Introduction to Audio Content Analysis

Module 6.4: Rhythm Descriptors

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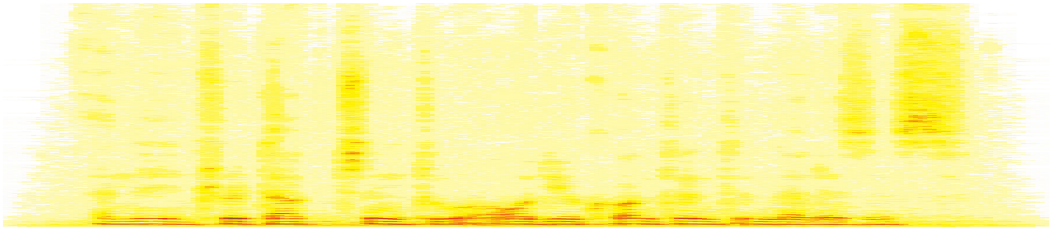

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introduction

overview

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corresponding textbook section

Chapter 6 — Temporal Analysis: pp. 133–135

- **lecture content**
  - introduction of the beat histogram
  - low level features used to describe rhythmic properties

- **learning objectives**
  - explain the terms beat histogram and beat spectrum and how they related to each other
  - describe two low level features derived from the beat spectrum and discuss their musical meaning and limits

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rhythm description

problem statement

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- challenges for extracting rhythm descriptors from an audio signal
  - onset, beat, and downbeat detection error prone
  - varying tempo

$\Rightarrow$ need for robust low level descriptors

beat histogram

introduction

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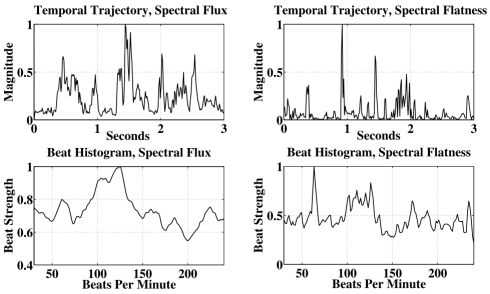
beat spectrum/**beat histogram**: compact representation of periodicities

1. compute novelty function
   - time domain features: envelope, rms
   - spectral differences: flux, ...
   - any other feature
2. compute transform
   - (resonance) filter bank
   - magnitude spectrum
   - pick onsets
     → compute histogram of Inter-Onset-Intervals (IOI histogram)



graph from[1]

[1] A. Lykartsis and A. Lerch, "Rhythm Features for Musical Genre Classification Using Multiple Novelty Functions," in *Proceedings of the International Conference on Digital Audio Effects (DAFX)*, Trondheim, Norway, 2015.

beat histogram

feature examples

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- **statistical features**
  - mean, centroid, standard deviation, kurtosis, ...
- **peak features**
  - value and position of absolute max
  - ratio (value and position) of strongest and 2nd strongest peaks
- **other features**
  - flatness, crest, high frequency content, MFCCs (??),...
  - features from ACF of beat histogram

beat histogram

feature examples

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beat histogram

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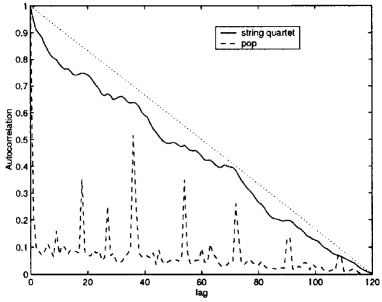

plot from[2]

[2] J. J. Burred and A. Lerch, "Hierarchical Automatic Audio Signal Classification," *Journal of the audio engineering society (jaes)*, vol. 52, no. 7/8, pp. 724–739, 2004.

rhythm description

general questions

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- should a rhythm description be tempo dependent or not?
- what role does microtiming play?
- should rhythm descriptors be normalized to bar length?
- what rhythms are perceptually similar?

summary

lecture content

- **beat histogram or spectrum**
  - some frequency domain representation of onsets
  - usually characterizing the periodicities
- **beat histogram features**
  - low level features characterizing the beat spectrum
  - often statistical descriptors
  - easy to extract but limited meaning