duration when compared with Virtual setups.

Keywords

DJing, Multitouch Interaction, Expert User evaluation, HCI

1. INTRODUCTION

Through related work and previous research, we identified that standard DJ solutions have inadequate hardware requirements and are unable to cope with the rise of new features that modern DJs praise. Furthermore, they have high acquisition, maintenance and transportation costs; driving many professional DJs to look for alternatives, such as software DJing products. Although these applications include exciting features in terms of musical expression and extensiveness, they are bounded to a non-natural interaction scheme, derived from exercising indirect control via input devices instead of the gestural lexicon available in standard DJ solutions.

We classify DJ tools based upon their interaction and technological idiosyncrasies and identify three major setups: Traditional, Virtual and Hybrid. As multitouch technologies mature, they are applied in DJing, offering bimanual control of a virtual environment, providing DJs with digital sound processing advantages and natural interaction.

However, an evaluation of DJing interaction paradigms has never been performed. We present such an evaluation, aiming at understanding the virtues of multitouch in the DJ scenario. We focus on a novel Human-Computer Interaction (HCI) comparison of DJ setups, conducted with DJ experts, in which we compared our multitouch prototype against all three standard DJ setups. Ultimately we concluded on the adequacy of multitouch in the DJ context, allowing future researchers to build upon this set of hands-free interaction metaphors.

2. DJ SETUPS

In this section we present an overview of Traditional, Virtual and Hybrid DJ setups (Figure 1). The three DJ setups represent evolution stages of DJing tools, both in hardware and on interaction paradigm. We based upon the Traditional setup to understand the DJ mental model regarding physical hardware interaction. On the other hand, an analysis of the Virtual and Hybrid setups allows us to understand how DJs interact with digital tools. Furthermore, we review the interaction metaphors in recent controllers, as well as related academic research on multitouch controllers.

One must stress that there is a handful of published research on DJing across a multitude of platforms, thus the scope of this survey is limited to professional DJ systems and academic proposals that address DJing concepts. Therefore, DJ systems for casual mobile-phone operation or gaming/educational purposes are left out. Furthermore, since we aim for a comparison of the standard and multitouch setups, we left out other interaction paradigms that are not touch-based, such as Wearable [8], Haptic [2] and some Tangible [14].

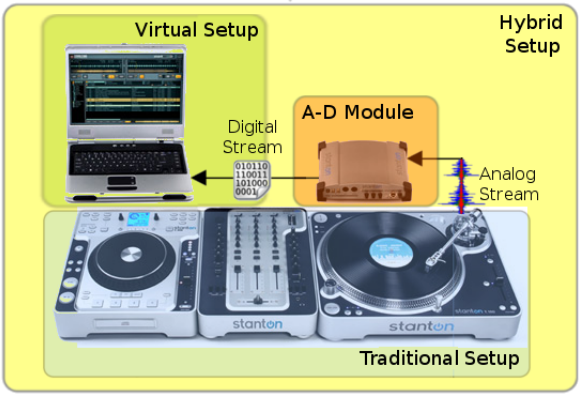


Figure 1: Relationship between the three setups.

2.1 Traditional DJ Setup

The Traditional setup is based on analogue devices, typically two turntables or CD-players and a signal mixer [7], as depicted in Figure 1. Throughout the last three decades, DJ's gestures and techniques have been strongly influenced by this setup.

In the Traditional users exercise direct bimanual interaction on the hardware, with instant visual and haptic feedback, which is an advantage [13, 11]; however, its dependence on complex and heavy equipment which often requires technical maintenance, is a drawback.

2.2 Virtual DJ Setup

Boosted by the rising popularity and increased performance of portable computers, the Traditional setup was virtualized into a software application, hence denoted Virtual setup. DJing applications in a Virtual setup provide digital audio processing, audio plug-in integration, unlimited tracks, and weightless storage environment. However, they are heavily criticized for their non-natural interaction, based on traditional input devices (mouse/keyboard) or dedicated hardware controllers, and also for their high learning curves, specially to users acquainted with traditional DJ gestures.

From an HCI perspective, most Virtual DJing applications offer a direct mapping of the Traditional setup, mainly because to make interfacing easier, the virtual controls resemble Traditional DJ gear setup (Figure 2). The user interacts with the turntable widgets to control the playout of songs, mixing them with virtual faders on a mixer-like widget. This visual trend follows the dual turntable metaphor, with a mixer in between.

(a) djay (b) Traktor DJ

Figure 2: Virtual DJ setup interfaces

However, Virtual setups face a serious HCI issue: they visually resemble the Traditional setup but do not feel as one. In this setup the user exercises indirect control [13, 11], not acting upon the interface, but operating at a distance, through a controller device.

2.3 Hybrid DJ Setup

To overcome the drawbacks of Virtual setups, the Hybrid setup was created, uniting Traditional and Virtual solutions. This gave DJs the possibility of using their traditional gestures over analogue gear to control a software application: by direct manipulation of the records, DJs are in fact controlling the digital audio playout. These systems depend on vinyl tracking to detect record position and acceleration. Although this solves the non-natural mapping problem found in Virtual setups, it also triggers the need for analogue equipment, known for its limited features and high acquisition, maintenance, and transportation costs. Furthermore, it has more limitations in terms of simultaneous playing tracks (usually two) when compared to the Virtual, since in the Hybrid all audio is controlled by turntables and needs to be routed back to the mixer.

Classifying a system as Hybrid may be misleading, because DJs may use full Virtual systems with accessory expression controllers without using computer input devices (typically mouse/keyboard). Our definition of Hybrid system embodies a setup that has at least one component found in the Traditional setup and one Virtual system; this categorization of the "Hybrid DJ setup" is also proposed by Bell [3].

2.4 Multitouch Controllers

Musical controllers have been around for quite a while, mainly due to the pervasiveness of the MIDI protocol - a *de facto* standard for audio control - but also because they provide a more natural interaction method for musical-related tasks [4]. Due to space restrictions, we focus on: the Lemur, a pioneer even amongst multitouch interfaces; the Reactable, with scratch[1] objects; the multitrack controller by Fukuchi, for uniqueness in gesture lexicon; and the Stanton SCS controllers, that include two finger touch-interactions.

2.4.1 Lemur

Lemur is a controller, although it has no physical controls (i.e., knobs, faders, IR beams) and everything is touchscreen based; all operations are performed on the touchscreen surface, as depicted in Figure 3. Lemur distinguishes itself from earlier controllers for its HCI contributions. The surface interface is fully customizable by the end-user, and new controls can be added, moved, resized and mapped into any OSC/MIDI message. This modular interface approach can be adapted by the user according to his needs, thus fitting any style of DJing. However, to accomplish customization, the user must operate through an offline application, running on a computer connected to the Lemur device. Although targeted at a larger usage spectrum, the

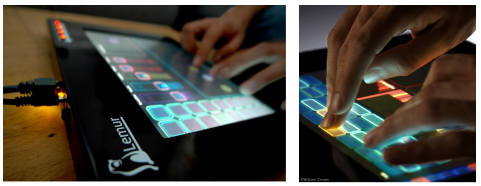


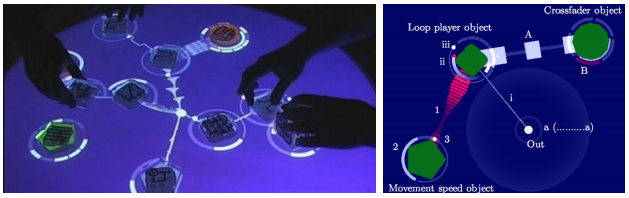
Figure 3: The Lemur device in touch control.[2]

Lemur can be used to perform some digital DJing tasks, namely because some GUI objects include faders and knobs, resembling the traditional gear. However, it is not designed for DJ gestures and there is no appropriate widget for the turntable-metaphor.

2.4.2 Reactable

In the Reactable [9] users can share control over the instrument by touching the surface or interacting with physical objects to build different audio networks. Each Reactable object represents a different audio concept, or component, with a dedicated function: generation, modification or sound control (see Figure 4(a)). Unlike the Lemur, which separates editing and playing modes, the Reactable combines both, creating a user-friendly, seamlessly integrated musical creation environment [10] - one more suited for synthesizer and audio processing, and not a traditional DJ tool. However, Hansen et al. have implemented a set of tangible objects to allow DJs to perform scratch gestures within this environment [6] and these are relevant to our research.

[1]Scratch is a DJ technique based on direct manipulation of record motion, that can be combined with fader movements.
[1]`www.jazzmutant.com`, accessed on 05/01/2011



(a) Collaborating [9] (b) Scratch Objects [6]

Figure 4: Reactable with Scratch Objects

In the Reactable framework, scratch uses three objects: the loop-player (controls audio), the movement-speed (controls turntable motion and speed) and finally the cross-fader (opens and mutes audio); with a combination of the three, a user can achieve the typical sound of scratching, as depicted in Figure 4(b). Hansen's evaluation [6] showed that as the test progressed, a Reactable expert became more optimistic and gained a deeper understanding; conversely DJs felt more pessimistic about the system, showing increasing discomfort with the control objects. Also, they identified that these systems cannot match the scratch experts' expectations of analogue turntable behaviour.

2.4.3 *Stanton SCS.3d and 3m*

Both SCS.3d and 3m are part of Stanton's "SC System Control Surface" product line. They are compact controllers with several two-finger touchable areas. Figure 5 shows that resemblance between the SCS.3d (a) and a turntable, or between the SCS.3m (b) and a mixer is not coincidental: Stanton expects to ease the user learning curve by mimicking the component design of a Traditional setup[3].

(a) SCS.3d (b) SCS.3m

Figure 5: Stanton SC System 3 [7]

Furthermore, it features some new interactions, not possible with typical DJ faders: touching directly on a slider's mark will make the value bump to that position - while in the "real world" a fader has to be manually dragged to the new position. Also, by holding one finger on the slider and tapping a new position with another finger will cause the cap to move to a new value for as long as that finger remains on the surface. When the second (upper) finger is removed, the slider will generate the value indicated by the first finger position.

2.4.4 *Multitrack scratch controller*

Fukuchi has proposed a multitouch-enabled device directed at scratching tasks [5], depicted in Figure 6, which enables the DJ to scratch several sources simultaneously, thus eliminating the time lost when users switch between various turntables. Fukuchi's Multitrack scratch controller is also highly effective in reducing space and component count. Fukuchi's metaphor does not follow the typical "revolving platter" found in turntables and in some DJ software, it uses a "moving waveform" metaphor. This metaphor is also used in Attigo[4] prototype, and can also be referred to as "conveyor-belt", because if the sound sample is looped, then the waveform reappears again in the beginning of the interface.

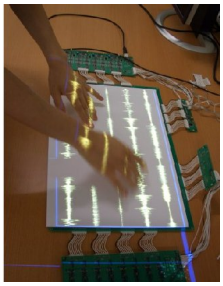


Figure 6: Multitouch scratch interface. [5]

In this multitouch interface the DJ interacts via direct manipulation of the waveform, making it move back and forth. Fukuchi also proposes a new metaphor, that enables DJs to perform record-crossfader combinations with just one finger, which increases scratching performance, but also generates a new "faderless" lexicon that was not easy to some DJs; thus raising the learning curve, as evaluations denote.

2.4.5 *Discussion on Multitouch Controllers*

Multitouch Controllers do offer new possibilities as Virtual DJing applications' controllers, so they stand out when compared to traditional mouse-based operations or button-based MIDI controllers. They allow improvements in two directions: increasing task performance by providing both bimanual interaction [11] and new interaction features (such as the aforementioned "slider jump"); and lowering learning curve by maintaining coherence with traditional DJ gestures.

With regard to visual feedback, these proposals have their own idiosyncrasies: Lemur and SCS are one-way slave controllers and therefore their visualization capabilities are often limited, and few DJing feedback can be shown to the user in realtime. On the other hand, Reactable and Multitrack scratcher do display the song's waveform, which is of value to DJs.

In terms of sensory feedback, touch-based controllers currently lack the tangible feel that Traditional and Hybrid setups can offer. Also, one must keep in mind that these controllers are application-driven, thus they do not offer interaction mechanisms for realtime DJ-specific tasks, such as adding new tracks, reorganizing setup (Lemur allows it in offline operation), altering connections between DJ components (audio re-routing), and so forth - all those tasks have to be carried out in the Virtual application, using a mouse/keyboard input device. Only the Reactable offers such possibilities, but then it is not driven by traditional DJ gestures.

3. MULTITOUCH DJ PROTOTYPE

To overcome the problems identified above, (non-natural interaction of the Virtual and the limitations associated with the Hybrid) we propose a multitouch interactive DJing application. The prototype was developed accounting feedback from four DJ experts (more details in [12]). The pro-

[3] `www.stantondj.com`, last accessed on 02/02/2011

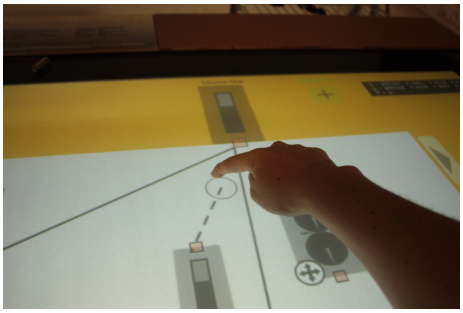
[4] `www.scotthobbs.co.uk`, last accessed in 02/01/2011

posed system merges the benefits of Virtual DJing applications with natural interaction found in Traditional DJing setups, rather than relying on typical input devices. Additionally, digital audio manipulation enables us to improve the DJ's performance, and also to exercise DJ creativity, by creating custom setups that are not possible in traditional live situations.

3.1 Interaction

Our interface is based on the following concepts: sound players, records, audio manipulators (volume faders, equalizer knobs, crossfaders, and so forth) and the relationships between these objects. These concepts are directly mapped into visual representations (of the objects) which the DJ can manipulate within a live performance, as depicted in Figure 7(a). All objects can be customized (moved, scaled, rotated) and linked to each other (see Figure 7(b)), allowing DJs to create a custom sound mixer, accordingly to their needs.

(a) DJ Mixing



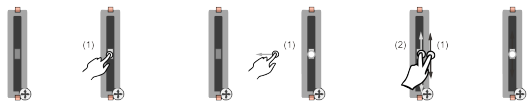
(b) Dynamic Audio Routing

Figure 7: Multitouch prototype in action.

The prototype supports the traditional gesture lexicon, and additionally our faders support new DJ-oriented features that altogether are not found in any previous work, namely: instant-jump, multiple-touch points and hold-down control. The instant-jump allows the fader to instantly jump without having to drag the fader cap manually.

In the multiple-touch points feature, the system not only registers multiple touches but also their order, returning to the previous position whenever the (last) finger is lifted. This allows instant kills on equalizers and fast crossfader switches.

The hold-down feature is the ability to control several faders with the same gesture. Figure 8 shows how to activate this feature: while touching a fader, the user can drag his finger around the canvas and still maintain control over the fader, up until that finger is raised, as depicted in Figure 8(b). If the user touches another fader with a new finger, that same behaviour is observed, thus the user can execute interesting motions, such as parallel control over



(a) First touch (b) Drag finger (c) Control faders

Figure 8: Controlling multiple faders with a single gesture.

two objects with the same hand, as depicted in Figure 8(c). Remarkably, our DJ testers took this feature even further; if one fader is rotated 180 degrees (up means volume 0), when the user moves both fingers in parallel up/down it is actually switching between those audio channels, without the need for the crossfader object.

Regarding record manipulation, the turntable widget mimics the platter's physical properties. Thus the user can expect the virtual record to behave as if it is under the force of the turntable motor, e.g., the record can be slowed down just by holding the finger in the label or, conversely, if one pushes the record forward, it will speed up until it reaches the normal torque. Both gestures are techniques that DJs use in analogue turntables to align songs together. Most techniques from traditional lexicon are also supported through the physical simulation that we provide, such as scratching, backspins and slip-cueing (hold and release the record instantly).

4. EXPERT USER EVALUATION

Tests were structured in three stages: a pre-test questionnaire to determine the DJ's profile and experience regarding multitouch devices; several DJ-oriented tasks; and, finally, an interview to get detailed information about interaction experience. With the users' permission tests were videotaped, application audio was recorded, interviews were transcribed from audio recording.

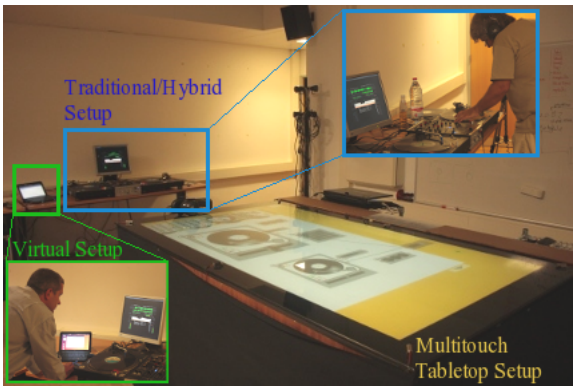


Figure 9: Multimedia room for Expert testing.

4.1 Apparatus

All tests were conducted in a closed environment, a large multimedia room with a 5.1 surround system, an 1.58x0.87m tabletop (LLP), a dedicated soundcard and DJ headphones. A video-camera recorded the test sessions, while a dedicated hardisk-recorder (with a pair of condenser microphones) captured audible output and user comments for later analysis. The room was fitted with all three standard DJ setups and our prototype. Figure 9 illustrates these setups, with

Virtual (Mixxx), Traditional (two turntables and a mixer) and Hybrid (Mixxx with vinyl tracking). Mixxx [1] was selected because none of the DJs had worked with it, thus levelling the test conditions regarding setup comparison.

4.2 Participants

Evaluation was carried out by ten DJs, four of them amateurs with two years of experience and six semi/professional DJs, with up to twenty years of knowledge. These DJs were not part of the aforementioned expert DJ panel to ensure that no previous knowledge would interfere with the test outcome. From our survey on DJ performance, we understood that different styles of DJing have specific application-requirements, and result in different DJ performances; therefore we included three Scratch, four Club, and three Radio-DJs in the testing group. Furthermore, all DJs were familiar with Traditional, Virtual and Hybrid tools, except the Scratch DJs that had never used Virtual setups.

4.3 Test Description

The tasks focused on mixing and beatmatching pairs of songs selected for their overall similarity, although with different tempi (ranging from 100-120 BPM). These songs were previously tested by consultant DJs to ensure that they had the same technical difficulty level and were indeed matchable. Songs were randomly selected from our song pool to guarantee that DJs could not to speed up the alignment task, in any test, by memorizing the correct pitch values.

Test-DJs were informed that no aesthetics judgement on the mix would be performed, as well as any skill-evaluation or score. In fact, DJs had to verbally inform us when they felt that both songs were aligned and the mix was completed. To further homogenize results we double-checked the video recordings of the tests; two different DJs (not part of the test-group) helped us in confirming the tasks' start and end points.

Each test session had five tasks, and a tutorial was given for Mixxx and for our prototype. The first four tasks aimed to mix/beatmatch a pair of songs in each setup, while the final task offered DJs a open session in our prototype, with songs of their choice. The first four tasks allowed us to develop a novel comparison between setups, and are denoted as: **V** (mixing on the Virtual setup); **T** (mixing on the Traditional setup); **H** (mixing on the Hybrid setup); and **Mt** (mixing on multitouch prototype).

4.4 Results and Discussion

From the test results we compute both the average and the standard deviation (σ) of the elapsed time for each task in every setup, as depicted in Figure 10. Our prototype's (**Mt**) result is better than that of the Virtual setup (**V**) with over less 100 seconds of elapsed time, proving that our setup is indeed more natural than the Virtual. But as expected, **Mt** took about 30 seconds more when compared with the Traditional (**T**) and the Hybrid (**H**), since the majority of our expert DJs has been using them for many years.

A detailed σ-comparison between all setups in Figure 10 validates not only the previous statement but also our group's DJ taxonomy (four Club, three Radio and Scratch), since DJs that classified themselves in a category got similar results (elapsed time) as others in the same class. **T** and **H** show a standard deviation of $\approx$26, while **V** ranks much higher, 76.89, because some users are not highly familiarised with this setup. This also shows that a separation of the results, Club/Radio vs. Scratch, is needed in order to evaluate the solution more precisely.

The average values shown in Figure 11(a) enable us to conclude that Club and Radio DJs operate quite well with

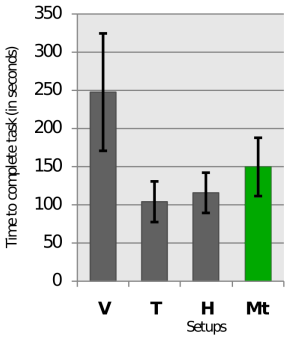
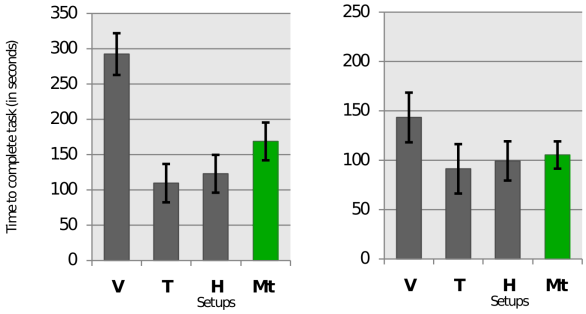


Figure 10: Average time needed time to complete the tasks for each setup.



(a) Club/Radio (b) Scratch

Figure 11: Separate analysis of Club/Radio (left) and Scratch DJs (right).

our solution, showing serious improvements when compared to the results in **V**. For Scratch experts, shown in Figure 11(b), we see that with **Mt** they only performed better than **V**, meaning that they are more efficient with direct record manipulation. Furthermore it seems that Scratch DJs perform faster in **V** than Club/Radio DJs because they tend to align and crossfade beats faster (as it suits their mixing style more accordingly). Indeed in **Mt** they exhibited a result very close to **T** and **H**, enabling us to conclude that the implemented physical simulation is worthwhile for those DJs.

In order to draw a final conclusion on the setups comparison, we must account the time differences for each user in each setup-pair, as depicted in Figure 12. It is easy to observe that the Virtual exhibited the worst results in any of

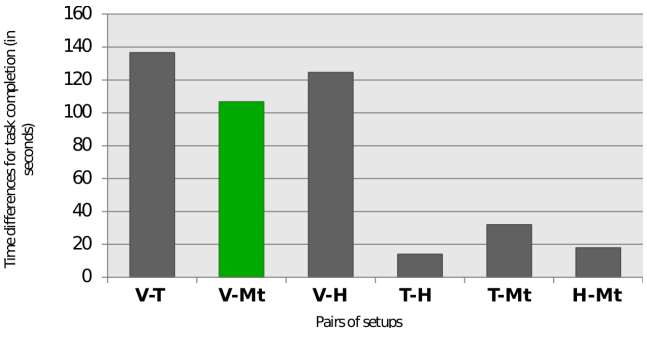


Figure 12: Time differences to complete tasks, between pairs of setups.

the comparisons, while in **V↔Mt** we observe our solution providing an average of 100 seconds of task improvement. This shows that touch support, bimanual and horizontal interaction help users to achieve better results with our setup than with Virtual Setups.

When comparing our setup to the Traditional/Hybrid, we collected optimistic results. **T↔Mt** and **H↔Mt** show that DJs mixed an average of 33.9 seconds faster in the Traditional and about 45.6 seconds faster in the Hybrid. This does not surprise us, since we are virtualzing the assets of the Traditional/Hybrid setup. The haptic feedback provided by touch surfaces is not good enough for Scratch-DJs, in particular when compared to the sensory feedback of the Traditional/Hybrid setups. Therefore, a multi-touch setup strikes a balance between available feedback and the digital benefits supported by the traditional lexicon.

Finally **T↔H** show a slight variation, because users tend to use the Hybrid solely through its traditional components, only using the computer for song selection.

4.5 DJ Comments

The overall feeling of DJs towards our multitouch proposal was promising. All users were keen to stress out the advantages of both bimanual interaction and multi-finger manipulation of the fader components, and also to denote how a tabletop environment offers a constant feedback during the DJ interaction, similar to the Traditional setup.

All users, including those who had no previous multitouch experience, mentioned that the interface was easy to use, and felt that the concepts were aligned the DJ's mental model. Manipulating objects around the canvas was recognised as a valuable feature for DJ users that want to exercise creativity in setup configuration.

5. CONCLUSION

To evaluate the adequacy of multitouch towards the DJing context, we tested DJ setups (Virtual, Traditional and Hybrid) against our proposal, with a panel of DJ experts; we also made a novel contribution to this subject area by cross-comparing all the standard setups.

The results suggest that our proposal can suit both expectations and needs of Club and Radio-DJs, but would fail against the mental model of Scratch-DJs due to the lack of haptic feedback of turntable motion. Tests show that Mt-DJing fared better than Virtual setups for all DJs, and task duration was reduced by an average of 100 seconds. As for tests against Traditional and Hybrid, multitouch solution slowed DJ tasks around 30 to 40 seconds. Our proposal has been quite favourably reviewed by DJ experts, which also contributed with additional comments, and have helped us in validating a set of gestural metaphors for the multitouch DJing context. From those we highlight: re-arrangeable interface, physical emulation of platter motion, dynamic routing between components and fader enhancements.

6. FUTURE WORK

Our work essentially studied touch-based interactions within the DJ context, leaving out many other interesting paradigms such as tangible or mixed reality scenarios. We plan to address these modalities, in order to analyse their contributions towards DJing.

Although the prototype was primarily targeted at medium/large multitouch tabletops, porting it to other platforms is possible; one can imagine how hand-held devices are exciting possibilities for DJ users that felt optimistic when mixing in our multitouch solution.

7. ACKNOWLEDGEMENTS

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