DEMONSTRATION OF AN HMM-BASED PHOTOREALISTIC EXPRESSIVE AUDIO-VISUAL SPEECH SYNTHESIS SYSTEM

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DEMONSTRATION BACKGROUND

- The usage of conversational agents is rapidly increasing in everyday life (cortana, siri, etc.) and ***speech synthesis (both acoustic & audio-visual)*** constitutes a vital asset for human – computer interaction
- Furthermore, an agent capable of expressing emotions has a stronger appeal to the human party and affects the interlocutor's emotional state
- **We demonstrate an HMM based photorealistic audio-visual speech synthesis system, capable of:**
  - **Generation of audio-visual speech in three emotions: happiness, anger, and sadness, plus in neutral speaking, for the Greek language**
  - **Usage of HMM adaptation, in order to adapt to a target emotion using only a few number of sentences**
  - **Usage of HMM interpolation in order to generate speech with mixtures of the original emotions and speech with different levels of expressiveness (by mixing with the "neutral" emotion)**

HMM-BASED AUDIO-VISUAL SPEECH SYNTHESIS

TRAINING

- Extract acoustic - visual features
- Train HMMs with EM algorithm
- Cluster similar phonetic contexts

SYNTHESIS

- Analyze input text
- Generate features from HMMs
- Reconstruct audio and video

ACTIVE APPEARANCE MODELS (AAM)

The face of the agent is modeled by Active Appearance Models:

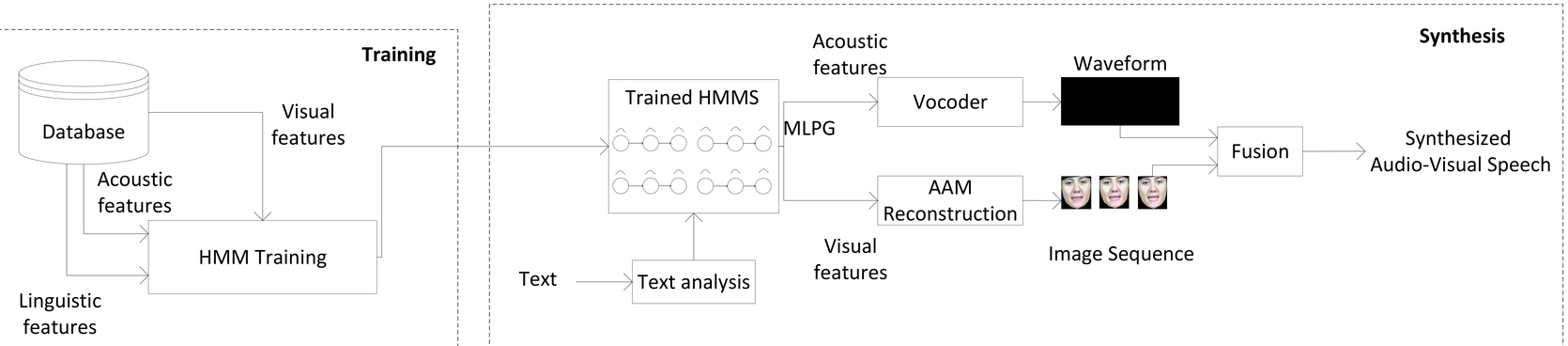
Face shape $\boldsymbol{s} = \bar{\boldsymbol{s}} + \sum_{i=1}^{n} p_i \boldsymbol{s_i}$

Face texture $\boldsymbol{A(x)} = \overline{\boldsymbol{A(x)}} + \sum_{i=1}^{l} \lambda_i \boldsymbol{A_i}$

$\bar{\boldsymbol{s}}$: mean shape
p_i: eigenshape coefficients
$\overline{\mathbf{A}(\boldsymbol{x})}$: mean texture
λ_i: eigentexture coefficients

DEMONSTRATION EXPERIENCE

- Watch videos of the talking head speaking in 3 different emotions (plus neutral) and see how the expressive talking head feels more natural compared to the talking head speaking in neutral style
- Watch the talking head speaking in two or more emotions at the same time, and see how the weights assigned to each emotion affects the outcome.
- See how the neutral talking head can be adapted to speak in another emotion using only a few sentences, and how the number of sentences used affects the expressiveness of the resulting talking head.

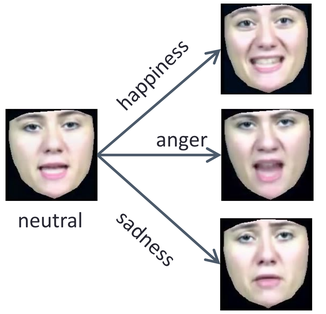


ADAPTATION

CSMAPLR adaptation is employed to adapt a neutral HMM system to another emotion using a small amount of adaptation sentences:

$$\bar{\boldsymbol{\mu}} = \boldsymbol{Z}\,\boldsymbol{\mu} + \boldsymbol{\varepsilon}, \qquad \bar{\boldsymbol{\Sigma}} = \boldsymbol{Z}\boldsymbol{\Sigma}\boldsymbol{Z}^{\mathbf{T}}$$

$\boldsymbol{\mu}, \boldsymbol{\Sigma}$: original mean and covariance matrix
$\bar{\boldsymbol{\mu}}, \bar{\boldsymbol{\Sigma}}$: adapted mean and covariance matrix
$\boldsymbol{\varepsilon}, \mathbf{Z}$: transformation bias and matrix



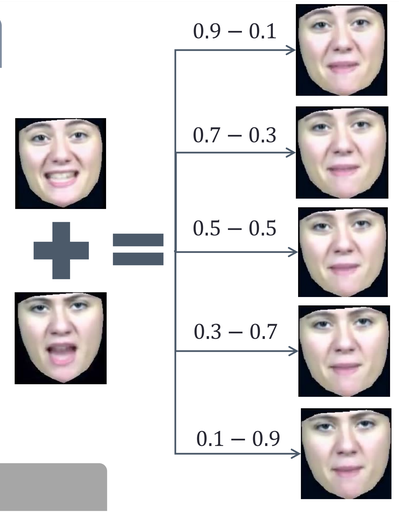
Adapting the neutral system to other emotions.

INTERPOLATION

Interpolation between observations is employed to interpolate statistics of HMMs from different HMM sets:

$$\boldsymbol{\mu} = \sum_{i=1}^{K} \alpha_i \boldsymbol{\mu_i}\,, \quad \boldsymbol{\Sigma} = \sum_{i=1}^{K} \alpha_i^2 \boldsymbol{\Sigma_i}$$

$\boldsymbol{\mu}, \boldsymbol{\Sigma}$: interpolated mean – covariance matrix
$\boldsymbol{\mu_i}, \boldsymbol{\Sigma_i}$: adapted mean – covariance matrix of *ith* HMM set
a_i: interpolation weight for *ith* HMM set



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