**Objective**

- Fully automatic: No manual interaction is required
- No database with pre-defined expressions: Our face matching is performed as a retrieval task using the existing source footage only
- No 3D face model: Our image-based face transfer can handle moderate head motion, while preserving the source identity

**Challenges**

- Expressions and pose may differ
- Timing and speech may not match
- Reenactment should look smooth and plausible

**Contributions**

1. Fully automatic: No manual interaction is required
2. No database with pre-defined expressions: Our face matching is performed as a retrieval task using the existing source footage only
3. No 3D face model: Our image-based face transfer can handle moderate head motion, while preserving the source identity

**Method Overview**

1. **Reenactment**
   - Two arbitrary facial performances
   - Replace faces and preserve target performance

2. **Face Matching**
   - **Frame Selection**
     - Lookup using nearest neighbor search in source sequence
     - Face descriptors: Local binary patterns (from main facial features) and motion of landmarks
   - **Target Cluster**

3. **Face Transfer**
   - **Shape Transfer**
     - Selected source landmarks are aligned to those of the target by minimizing a warping energy:
     \[
     E(\mathbf{X}_R) = \omega_{\text{aff}} E_{\text{aff}} + \omega_{\text{nr}} E_{\text{nr}}, \quad \omega_{\text{aff}} + \omega_{\text{nr}} = 1
     \]
     \[\mathbf{X}_R\] are the aligned landmarks, and \( E_{\text{aff}}, E_{\text{nr}} \) denote the affine and the non-rigid term
   - **Appearance Transfer and Compositing**
     - Source texture is transferred by inverse warping
     - Main facial features are seamlessly implanted on the target subject

4. **Temporal Stabilization**
   - Clustering: Segment target video and match each temporal cluster to a representative source frame
   - Motion of landmarks in the whole temporal cluster controls abrupt expression changes

**Project Website**

http://gvv.mpi-inf.mpg.de/projects/FaceReenactment/