The Constant-Q Transform Spectral Envelope Coefficients: a musically-adapted timbre feature

I. Scope

TIMBRE is the attribute of sound which makes, for example, two musical instruments playing the same note sound different. It is generally associated with the spectral (but also temporal) envelope and is typically assumed to be independent from the pitch (but also the loudness) of the sound [1]. This article will show how to derive a timbre feature ...

The feature will be derived from the constant-Q transform (CQT), a log-scaled frequency transform better adapted to musical data [2], [3].

The CQT-SEC will compare with the mel-frequency cepstral coefficients (MFCC), on the NSynth dataset, a publicly-available dataset of musical notes [4].

II. Relevance

III. Prerequisites

Basic knowledge of audio signal processing and music information retrieval is required to understand this article, in particular, concepts such as the Fourier transform, convolution, spectral envelope, pitch, CQT, and MFCC.

IV. Problem Statement

V. Solution

A. Observations

Assumption: A log-spectrum, such as the CQT-spectrum, can be represented as the convolution of a pitch-invariant log-specrtal envelope component (= timbre) and a envelope-normalized pitch component.

- A pitch change in the audio translates to a linear shift in the log-spectrum.
- The Fourier transform (FT) of a convolution of two functions is equal to the point-wise product of their FTs (convolution theorem).
- The magnitude FT is shift-invariant.

VI. Numerical Example

VII. What We Have Learned

We have shown that ...

VIII. Author

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References

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