Learning Semantic Representation via Joint 3D Face Reconstruction and Facial Attribute Estimation

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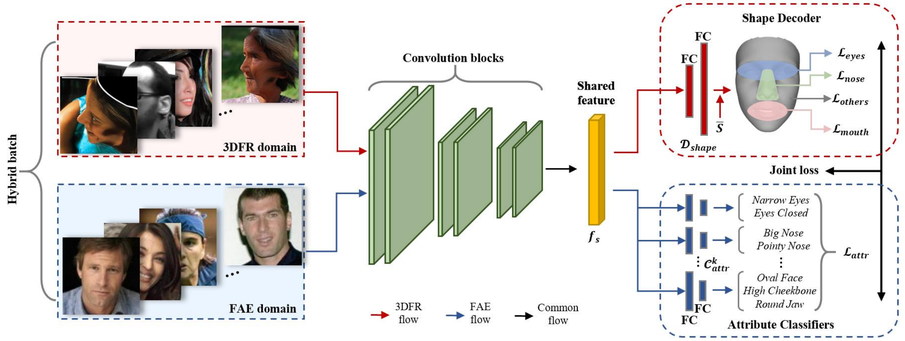
Overview

- **Joint learning with two tasks: 3D face reconstruction (3DFR) and Facial Attribute Estimation (FAE)**
- **Semantic facial representations for both tasks**

Related Works

- **Fully-supervision / self-supervised:** lack of feature explanation
- **RingNet (CVPR-19'):** feature consistency constrained by Triple loss
- **Liu *et al.* (CVPR-18'):** feature consistency constrained by Face Recognition loss
- **Ours:** FAE has more explicit correlation with 3DFR than Face Recognition

Joint Framework



- **Losses:**

$$\mathcal{L}_{attr} = -\sum_{k=0}^{K-1}\sum_{m=0}^{M_k-1}[\alpha_m^k A_m^k \log(\hat{A}_m^k)+(1-A_m^k)\log(1-\hat{A}_m^k)] \quad \text{(3D Reconstruction Loss)}$$

$$\mathcal{L}_{shape} = \frac{1}{N}\sum_l \mathcal{L}_l \cdot W_l = \frac{1}{N}\sum_l \left\| S_l - \hat{S}_l \right\|_2^2 \cdot W_l \quad \text{(Facial Attribute Loss)}$$

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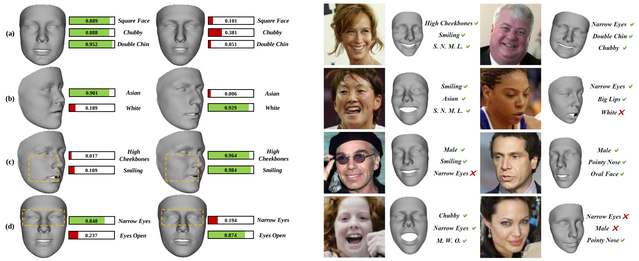
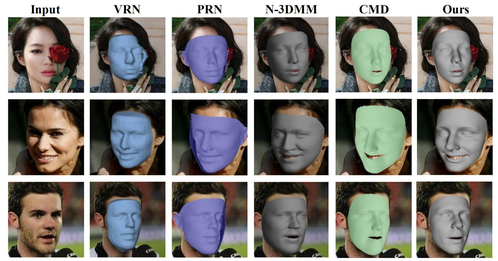
Qualitative Results

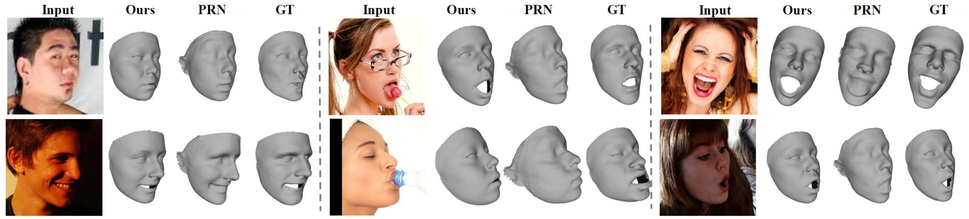
- **Semantic facial representation in the feature space:**



- **Comparison on CelebA dataset:**



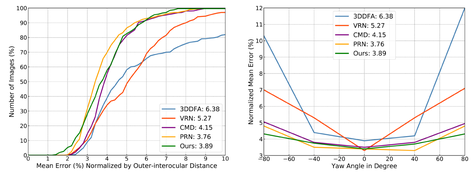
- **Comparison with PRNet and ground truth on AFLW2000 dataset:**



(a) Race (b) Occlusion (c) Extreme expression

Quantitative Results

- **Comparison on Florence dataset:**



(a) CED curves (b) Pose-specific NME

Contribution

- For the first time, we train two highly relevant facial tasks, 3DFR and FAE, in a joint manner. Quantitative evaluation and qualitative visualization indicate the effectiveness and robustness of our method.
- We develop an in-batch hybrid-task training scheme that enables our model to learn from hybrid facial datasets with heterogeneous labels.
- The proposed MTL framework allows CNN to extract semantic facial representations from in-the-wild images, which are significant for unconstrained 3D face reconstruction.