A MULTIPATH ARCHITECTURE WITH ARBITRATOR FOR BEAT TRACKER

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ABSTRACT

This study proposed multipath architecture for a dynamic (DP) programming approach to solve the problem of the uncertain starting points in dynamic programming. The starting points of those paths are selected from the local maximum of onset detection function and beginning interval of excerpts. We also utilize the tempi of tempo estimation to give the guidance of the beat tracking.

Index Terms – Weighting Function, Cost for DP

1. INTRODUCTION

Rhythmic information is the essential element in music. The prominent features of rhythm are beat position and tempo which comprise the basic characteristic of music. Although the sense of beat sometimes is obvious for human being, the exact estimation is still challenging task when especially the music has time-varying tempo.

Conventional beat tracking schemes [1] handle certain music contents with stable tempo well. Under the related stable-tempo assumptions, most approaches of beat tracking are accomplished by two phases. In the first phase, the onset detection of music along time, called onset detection function, onset strength and *novelty curve*, is obtained to indicate the possible positions of note onsets. In the following phase, the quasi-periodic patterns in novelty curve are analyzed to discover the possible tempo value and the corresponding beat positions. Usually in the deduction process, tempo is assumed to be stable throughout the whole piece of music. However, the above-mentioned assumptions do not hold true universally, especially for music of classical and jazz. Music of these genres often has significant tempo variations, making it unreasonable to make the assumption of stable tempo. In our work, we break the assumption of stable tempo. Therefore, we generate the tempogram from the novelty curve, which the tempo information is embedded. Then we apply dynamic programming (DP) to the tempogram to derive the so-called *tempo curve*, which represents the most likely tempo at each time frame which is time-varying.

There are several important previous studies that attempted to deal with time-varying meters. Klapuri et al. [2] used the bandwise time-frequency method to obtain accentuation information, then used comb filter resonators and probabilistic models to estimate pulse width and phase of different music meters, including tatum, tactus, and measurement. Davies and Plumbley [3] proposed the use of complex spectral difference onset function to obtain middle level representation. Their algorithm employs two-state switching model, including general state and context-dependent state, to obtain final beat positions. Groshe and Muller [4] used the novelty curve to generate predominant local pulse (PLP) for estimating time-varying tempos. G. Peeters and H. Papadopoulos [5] propose a probabilistic framework for estimation of beat and downbeat simultaneously given information of tempo and meter. The probabilistic model is based on HMM (Hidden Markov Model) which has beat-times and their associated beat-position-inside-a-bar (BPIB) as the hidden states. The model is based on non-casual signal observations of the local bar which the beat is located in. This provides the work with an inherent local optimization of the probabilities (an adaptation to the local properties of the signal).

In this study, we follow the three-phase framework [6] of beat tracking by developing a two-fold DP approach for robust beat tracking. In the first DP, the tempogram curve is adaptive to the tempi of tempo estimation [7]. In the second DP, staring points of the multipath are selected with the interval of the beginning of excerpts. Each path produce a beat sequence, and all of the beat sequences are arbitrated to determine the final result of beat tracking. The following section describes the flowchart of the system and illustrates the multipath of the dynamic programming of beat tracking.
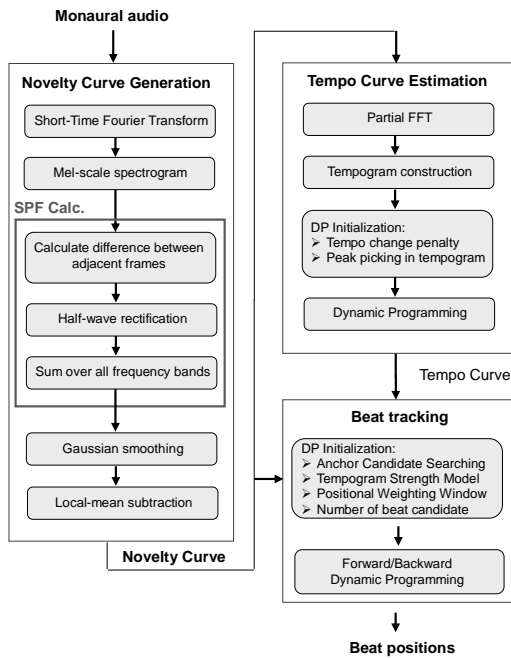
Figure 1 Flowchart of the beat tracking system

2. THE MULTIPATH ARCHITECURE

The reference beat tracking system is shown in Figure 1. The first block computes the novelty curve, while the second block generates the tempogram and estimates the tempo curve from the novelty curve [8]. The third block of beat tracking setups a DP cost model to count the strength of novelty curve and relative position window weighting to previous beat position, which illustrated in the subsection.

2.1 Starting Point Selection and the Arbitrator

When we select the starting points for the paths of beat tracking, we find the intervals of few seconds from the beginning of excerpts. Each starting points stimulate a unidirectional DP beat tracking path, which comprised of the estimated beat positions from the specified points, tracks the same tempo curves. Figure 2 show the selection of the starting points and the direction of the DP beat tracking.

After the beat tracking paths had finished, we conduct mutual similarity check on those beat sequence and select the most related path. The similarity test is alike to the work of mean mutual agreement (MMA) [9].

3. REFERENCES

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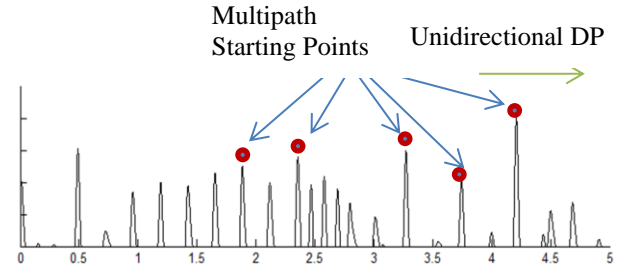

Figure 2 Starting points of DP beak tracker

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