Audio Source Separation: "De-mixing" for Production

De-mixing ‘The Beatles at the Hollywood Bowl’ using Sound Source Separation

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Overview

• Historical Background
• Sound Source Separation
• Considerations for De-Mixing
• Source Separation Techniques
• Audio Examples
Historical Background

• The Beatles at the Hollywood Bowl
  – Beatlemania had just landed in the US
  – Previous attempt to record live performances blocked by musicians union in the US
  – 1964 tour, Capitol attempted to record concert
  – 15,000 screaming girls created a wall of sound
Historical Background

• Three Concerts 1964 and 1965
  – Recorded on Ampex 3-track machines
  – Vocals on 1 track
  – Instruments on remaining 2 tracks
  – Crowd mixed purposely into instrument tracks

• Problems
  – Engineered by the Hollywood Bowl and not Capitol
  – No monitoring on the 3-track
  – Capitol had no influence on actual recording
  – Excess crowd levels not discovered until playback in studio
Spectral Sources
• Solution – Create new stereo re-mixes using Sound Source Separation technology

• Sound Source Separation - Given a recording of a mixture of sound sources, attempt to recover the original sound sources in isolation.

• Problem: There are usually many more sources than signals, it is a difficult task, but still possible.

• Why use sound source separation?
  – Filtering by EQ affects all recorded signals as discovered by Martin and Emerick in 1977. We can now attempt to isolate crowd directly
Project Timeline

- 2009 started research into source separation
- 2011 Capitol discover original 3-track recordings and send to Abbey Road
- Approached by Giles Martin to see if I could do anything to improve the audio
- Source Separation succeeds by assuming crowd is signal and not noise
- Early 2012, re-mixes approved by ”the board”
- 2016, ‘Live at the Hollywood Bowl’ Album released, coinciding with the release of the film *The Beatles: Eight Days a Week*
Sound Source Separation

• 3 Main types of Sources
  – Vocals
  – Pitched Instruments
  – Percussion/Drums
  – No one algorithm is optimal for all these sources - use different techniques
  – Prior knowledge of the sources should be used where possible (some multitracks are available)
Results
Considerations for re-mixing

• Use filters where the separated sources sum back to give the original signal – No information lost
• Any artefacts due to separation will then be masked – our brains re-integrate the parts
• Separation does not have to be perfect, just good enough to impart directionality.
Considerations for re-mixing

- However, if panned too far re-integration can break down.
- No phase problems between channels due to the type of filters used.
- Source drift due to incorrect separation can be a problem – ameliorate by choice of pan position – Sources placed in original positions.
Source Separation Techniques

• Drums/Percussion
  – Highly localised in time, broadband spectra and repetitive
  – Many approaches – Decomposition into parts (NMF), dictionary based methods, heuristics-based (drums –vertical lines, pitched instruments horizontal)

• Vocals/Lead Instruments
  – Decomposition into parts (NMF), melody tracking and filtering, heuristics-based (backing track is more repetitive than the main melody)

• Pitched Instruments
  – Again NMF, Additive Synthesis based decompositions, Source-Filter models

• User Assisted Algorithms
  – Use prior information to aid the separation process (Knowledge of melody, existence of backing tracks, chord progressions and so on)
Source Separation Techniques

• Different methods work better on different types of material, it varies from song to song
• Pick the techniques based on the song
• Order of separation can make a big difference in some cases

• Whatever sounds best
Audio Examples

• SLY – Original Stereo
• SLY – Original Track 1
• SLY – Extracted Drums
• SLY – Extracted Bass
• SLY – Extracted Crowd