Computational analysis of rhythmic aspects in Makam music of Turkey

André Holzapfel

MTG, Universitat Pompeu Fabra, Spain
hannover@csd.uoc.gr

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1 Rhythm Workshop

2 Fundamental Approaches

3 Proposed Tasks
   - Segmentation
   - Usul recognition
   - Fundamental pulse recognition
   - Onset Detection
   - Usul recognition
   - Usul tracking/annotation

4 Conclusions
Outline

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Some examples for meter in Turkish makam music

1. Şarkı: Usul Düyek, Makam Kürdilihicazkar
2. Saz semaisi: Usul Aksaksemai, Makam Uşşak
3. Peşrev: Usul Devrikebir, Makam Isfahan
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Figure: Concept of layers that build up the temporal structure in music

1.: Top-Down(-Top)

Sentence Structure (L4) → Usul Layer (L3) → Beat Layer (L2) → Onset Layer (L1) → L2 ...
2.: Dual

1. MIDI-data
   - Currently 1700 compositions available.
   - Dataset can be extended according to our needs.

2. Parallel audio data
   - Recordings of compositions available as MIDI.
   - Currently 452 pieces with related MIDI.
Figure: Distribution in parallel data according to the form

Number of pieces

- sirto
- yuruksemai
- turku
- sazsemaisi
- pesrev
- sarki

Number of pieces
Fundamental Approaches: Duality

Some statistics

Figure: Distribution in parallel data according to the *makam*

- suzinak
- evic
- acemkuri
- acemasiran
- suzidi
- isfahan
- sehnaaz
- neva
- sedaraban
- muhayerkuri
- ferahfez
- saba
- mahur
- hicazkar
- muhayer
- nihavent
- ussak
- kurdilhicazkar
- huzzam
- segah
- rast
- hicaz
- huseyni
Some statistics

Figure: Distribution in parallel data according to the *usul*

Number of pieces: 0, 10, 20, 30, 40, 50, 60, 70, 80

- aksak
- aksaksemai
- duyek
- curcuna
- devrikebir
- fahite
- semai
- musemmen
- agirduyek
- hafif
- turkaksagi
- senginsemai
- sofyan
- nimsofyan
- muhammes
- agiraksak
- yuruksemai
- devrikebir
- curcuna
- duyek
- aksaksmai
- aksak
Fundamental Approaches

1.: Top-Down(-Top)
Sentence Structure (L4) $\rightarrow$ Usul Layer (L3) $\rightarrow$ Beat Layer (L2) $\rightarrow$
Onset Layer (L1) $\rightarrow$ L2 ...

2.: Dual
Parallel MIDI-Audio corpus

3.: Comparative
- What are the differences to styles in other music?
- Regular discussions between those people in Compmusic working on rhythm must happen.
- Proposed tools should be evaluated not only on data of the specific culture.
- A first step should be: How good can current approaches handle that problem?
Tasks in proposed chronological order

1. Segmentation (L4)
2. Usul recognition (L3)
3. Fundamental pulse recognition (L2)
4. Detection of Ornamentations (L1)
5. Usul tracking/annotation (L2)
6. Usul recognition revisited (L3)
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Segmentation

- Preparation of aligned data
  - Current state: 82 Peşrev, 72 Saz semaisi, 217 Şarkı
  - Manual annotation of sections necessary

- Systematic evaluation and improvement of current segmentation approach.

- How does the approach compare to methods tailored for Western music?

- Can our approach be of advantage for Western music?

- Examine signal characteristic at phrase/segment boundaries.

- Extension: Examine self-similarity on audio.
Usul recognition

Usul
The meter of a composition in makam music of Turkey is defined by a verbal sequence of certain length that defines a series of weak and strong intonations in time.

Example for an usul: Aksaksemai

Figure: Velvelleli

Figure: Simple form
Usul recognition

Preliminary study on symbolic data

In what aspects differ compositions when they follow different usul?

Possible aspects

- Onset locations
- Note durations
- Inter-onset-interval histograms
- Metrical contradiction, Example 1, Example 2
- Note intervals?

(a) Onset location

(b) Duration

(c) Theory
Fundamental pulse

Do Turks beat it?
This task is similar to beat tracking in Western music. But...
Can we speak of a beat in Turkish music?
Would Turkish musicians/listeners tap to some regular pulse?
Do they agree in that?

Approach
- Expert interviews with Turkish musicians and listeners.
- Tapping experiment: Turkish and non-Turkish listeners will be asked to tap a pulse to music.
- Can we obtain a consistent answer from interviews and computational analysis of taps?
- Do Turkish and non-Turkish tap sequences differ?
**Fundamental pulse**

**Do our algorithms beat it?**

How well do existing state-of-the-art approaches in finding annotated pulses? How can their performance be improved?

**Approach**

- Pulse annotate a set of pieces that we have the taps for.
- How well do algorithms and tappers agree with that pulse?
- Can we improve algorithms by providing knowledge about onset distributions or tempo priors?
- How is algorithmic performance in comparison with Western music?
- Can a committee of beat trackers help that use various signal characteristics as input?
- How does performance on real audio compare with performance on synthesized audio?
Ornamentation detection

Is there anything specific about Turkish onsets?

- Transient characteristics can be considered widely the same as for Western music (exception: Ney).
- Playing style differs widely.

Figure: A short oud sample
Ornamentation detection

**Approach**

- Derive an alignment between onsets existent in a score and those detected in audio.
- Combine signal aspects for onset detection, concentrating on F0 characteristics.
- Detect areas where number of onsets in audio deviates from that in the score.

*Figure: Onset Example*
Questions

1. Which of those overdetections are related to ornamentations?
2. What type of ornamentations do exist?
3. Do ornamentations appear in specific parts of the meter?
4. How strong do they depend on the type of instrument?
5. Can we automatically detect them?
6. Can we remove them?? (a risky task...)
Periodicity descriptors

- Periodicity based models describe the strength of pulses at different tempi.
- As they basically describe a spectral magnitude, they lose information contained in phase.
- This implies that they cannot describe the sequential order of events that are related to the magnitudes.
Usul recognition (audio)

Sequential descriptors

- Example: Onset frequency count histograms, note length histograms, or combinations thereof.
- In a first step, compare those descriptors with those derived from symbolic data!
- Use them to derive a classification or similarity measurement.
- How do these descriptors perform compared with periodicity descriptors?
- What are the additional difficulties/benefits we have on audio?
- Observe dependence on good fundamental pulse recognition.
Usul tracking/annotation

Tracking vs. annotation

- **Usul annotation**: Assign the syllables of the *usul* to time instances in the piece off-line.
- **Usul tracking**: Causal, real time process, useful for automatic accompaniment of performance.
- It should be discussed if tracking would be of practical value.

Did Turks beat it?

- Nowadays, we almost always have percussion in Şarkı, sometimes even *drums*.
- In old *recordings*, percussion are less common.
- This presents us with a wide variety of signal characteristics for tracking!
- Surely, an annotation of the *usul*-syllables would be more meaningful for musicians than generating a pulse.
Usul tracking/annotation

Case 1: percussive accompaniment

- **Example**
- Try to separate percussive and harmonic elements (e.g. Fitzgerald).
- Do an usul annotation using the percussive onsets, possibly supported by harmonic part characteristics.
- Cluster percussive sounds in strong and weak beats.
- Feasible even without knowing the usul, might even be used for classification.

Case 1: only melodic instruments

- Is it easy to find fundamental pulse?
  1. **Yes**: align usul pattern with pulse synchronous features.
  2. **No**: What we are going to do has nothing to do with beat tracking...
Music with meter, but without obvious pulse

- This is apparently a contradiction, as music having a meter is a subgroup of music having a pulse.
- Parallels to Western music: often encountered in solo performances of e.g. Romantic music.
- However, the way musicians perceive the underlying meter is likely to be different in Turkish music.

Free rhythm (Clayton, Martin R. L.)
Music with meter, but without obvious pulse

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Some thoughts:

- As pulse cannot be detected, use information from other layers (onsets, phrase boundaries).
- Try to find “periodic regions”.
- Task is dramatically simplified when having symbolic data as well.
- The task bears high resemblance to seyir analysis (melodic development in improvisation).
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Presenting the work

- In forms of Journal and conference contributions
- Demo platform for musicians:
  1. An automatic alignment between score and audio enables for flexible browsing
  2. Ornamentation detection enables to propose specific phrases for focussed study
  3. Platform: RepoVizz?
  4. Also makam analysis results should be included into the platform.

Personal goal

- Do *usul* fit into our common understanding of meter in music?
- Does it make sense to impose a hierarchical structure to meter in makam music?