

Reconsidering the method of evaluation for tempo estimation

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ABSTRACT

Tempo estimation for musical audio has been intensively conducted in the field of MIR (Musical Information Retrieval). Most popular methods for tempo estimation use frequency analysis for envelope of the audio to obtain tempo from power spectrum of the Fourier transform of the envelope. A method is implemented to estimate local tempo for the audio of tempo-varied music. To estimate it, the authors' former study employs conventional Zero-padding, in order to obtain high resolution of tempo estimation. The resultant accuracy of tempo estimation is, however, not so high (37.6%) compared to their global tempo estimation's result (83%). Possible reason of it is the difficulty to have appropriate length of time window, since the desired length of the window depends on the cycle of beats. Thus, this report proposes a novel method for local tempo estimation for tempo-varied musical audio. The authors propose to use a certain set of time window length for the musical audio, to obtain frequencies from power spectrum, and then estimate tempo by integrating the results of the Fourier analysis for the signals from different time windows.

Keywords: Tempo estimation, FFT, FFT window, Beat

1. BACKGROUND

Tempo is an index of the speed in music calculated by intervals between two beats, which usually have large acoustic energy in musical signal. The envelope of the musical signal includes large energy corresponding to the musical beats. Conventional methods [1,2] for the estimation of tempo utilize the frequency analysis for the envelope. The frequency analysis is possible to analyze periodic feature of current waveform and describing it as constant periodic signal. However, if the waveform is aperiodic signal is analyzed, the resultant power spectrum is complex due to the aperiodic feature of signal. The beats of musical audio of tempo-varied music appears aperiodically. Thus, tempo estimation for tempo-varied music is said as difficult to obtain correct tempi.

2. MANUSCRIPT FORMAT

2.1 Aims

This report proposes a novel method for local tempo estimation for tempo varied musical audio.

2.2 Theory

Including several beats on tempo varied music in time window on frequency analysis may provide a difficult result. Thus, designing a time window that includes only two distinct beats is desirable. On other hand, estimation of the length of time window means the estimation of the tempo so that it is not be conducted easily. At this point, considering window length, used by one pattern window length isn't suitable method. An alternative to cope with the problem is to utilize a certain set of length of time window.

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2.3 Method

This report tries to employ two length of time window for 1sec and 2sec, to obtain frequencies from power spectrum and then estimate tempo by integrating the results of the Fourier analysis for the signals from different time windows. Integrating method compare to two calculated by two windows of rate is 2:1 (1sec and 2sec), and employ having high power.

2.4 Results

Figure 1 shows the result of tempo estimation by two type of time windows for the signal with aperiodic click sounds. Figure 2 shows the result of tempo estimation by proposed method, by integrating the results of the two windows. Correct tempo is represented as a stepwise function. As the figures shows the effectivity of use of the two windows to estimate tempo for interval varied click sound.

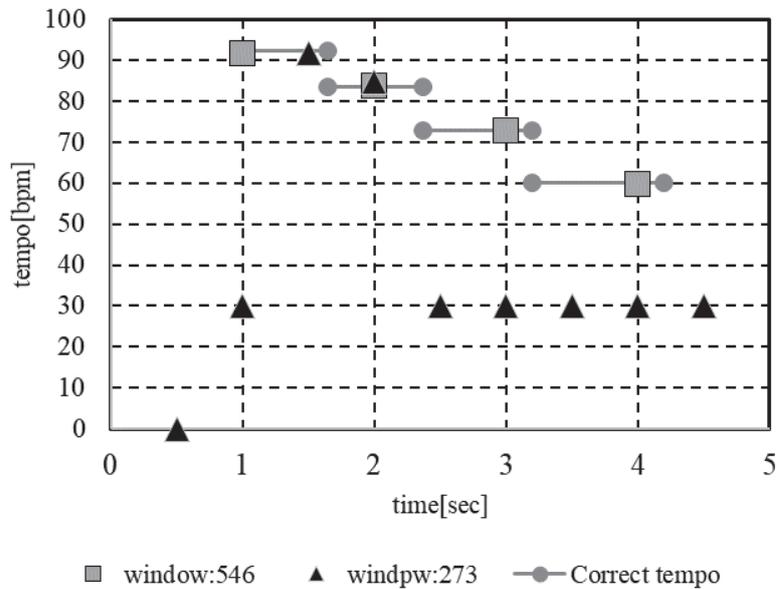


Figure 1 Result of tempo estimation by two type of time window

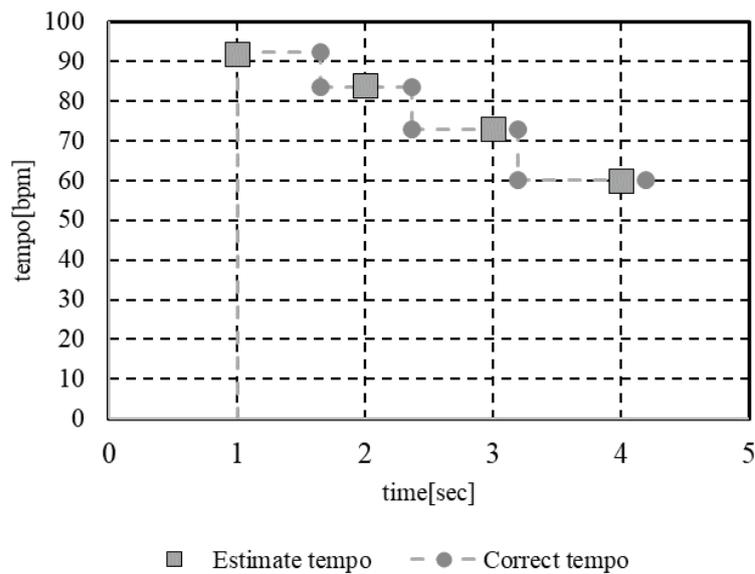


Figure 2 Result of tempo estimation by proposed method

3. CONCLUSIONS

Here we newly proposed a method to employ several windows on the FFT, to preserve both time resolution and frequency (at here, the bpm) resolution. Preliminary experiment was conducted to examine the effectiveness of the proposed method. The efficiency of the method was confirmed. At future work, we discuss the number of windows and the length on each window, so that the precision of tempo estimation will be better than current result.

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