

Travaux ECL LIRIS

MusicDiscover

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Outline

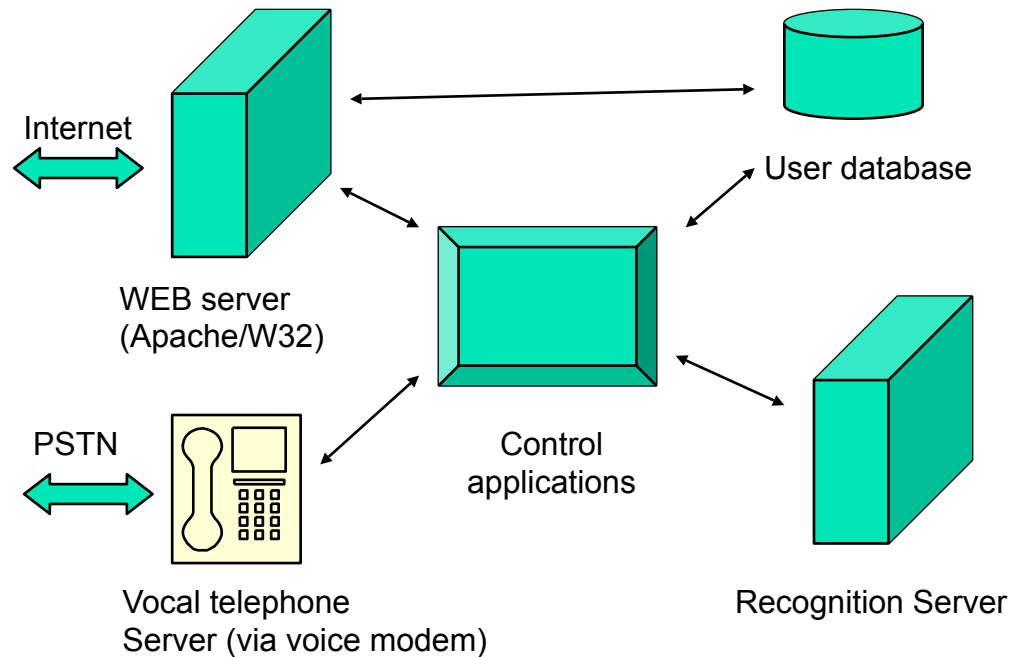
- Musical title recognition
- Similarity measures
 - Ideas
 - Details
 - Application and results
 - Automatic genre classification
 - Similarity search and playlist composition
 - Conclusion
- Other works



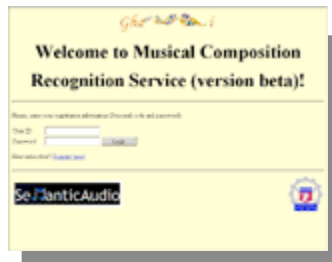
Musical Title Recognition System

Introduction

- Extraction of fingerprint
- Realization in the form of web service (recognition by telephone)



Web service prototype



Login page



Recognition history page



Associated playlist page



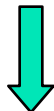
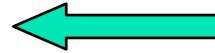
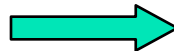
New user registration page



MP3/WAV upload page



Demo file download





Musical Similarity Measures

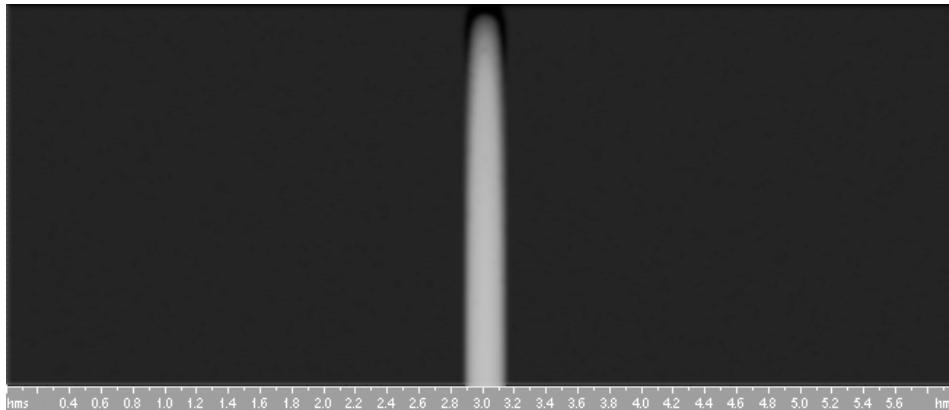


Introduction

- Tempo, rhythm \neq rhythmical image
- Tempo in BMP is not interesting
- Perception of tempo may have an error of 2
- Existing techniques
 - energy envelop
 - signal autocorrelation
 - mathematical models-resonators
 - image treatment techniques

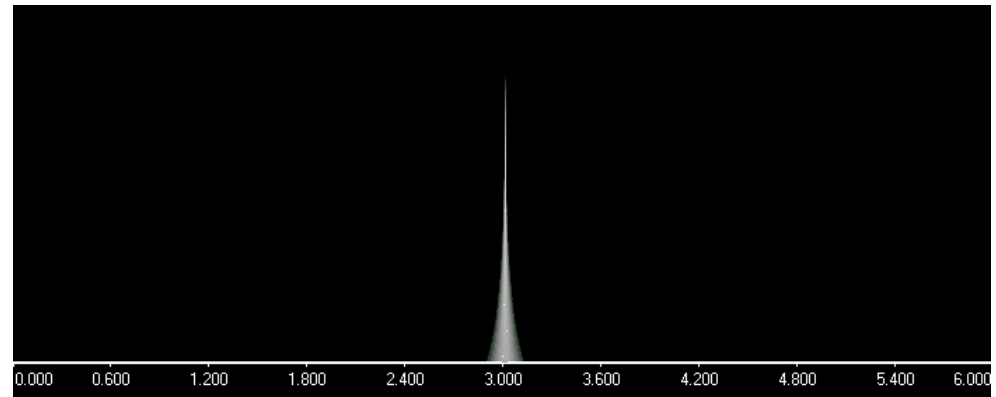
FFT vs. Wavelets?

- Delta-impulse



FFT

Wavelet



Wavelets used

- “Wavelet-kind” function

$$\psi(x, k) = H_{x, m(k)} e^{jw(k)x};$$

$$m(k) = L_{\max} K1 \times e^{-\frac{K2(k+1)}{N}}; \quad w(k) = \frac{2}{L_{\max}} e^{\log\left(\frac{L_{\max}}{L_{\min}}\right) \frac{k+1}{N}}$$

where

k – number of wavelet

K1, K2 – scale choice factor (0.8 and 2.8)

Lmax/min – maximum/minimum scale of wavelet (6000 and 14)

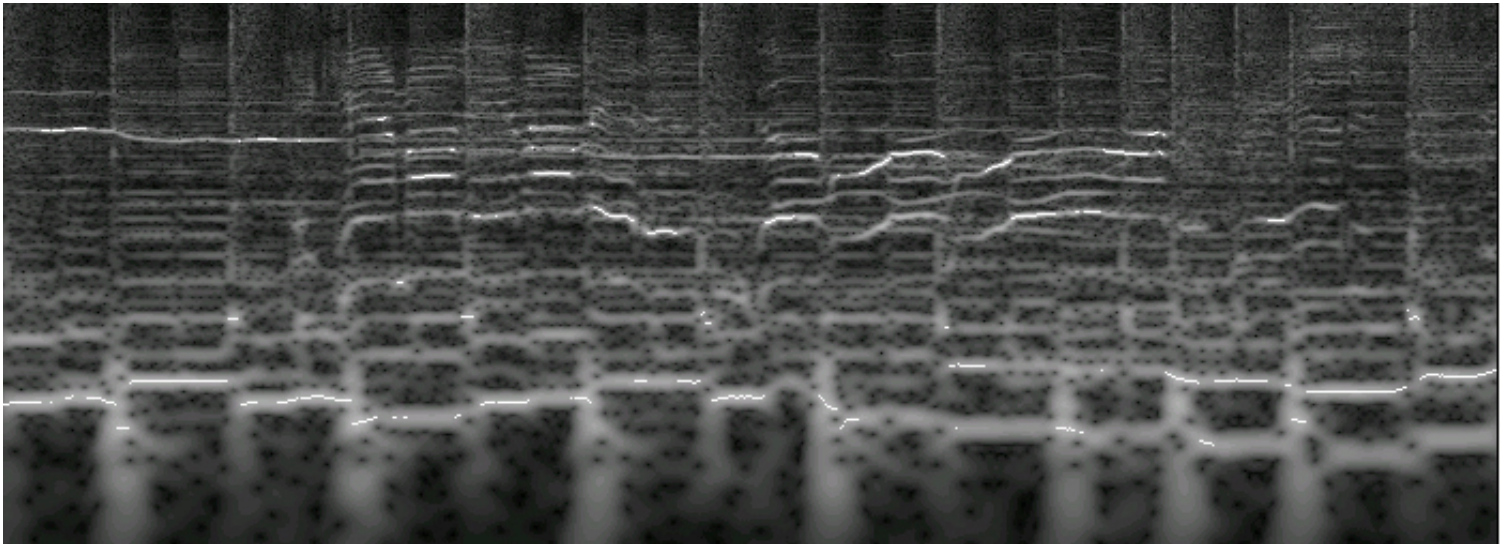
N – total number of wavelets used (256)

H(x, m) – function of Hamming window



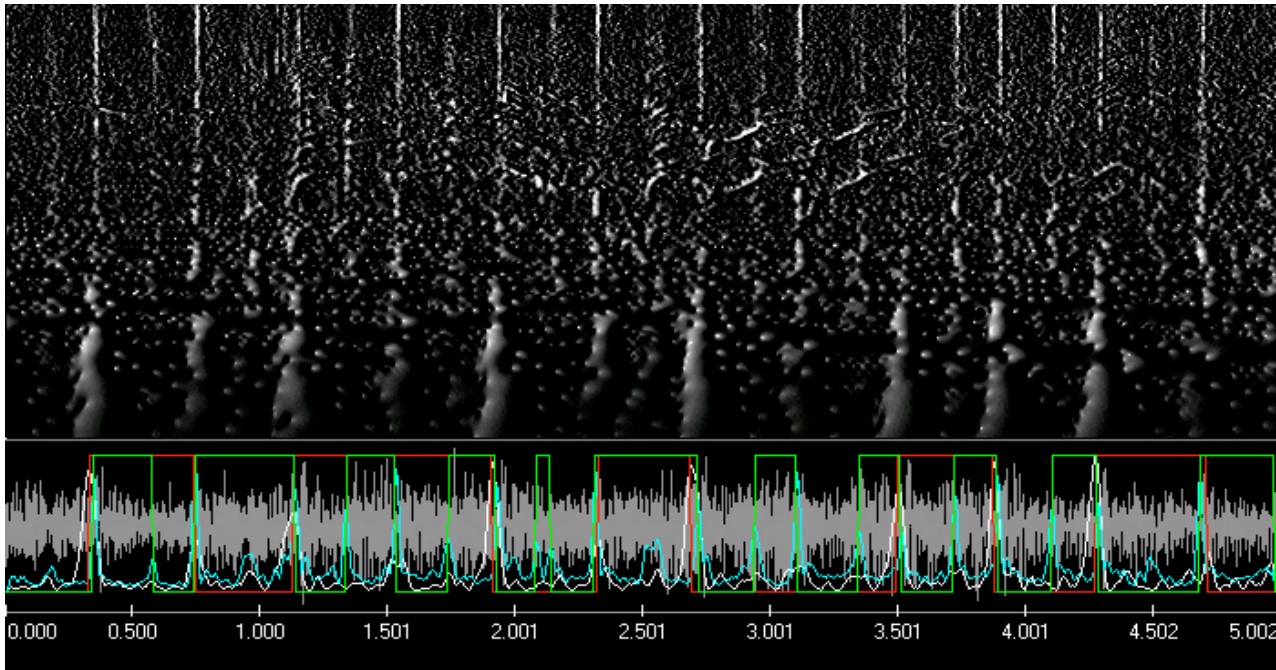
Wavelet image

- Example of CWT representation of musical excerpt
 - strongly visible vertical structures
 - melody and voice lines are enough clear unlike FFT



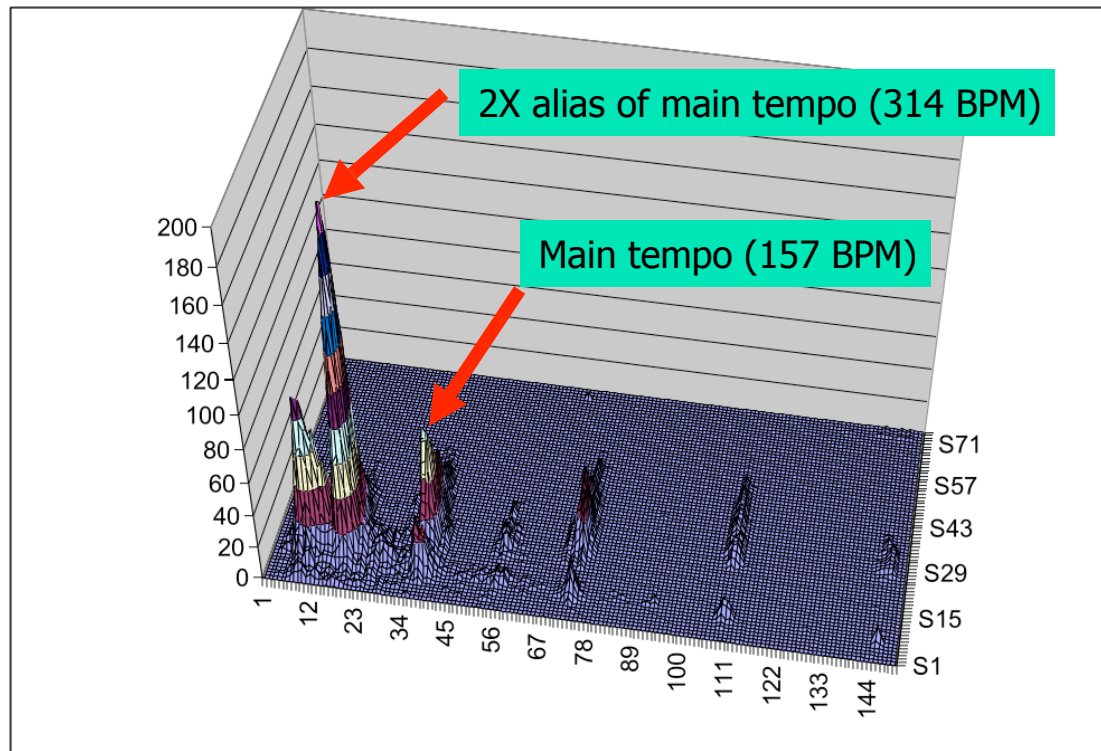
After enhancement

- Application of image treatment techniques
- Beat probability curve



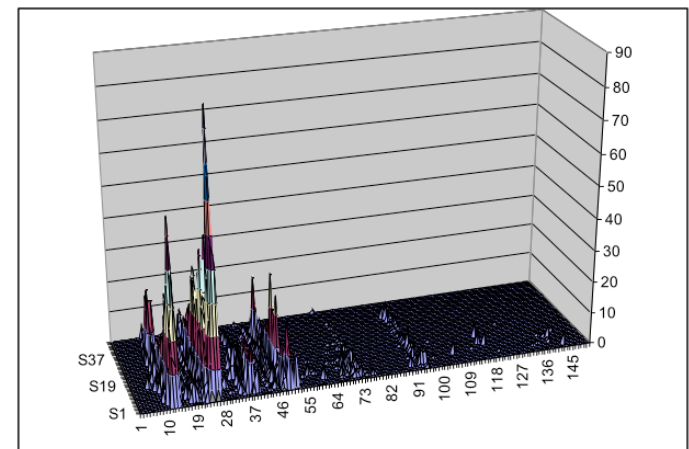
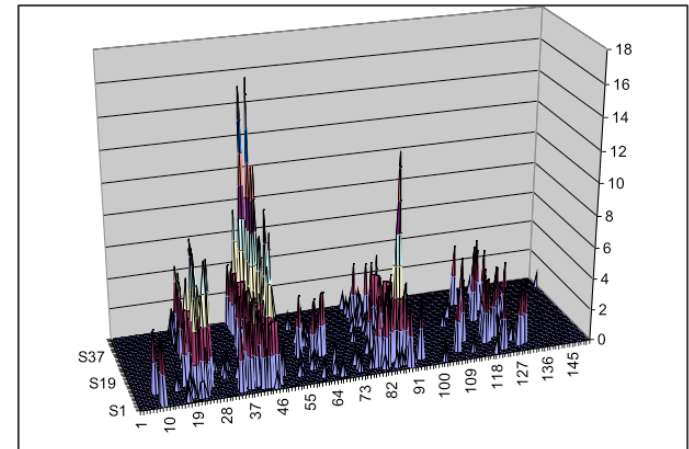
New beat histogram

- A 3-D beat histogram
 - axis X – beat period
 - axis Y – amplitude of a beat (defined as threshold in peak detection algorithm)



New beat histogram

- Can be used for
 - Genre classification
 - Tempo estimation
 - Feature vector for similarity search



Distance measure

- Needed for similarity search

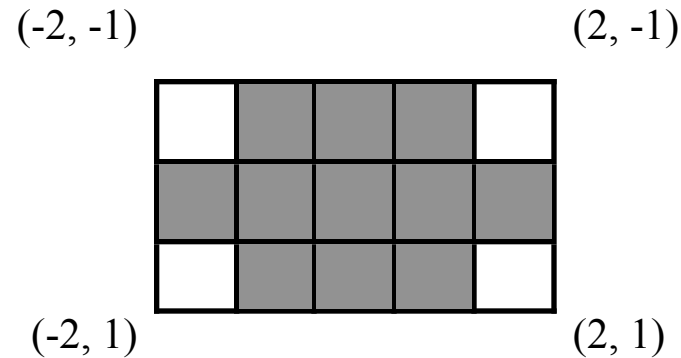
$$Dist_{H1,H2} = \sum_{x=1,y=1}^{N,M} \frac{1}{2} \left(\min_R \left(|H1_{x,y} - H2_{(x,y)+R}| \right) + \min_R \left(|H1_{(x,y)+R} - H2_{x,y}| \right) \right)$$

where

$H1, H2$ – beat histograms to compare

N, M – beat histogram size

R – an area of the following form



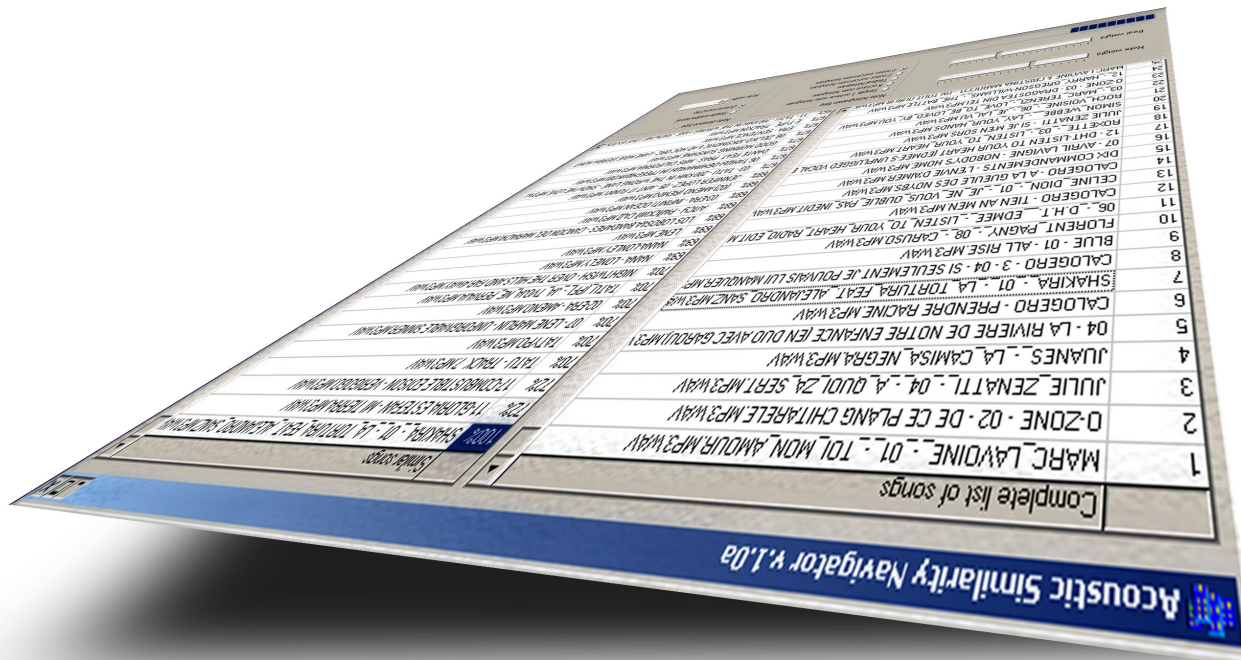


Applications

- Search by similarity
 - Subjective evaluation
 - Objective evaluation
- Genre classification

Software

Music navigator (automatic playlist composition)





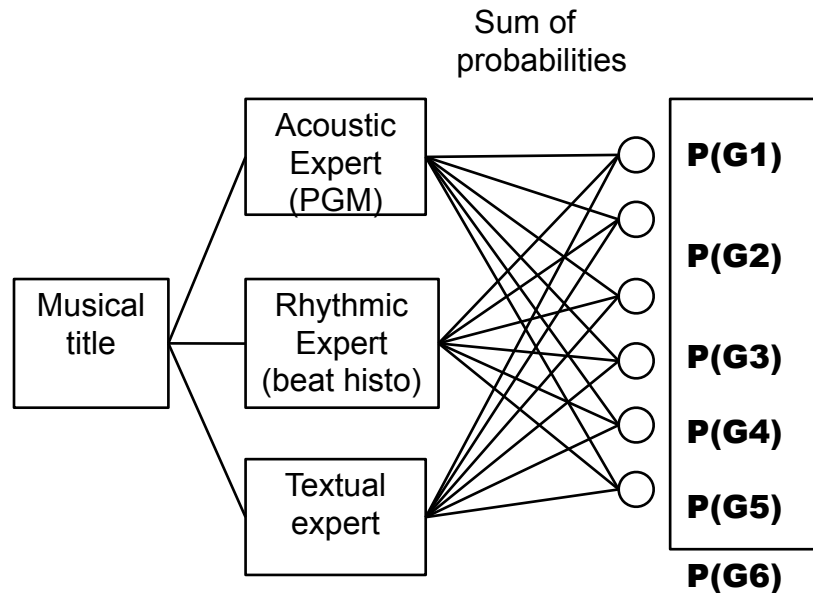
Search by similarity

- A database with 1000 various musical titles
- 8 songs with multiple (from 2 to 6) reinterpretations injected
- Composition of playlists by acoustic similarity
- Consideration of positions of similar titles

Original music composition	Number of interpretations	Positions of similar titles in playlists
Chi Mai	3	(1), 2, 3
Listen To Your Heart	3	(1), 3, 12
Wish You Were Here	2	(1), 2
Not Gonna Get Us	2	(1), 2
All the Things She Said	3	(1), 2, 3
30 minutes	2	(1), 2
Cry Me a River (ver. 1)	5	(1), 2, 3, 4, 6
Cry Me a River (ver. 2)	6	(1), 2, 4, 7, 8, -1

Genre classification

- Database of 1873 titles from 822 artists
- **6 genres**
- Multi-expert architecture





Genre classification

Average 70.3% classification rate

	Classic	Danse	Jazz	Metal	Rap	Rock
Classic	88	0	14	7	2	7
Danse	2	68	3	5	6	3
Jazz	5	8	67	1	8	12
Metal	3	9	3	68	6	13
Rap	1	7	5	3	72	6
Rock	1	8	8	16	6	59



Conclusion

- Tempo in BPM itself is not important
 - Still some evaluation was made in tempo estimation (Compared to ISMIR2004 tempo contest)
 - 71% (with 2x tempos) / 46%
- A good rhythmical image representation was found
 - Experiments in similarity search showed acceptable results – perceptive and objective similarity of musical compositions



Other Works



Other works

- Emotion classification
 - Hierarchical emotion classification
 - Work underway by Zhongzhe Xiao, Emmanuel Dellandréa