Survey of Turntable-like HCI for Scrubbed Media Performance

Karl M Yerkes
University of California, Santa Barbara
Media Arts and Technology Program
yerkes@mat.ucsb.edu

Abstract

Many human computer interface devices exist that emulate and extend the turntable concept, allowing playback of recorded media (scrubbing) for audio and video performance. This paper will present and explore a few of these research projects and comercial products, assessing how accessable each device is to the individule (the author is bias toward do-it-yourself projects). Finally, this paper will describe of the author's own turntable HCI project (disky) as well as a proposal for future work in light of this research. The motivation behind this paper is to put the author's work into context, determine the best direction to go.

Keywords: repurposed harddrive, hci, turntable, disky

1. Turnable Interface

Turntables could be called the oldest, newest instrument. What once was only known as a tool for reproducing recorded media, is now (and has been for some time) an esablished instrument. In the same vein, a sampler or tapedeck could fit into this category. And even though many intruments have been designed from the start with recorded media playback at their core, the turntable has reached icon status where other devices have not.

Traditional turntables like the Technics SL-1200MK2 (Figure 1) reproduce recorded media by rotating (whether by motor or by hand) a vinyl record against a needle. As the record turns, the needle is held captive in a spiral-cut groove. As the needle moves in that groove, audio data (stored as a series of bumps) is converted to electrical signals by the needle, which is a transducer. These electrical signals are amplified and prehaps conditioned electronically, then converted to sound with a speaker.

This rather mature system has some great qualities as a music controller and instument. First, it allows both very fine and very coarse control of media playback. Because the entire playback process happens within the analog domain and because the audio data is stored sequencially and locally

Figure 1. Technics SL-1200MK2

on the record, the latency of the system is very low. Second, it allows for both continuous and discontinuous (repositioning the needle along the radius) traversal of media data. Also, it deals gracefully with manual interupption (scatching).

At a high level, we could say that this system maps tightly the phase of recorded sound to the rotational position of a disk, except when the system is muted with a switch or fader.

The physical extent of a traditional turntable is quiet suitable for human scale. Parameters, such as size, friction, weight, rate of spin (in normal opperation), and motor torque, do not exceed reasonable human limits.

2. Survey of Turntable-like HCI devices

The turntable interface has for many years caught the attention of experimental musical instument builders around the world. Corporations, researchers, and individuals have crafted a number of experimental and comercial devices based on the turntable metaphor, adding, subtracting and mutating parameters, features, and aesthetic characteristics.

These devices range in character from simple digitization of traditional turntables, abstracting control signals, but leaving the turntable untouched, to augmentation of traditional turntables, installing or replacing devices, to total reimplementation of a turntable-like devices, attempting to challenge and explore the turntable metaphor.

We explore a few such devices, moving from most traditional, to most experimental. We start our survey of turntable interface with a comercial product that has been around since 1998, Final Scratch.

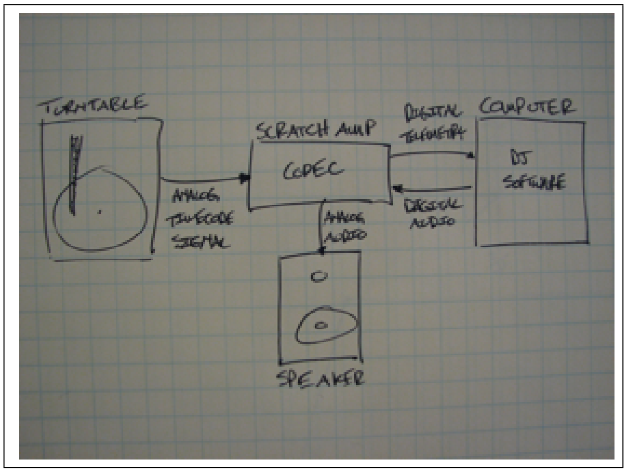

Figure 2. Final Scratch Hardware System

2.1. Final Scratch

The Final Scratch system is not itself a turntable device. Instead, it allows the reuse of traditional turntables to control digital content through the use of special hardware called a Scratch Amp in conjunction with specially time-coded records.

The Final Scratch hardware system (Figure 2) consists of a traditional turntable, a Scratch Amp, a personal computer and some sort of amplification/speaker system.

The Scratch Amp decodes analog time-code, providing position, direction and velocity information to a personal computer. Given this information, software on the computer decides what specific digital audio to sent to the Scratch Amp for convertion to analog signals.

Perhaps the most interesting aspect of the Final Scratch system is the time-code used. A special record holds a 1200 Hz amplitude modulated sine wave in each channel (left and right), 90 degrees out of phase. This phase offset allows the Scratch Amp to deduce the direction of the record when it moves (one channel will be ahead of the other). As the record changes speed, what is normally a 1200 Hz sine wave at some reference speed, changes pitch. This pitch change is proportional to speed change. Finally, encoded in the amplitude modulation is a 40 bit code that represents the absolute position of the needle.

2.1.1. Accessibility

This system works well, with tollerable latency. However, the system currently costs approximately $300 and requires special sofware and at least one traditional turnable. This does not meet the author's criterea of accesibility.

2.2. TT-M1

The TT-M1 (Figure 3) is a commercial product by Tascam. It it is designed to attach to the side of a traditional turntable and glean rotation direction and speed from the record, using a simple rotary encoder wheel mechanism very similar to what one might find in a standard ball mouse.

Figure 3. Tascam's TT-M1

Figure 4. HDDJ of ColorDex DJ System

2.2.1. Accessibility

At about $100, the TT-M1 costs less than the Final Scratch system and produces similar results. However, it is a proprietary device that connects only to Tascam products, so it is not that accessible to the diy artist. There are rumors that the TT-M1 protocol has been reverse-engineered, but the author could find no HOWTOs on this.

2.3. HDDJ

One of the more impressive devices to be published recently is HDDJ (Figure 4) of The ColorDex DJ System[1]. In this project, the authors repurpose a standard personal computer hard drive to act as a turntable interface for their dj system (very much like disky).

In the ColorDex system, the HDDJ interface is used to scroll and scrub through a selected track of digital audio in the ColorDex software. Cursor position information is sent to the computer from a microcontroller over USB. The microcontroller deduces speed and direction information by decoding the signals from hard drive motor using a relatively simple circuit employing comparators.

However, HDDJ suffers from one crucial flaw. Because it works by decoding the signals that are produced by spinning

Figure 5. D'Groove

the hard drive's variable reluctance motor, the device is only effective above some critical speed. Under this speed, turn information is not available due to weak motor signals. In the words of the authors:

> "While suitable for our requirements, the HDD solution does have some limitations: chiefly, it requires some amount of spin, above a certain threshold, for the motor to output measurable signals. As a result it is not possible to detect small 'scratch'-like movements, and as such is not a replacement for a digital turntable. It is still well suited as a rotary input device that spins effortlessly and has a high tactility factor..."

2.3.1. Accessibility

To bulid an HDDJ would only cost a few dollars in parts and a few hours of work. It is very accesible to the individual. An instructable HOWTO has been posted online.

2.4. D'Groove

The goal of the D'Grove (Figure 5) is to create a system that allows those with turntable skills to continue with their instrument, improving and expanding it's capabilities without sacrificing existing functionality. Improvements include haptic force feedback, playback of arbitrary digital sounds, and improved reliability and maintainablity.

D'Groove employs a very high resolution (14400cpr) rotary encoder together with a high precision stepper motor to complete the turntable metaphor and introduce haptic feedback.

In the words of the authors:

> "We can produce bump like feelings on the turntable by sending it varying amounts of current with respect to its position. We can control the height and number of bumps around the turntable as the user moves the platter. Each bump can correspond to a beat in the song, enabling the user to feel the beat structure as the platter is moved."

Also:

> "By altering the damping forces, we can vary the resistance felt by the user as the platter is rotated manually. The amplitude of the song is mapped to the friction applied to the turntable so that heavily damped 'muddy' spots can correspond to musically 'heavy' (or frequency rich) moments in a song. Lighter musical moments (breaks) can be accompanied with less damping on the turntable motor. Thus the user can feel musical events in the song when in this mode."

These features are very exciting and attractive.

2.4.1. Accessibility

A combination 14400cpr encoder and precision, high-torque stepper motor cannot be cheap. It is not a part that is easily accessible to the individual.

3. Disky

Disky is this author's experimental turntable-like interface. It consists of a repurposed hard drive that has been retrofitted with a hand-made rotary encoder system, capable of approximately 200cpr.

3.1. Future Work

In composing this paper and digesting the research involved, the author's work on disky was placed in the context of these projects. Disky is very similar to HDDJ, but it does not suffer from the critical speed problem because it uses a handmade encoder instead of decoding motor signals. Introducing haptic feedback like that which is shown in D'Groove is the next logical step for Disky, but the challenge of controlling the variable reluctance motor is a major stumbling block.

4. Final Words

In composing this paper, the author consulted three basic information sources: Corporate websites and advertising materials, individual websites and videosites, and papers from academic proceedings such as NIME, ICAD, and ACM. Each source had it's own character and set of defects.

Youtube.com is very accessable, easily searchable, and is ripe with 'video' information on projects relavent to this topic. However, basically all of these 'videos' are *not* accompanied by instructions, detailed descriptions or any information that could lead the viewer to reproduce the work. It is as if the poster wants to keep secret his or her work.

Corporate websites and advertising materials are always trying to sell something or spin something and it is assumed that they mean to keep the details of their work secret in order to limit reproducability because it would hurt their bottom line. However, their information is sometimes quite useful.

The most useful, highest quality information is in papers from academic proceedings. Papers from NIME, ICAD, and SIGs are detailed, peer reviewed, and aimed toward reproducability (and therefor accessibility) instead of away from it. Reading these papers can be very useful for the do-it-yourself artist.

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