Creating Communication Technologies

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Language resources for the adaptive speech synthesis of dialects

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State-of-the-art

- Intelligibility of synthetic speech (solved)
  - diphone based speech synthesis, formant synthesis
- Naturalness of synthetic speech (solved)
  - unit selection based speech synthesis
- Flexibility of TTS systems (solved)
  - HMM based speech synthesis
- Conversational speech synthesis (unsolved)
  - System that speaks like in a natural human-human conversation in any speakers voice (variety switching, prosody, non-linguistic particles (filled pauses, hesitations, laughing, whispering))

Applications

- Web reader (`http://wien.at`)
- Screen reader for blind users
- Spoken dialog systems
  - Call center automation
  - Information systems (Viennese dialect dialog system 01/8904055-7051)
- Multimodal dialog systems
  - Car navigation systems
  - Personal digital assistant (Siri)
  - Virtual reality applications

Persona design for speech-based interfaces

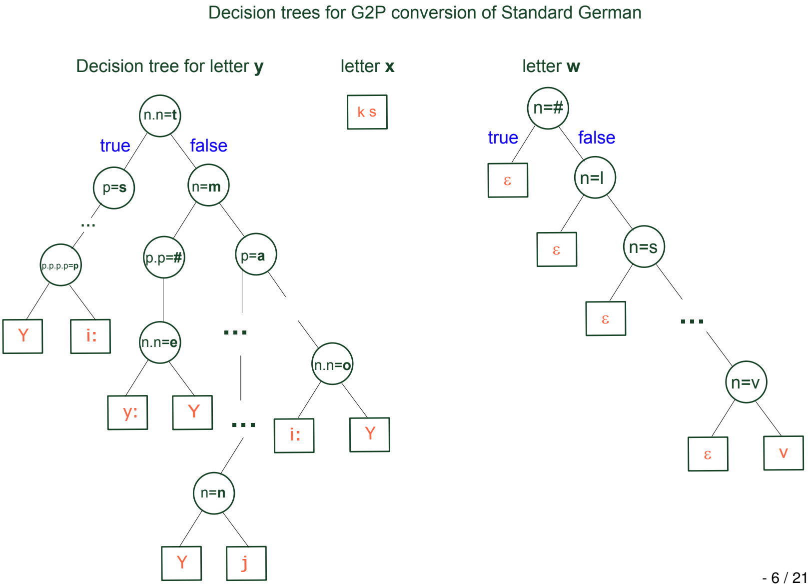
- “there is no such thing as a voice user interface with no personality” (Cohen, et.al. 2004).
- Perception of sociolect and dialect influence our evaluation of speaker‘s attributes (competence, intelligence, friendliness, etc.).
- Persona is defined as the“Standardized mental image of a personality or character that users infer from the application‘s voice and language choice” (Cohen, et.al. 2004).
- Speech synthesis is an essential part of a spoken dialog system‘s persona.

Text-to-speech synthesis (TTS)

A text-to speech synthesis system consists of:

1. Text analysis: Numbers, abbreviations, etc.
2. Grapheme-to-phoneme conversion
   - dictionary look-up
   - decision tree based grapheme-to-phoneme rules
3. Prosody prediction (pauses, durations, F0) and waveform generation
   - Concatenative: Unit selection speech synthesis
   - Parametric: Hidden Markov model (HMM) based speech synthesis
   - Concatenative and parametric: Hybrid systems

Decision tree for G2P conversion of German



Speaker independent (adaptive) HMM based speech synthesis system

- Training of models for spectral (Mel-cepstrum), excitation parameters (F0), and duration.
- Adaptation of models with target speaker data.
- Generation of parameters from adapted models.
- Synthesis from parameters.
- Austrian German voice adapted with 200 utterances `audio2/at-adapt1.wav`, `audio2/at-adapt2.wav` (Voices in Edinburgh HTS library 0.99).

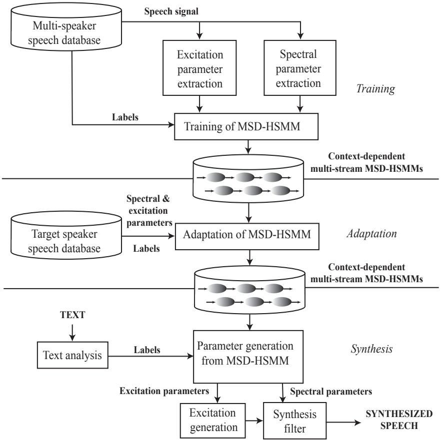


Figure: Adaptive HMM-based speech synthesis system.

Speaker independent (adaptive) HMM based audio-visual speech synthesis system

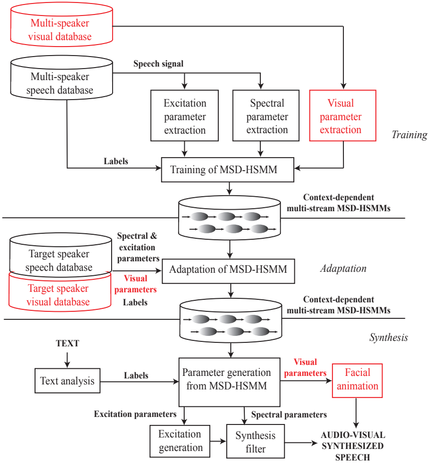
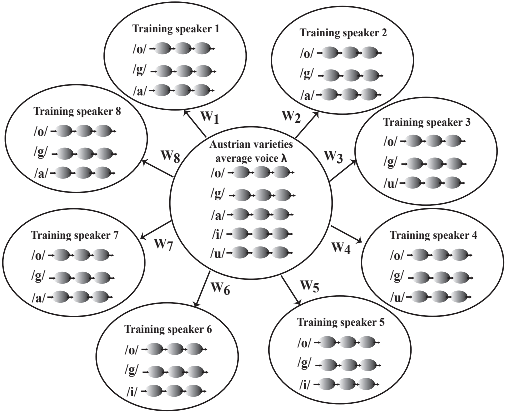


Figure: Adaptive HMM-based audio-visual speech synthesis system.

Speaker adaptive training (SAT)

- If we already know that a model will be used for adaptation we can apply adaptation specific training strategies like *s*peaker adaptive training (SAT).
- The goal in SAT is to estimate a HMM λ such that the transformations $\boldsymbol{W}_1(\lambda), .., \boldsymbol{W}_8(\lambda)$ maximize the likelihood of the adaptation data $O_1, ..., O_8$ (8 different speakers).



Context clustering

- To deal with unseen data (i.e. unseen quinphones) **decision-tree based clustering** is performed where the whole possible feature space is clustered.
- Acoustic-articulatory features can be used for clustering.
- In **shared decision-tree clustering** we train one decision tree per state (mostly used in synthesis).
- In **phonetic decision-tree clustering** we train one decision tree per state and phone (mostly used in recognition).

6.

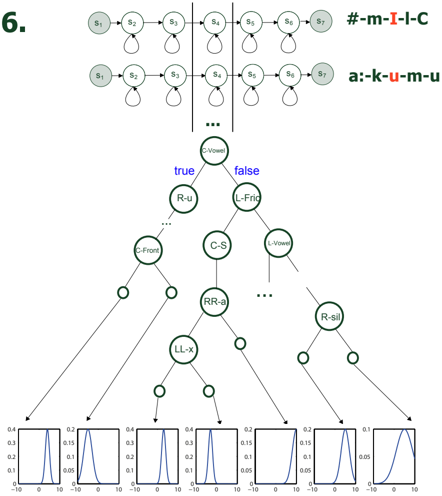


Figure: Decision-tree based state tying.

Context clustering

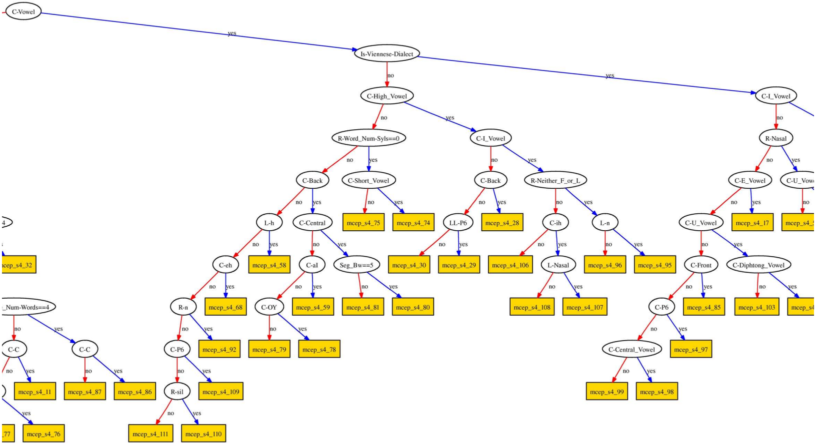


Figure: Part of decision-tree for mel-cepstrum of 3rd state (central state in 5-state HMM) for variety independent / speaker dependent model with full feature set.

Building TTS systems from scratch

1. Defining the phone set of the language / variety / dialect.
2. Create a recording script.
3. Selection of appropriate speakers.
4. Record the audio-visual data.
5. Automatically align the data.
6. Build the utterance data structure including syllabic (stress) and prosodic information.
7. Train the voice models (unit selection, HMM-based, or hybrid).
8. Develop the front-end including text analysis, lexicon, and grapheme-to-phoneme rules.
9. Develop interfaces for integration.

Defining the phone set of the language / variety / dialect

- Defining a phone set for a new language needs special linguistic knowledge.
- In one of our previous projects we have defined phone sets for Viennese varieties (`https://portal.ftw.at/projects/vsds`).
- In this project we have defined phone sets for
  - the dialect of Bad Goisern, Upper Austria (South-Middle Bavarian transition zone) and
  - the dialect of Innervillgraten, Eastern Tyrol (South-Bavarian dialect) (`https://portal.ftw.at/projects/avds`).
- Direct correspondence of phones and particular parts in the speech signal - necessary for automatic alignment

Create a recording script

- Compilation of a set of 600-700 phonetically transcribed sentences
- The sentences have to be phonetically balanced with respect to
  - the phone set established for the dialect
  - frequency of occurrence of each phone in the data
  - sufficient context-specific variation of phones
- The sentences are extracted from a larger corpus of material
  - 18-20 hours of recordings for each dialect, at least 10 speakers / dialect
  - spontaneous speech (elicited with key words) and translation tasks
- Creating a lexicon of occurring words in the material
- The sentences are recorded with 4 speakers (2 male, 2 female) for each dialect

Selection of appropriate speakers

Linguistic criteria

- “Native speaker”
- Consistent application of characteristic phonological processes (e.g. assimilations, deletions)
- Lexical knowledge and morpho-syntactic competence

Non-linguistic criteria

- Readiness to participate
- Concentration capacity
- Physiological characteristics (beard, eyes, glasses)

Record the audio-visual data - Hardware for visual recordings

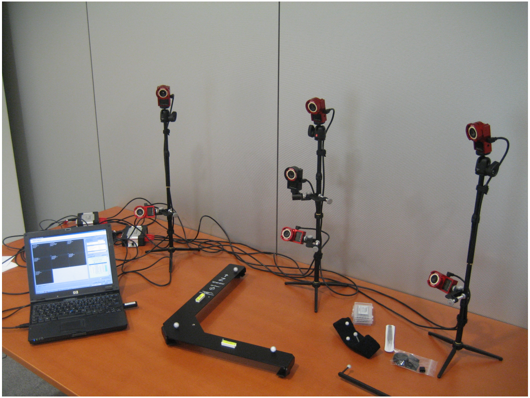


Figure: Hardware for visual marker recording.

- 6 infrared (IR) cameras.
- 1 grayscale video camera.
- Synchronization hub.
- Markers and calibration equipment.

Record the audio-visual data - Visual features for marker-based synthesis

Visual speech is characterized by the movements of 42 marker points in the face.

`audio2/psc_ivg_019-050.avi`

Figure: Audio-visual recordings of Innervillgraten speaker.

Record the audio-visual data - Read and play prompts

For recording the audio-visual dialect data we used a setting where

- the speaker can hear the utterance the he / she is supposed to say
- and at the same time see an orthographic transcription of the utterance.
- *Na vorgestern bin ich in einem Haus gewesen, na garstig und dreckig ist es da gewesen, na fürchterlich.* (`audio2/p271_006.wav`)

This is not necessary

- when an orthographic standard is available
- and the speakers know how to produce speech from the standard transcription.
- *Gestern stürmte es noch.* (`audio2/mpu_BERLIN_005.wav`)

Synthesis samples

- Acoustic Viennese speaker dependent voice (`http://cordelia.ftw.at/index3.html`)
- Acoustic East Tyrolean (Innervillgraten) speaker dependent voice
  - Recorded - `audio2/lsc_ivg_497.wav`, `audio2/lsc_ivg_508.wav`
  - Synthesized - `audio2/lsc_ivg_497_synth.wav`, `audio2/lsc_ivg_508_synth.wav`
- Audio-visual adapted Austrian German voices (`http://userver.ftw.at/~schabus/interspeech2012/`)

Conclusion

Creating Communication Technologies

- We showed a state-of-the-art audio-visual speech synthesis system.
- We discussed the importance of realistic personas for spoken dialog systems.
- We showed how to perform speaker selection, phone set definition, and recording for synthesis of varieties.
- In future work we will investigate adaptive audio-visual modeling of 2 dialects and transformation of varieties.

References and Acknowledgements

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- M. H. Cohen, J. P. Giangola, J. Balogh, *Voice User Interface Design*, Addison-Wesley, 2004.

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