ONLINE MUSIC PERFORMANCE TRACKING USING PARALLEL DYNAMIC TIME WARPING (PDTW)



I-Chieh Wei and Li Su Institute of Information Science, Academia Sinica, Taiwan





- In each music performance, a music piece can be played differently with various speeds, loudness, and timber.
- A fast, reliable online alignment algorithm is the key component to enable real-time interaction during

PDTW system performance evaluation

- Alignment accuracy (ACC) mainly depends on thread numbers K and DTW window size Mdtw
- With more *threads* running DTW simultaneously, *alignment error* is significantly reduced.
- Reliable score position can be inferred with multiple short DTW segments.

music performance.

- Problem: How to synchronize time information?
 - → "predict" current time instance given the MIDI score and the live audio.

The tracking process pipeline





Small DTW hop size the means low system response time (low latency), high alignment accuracy but requires more computation resource.

Alignment ACC. vs. CPU usage	
100	9
→ CPU Usage	→ Mean Error

Parallel Dynamic Time Warping (PDTW)

- Multiple time-shifted input series $(A_1 A_N)$ for alignment.
- Unleash multi-core computation power.
- Simple, fast and reliable alignment algorithm.

PDTW alignment on multiple CPU





Application in live performance

Alignment ACC. vs. DTW hop size

100-

- PDTW has been applied in an enriched music performance in the National Concert Hall of Taiwan.
- In the concert, two music pieces were performed with the visualization: *Mozart's Divertimento, K. 136*, and Schubert's Arpeggione Sonata, D. 821.
- Three different visual designs of musical concepts (piano-rolls, instrument activation, and the tonnetz representation) are projected on stage.



Enriched musical concert using PDTW for real-time audio/score alignment

