

## Problem & Contributions

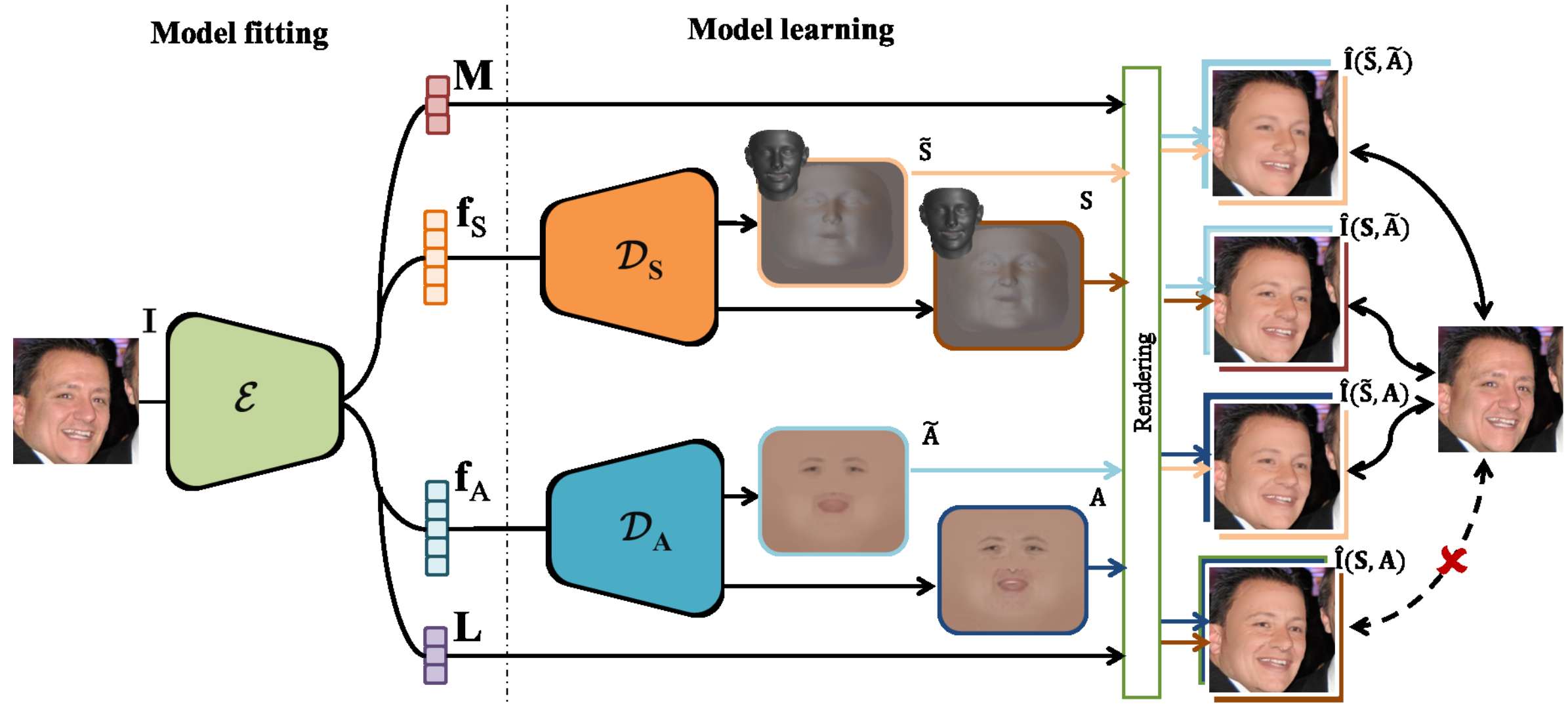
- Conflicting learning objective in 3DMM (*strong regularization* for a global shape vs. *weak regularization* for capturing higher level details).
- We solve the problem by learning shape, albedo *proxies* with a novel pairing scheme & proper regularization.
- The *global-local-based network* offers more balance between robustness and flexibility.
- Our model allows high-fidelity 3D face reconstruction by solely optimizing latent representations

## Related Works

- Linear 3DMM**
  - Linear*: PCA models
  - Learned with small number of 3D scans
- Nonlinear 3DMM.**
  - In-the-wild texture *Booth et al.*
  - Deep Boltzmann Machines: *Duong et al.*
  - MLP, CNN: *Tran an Liu, Tewari et al.*
- Global/local-based facial parameterization**
  - Region-based PCA: *Blanz and Vetter, Tena et al.*
  - Localized multilinear model: *Brunton et al.*
- Residual learning**
  - Face-alignment: *Zhou et al., Jourabloo et al*
  - Super-resolution: *Kim et al.*

## Nonlinear 3DMM Learning

### Nonlinear 3DMM with Proxy and Residual

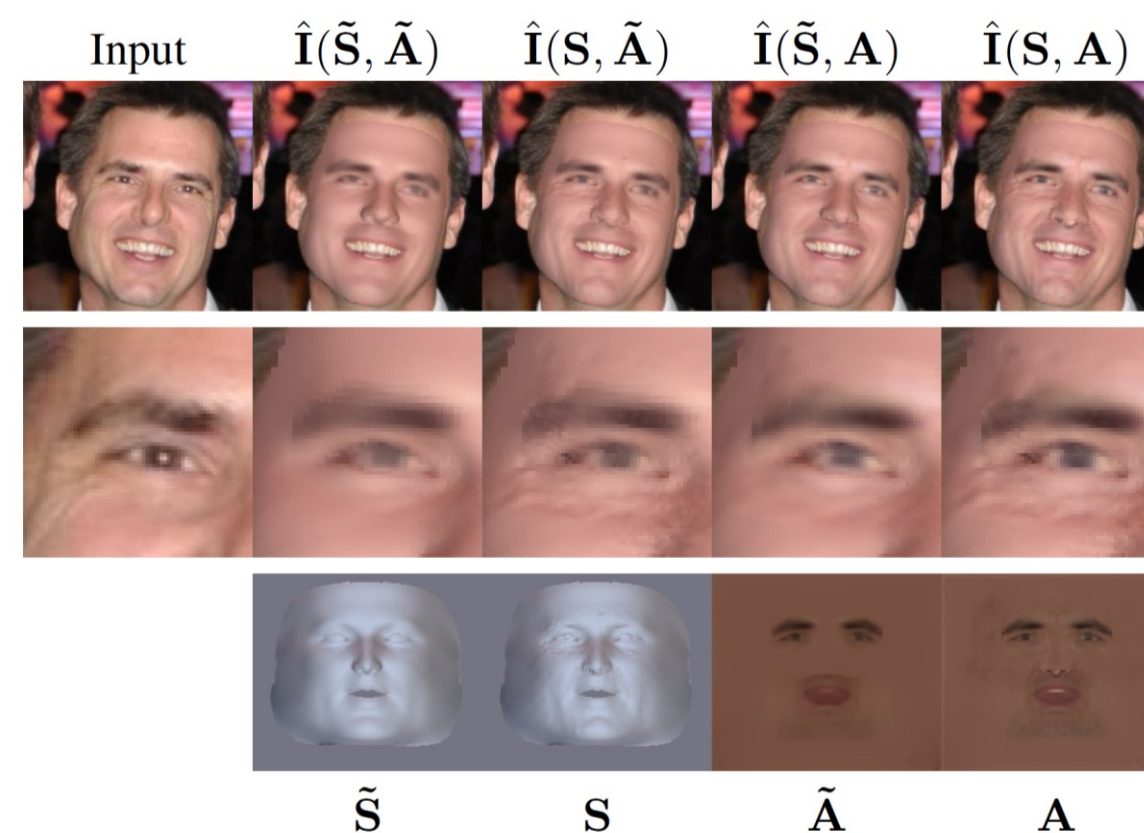


$$\mathcal{L}_{\text{reg}} = \mathcal{L}_{\text{sym}}(\mathbf{A}) + \mathcal{L}_{\text{con}}(\mathbf{A}) + \mathcal{L}_{\text{smo}}(\mathbf{S})$$

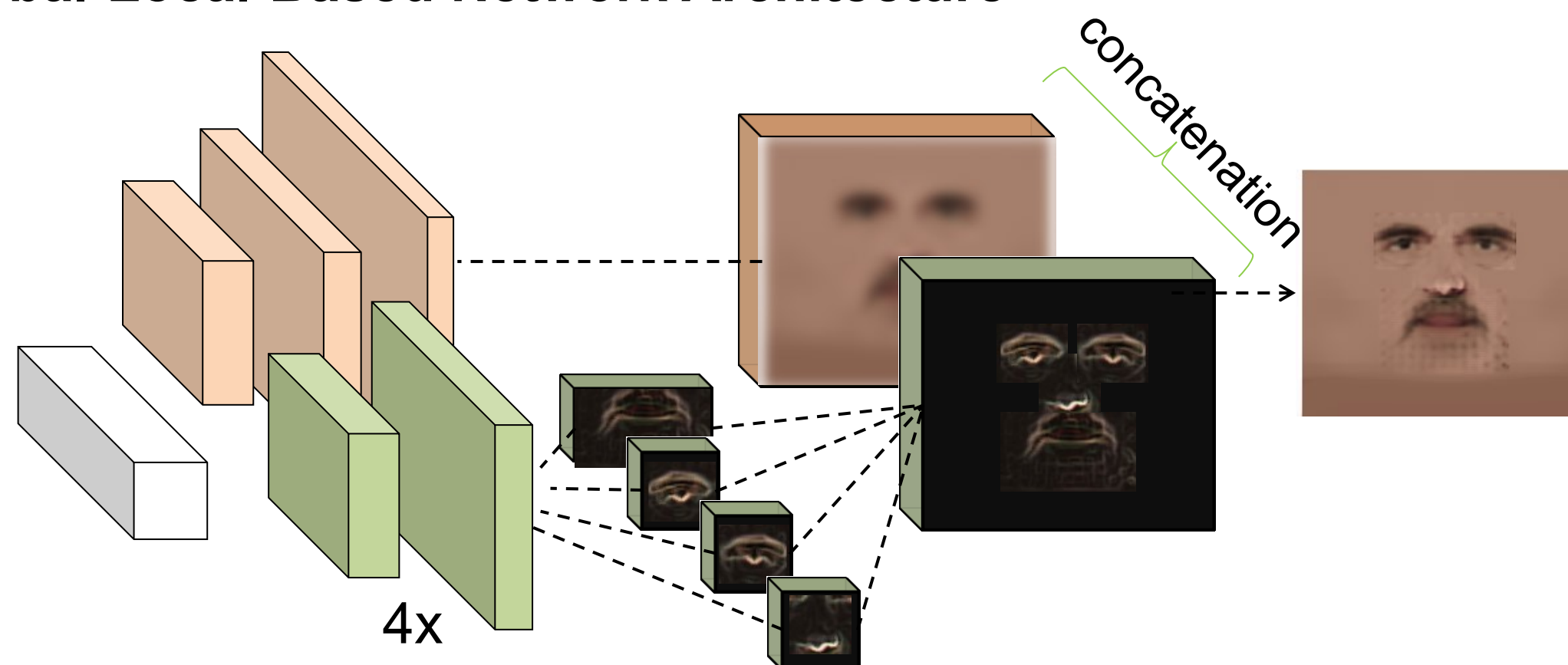


$$\mathcal{L}_{\text{reg}}^* = \mathcal{L}_{\text{sym}}(\tilde{\mathbf{A}}) + \mathcal{L}_{\text{con}}(\tilde{\mathbf{A}}) + \mathcal{L}_{\text{smo}}(\tilde{\mathbf{S}})$$

$$\dots + \|\mathbf{A} - \tilde{\mathbf{A}}\|_1 + \|\mathbf{S} - \tilde{\mathbf{S}}\|_1$$



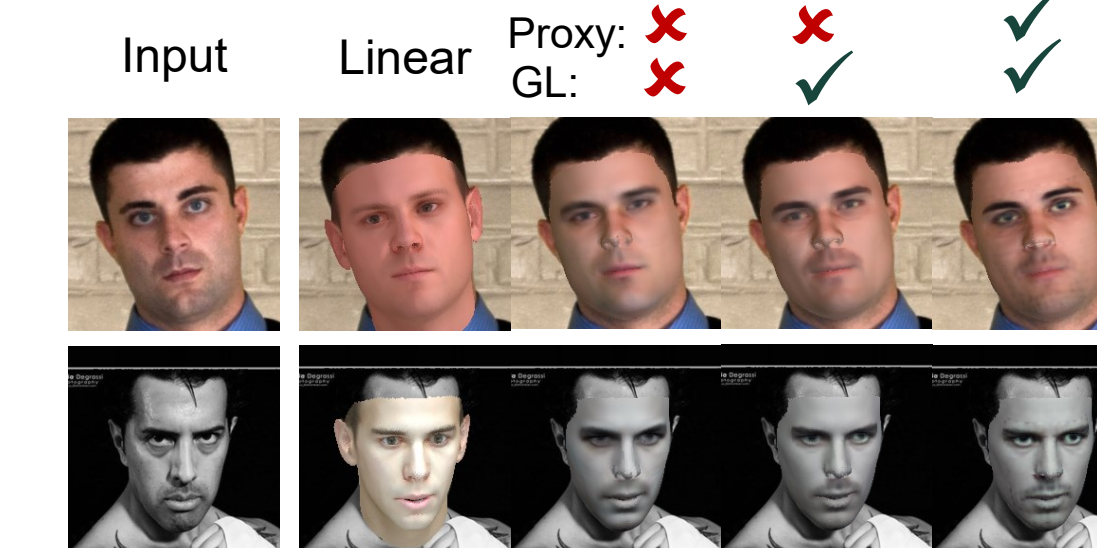
### Global-Local-Based Network Architecture



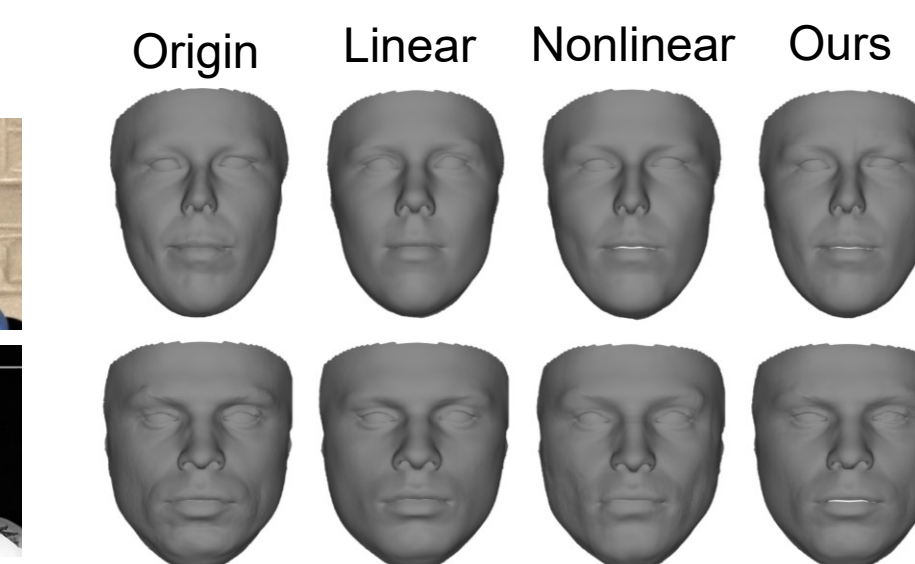
## Experimental Results

### Representation power

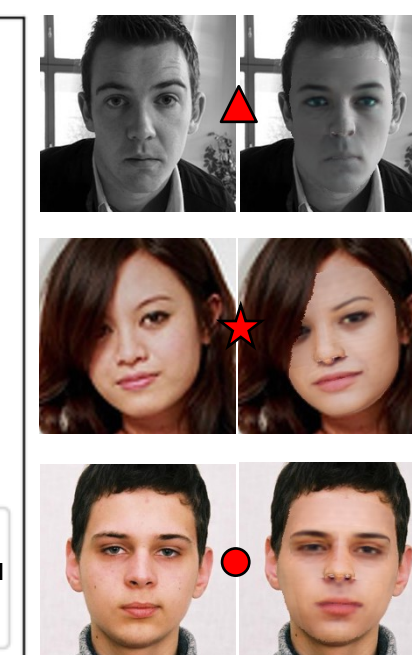
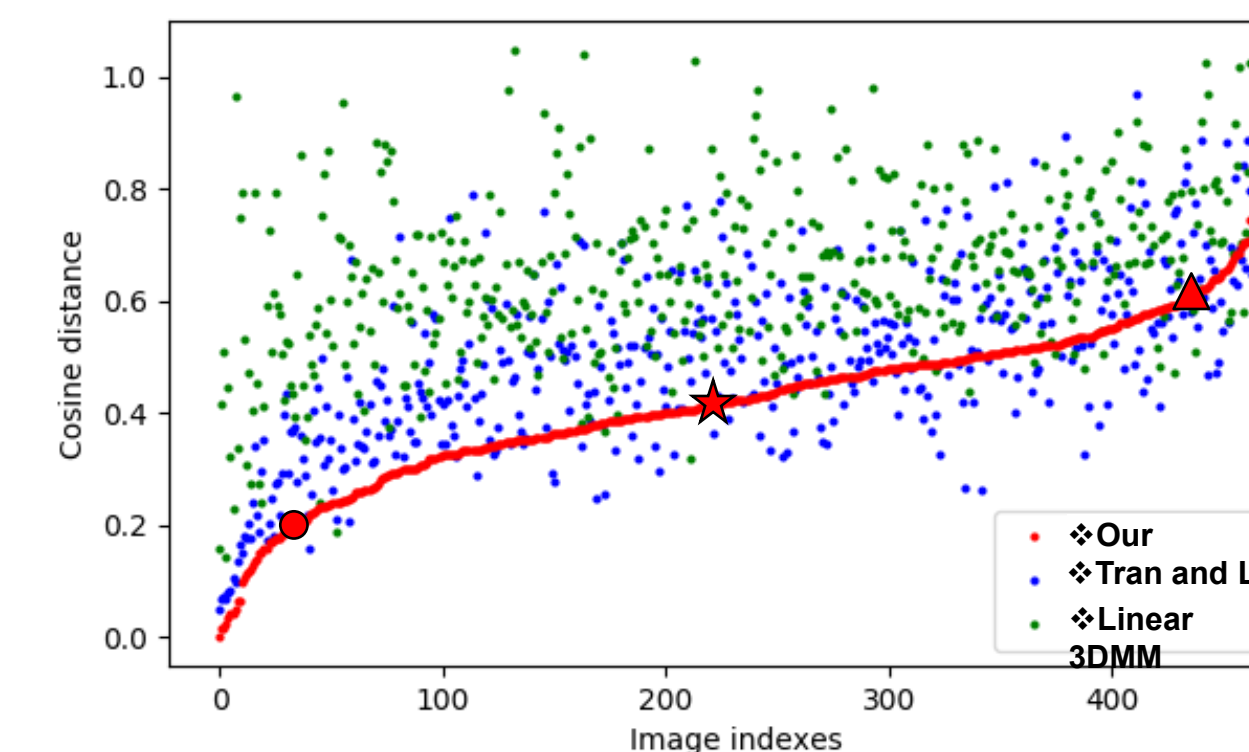
#### Texture



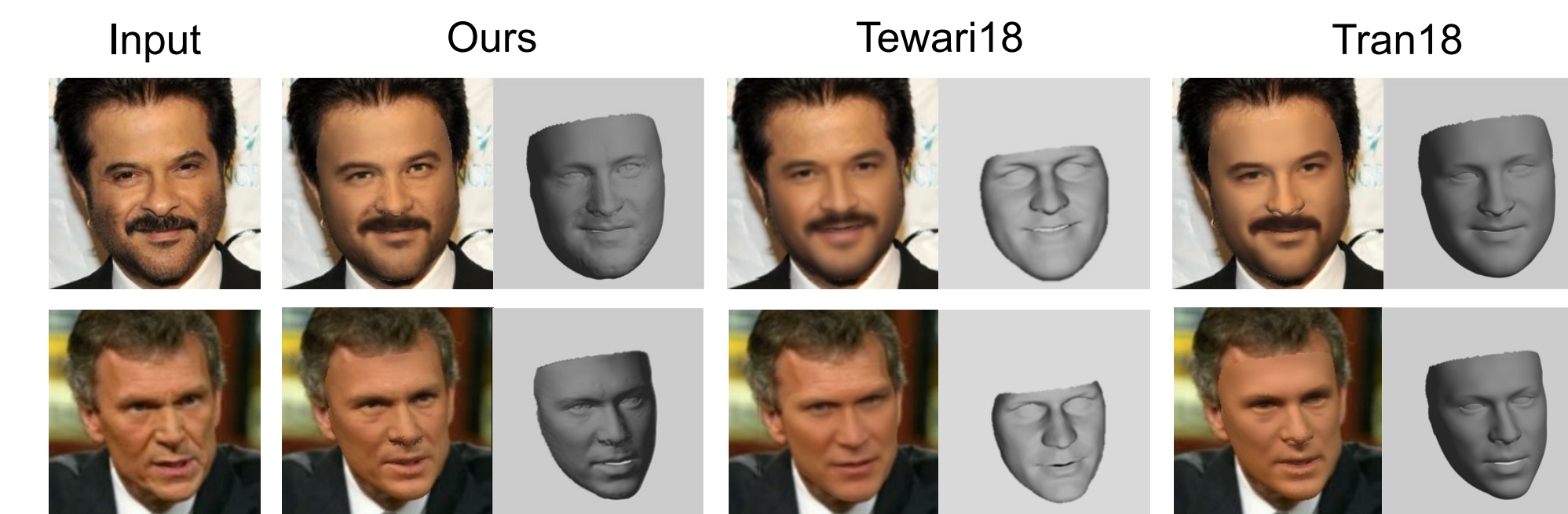
#### Shape



### Identity Preserving



### 3D Reconstruction



## Conclusions

- Present a novel approach to improve the nonlinear 3DMM modeling in both learning objective and network architecture.
- A step toward building high-fidelity model, through which 3D face reconstruction can be achieved solely by doing model fitting.