Insights into the Nature of Drum Machine Sounds

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Introduction

- Programmable drum machines date back to early 70s.
- Popular drum machines have since been used in countless recordings and sounds appear in hit records such as Prince's Purple Rain.
- To our knowledge, this research is the first audio feature analysis on a set of drum machine samples of this size.
- Utilizes techniques from the growing field of Music Information Retrieval (MIR).
- Fits into a larger body of work being done in the development of new pedagogical methods for sound recording and music production, as well as the field of Intelligent Music Production (IMP).

Research Objectives and Questions

- Use an available MIR toolkit to programmatically run feature extraction algorithms on a set kick and snare drum samples.
- Do distinguishing low-level audio features exist between different types of drum samples? Between samples from different drum machines?
- What are the most important low-level features for describing variation between kick and snare drum samples?

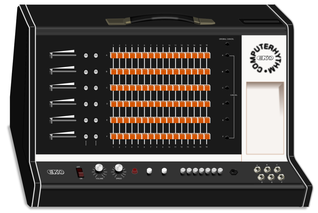
Methodology

- 4230 kick and snare drum samples collected from a number of free and paid-for online sample packs: represents over 250 different drum machines sources.
- Pre-processing applied to entire collection: This included mixing to mono, resampling to 44.1kHz, normalizing amplitude, and removing silence.
- Automated feature extraction, implemented in the Python programming language, using the Essentia[1] MIR toolkit to create an 8-dimension feature vector for each sample:
  - Amplitude: **RMS**, **Loudness**
  - Temporal: **Temporal Centroid (TC)**
  - Spectral Centroid: Calculated over three different time segments: **SC** Entire sample, **SC1** 1024 samples from onset, **SC2** 1024 samples from TC
  - Other Spectral Features: **Spectral Kurtosis**, **Pitch Salience**
- Outliers detected and removed based on distance from three nearest neighbors.
- Primary Component Analysis (PCA), a technique that has proven useful within the field (Wilson & Fazenda 2016), was computed on the 8-dimension feature space.
- Outlier detection and PCA calculations completed using the SciKit-Learn[2] Python Library.

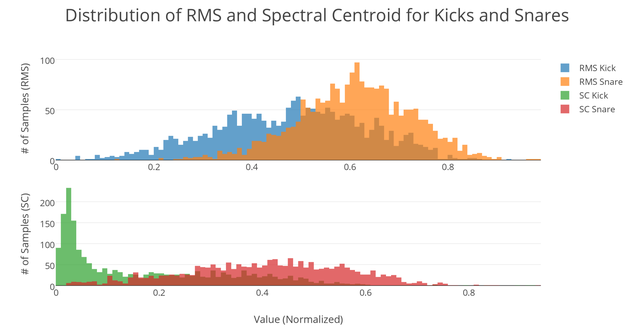
[1] http://essentia.upf.edu/
[2] http://scikit-learn.org/stable/

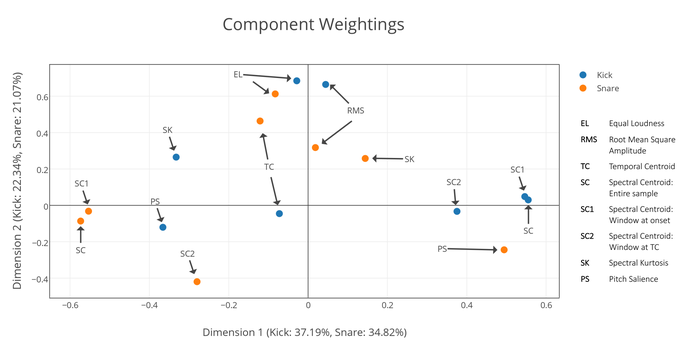
Linn LM-1 Drum Computer, released early 80s

Roland TR-808, released early 80s as a competitor to Linn. Initially a commercial failure. Has been used on more hit records than any machine



Eko ComputeRhythm, released 1972





Results

- Histogram plots of individual features show some basic similarities and differences between kicks and snares:
  - Both snare and kick drum sounds have a normal distribution of RMS amplitude.
  - Not surprisingly, kick drum sounds on average have a much lower spectral centroid than snare drums
- PCA reveals new dimensions of greatest variation, which are linear combinations of the original 8 dimensional feature space.
- The component weightings of PCA dimensions give insight into how the features relate to the variation found between samples.
- RMS, Loudness and Spectral Centroid are identified as containing the most variance for both kicks and snare.

Discussion

- This is initial work looking at feature extraction on an extensive selection of kick and snare drum samples from a large number of drum machines.
- The differences found between kick and snare samples in the histogram plots, as well as the dimensions of variance determined through PCA suggest that the features selected are important in the classification of kick and snare drum sounds.
- Future work in the area of drum sample analysis may include running a larger set of feature extraction algorithms on this sample to determine whether there are other known MIR audio features that may be useful.
- This work may also be useful for IMP tasks such automatic drum sample recommendation or sample classification.

References

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