Visualizing Song Structure on Timecode Vinyls

Florian Heller
RWTH Aachen University
52056 Aachen, Germany
flo@cs.rwth-aachen.de

Jan Borchers
RWTH Aachen University
52056 Aachen, Germany
borchers@cs.rwth-aachen.de

ABSTRACT

Although an analog technology, many DJs still value the turntable as an irreplaceable performance tool. Digital vinyl systems combine the distinct haptic nature of the analog turntable with the advantages of digital media. They use special records containing a digital timecode which is then processed by a computer and mapped to properties like playback speed and direction. These records, however, are generic and, in contrast to traditional vinyl, do not provide visual cues representing the structure of the track. We present a system that augments the timecode record with a visualization of song information such as artist, title, and track length, but also with a waveform that allows the DJ to visually navigate to a certain beat. We conducted a survey examining the acceptance of such tools in the DJ community and conducted a user study with professional DJs. The system was widely accepted as a tool in the DJ community and received very positive feedback during observational mixing sessions with four professional DJs.

Keywords

Digital vinyl system; DJ; turntable; music; visualization; tangible interface; augmented reality

1. INTRODUCTION

The interaction with vinyl records and a turntable is unique as the content of the medium is directly at your fingertips. This direct manipulation is the reason why, despite being an analog technology, the turntable has survived long into the digital era and is still an irreplaceable performance tool for many DJs [2]. If we take a closer look at traditional vinyl records, we can see that the physical features of the engraved track also provide visual cues about the structure of the music [9]. However, the traditional vinyl record has the disadvantages of being heavy and wearing out when played often. Furthermore, music production and distribution are digital processes today, and manufacturing vinyl records is only of interest to a growing, but small number of people [13]. Digital vinyl systems (DVS) such as Traktor Scratch[1] or Scratch Live[2] use special timecode records to combine the haptic handling of the turntable with digital media playback. These vinyls contain a timecode that is decoded by a computer and mapped to playback position, speed, and direction. As the timecode record only contains a generic audio signal, the visual cues of the vinyl do not represent the structure of the track actually being manipulated in software. The duration of the timecode tracks ranges from 10-17 minutes but, depending on the length of the track loaded in the software, only a part of that is used. This forces the DJ to look at the computer screen to find essential information such as the remaining time in the song. This phenomenon where the DJ seems to constantly stare at his laptop and loses the connection to the crowd is called the "Serato face" [1]. The audience might perceive this as a distraction since the DJ could also be checking her email [10].

Figure 1: DiskPlay visualizes track length, playback progress, cue points and the waveform on a timecode vinyl.

To overcome this problem, we developed a system that brings back these visual cues and displays not only start and end of the track, but also cue points, track metadata and track waveform. Using top-projection, we bring the major sources of information of DVS software to the turntable that the DJ manipulates, thereby recombining visualization and control. We integrated our tool (Fig. 1) into Serato Scratch Live, a professional DVS used by many DJs, and made the software available to the community along with a questionnaire investigating the acceptance of such tools in the DJ world. To get a detailed understanding of the interaction with our system we did an observational study of its use with four DJs in our lab.

[1]http://www.native-instruments.com
[2]http://www.serato.com

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2. RELATED WORK

Combining the physical handling of the turntable with the advantages of digital media was subject of a series of interesting projects. However, none was able to reconstruct all the features of traditional vinyl while maintaining its haptic handling.

D'Groove [4] is a prototype to explore the possibilities that emerge when the turntable is used as a haptic input and output system. A record with four marks is mounted on top of a software-controlled stepper motor. Since the software knows the structure of the audio track, it can adjust the speed to have one revolution match to one bar and thereby provide a beatmatching aid. The system also provides haptic feedback of the song structure, e.g., by offering higher resistance to movement when playing a section with high-energy music or by creating a haptic bump on every beat.

The *Lupa* hard- and software interfaces [11] are designed to prohibit all physical and minimize visual interaction with the laptop during the performance. The user interface provides an at-a-glance overview and does not support presets or automation. This design promotes the liveness of a performance and creates an experience for the audience that is truly unique.

A series of projects looked into the use of multitouch screens and interactive tabletops for their use as DJ controllers. Lopes et al. [12] compared the mixing performance of a multitouch DJ interface running on a tabletop to traditional vinyl, DVS, and a standalone software. Although the participants showed great interest in the system, they took longer to complete the mixing task using the multitouch installation. While the multi-touch system suits the expectations of mix-DJs, especially scratch-DJs preferred the turntable and DVS, since they provide better haptic feedback and control.

Instead of having a virtual turntable rotate, the interface can also be a viewfinder moving over the waveform, also referred to as the "conveyor-belt" metaphor [12]. Consisting of a large touchscreen, the *Attigo TT*[3] is designed as an in-place substitute for the turntable. Similar to vinyl records, it lets you manipulate the song by touching the waveform, making it easy to shortly stop the track, scroll forward and backward, or scratch, but it lacks haptic feedback and requires learning a new set of gestures.

Being portable and providing enough storage capacity for a large music collection, multi-touch tablets are an attractive platform for DJs. *Traktor for iOS*[4] does not mimic the traditional setup of two turntables and a mixer, but provides an interface adapted to small touch screens. It uses two conveyor belts to show the waveforms and provides a two-channel mixer with equalizer and effects section. The integration of loops and effects extends the DJ's performance from mere playback to live remixing of tracks. Fukuchi [6] presented a similar multi-track mixing interface. That allows rapid switching between tracks by just dragging from one track to the other, thus using the entire surface as crossfader.

Like all touch devices, it does not provide any haptic feedback and the space for artistic expression is fairly limited. In their analysis of scratching, Hansen et al. described that the crossfader can be opened in bursts as short as 10 ms [9], for which the predominant techniques require a physical control [8]. This need also explains the growing number of dedicated hardware DJ controllers available for iPad and iPhone.

[3]http://www.attigo.co.uk
[4]http://www.native-instruments.com

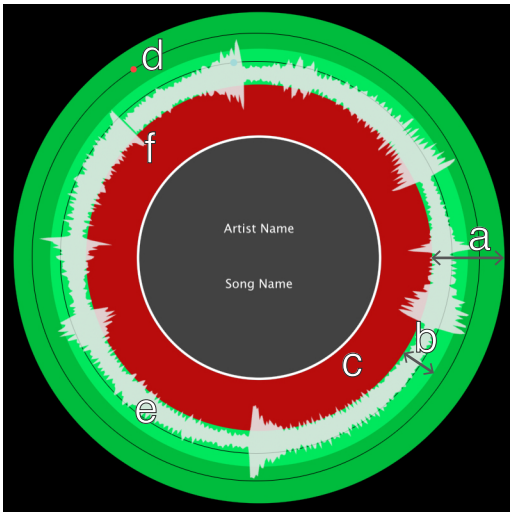

Figure 2: The visualization in detail: (a) overall track length, (b) remaining track length, (c) unused timecode, (d) cue point, (e) track waveform, (f) entry/exit point for the waveform

DiskPlay [10] visualizes basic track information such as track length and cue points on a timecode vinyl. This allows the DJ to come back to his known skill set from the traditional turntable and to keep the interaction focus on the turntable. The software is an extension of Mixxx [3], an open source DJ software designed to support easy prototyping of new interaction models. DiskPlay only shows a very small subset of the information that DJ software provides on a computer screen. Additionally, the timecode-tracking of Mixxx is not as smooth and robust as the fine-tuned algorithms of professional software.

The project *Two turntables and a mobile phone* [5] provides a very small, rotating window running over the track's waveform. A smartphone is mounted on the platter of a turntable and detects rotation speed and direction through its onboard sensors. It then creates a waveform of the loaded track and shows the part that is supposed to be underneath the smartphone. With this display, finding a precise beat is easy, but it is not possible to get an overview at a glance or to see the beginning of the track approach. DJs will have to adapt their techniques to the missing tonearm and to the smartphone's weight.

Overall, none of the above projects has recreated the visual features available on traditional records while maintaining the physical properties of the turntable.

3. THE VISUALIZATION

We designed a visualization that brings all major UI elements of DVS software onto the turntable, and thus only requires the DJ to look at the computer screen when she wants to switch to another song.

The visualization builds on the structure described in [10]. Similar to their software, the part of the timecode that was already played is colored dark green, the remaining track is colored bright green, while the unused part is colored red (Fig. 2).

In this project we tackle two big issues of this visualization: the lack of a waveform to support visual navigation and the navigation to cue points. We added a semitransparent white waveform laying on the top layer and positioned at the half radial distance from the outside of the record to the label. The waveform represents the content of one rev-

olution and sticks to the record, meaning that the peak in the waveform always corresponds to the peak in the audio signal. To have a maximum of the waveform visible on the record, it appears/disappears opposite of the stylus. The visualization can thus be considered as a circular conveyor belt with a view of approximately the size of the record's circumference.

3.1 Cue points

Cue points are very helpful to bookmark specific points in a song, e.g., the beginning of a break or a vocal. These are visualized as small dots, color coded as in the DVS software. A black concentric circle, the orbit, serves as hint where to place the stylus to quickly navigate to that cue point. As the resolution of the projector is too low to render a line that matches to a single groove, it is hard to hit the cue point exactly. To compensate for this problem, we added an animation that helps decide whether you have to rotate the record clock- or counter-clockwise to reach that cue point. When the playback is closer than 8 s to the cue point, a rectangle and a bar appear next to the stylus (Fig. 3 a). The horizontal bar indicates the time to the cue point in both directions and the direction in which to rotate. When the cue point is hit, the border of the rectangle is thickened as visual feedback (see Fig. 3 c).

As requested by some of the participants in [10], the record flashes red if the track is closer than 30 s to the end, similar to the visualizations in DVSs. In summary, the representation on the turntable contains the major sources of information that the DVS software provides on the computer screen.

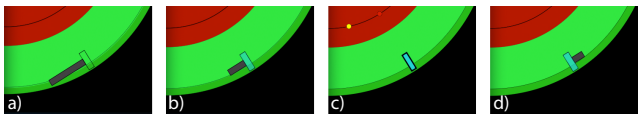

Figure 3: Detailed view of the visualization passing a cue point. The horizontal bar shows the time to the cue point (a) and the direction in which to rotate to reach it (b,d). The rectangle's outline is stroked when the cue point is reached (c).

When designing new interfaces for DJs, one has to be aware that the community is split in their acceptance of these tools. A large part embraces new technology and tries to extend their artistic performance, whereas some consider using new technology as cheating [7], as it automates techniques that need a lot of practice if done manually, e.g., beatmatching. These two aspects are also visible in the two most popular DVS: Traktor Scratch provides automatic speed adjustment, sample players, and a series of effects, and Scratch Live keeps functionality minimal but provides a sleek UI that focusses on optimal performance support.

We did not integrate a BPM indicator because this would extend the visualization far beyond what is available on traditional vinyl. Cue points are an extension of the stickies that scratch-DJs put on their records to mark specific beats, and the waveform is an extension of the grooves on traditional records. Displaying BPM values would break this concept and might be considered inappropriate [7].

4. SYSTEM ARCHITECTURE

To take advantage of the better timecode tracking compared to open-source solutions as Mixxx [3] and to have the DJs work in their known environment, we integrated the visualization into professional DJ software. Unfortunately, neither Serato nor Native Instruments provide an SDK for their tools. Scratch Live however, can be extended with Serato Video, a plug-in that allow VJs to use timecode records as controller for their multimedia installations, or DJs to extend their performance with visuals. On the Mac platform, this plugin also plays Quartz Composer[5] patches and provides these with precise timing information. Quartz Composer is a visual programming language, initially designed to quickly create animations such as iTunes visualizations or screen savers. The visualization we wanted to create, however, was too complex to be realized with a Quartz Composer patch, so we decided to stream the data to an external application using a UDP network connection.

Serato's Quartz Composer API does not provide access to the cue points. We decided to determine the time of the five cue points that Scratch Live supports by taking a screenshot of the application every second and get the timestamps using OCR.

A projector mounted above the turntable displays the visualization on a white timecode record. At the time of writing, an implementation integrated into Traktor Scratch was work-in-progress, but will be available on the project webpage[6].

5. EVALUATION

5.1 Acceptance

We conducted an online survey to gauge the acceptance of a tool like ours in the DJ community. We compiled a package with the software and detailed explanations how to set up the system. We published the link to the survey and the software in a series of popular DJ forums and got 20 valid responses in total. The respondents had an average experience as DJ of 9 years (SD=6) and on average 4 years (SD=3) of experience with digital vinyl systems. Most used Scratch Live or Traktor Scratch, only one worked exclusively with a different software. Mixing with timecode records was not perceived as being more complicated than with traditional vinyl (Mdn=3 on a 5-point Likert scale), but 75% of the respondents felt bothered by having to look back and forth between computer screen and turntable (Mdn=4). More than half regularly used cue points to find certain positions in a track, and mostly 1-2 cue points were set per track.

When asked if systems like this should not be used, the participants strongly disagreed (Mdn=1), which suggests a high acceptance. Most of the participants would feel comfortable to perform with a system like ours (Mdn=4, 68% approval). One of the major concerns that the respondents mentioned is the installation of one or two projectors above the turntables. This is of course a limitation of the current prototype and the hardware would need to be ruggedized to be transportable to a nightclub, but for our research purposes it is a feasible solution. The system could also be part of a fixed installation in the DJ booth of a club.

5.2 Mixing task

To evaluate the use of our system in practice, we conducted mixing sessions with four professional DJs with two to 25 years of experience. We let the DJs perform a mixing task between different tracks with traditional vinyl, using Scratch Live, and with our system. We set up two Technics SL-1200 MK5 series turntables and a standard DJ mixer, along with Serato Scratch Live running on a laptop next to the turntables. The projector was mounted above the left turntable only. To ensure this would not affect observations, we asked the participants if they noticed any preference in the direction of mixing, but none reported such

[5]http://developer.apple.com
[6]http://hci.rwth-aachen.de/diskplay

observations. The sessions were recorded by two cameras, one capturing the two turntables and the mixer, the other one was mounted above the computer screen to see where the DJ was looking.

We could not verify our expectation that visualizing track information counters the "Serato face" problem. The number of focus switches between turntable and computer screen did not differ in the different conditions. One DJ even stared at the computer screen when he was mixing with traditional vinyl, and the DVS did not show anything meaningful. The participants described this as a habit, which is consistent with previous evaluations [10].

To achieve their sophisticated skills, DJs often restrict their equipment to a small set of hardware that they know really well. A new component probably needs some time to be fully integrated into the performance, which is why we suggest a long-term study to evaluate the changes in behavior.

We observed that two of the DJs used the headphones only for a last check or not at all, mixing purely with visual feedback from the DVS. Our system is very well suited for this kind of mixing, since finding a beat or a cue point is supported visually directly on the turntable.

5.3 Feedback

In both the online survey and after the mixing sessions, participants were asked for feedback about the system and how to improve it. The overall feedback was very positive to enthusiastic. During the survey we got responses such as *"everything...perfect idea and this would help DJs a lot"* or *"the idea is really top and thought through! thumbs up!"*. In the interview after the mixing sessions, three participants mentioned being bothered by the focus switches when using a DVS. One said *"It's about time that someone does something about this. It has been bothering me since I bought my DVS"*, and another added that he liked the idea of having *"the visualization right where he is working"*.

6. CONTROLLERS

With the integration of sample players in the DVS software (called Remix Decks in Traktor or SP-6 Sample Player in Scratch Live), which can be triggered by standard MIDI controllers, the barriers between the performance as a DJ and as an electronic music live act blur. A controller like the Novation Dicer[7], today, is a common add-on to the traditional setup of two turntables and a mixer. The new Reloop RP-8000[8] turntable even has the controller already integrated. This evolution represent a shift, moving the turntable from a pure playback device more towards being a controller. With the adoption of new technology, we imagine the display becoming an integral part of the turntable, making the additional top-projector obsolete and having a single, robust piece of hardware.

The visualization we presented in this paper can also be transferred to CD players or DJ controllers. These MIDI controllers, potentially with motorized platters like Numark's NS7II[9], essentially have the same problem of separating visualization and control. Augmenting these with an additional display in the jog wheels (similar to Pioneer's CDJs[10]) would make these even more powerful. The handling would still be different than a real turntable, but could fit the personal preference of some DJs.

[7]http://novationmusic.de
[8]http://reloop.com
[9]http://www.numark.com
[10]http://www.pioneerdj.com

7. SUMMARY & FUTURE WORK

In this paper we presented a visualization of song information on a timecode record. It includes track start and end marks, cue points, and the song's waveform. The tool was integrated into Serato Scratch Live, a professional DVS software, and made available for download. In an online survey, the project received very positive feedback and was accepted by the community. A lab study with four professional DJs could not show that this visualization helps to prevent the "Serato face" [1], likely because the participants watched the computer screen by habit. However, we received encouraging feedback and comments suggesting that this is a suitable approach to address this problem.

As future development, we will port the software to the other popular DVS, Traktor Scratch. Backed by the two major platforms, the next step would be the integration of the display into the turntable itself, making the projector obsolete and addressing the major concern of our study participants. To evaluate if such a visualization helps to reduce the constant glimpse at the computer screen, such an integrated hardware would make a long-term study feasible.

8. ACKNOWLEDGMENTS

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