A probabilistic model for lyrics-to-audio alignment based on knowledge of singing voice specific characteristics

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A hidden Markov model phonetic recognizer with variable-time transition matrix, guided by onset-aware phoneme transition rules

Abstract

- Goal: detect begin and end timestamps of words
- Novel fuzzy cross-language phoneme mapping
- Makes use of vocal note onsets detected automatically
  1. Introduce onset-aware phoneme transition rules
  2. Alter transition probabilities according to the rules
- Evaluate on a cappella Turkish Makam singing

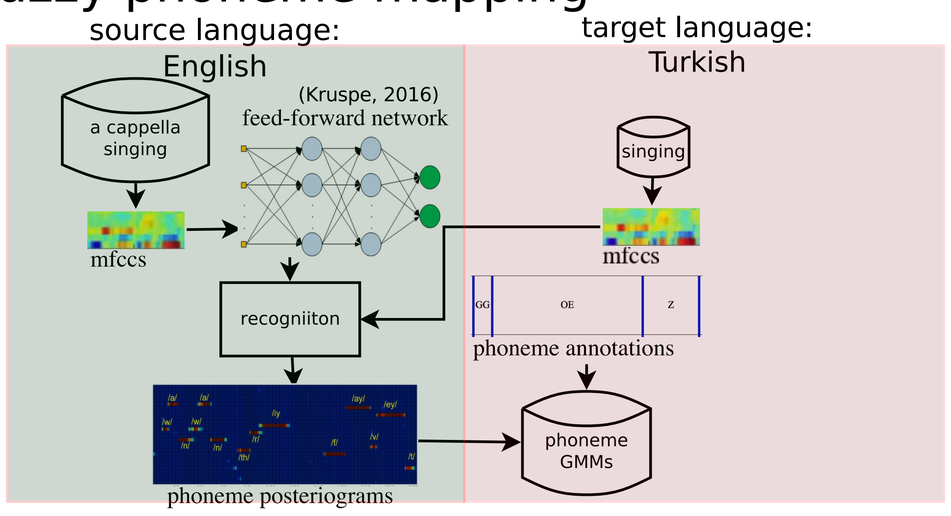
Dataset

- 12 acappella recordings, 25 minutes
- Especially recorded for this study
- Words, phonemes and note onsets annotated

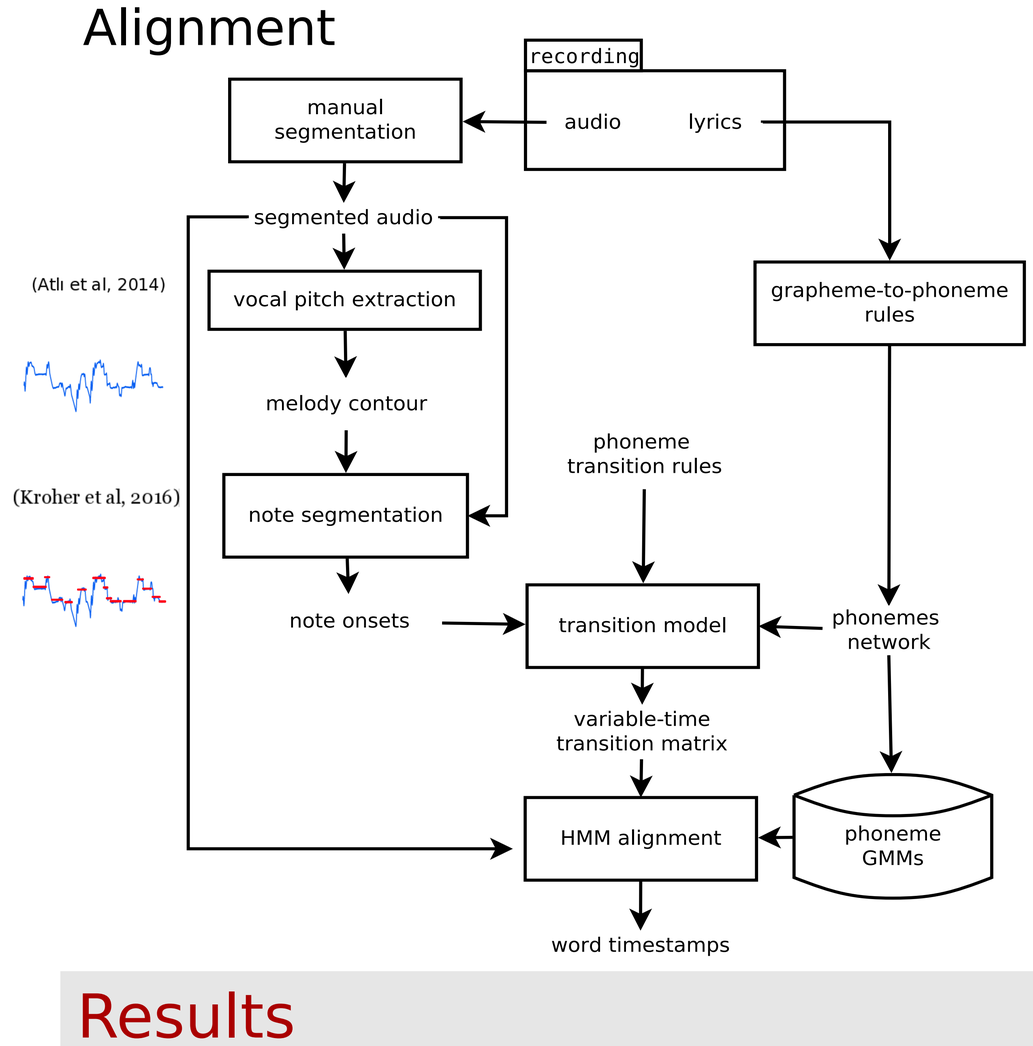
http://compmusic.upf.edu/turkish-makam-acapella-sections-dataset

Method overview

Fuzzy phoneme mapping



Alignment



Phoneme Transition Rules

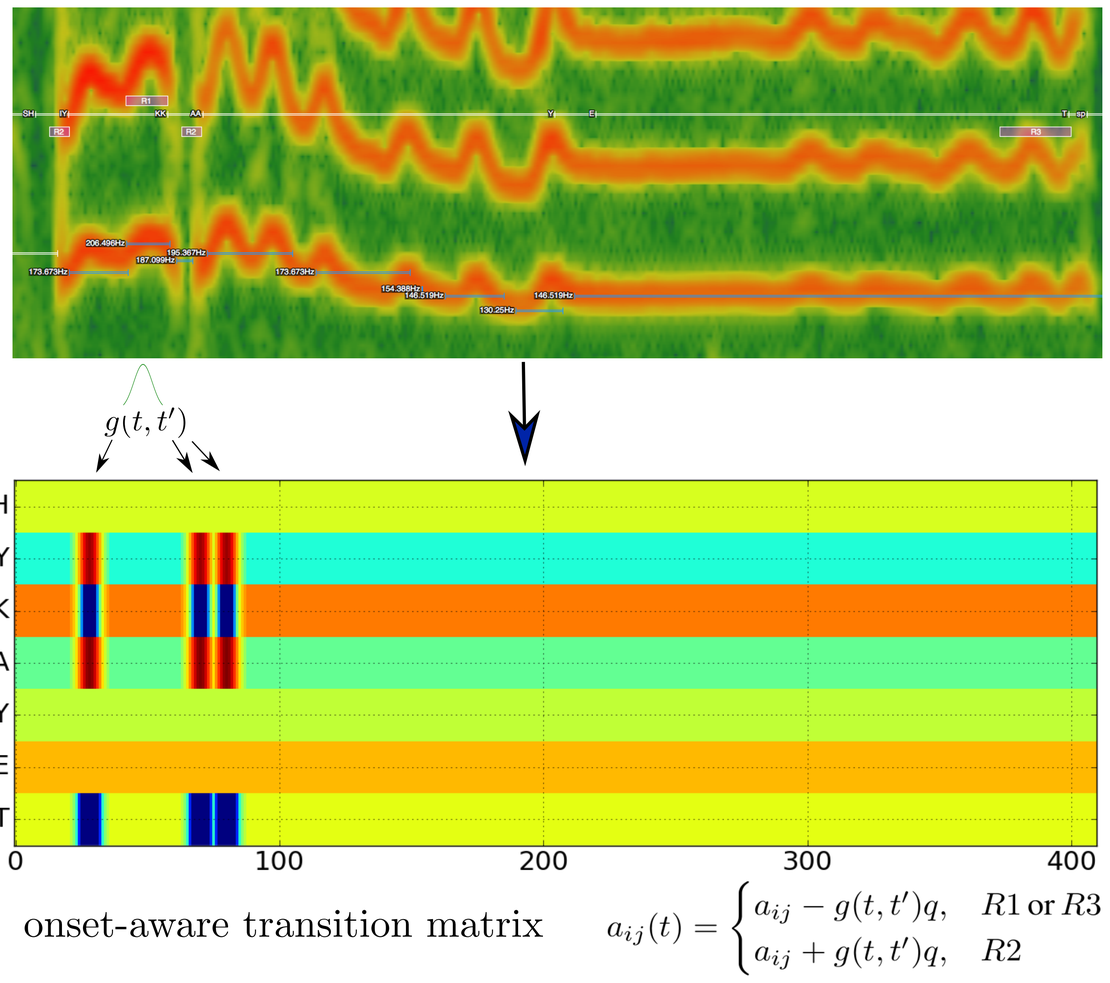
R1: $i_t = V \quad i_{t+1} = C \backslash L$

R2: $i_t = C \backslash L \quad i_{t+1} = V \text{or} L$ * } inter-syllable

R3: $i_t = V \quad i_{t+1} = C$ } intra-syllable

(Dzhambazov et al. 2016)

C: consonant V: vowel L: liqud(L,M,N) or semivowel Y



onset-aware transition matrix $a_{ij}(t) = \begin{cases} a_{ij} - g(t,t')q, & R1 \text{ or } R3 \\ a_{ij} + g(t,t')q, & R2 \end{cases}$

Evaluation

alignment accuracy (in %)

Results

Alignment accuracy Vs recall of automatic note onset detection

Comparison of baseline HMM and onset-aware HMM with different phoneme mapping strategy

phoneme mapping	HMM	onset-aware HMM	
		automatic onsets	oracle onsets
direct	79.2	81.7	82.5
fuzzy	83.5	84.8	86.1

available in python at:
https://github.com/georgid/AlignmentDuration/tree/noteOnsets
demo available at:
http://dunya.compmusic.upf.edu/makam/lyric-align/

Conclusion

- Phoneme model mapping works relatively well for English-to-Turkish
- Onset-aware phoneme transition rules help improve alignment
- Glass ceiling with oracle onsets indicate fitness of the approach

References

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