

Vocal Removal of Hip-Hop for MUS 499

Purpose:

The purpose of my project was to attempt to devise a method to remove vocal parts from hip-hop recordings in a rigorous, non-disruptive, and, if possible, automated method. I successfully removed vocals from a number of tracks with a high degree of accuracy, including Eminem's *Lose Yourself*, the Wu-Tang Clan's *Wu-Tang Clan Ain't Nothin' To F*** With*, and Dr. Dre's *Still D.R.E.* (used as a test track). This method shows promise for vocal removal in future recordings, but automation has not been achieved.

Project Overview:

There is a major absence in 90s-era hip-hop music of high-quality and faithful instrumental recordings, even for famous and respected artists and producers. Although there is most definitely the same problem in modern hip-hop and rap music, modern releases are largely outside the scope of this project, due to reasons that will be discussed below. Thankfully, instrumental releases today are much more common and are on the rise, but notable and influential artists, such as the Wu-Tang Clan (many individual members included), The Notorious B.I.G., Warren G, De La Soul, Canibus, and many others have all been featured on singles, EPs, and albums that have never had official instrumental releases.

Often, instrumental releases are no longer publishable due to label bankruptcy (perhaps not very surprisingly common among a label employee/producer demographic consisting of a large amount of gangsters and criminals), other loss of master recordings, or ongoing legal battles between producers and labels. Many recordings are self-released and the producer has no desire to publish an instrumental release, and although labels do occasionally release 20- or 25-year anniversary editions of albums, these are often extremely limited and difficult to listen to, even if one attempts to use, shall we say, less than savory websites. While there are a lot of low-quality basement MP3s available for listening online, these recordings are often of dubious origin and are also frequently 192mbps or lower quality--not suitable for audiophile listeners. To this end, I was motivated to develop a method to produce bootleg high-quality instrumental versions of hip-hop tracks using the original releases as source material. Additionally, currently available software methods such as Audacity's **Vocal Remover** tool are very limited in scope and only work for select center-panned vocals recordings.

Although automation was not achieved, a method was developed using various tools available in the free audio analysis and editing software package Audacity that has effectively removed vocals from a number of hip-hop tracks with varying degrees of success, and shows promise for vocal removal in many other hip-hop recordings and for multiple artists.

The method, dubbed the "chop shop" method herein, involves the use of silence insertion and beat-matched samples of the drum loop used within a given track to construct a piecemeal user-defined "chopped" drum loop, leading to a "chopped track" with the intention of duplicating the drum loop found in the original track. This chopped track is then overlaid onto the original track and edited manually to match its drum loop as closely as possible, and the signal from each track is subtracted in order to obtain a vocals-only track. Finally, this vocals-only track, the "working track" produced using the original chopped loop, is edited further to remove noise used on records sampled during original recording, non-loop instrumentals and samples, and background vocals, and overlaid onto the original track once more to obtain an instrumental version. A defining characteristic of the chop shop method is that it is highly dependent on the individual artist and producer featured on a specific recording, and many additional steps must be undertaken to produce instrumental versions of some recordings than others.

Project Details:

Using Audacity tools, the chopped loop is assembled using ~15 different samples typically 0.02-1.5 seconds in length of the exposed drum loop of the original recording, with the goal for this chopped loop to closely match the original 8- or 16-bar drum loop in a particular segment of the original recording. From the tracks I've worked on, a typical track has ~4 different melodic sections and therefore the same amount of chopped loops required, usually with different samples or instruments being used in each bridge and refrain and often with more, for reasons that will be elaborated on below. These samples are extracted from any exposed element of the drum beat present in the original recording, ie; a period of time during the original recording where a rapper takes a breath or drops out for a phrase, a full or partially instrumental bridge, or during an initial fade-in of a drum loop, and official scores or tabs are used where possible to determine whether the loop is in an 8- or 16-bar phrase (typical), or whatever rhythmic repetition it may be in.

The chopped loop is difficult and time-consuming to assemble manually for a number of reasons. Importantly, it can be quite painstaking to select individual samples listenable in the original recording that compose the drum loop of the piece--when I've used the chop shop method, these selections have been done by me, subjectively, and these are often indistinct and very short samples. If a piece has a completely instrumental bridge and a fade-in or fade-out of the main drum loop at the beginning or end, typical of Eminem and other Detroit producers, a chopped loop can be very easy to make, and will be composed of only a handful of individual samples. For some producers such as Snoop Dogg, the speed of vocal delivery and the lack of instrumental bridges makes chopped loops very difficult to generate.

After the "chops", or individual samples, have been selected, they must be looped. After determining the length of the loop, the chops are edited in Audacity and repeated under beat matching parameters to match the original drum loop in each individual melodic section. Once all the different sections have been combined and the loop has been assembled (details on the method are in the next section of this report), the first working track is obtained by using Audacity's Invert tool on the

signal. If the editing is done correctly (something that takes many, many attempts), the signal present in the original track and the chopped track will partially but totally cancel each other out, leaving a working track composed of vocals, background vocals, and non-loop instruments.

At this point, a good deal of further editing is required to the working track. It's likely to contain at least 3 or 4 producer-inserted non-loop samples, as well as background vocals and elements of the drum loop in each melodic section that weren't considered in the chopped track. In other words, if this first working track were again inverted to produce an instrumental version of the original recording, there would be no vocals, yes, but there would also be periods of total silence in the drum loop and many instruments and samples would be absent. The working track is refined usually ~5 times in order to more precisely match an *a cappella* arrangement of the original recording, with additional refinements made to the chopped track between each version. In this project, I've used my own best judgment to determine when a chopped track is finished and ready to be inverted onto the original.

Once the final and most precise working track has been produced, it's edited onto the original track and inverted in order to obtain an instrumental track of high quality. Obviously, due to the limitations of sample selection used to construct chopped loops and the difficulty of inserting non-repeated samples and instrument parts into the working track, certain elements of the original recording that may belong in an instrumental version will not be reproduced using the chop shop method. However, when possible I've attempted to use various other production tricks, not covered here--such as Audacity's frequency analysis functionality and other tools to segregate vocal-range signal from drum or synth signal--to maintain these elements in the instrumental versions I've produced.

The chop shop method is uniquely suited to produce instrumental versions of 90s-era hip hop recordings due to the typical production style of that music and the instruments used by producers. Most, if not all, well-known producers active during this time played on some combination of MPC-12s or similar drum machines, loop pedals, and turntables. Due to the nature of the equipment, this style of production led to music that had perfectly repeated drum loops at a constant volume and a methodical and loop-dependent insertion and removal of instrumental parts, with little if any distortion or abrupt drop-in or drop-out of the backing drum loop. Modern hip hop production has increased in complexity and stylistic complexity immensely due to the presence of APCs and laptop production software, and producing an accurate chopped loop of a modern rapper's work would in many cases be immensely difficult or impossible. Due to these same difficulties, there are of course many 90s-era hip hop tracks that can't be used to produce instrumentals using the chop shop method, depending on the artist and album.

Methodology:

Presented here as a step-by-step list. Not all steps will be necessary in the production of an instrumental version from a particular track as discussed above. Steps for testing are also included. From the tracks I've worked on, the average

length of time from start to finish to produce an instrumental version of an original track is ~9-14 hours, although this can vary widely.

1. Obtain Audacity at <http://audacity.sourceforge.net/>, and open it.
2. **File>Open** your hip-hop track of choice, vocals and all.
3. Select the track by left-clicking outside of the tracking area, under the crossfade and volume sliders.
4. Compress the two stereo halves of the track into a mono track with **Tracks>Stereo Track To Mono**.
5. Just in case, select the new mono track and use **Tracks>Resample...** at 44.1kHz to ensure that the entire track is at the same sample rate--this is necessary to provide a recording that's at uniform sampling rate, and in most cases will not affect the studio recording at all. For the purposes of this paper, this is the original recording.
6. **File>Save Project** the original recording, and **Open** up a new blank Audacity project (or simply another track in the same project, your choice) to place the chopped loop in.
7. Begin collecting samples to compose the chopped loop. In the case of an instrumental fade-in or fade-out, an easy way to do this is to select that section of the original recording and attempt to use **Effect>Fade In** or **Effect>Fade Out** to oppose the original recording's volume, as appropriate. If that doesn't work, use **Effect>Adjustable Fade** to make the volume to as close to uniform as possible. Otherwise, any sample that contains no vocals will do, as long as it is placed properly within the chopped track. It's unlikely that samples of >1.5s will be suitable.
8. As samples are collected, select them then use **Edit>Copy** and **Edit>Paste** to move new samples into the chopped track.
9. Between individual samples, use **Generate>Silence** to insert an appropriate amount of silence. Typically I insert ~0.05 seconds of silence as a baseline between individual samples, and then delete segments of silence as in step 13 to refine the chopped loop.
10. Repeat the two above steps until a suitable drum track, with a length equal to one phrase of the drum loop in the original track, is obtained. Using the steps below, this loop will later be further refined and revisions will be made. When putting the chopped track together, **Copy** and **Paste** the loops as above in order to produce a chopped track, which will include sections of different chopped loops corresponding to the original track's melodic sections. Once a chopped loop for a given melodic section is completed, use **Effect>Repeat...**
11. **Save** your work and **Open** another new blank audacity project or track. This will house the working track.
12. First **Paste** your original track into this project, and then, in a separate track in this project, **Paste** the chopped track. Use **Tracks>Align Tracks>Start to Zero** to ensure that each track has the same start point.
13. If necessary, edit the working track using **Effect>Change Tempo** to more carefully align your working track with the original track (the easiest way to do this is by zooming out with **View>Fit In Window** to view the entire duration of the original track, then manually elongating the working track using **Change Tempo** until it is the same length), and remove silence between melodic sections of the working track to ensure each individual

chopped loop section is in the appropriate position with respect to the original track. To remove silence from the working track, hold **SHIFT** and left-click two time points in the working track, then hit **DELETE**.

14. This is where the magic happens. **Effect>Invert** the track of your choice (I usually invert the chopped track, although this is arbitrary).
15. **File>Export** the overlaid original track and inverted chopped track--this is your working track.
16. As above, **Open** the working track and the original recording in the same project (or open a new project), and **Invert** the working track.
17. If you've made a good working track, listening to the two mono tracks at the same time will now simulate an instrumental track of the original recording! If that's the case, **Export** to your preferred audio format.
18. If, as is more likely, your working track overlaid onto your original track and inverted results in incomplete vocal elimination, the chopped track must be refined. Go back to it.
19. This is the most time-consuming part of the entire process--the relative timings of samples from the original track within the chopped loops must match the original track precisely in order to properly cancel after being **Inverted**. Complicating this process, individual instruments present within the buildup/breakdown of the drum loop present in each melodic section must usually be accounted for in the chopped track used to construct the working track.
20. Repeat steps 7-17 as necessary to further refine the chopped track and working track. Typically, I attempt to add one "instrument" or sampled element of the drum loop at a time to each individual melodic section of the chopped track, and listen working track after each edit to determine what needs to be added to the chopped track. A perfect working track would be flawlessly a *cappella* and would have nothing in it except for main vocals.

Obviously, a "perfect" instrumental version of an original recording will not be possible with the chop shop method--although in the author's opinion, some recordings subjected to my method can produce some very, very nice instrumental versions. A typical piece will require at least a couple dozen revisions to the working track (assuming one melodic section is revised at a time and one instrument is added at a time to the chopped track) in order to produce a mostly-clean instrumental version, and further edits will still be required at that point to accommodate individual musical elements as described above. **Analyze>Silence Finder, Effect>Truncate Silence, Effect>Compressor, and Effect>Normalize**, as well as all the tools described above, can be used to attempt to isolate individual samples and place them into the chopped track.

Conclusion

In summary, the chop shop method has been used to successfully produce instrumental versions of several hip-hop recordings, some without official instrumental releases. The method is laborious and extremely time-consuming, however, if applied correctly it can be used to produce an almost flawless instrumental version of a lossless or high-quality original recording, making it superior in performance to most currently available vocal removal techniques. The method requires nothing except a high-quality original recording, a solid

understanding of Audacity, and a large amount of the user's free time. Future work will focus on (if possible) automating this process through the use of Python or MATLAB script; looking at results of past years' submissions to MIREX, I see that there have been several attempts at automated vocal removal submitted there, with varying levels of success.

The author wishes to thank Prof. Tipei for his rigorous and brain-tickling questions as to how this method might work, as well as providing several ideas for how it might be attempted and refined throughout the semester, as well as the other students of MUS 499, who each have their own awesome projects. Instrumental versions of the tracks mentioned in the first section of this report will be made available upon request, and several additional instrumentals will be attempted over the course of this summer and next semester. (Note that there is an official instrumental release of Dr. Dre's *Still D.R.E.*; this release was compared to the instrumental produced via the chop shop method and they were almost identical.)