CIRCULAR PITCH SPACE BASED CHORD ANALYSIS

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ABSTRACT

In this paper we present a chord finding system that is based on circular pitch spaces (CPS) introduced by Gatzsche et al. in 2008 [1] and Hidden Markov Models (HMM). The classifier HMM works with the output of the CPS that is directly calculated from the chromagram (Figure 1). The CPS displays harmonic events clearer than the common used chromagram. Therefore it is appropriate for chord analysis. Another circular pitch space – introduced in 2006 by Harte, Sandler and Gasser [2] – will be used for comparison. Several papers showed that the CPS_HSG is also useful for chord detection.

1. INTRODUCTION

Chord Analysis is an important task for music information retrieval (MIR). If the chords or the chord sequence of a musical piece are known you can accompany the song, you are able to compare musical pieces, you can search for different music or you can analyze the structure of it for higher order classification, e.g. the genre.

2. RELATED WORK

Harte, Sandler and Gasser [2] introduced in 2006 a 6-D tonal space (CPS_HSG) made of three centroid vectors that are developed from the so called *Tonnetz* or also *Harmonic Network*. They used this tonal space for harmonic change detection. In [3], [4] Lee and Slaney used the CPS_HSG for chord transcription, key extraction and genre classification.

Gatzsche et al. [1] gave an overview on different tonal pitch spaces and introduced a new model (Symmetry Model - SYM) that is based on centroid vectors, similar to [2], but the centroids of this model are calculated in different key related circles giving the ability to analyze harmonic events in different keys in parallel.

Hidden Markov Models had been used for many research purposes. In 2003 Sheh and Ellis [5] trained a HMM for chord segmentation and also recognition. Bello and Pickens [6] used HMM in 2005 for mid-level representation of music and similarity analysis. In 2007 Papadopoulos and Peeters [7] made a large-scale study with over 100 Beatles-Songs. For an Introduction to HMM refer to Rabiner [8].

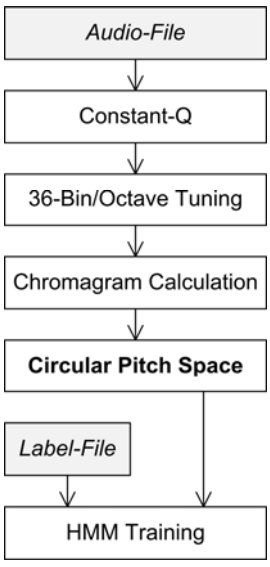

Figure 1. HMM training with a circular pitch space.

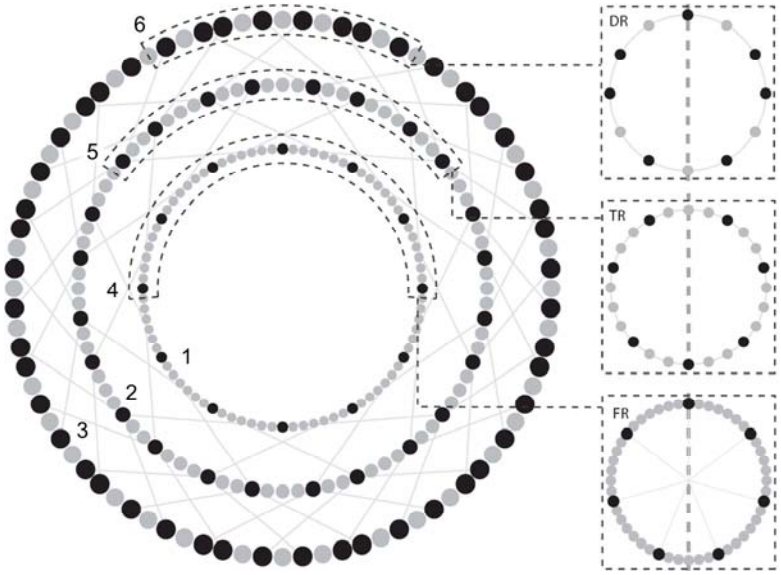

Figure 2. Circular pitch space system, from [1].

3. CIRCULAR PITCH SPACE

Figure 2 displays the CPS system (SYM) used here, refer to Gatzsche et al. [1]. The circle labeled with '1' is the *circle of fifths* (F). This circle is the starting point of the SYM and the circles '2' and '3' are calculated from F by first doubling each tone (the black dots) one octave up and down and second by doubling each tone six halftones up and down. The result are two new circles: '2' The *key spanning circle of thirds* (T) – including all major and minor triads; '3' The *key spanning circle of diatonic scales* (D) – including all twelve different diatonic scales. The F, T and D are used to extract different sets of tones (seven neighbored tones belong to a key). In figure 2 on the right side there are the so called *key related circles* of one certain key: '4' The *key related circle of fifths* (FR); '5' The *key related circle of thirds* (TR); '6' The *key related diatonic circle.*

4. THE MIREX ALGORITHM

Comparisons between CPS_HSG and CPS showed that the two models have nearly the same performance depending on the selected set of training and test songs. Therefore we decided to use the Symmetry Model as basis for our chord analysis system: We selected the twelve FR and twelve TR, one circle for each key. The chroma vector of every frame is mapped to these CPS by calculating one centroid in every circle which results in a 48-D feature vector. Based on the energy distribution in the 48-D space, several processing steps are applied. The outcome of these step is finally fed to an HMM. The results have been made on a frame wise basis. The algorithm can be improved by applying beat-tracking or harmonic change information. This leads to an event based chord analysis.

5. REFERENCES

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