Facial Expression Editing in Video Using a Temporally-Smooth Factorization

Fei Yang[1] Lubomir Bourdev[2] Eli Shechtman[3] Jue Wang[3] Dimitris Metaxas[1]

[1]Rutgers University [2]Facebook Inc. [3]Adobe

Introduction

Goal: Edit expression in video – exaggerate, attenuate or replace facial expressions in a video (e.g., an interview).

Approach:

- Use a 3D tensor-based model that factors out variations due to: pose, expression and identity.
- Fit the model to all frames s.t. the identity is fixed and the expression and pose vary smoothly.
- Adjust expression coefficients.
- Combine warping with frame reordering to render the final edited frames .

Joint Fitting

Decomposing face geometry into expression and identity

Expression Identity

$$s_t = \bar{s} + V \otimes \beta_t \otimes \gamma_t$$

(s_t: new shape $\bar{s}$: mean shape V: tensor core)

How to fit the model to face images?

$$E = E_f + \lambda_\gamma E_\gamma + \lambda_\beta E_\beta + E_e$$

- Minimize geometric error

$$E_f = \sum_t ||W^{1/2}(P_t s_t - Y_t)||^2$$

W: weights
P_t: projection
Y_t: landmarks

- New shape is close to distribution of training set

$$E_\gamma = \frac{1}{2}\gamma^T\gamma \qquad E_\beta = \frac{1}{2}\beta^T\beta$$

- Expression changes smoothly over time

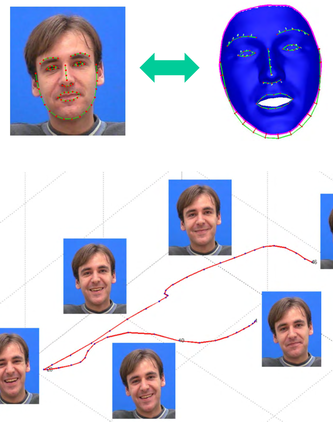
$$E_e = \frac{1}{2}\sum_t (\lambda_1 ||\nabla_t \beta_t||^2 + \lambda_2 ||\nabla_t^2 \beta_t||^2)$$

- Same identity γ_t across all frames

Fitting Algorithm

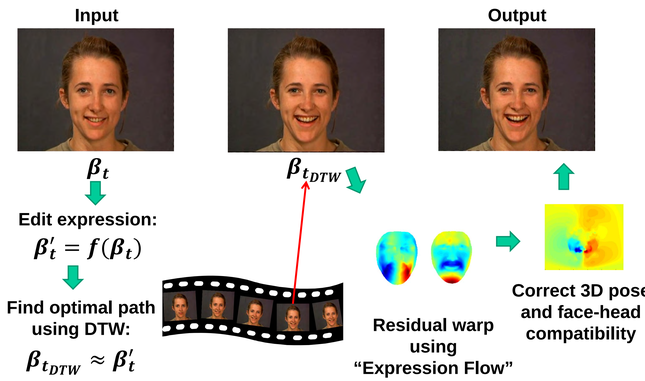
Energy minimization with respect to pose, expression and identity parameters

1. Repeat
2. Fit projection matrices
3. Update landmark correspondences
4. Fit identity coefficients
5. Fit expression coefficients
6. Until converge

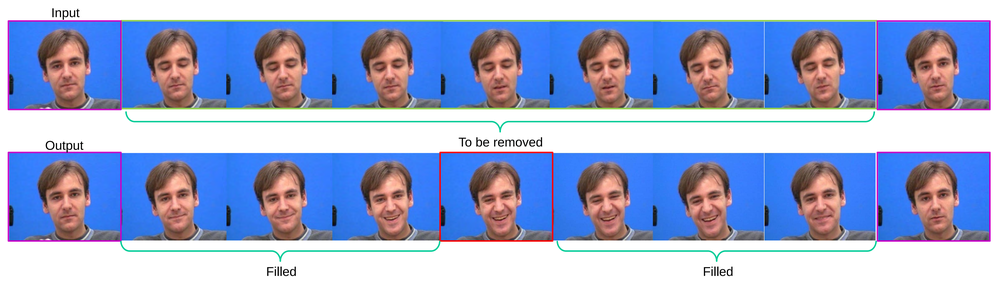


Expression Manipulation

- Adjust expression coeffs. and fix other parameters
- Dynamic Time Warping to reorder frames
- "Expression flow" to correct residual discrepancies
- Additional flow to correct boundary compatibility



Examples – Replacing Expressions



Examples – Magnifying and Suppressing Expressions