Paper V

Mapping strategies in DJ scratching

Kjetil Falkenberg Hansen and Roberto Bresin

Mapping strategies in DJ scratching

Kjetil Falkenberg Hansen   Roberto Bresin

Abstract

For 30 years Disc Jockeys have been expressing their musical ideas with scratching. Unlike many other popular instruments, the equipment used for scratching is not built as one single unit, and it was not intended to be a musical instrument. This paper gives an overview of how DJs use their turntable, vinyl record and audio mixer in junction to produce scratch music. Their gestural input to the instrument is explained by looking at the mapping principles between the controller parameters and the audio output parameters. Implications are discussed for the design of new interfaces with examples of recent innovations and experiments in the field.

1   Background

The success of a musical instrument will have a multitude of reasons. Some immediate suggestions are that it is cool to look at while somebody plays it; it sounds really good; one can express feelings and communicate emotions with it; it is cheap; you can feel its vibrations; it has blinking lights; it has a shoulder strap; you can hit it... Scratching is one such successful "instrument" that takes some effort to get acquainted with.

Scratching is, firstly, not an instrument, it is what Disc Jockeys (DJs) sometimes do with turntables and mixers. The popularity and history of this musical niche has been explained in several aspects in previous works (see for instance Beamish (2004); Hansen (2002); Khazam (1997); Toop (2000); White (1999)). The combination of using both a turntable and a mixer laid the ground for scratching about three decades ago, but despite this, DJs only refer to their instrument as "turntable", inadvertently including the mixer unit. Indeed, analysis of common DJ scratching techniques have shown that the mixer is almost as important for the musician as the turntable (Hansen and Bresin, 2004). Imperative to the control and interface part is the sound *source*, the vinyl record. Sound generation is therefore controlled by two different devices, but dependent on what is currently playing on the record. In this sense, scratching can be compared to new computer based instruments that has separated the interface and controllers from the sound generator.

Recent alternative interfaces for scratching follow to a great deal the separation of a sound level unit and a sound 'source' unit. Why is this so? Should not the effort of the new interface developers be focussed on the task of making *one* instrument for scratching? Evidently, there is a mismatch between development of the turntable-part and the mixer/crossfader-part: this is because the struggle to make an acceptable substitute to the turntable is of highest priority. For instance, all leading manufacturers have each marketed a number of devices for scratching digitally stored sound, but only one of them has produced a mixer with additional control possibilities (Vestax Corporation, 2006).

2   Controllers and mappings

Mappings in interfaces for scratching are quite intuitive, but not simple one-to-one mappings as it may seem at a first glance. One hand controls the playback speed of the record by pushing and dragging it with fast, short movements. The other hand controls the sound level out from the system, in general only the extremes of total silence and full sound[1].

2.1   Common interfaces

The turntable and vinyl record

Playback speed modulations directly affects the pitch we hear, but they do more also. Sound samples[2] used in scratching are often words, short phrases, synthesized sounds, instrumental sounds, and sound effects from movies or daily life. However, they are seldom played as withheld and straight tones of constant pitch. Therefore the perception of the sound changes dramatically when played at different speeds and backwards. This is true not only in the time domain when sounds are compressed or stretched out in time, but also in frequency domain when the whole spectrum is shifted up or down. To disguise the origin of the sound being scratched further, there is normally a fast acceleration and deceleration with each hand gesture that transforms the sound.

Another aspect to consider related to the mapping between the record-moving gesture and the sound we hear, is clearly the sound source on the record itself. As stated, pitch changes and artifacts in the time domain will occur in the interaction with the turntable. But these are not at all consistent for all sounds. For instance, short sounds of low frequency are hard to stretch out in order to manipulate them with the crossfader, while longer sounds easily allows virtuous use of crossfader. Some sounds are unfit for playing with pitch, such as the sound of a snare drum

---

[1]The DJ mixers also have tone controllers and linear amplitude sliders, but the most utilized control is the logarithmic crossfader which works as an on-off switch for sound level.

[2]In this text, *samples* are recorded sounds on vinyl records. Samples can be short (from a tenth of a second) or long (to more than a minute), but typically they are a bit less than one second.

hit, while others such as a sample of James Brown shouting 'aaayeah', are perfect for that purpose.

Not only the sounds on the record are important for identifying the mapping. Even the silent parts before and after each sound sample must be taken into account. If the DJ starts to move the record *before* the needle reaches the spot where the sound starts, the sound will start with a high pitch. If she starts the move when the needle is located *within* the sound, a sudden glissando effect can be heard. Likewise, if the DJ pulls the record back and forth repeatedly over an entire short sound sample, we will hear a succession of sharp tone onsets, while the same movements "inside" for instance the long James Brown sample will generate a very different, more siren-like sound gliding fast up and down in pitch.

Consequently, if the record on the turntable consisted of a long, unchanging sound, such as a synthesized tone of constant pitch, the musician's gesture in moving the record would be more audible and apparent.

The three most common gestures for moving the record are to place the hand flat down with fingertips on the record and use the elbow to move; to hold the hand at an angle and use the wrist; and to hold the hand steady and only make small movements by using the finger joints. In the first two cases, the hand and fingers are flexible and can supplement the main gesture.

The audio mixer

The audio mixer is placed between the turntable and the loudspeaker, so the signal from the record is always going through the mixer. It has a number of controllers, most important are the crossfader, a line/phono switch, a volume fader and one or more knobs for equalization (tone control). DJs use the crossfader much more than the other mixer controllers. During recent years, the crossfader has evolved from fading linearly between the two turntables in the DJ set-up to being a logarithmic fader with very steep fading curves that in practice is only an on-off switch for sound. Traditionally, the line/phono switch was used for turning the sound quickly and sharply on and off, but today it is superseded by the crossfader, which is much better suited to fast manipulations than the switch.

The crossfader knob can be moved using different hand gestures, but two methods are dominant. The knob is either pinched between the thumb and a finger and pushed the short distance on the fader that runs from silent to sound, normally adjusted to 1-2 millimeters, or it can be lightly hit with one or more fingers against the thumb which acts as a spring, bouncing the fader back. Either way, the starting position can be both in the silent and the full sound area. The crossfader can be reversed so that the silent part can be on either the extreme right or the left side of the fader run.

Figure 1: Mapping sound output parameters (left and right) to control parameters (middle) in a normal instrument setup for scratching. Onset and pitch are undeniably the most crucial sound attributes, and are placed to the right in the figure. Line thickness (from dashed to bold lines) represent the importance of the connection. The bold boxes are considered to be the most essential control parameters: record movement, sound sample properties and crossfader movement.

2.2   Current mapping in scratching

By following principles for describing instrument mapping strategies suggested by Hunt et al. (in Hunt and Kirk (2000a,b); Hunt *et al.* (2003)) an overview of the existing mapping between gestures and sound in scratching is presented here. The controller parameters considered are record speed, sound source (on the record), the needle's placement in the sound groove, and on the mixer the use of crossfader, volume slider and tone control knobs. The audio output parameters considered are pitch (not necessarily in the meaning of discrete semitone steps), tone onsets and durations, and tone or sound characteristic such as timbre and dynamics. Figure 1 shows the relations between controller and audio output parameters.

Timbre and dynamics

Timbre is determined by the sound source used, and the speed at which it is played back. In addition, the DJ can control timbre to a certain degree using the tone control knobs, which is done for certain scratch techniques (Hansen, 2002).

Dynamics, or sound level variation, is a very important factor for expressive playing in most musical instruments. However, it is rarely found in scratching. Sound level is determined by the volume slider on the mixer, the sound source and the playback speed. The crossfader can not be regarded as a controller for dynamics, as its fading curve is far too steep. The needle's placement in the sound

groove can have a great effect on dynamics, as many sounds decrease in amplitude over time.

Timbral and dynamical variations can also be achieved by choosing locations with different amount of wearing on the record. In records where one sound is repeated (e.g. for several minutes, as in DJ 1210 Jazz (2001)) the sound can be more deteriorated in some grooves than others, making the same sample sound different depending on where the needle is located (Hansen and Bresin, 2003).

Pitch

Pitch is determined by the sound source and is adjusted straightforwardly with the playback speed. Experienced DJs sometimes use the pitch adjustment slider on the turntable to "tune" the sound sample to the tonality of the piece to which they are scratching. A large part of all (scratched) tones have the same speed as, or close to, the revolving turntable (Hansen and Bresin, 2004). For many of the favored sounds on the record, it is hard to hear a fundamental frequency. Several samples, for instance the popular "Fresh" (a long *shhh* sound, Fab Five Freddie (1982)), have a noise band with a broad maximum, inducing the perception of some pitch.

Tone onsets and durations

By tone onsets it is meant both the start of a tone and the characteristics of its attack. Attack properties are controlled by record speed, sound placement and sound source. A slow push produces a slow rise in pitch and a "soft" attack, while a fast push produces a harder attack. A movement starting with the needle positioned inside a sample produces a softer attack than the same movement starting before the sample starts. The sample of a snare drum hit as sound source will have a very different attack from a sample of a moaning soul singer.

The rapid stream of tone attacks is a very noticeable and distinguishing aspect of scratching. In a typical technique with a duration a couple of tenths of a second, there can be as many as 6-9 tone attacks (Hansen and Bresin, 2004). The most important controller for generating such rapid onsets is the crossfader, especially when the fingers bounce it against the thumb. Also quick shifts in playback tempo from going forward to going backward generates onsets. Certain techniques can produce more than 20 onsets a second only using the record speed. A third control possibility is to use sound sources where short sounds are placed close to each other, for instance a slow drum roll or hand-clapping. One single gesture of moving the record over such samples produces a multitude of tone attacks.

The length of the sound sample influences the durations of the tones which can be controlled by hand gestures on the turntable. The crossfader can at any time shorten the duration by stopping the tone. It is often hard to sustain short samples for long, which is also still the weakest point of all the interfaces for scratching digital sound files. Even long samples can be hard to sustain with a constant speed, as the turntable's tone arm obstructs and makes circular gestures problematic.

2.3   New interfaces for scratching

New interfaces introduce new possibilities. Generally, the common first feature is to give control over an additional parameter, either in the sound itself or in processing the sound (Paradiso and O'Modhrain, 2003). With scratching, the first step has been to reproduce the existing hardware (the turntable part) in software models and with alternative controllers, often realized as some type of a revolving wheel resembling the turntable. This strategy is obviously in conflict with the design principles lined up by Cook (Cook, 2000). The pursuit to produce an acceptable virtual turntable has led to commercially available interfaces for controlling sound files that are quite good. Solutions for allowing control over additional parameters, however, is still a rather unexplored field, and the big companies have not yet acknowledged the potential.

In previous NIMEs and in related journals, and even in commercially available products, several new interfaces for DJs have been envisaged. This section of the paper gives a short review of possible mapping strategies of a selection of these interfaces with regards to the previous section.

Of the many interfaces manipulating digitally stored sounds, *Final Scratch* by Stanton has probably been most accepted, using a time-coded vinyl record to control sound files on a computer. Other such interfaces include devices for scratching with CDs, marketed in various designs by all leading manufacturers (e.g. Pioneer, Technics, Stanton, Vestax and Denon). Common for this group of interfaces is that they do not offer new ideas for controllers nor new mapping possibilities.

DVD scratching is a similar concept to above mentioned scratch tools for digital media. Although few companies have marketed instruments for this, Pioneer being one exception (Pioneer, 2003), it is a promising performance concept for VJs (video DJs). Current version can treat the video image equivalently to sound by modulating the playback speed. The visuals introduce new output parameters for the interface, which parameters can be mapped to other controllers than just the 'turntable' gestures.

Mixxx by Andersen (2003) is developed both as a set of performance tools and as a means of studying DJ performances. Both mixer and turntable interfaces are replicas of the standard interfaces, but they also send MIDI messages. For performance, it enables to have a mapping layer between the controller parameters and the audio output, so that they can be used for controlling new or existing sound properties. *Mixxx* also includes a new visual feedback technique in an augmented turntable, the *Fisheye* (Andersen and Erleben, 2002), a method for projecting a waveform image on the record. In the presented implementation, *Mixxx* is not addressing DJ scratching specifically.

The *D'Groove* by Beamish *et al.* (2004, 2003) introduces haptics, induced by a force feedback motor, as a feedback method in the turntable interface. This allows for haptic 'visualization' of the sounds on the record, which assists the DJ in for instance finding the sound sample 'borders'. In tests, experienced scratch DJs quickly start to experiment with new techniques and performance ideas, and learned

to use the novel features that haptic feedback provided. Some new controllers were also implemented, but did not suggest new mapping layers or strategies, as was the case with *Mixxx*.

Skipproof (Hansen and Bresin, 2003) is a software tool for evaluating synthesized scratch techniques, and also a scratch performance instrument. The controller and audio output parameters found in common DJ set-ups can be mapped freely to various devices for computer input, such as MIDI interfaces or gesture sensors. *Skipproof* does not have the general approach to DJing as the above mentioned interfaces, but is focussing on the skip proof feature found in specialized records for DJs where a one revolution long sample (1.8 seconds) is looped. This allows for designing specific scratch interfaces that contrast the established ones.

16padjoystickcontroller by Lippit (2004) is a realtime sampling system for scratch DJs. Lippit acknowledges that DJs are fully occupied with their hands during performance and suggest supplementary controllers, a foot switch, a joystick and a drum pad, that enable the DJ to interact with their own performances in real-time. With these controllers, DJs can record and manipulate portions of their scratch performance. In such context, the added controllers are separated from the existing ones and represent isolated instrument systems without possibilities for interaction.

Samurai mixers by Vestax (2006) are the only commercially available tools from a major manufacturer that have added possibilities for sound control with the crossfader. The crossfader is programmable so that the DJ can handle amplitude patterns instead of the normal fading curve, so that one gesture on the crossfader can generate several onsets, not just one. Vestax has also marketed a turntable with integrated crossfader, the *QFO*, but this interface does not introduce new control possibilities or mappings. It illustrates however the need for a dedicated scratch instrument.

3   Conclusions

The existing mappings between gestures and sound with a turntable and a mixer should be considered when designing and building new interfaces for scratching. Up to now, gestures used for scratching have originated from the idea of reading a sound file at varying speeds and direction, with a one-to-one mapping between the extent of a (hand) movement and the position in a sound. Regardless of the kind of gesture, it is always a measure of distance. Gestures for controlling crossfader, or sound on/off, are not as intuitive as the turntable-controlling gesture, and also much less studied.

In general, commercial manufacturers of equipment and instruments focus on existing control paradigms instead of exploring new possibilities at hand. Immediate responses from DJs participating in the described interface developments and experiments, indicate an openness to new control concepts and mappings for scratch performances. New interfaces will probably contribute to develop the playing styles and DJ techniques in other directions.

DJs have with great consensus developed a common language of playing techniques that require complex, synchronized gestures to be performed correctly (Hansen, 2002). Despite the rather unusual and hard-to-master handling of the instrument, its principles can be applied to other interfaces, both for music performance and for general human-computer interaction.

4   Acknowledgements

References

Thue Haste Andersen. 2003. Mixxx: Towards Novel DJ Interfaces. In *Proc. of the Conference on New Interfaces for Musical Expression*, pages 30–35, Montreal, Canada. Faculty of Music, McGill University.

Tue Haste Andersen and Kenny Erleben. 2002. Sound interaction by use of comparative visual displays. In *Proc. of the Second Danish HCI Symposium*. HCØ Tryk.

Timothy Beamish. 2004. A Taxonomy of DJs, the online taxonomy of DJ practise. URL `http://www.timothywisdom.com/science/djtaxonomy/djtaxonomy.php`. Last accessed December 2009.

Timothy Beamish, Karon MacLean, and Sidney Fels. 2004. Manipulating music: multimodal interaction for DJs. In *CHI '04: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 327–334, New York. ACM.

Timothy Beamish, Kees van den Doel, Karon MacLean, and Sidney Fels. 2003. D'Groove: A Haptic Turntable For Digital Audio Control. In *Proc. of the 2003 International Conference on Auditory Display*, Boston.

Perry Cook. 2000. Principles for Designing Computer Music Controllers. In *Proc. of the CHI 00*, NIME Workshop.

DJ 1210 Jazz. 2001. Book of Five Scratches. Book 2. LP: Snickars Rec., SR1206.

Fab Five Freddie. 1982. Change The Beat. New York: Celluloid Records, CEL 156. 12" EP.

Kjetil Falkenberg Hansen. 2002. The Basics of Scratching. *Journal of New Music Research*, 31(4):357–365.

Kjetil Falkenberg Hansen and Roberto Bresin. 2003. Complex Gestural Audio Control: The Case of Scratching. In Davide Rocchesso and Federico Fontana, editors, *The Sounding Object*, pages 221–269. Mondo Estremo, Florence, Italy.

Kjetil Falkenberg Hansen and Roberto Bresin. 2004. Analysis of a Genuine Scratch Performance. In Antonio Camurri and Gualtiero Volpe, editors, *Gesture-Based Communication in Human-Computer Interaction, 5th International Gesture Workshop*, LNCS 2915, pages 519–528. Springer Verlag, Berlin Heidelberg. Selected Revised Papers.

Andy Hunt and Ross Kirk. 2000a. Mapping strategies for musical performance. In Marcelo M. Wanderley and Marc Battier, editors, *Trends in Gestural Control of Music*, pages 231–258. Ircam - Centre Pompidou.

Andy Hunt and Ross Kirk. 2000b. Multiparametric control of real-time systems. In Marc Battier, Joseph Rovan, and Marcelo M. Wanderley, editors, *Trends in Gestural Control of Music*. FSU - Florida.

Andy Hunt, Marcelo M. Wanderley, and Matthew Paradis. 2003. The importance of parameter mapping in electronic instrument design. *Journal of New Music Research*, 32(4):429–440.

Rahma Khazam. 1997. Electroacoustic alchemist. *The Wire Magazine*, 160:36–40.

Takuro Mizuta Lippit. 2004. Realtime Sampling System for the Turntablist, Version 2: 16padjoystickcontroller. In *Proc. of the Conference on New Interfaces for Musical Expression*, Hamamatsu, Japan.

Joseph A. Paradiso and Sile O'Modhrain. 2003. Current Trends in Electronic Music Interfaces - guest editors' introduction. *Journal of New Music Research*, 32(4): 345–349.

Pioneer. 2003. *Pioneer DVJ-X1*. Pioneer. URL `http://www.pioneer.co.uk/uk/content/press/DVJ-X1.html`.

David Toop. 2000. *Rap Attack #3*, 3rd edition. Serpent's Tail, London.

Vestax Corporation. 2006. Vestax Samurai Mixer Series. URL `http://www.vestax.com/v/products/mixers/`.

Miles White. 1999. The phonographic turntable and performance practice in hip hop music. *Ethnomusicology OnLine*, 2:1–6.