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RHYTHM MAP: Extraction of Unit Rhythmic Patterns and Analysis of Rhythmic Structure from Music Acoustic Signals

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Abstract

Goal:

To extract constituent percussive rhythm unit patterns in a music piece given as acoustic signals and to analyze the music structure with a map of constituent rhythmic patterns.

Method:

We propose a mathematical method based on On-pass DP algorithm and k-means clustering to extract unit percussive rhythmic patterns. As the result of identifying and localizing the unit patterns in the entire piece, we obtained a clear music structure in the form of a map of rhythmic patterns.

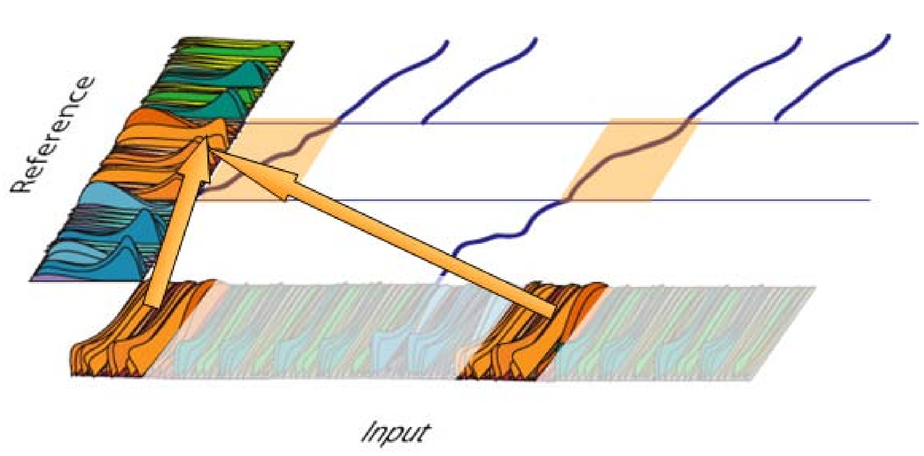
Our Approach

4 problems

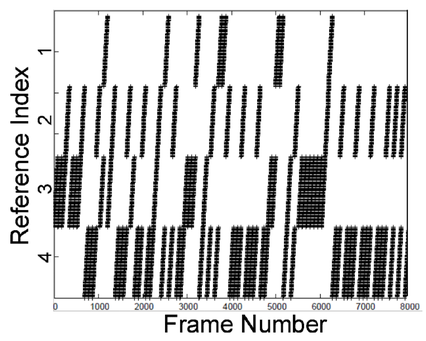
(i) The input acoustic signals may contain not only percussive sounds but also harmonic sounds.
(ii) There may be fluctuations in tempo and in pattern itself made by the performer.
(iii) Unit segmentation is unknown.
(iv) Unit rhythmic patterns themselves are unknown.

Algorithm

(i) Emphasizing Percussive Components (to solve problem (i)).
(ii) Rhythmic Structure Analysis by One-pass DP Algorithm.
If the true set of unit rhythmic patterns is given as templates, One-pass DP algorithm divides a music piece into segments each optimally corresponding to unit patterns (to solve problem(ii) and (iii)).
(iii) Updating Unit Patterns by *k*-means Clustering.
Central patterns of each clusters are calculated and are set as new referencec patterns (to solve problem(iv)).
(iv) Itaration (ii) and (iii) until the dissimilarity cost calculated in One-pass DP algorithm converges.



Rhythm Map



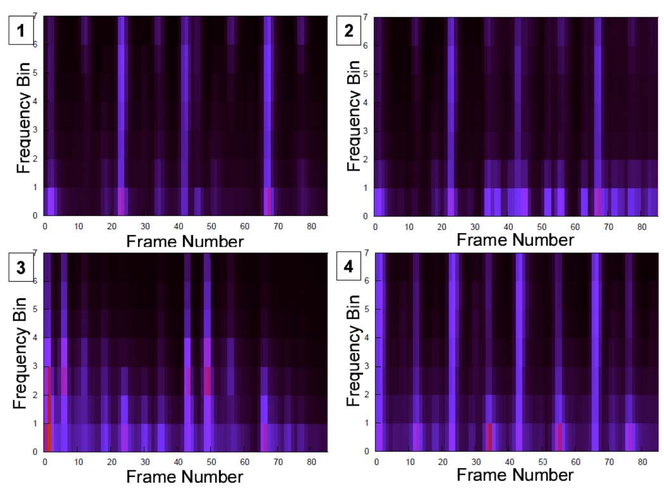
Initial haphazard alignment

Converge

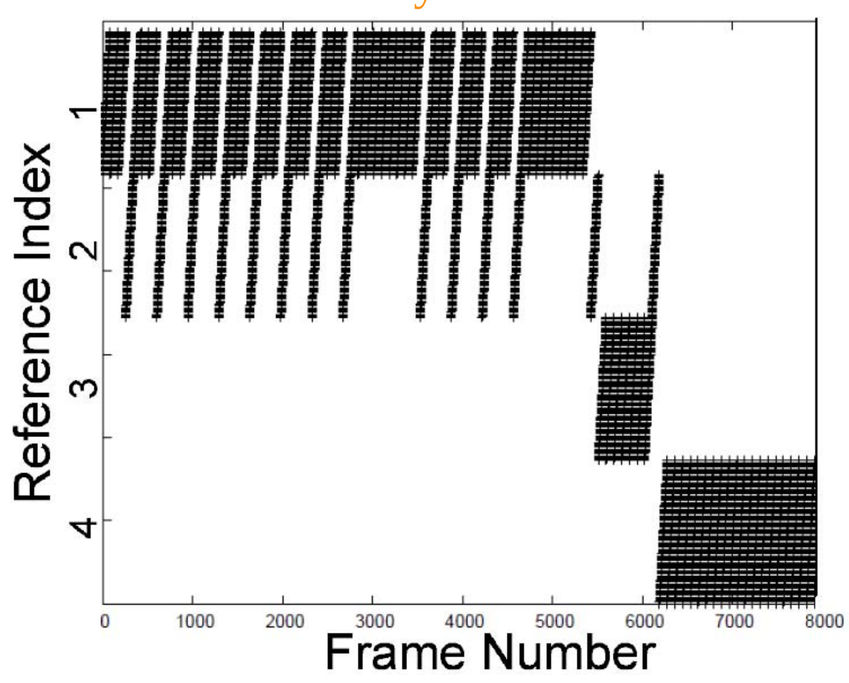
Interval

Fundamental rhythm

Climax



4 Rhythmic Patterns' Spectrograms



"Rhythm Map" of a dance music