



## Speaking rhythm control by non-negative temporal decomposition

**Abstract**— Speaking rhythm plays an important role in speech production and the perception of non-native languages. However, conventional techniques are insufficient to control speaking rhythm. In this study, we invented a novel method for extracting the speaking rhythm from speech signals using a non-negative temporal decomposition (NTD) and controlled the speaking rhythm using the method. This algorithm decomposes a speech spectrogram into a set of temporally overlapped phoneme-dependent event functions and corresponding event vectors under speech-specific restrictions. We found that the speaking rhythm can be converted by modifying the obtained event functions. We hope that this technique will alleviate the burden involved in communication with non-native languages.

### Decompose a spectrogram into frequency and temporal information

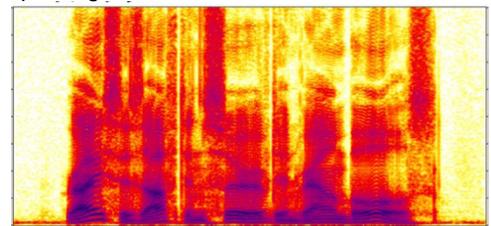
$$Y \cong A \Phi$$

Spectrogram Frequency information Temporal information = Speaking rhythm

Speech signals

Spectrogram

Frequency [Hz]



Time [second]

### Temporal information under speech-specific restrictions

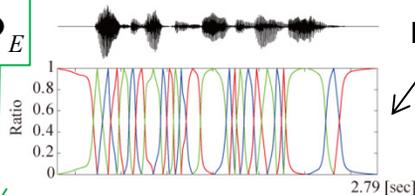
- ① Introduce the phoneme-specific model
- ② Only adjacent phonemes affect the temporal information (i.e., coarticulation)

### Replace the temporal information

$Y_E = A_E \Phi_E$  English native speaker

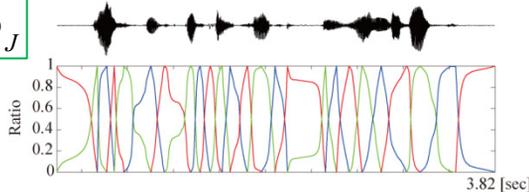
'Rice is often served in round bowls.'

Phoneme-specific temporal information



English native speaker

$Y_J = A_J \Phi_J$  Japanese native speaker



**Speak like a native**  
Japanese native speaker speaks like a English native speaker



$$Y_{J \rightarrow E} = A_J \Phi_E$$

#### Related works

- [1] S. Hiroya, "Non-negative temporal decomposition of speech parameters," in *Proc. The 35th International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2010.
- [2] S. Hiroya, T. Kitamura, "Generation of a vocal-tract movie based on sparse sampling," in *Proc. The 9th International Seminar on Speech Production (ISSP)*, 2011.

#### Contact

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