

Label Denoising Adversarial Network (LDAN) for Inverse Lighting of Faces

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Applications

Lighting Transfer (Images from Zhixin Shu et.al., SIGGRAPH 2017):



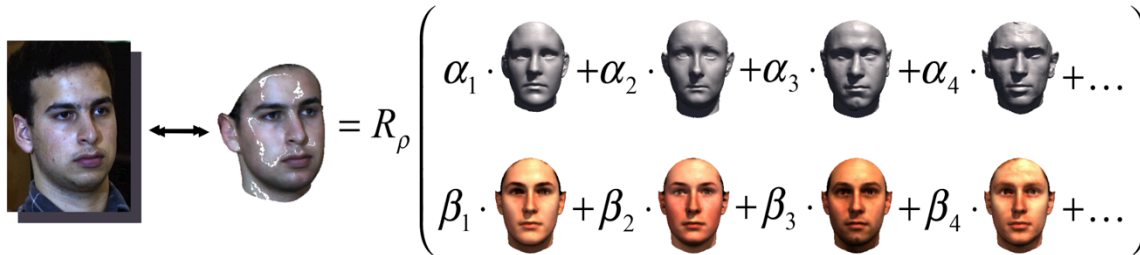
Image Forensics:



→ Same lighting or not?

Prior Art in Lighting Estimation

3DMM Fitting (Blanz *et al.* SIGGRAPH 1999)

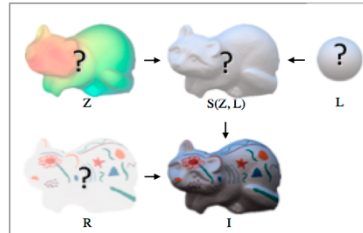


The diagram illustrates the 3DMM fitting process. On the left, a photograph of a person's face is shown next to a 3D model of the same face. A double-headed arrow connects them. To the right of the 3D model is an equals sign followed by a large right parenthesis. Inside the parenthesis, the expression R_ρ is followed by a sum of two rows of terms. The first row contains four terms: $\alpha_1 \cdot$ (a gray 3D face model), $\alpha_2 \cdot$ (a gray 3D face model), $\alpha_3 \cdot$ (a gray 3D face model), and $\alpha_4 \cdot$ (a gray 3D face model), followed by $+\dots$. The second row contains four terms: $\beta_1 \cdot$ (a colored 3D face model), $\beta_2 \cdot$ (a colored 3D face model), $\beta_3 \cdot$ (a colored 3D face model), and $\beta_4 \cdot$ (a colored 3D face model), followed by $+\dots$.

$$\text{Image} \leftrightarrow \text{3D Model} = R_\rho \left(\begin{array}{l} \alpha_1 \cdot \text{Model}_1 + \alpha_2 \cdot \text{Model}_2 + \alpha_3 \cdot \text{Model}_3 + \alpha_4 \cdot \text{Model}_4 + \dots \\ \beta_1 \cdot \text{Model}_1 + \beta_2 \cdot \text{Model}_2 + \beta_3 \cdot \text{Model}_3 + \beta_4 \cdot \text{Model}_4 + \dots \end{array} \right)$$

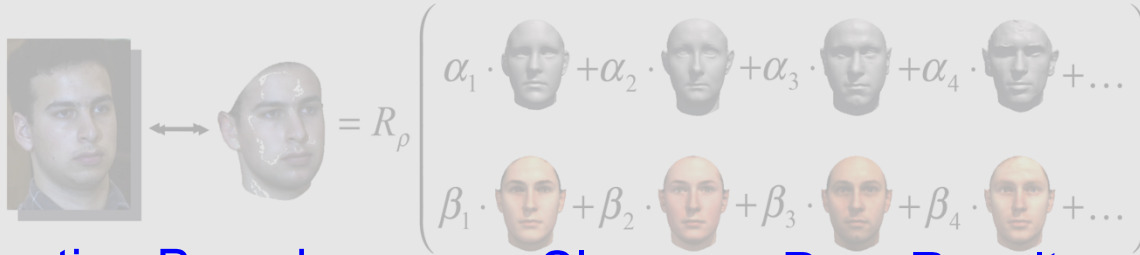
Intrinsic Image Decomposition (Barron *et al.* PAMI 2015)

$$\begin{array}{ll} \underset{Z, R, L}{\text{minimize}} & g(R) + f(Z) + h(L) \\ \text{subject to} & I = R + S(Z, L) \end{array}$$



Prior Art in Lighting Estimation

3DMM Fitting (Blanz *et al.* SIGGRAPH 1999)



The diagram illustrates the 3DMM fitting process. On the left, a 2D face image is shown with a double-headed arrow pointing to a 3D face model. The 3D model is composed of several basis faces, each multiplied by a coefficient. The equation is represented as $= R_{\rho} \left(\begin{matrix} \alpha_1 \cdot \text{face}_1 + \alpha_2 \cdot \text{face}_2 + \alpha_3 \cdot \text{face}_3 + \alpha_4 \cdot \text{face}_4 + \dots \\ \beta_1 \cdot \text{face}_1 + \beta_2 \cdot \text{face}_2 + \beta_3 \cdot \text{face}_3 + \beta_4 \cdot \text{face}_4 + \dots \end{matrix} \right)$.

Optimization Based

Slow

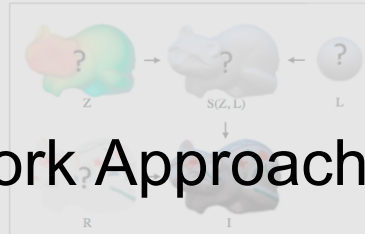
Poor Results on Low-Res

Intrinsic Image Decomposition (Barron *et al.* PAMI 2015)

minimize
 Z, R, L
subject to

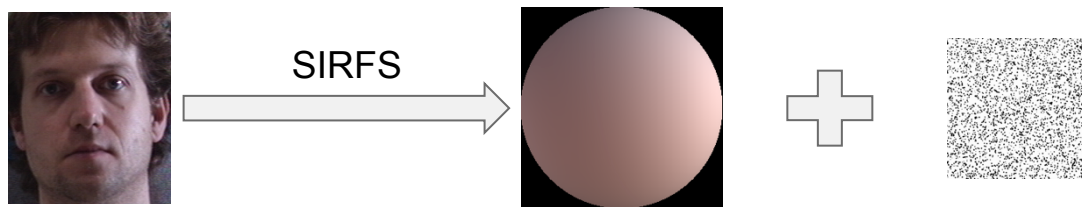
$$g(R) + f(Z) + h(L)$$

A Neural Network Approach?

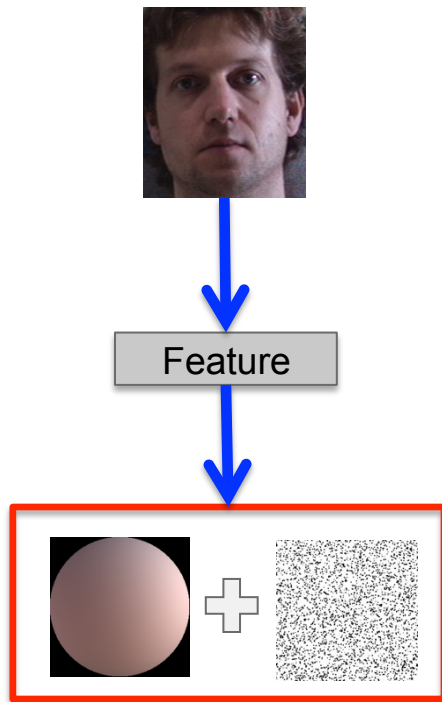


Label Denoising Adversarial Network

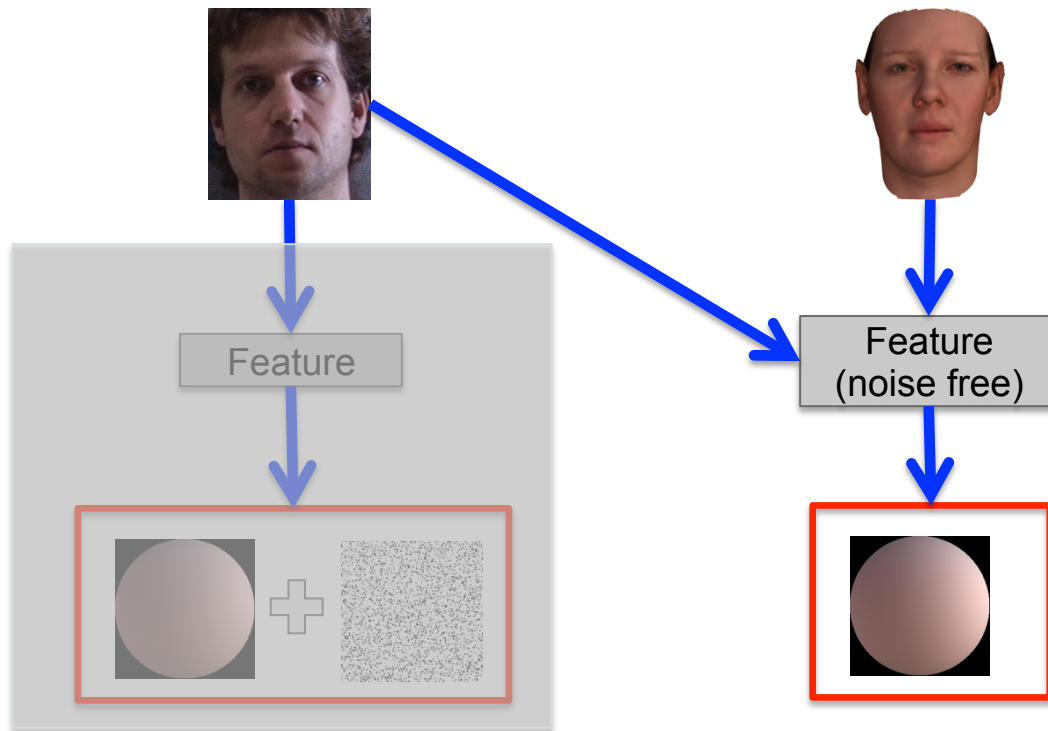
Use SIRFS (Barron *et al.* PAMI 2015) for “noisy labels”



Synthetic Data to “Denoise” the Labels

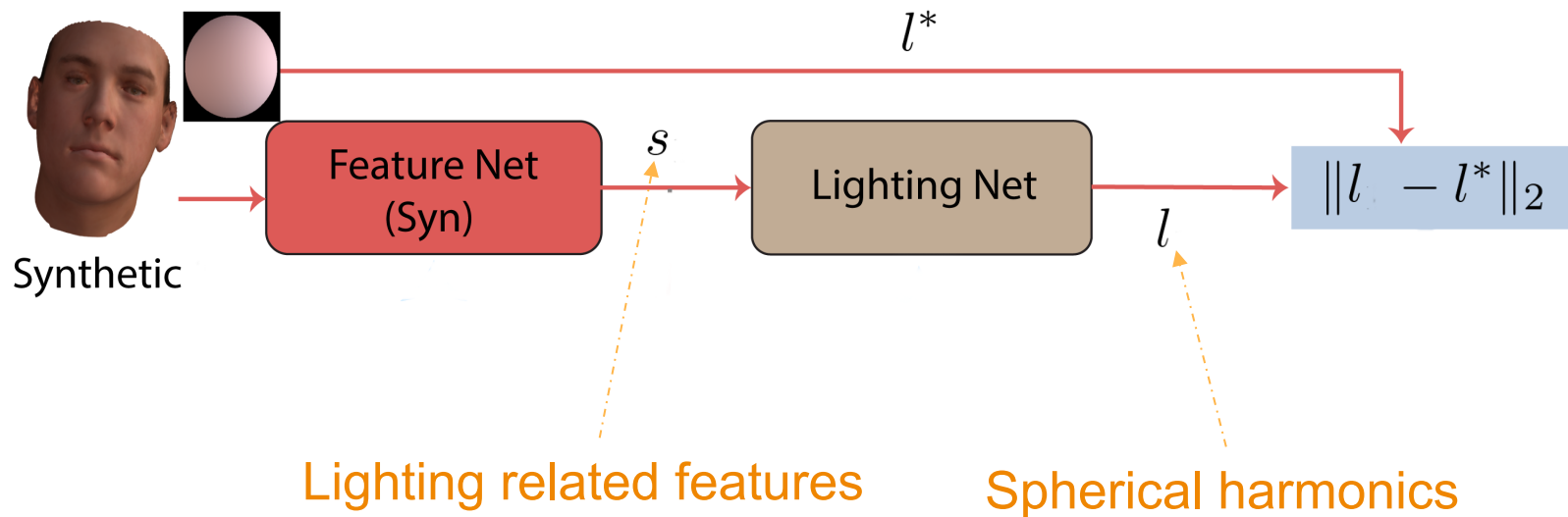


Synthetic Data to “Denoise” the Labels



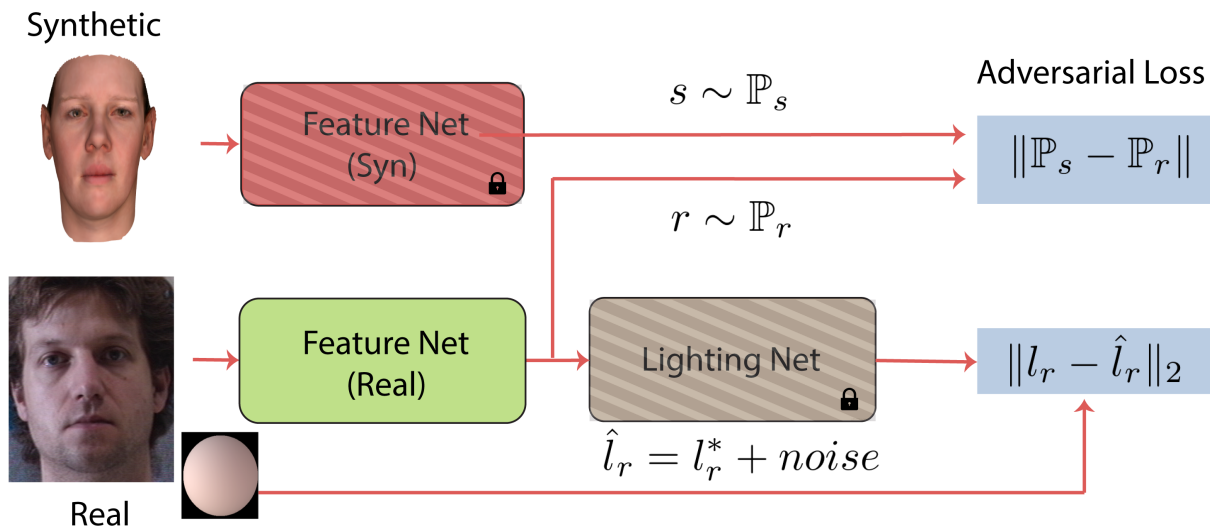
Label Denoising Adversarial Network

Step 1



Label Denoising Adversarial Network

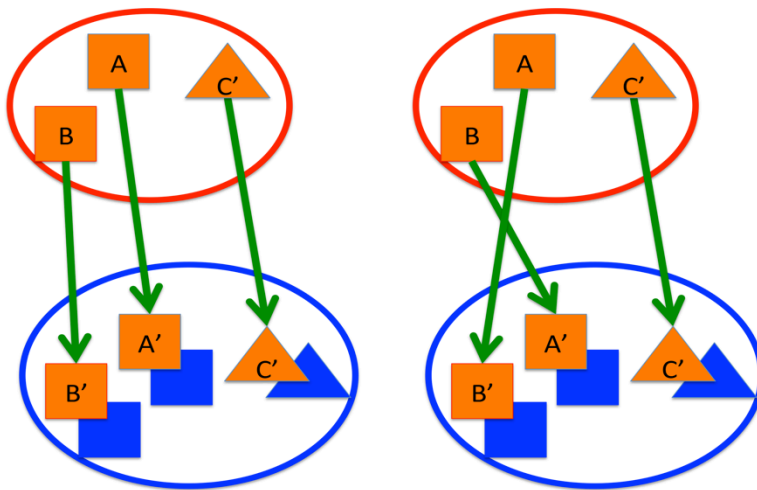
Step 2



Label Denoising Adversarial Network

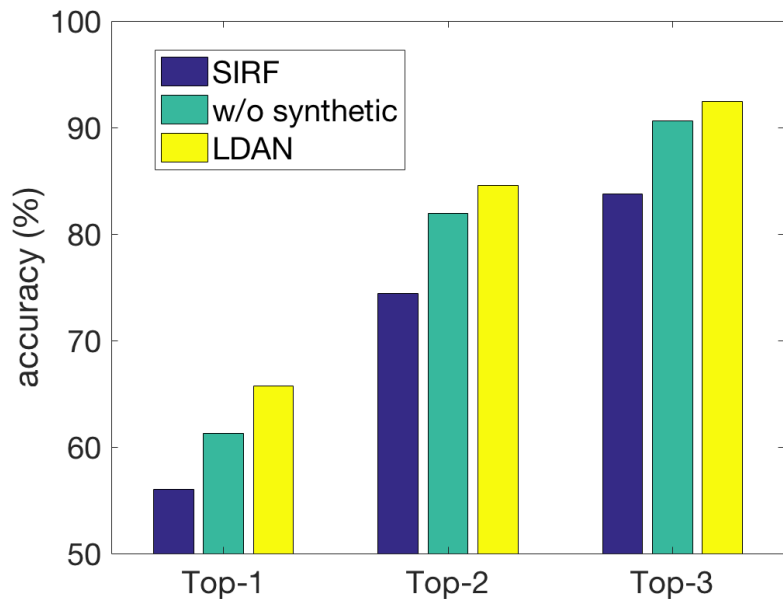
Toy example of mapping features of real faces to features of synthetic faces

- Classification: both are the same
- Regression: only one is correct

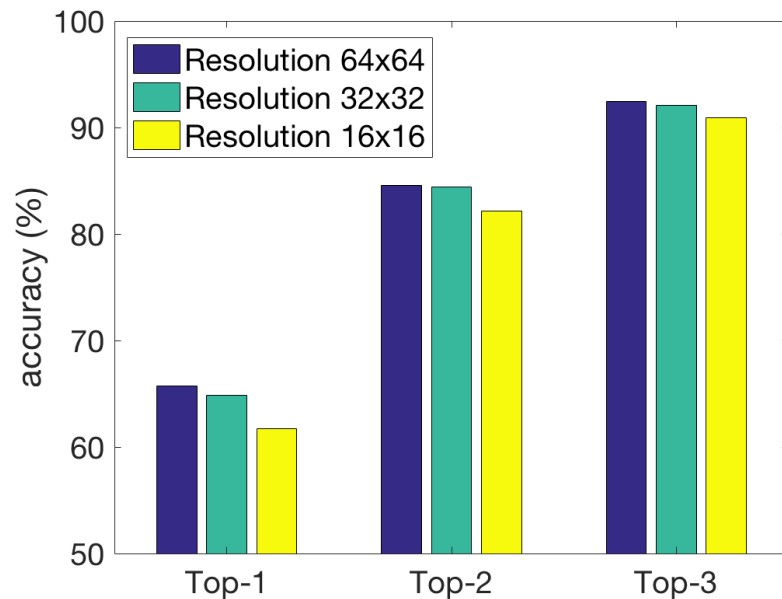


Lighting Classification Result on MultiPIE

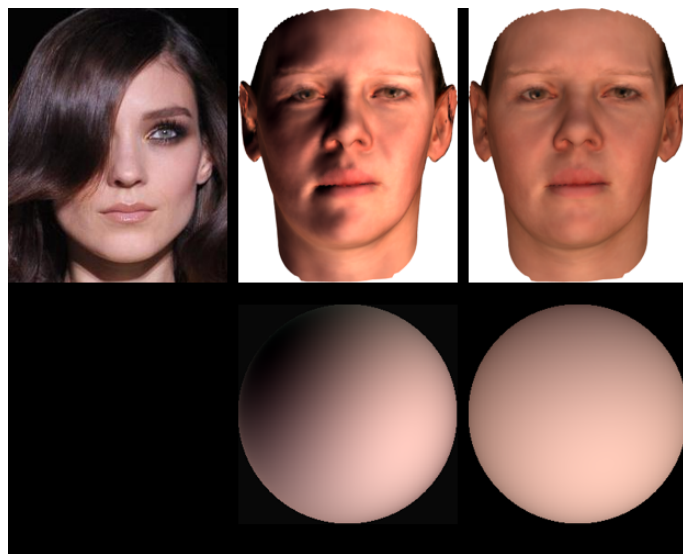
Comparison with Baseline



Low-Res Robustness

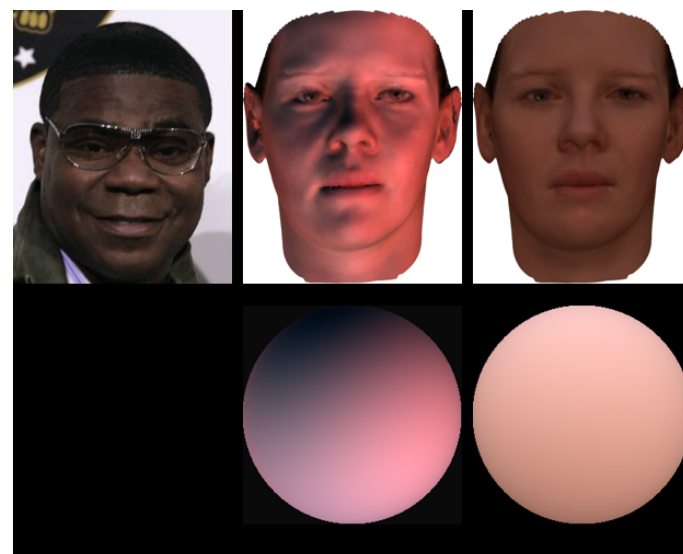


Qualitative Result



SIRFS

LDAN



SIRFS

LDAN

Comments?
Questions?

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